section 5: needs and gap analysis

FAST act requirements

The Fixing America's Surface Transportation Act (FAST) was signed into law on December 4, 2015. The FAST Act identifies several new requirements for the transportation planning process that are required to be incorporated or addressed into the Metropolitan Transportation Plan on or prior to fiscal year 2018. The Waco MPO adopted Amendment 3 to the 2015 MTP, and the Policy Board approved several resolutions, to respond to these requirements by the 2018 deadline.

Transportation Performance Management (TPM) is federally required through the FAST Act. It is a strategic approach that uses goals, measures, and data to make better informed decisions about how to invest transportation funding to result in a better performing national multimodal transportation system with greater public benefit. Emphasis is placed on efficient delivery of goods, and safe reliable journeys to work, school, shopping, and community activities. Funding is intended to be targeted toward projects aimed at achieving national performance goals established by Map-21 legislation for improving the safety, reliability and condition of roadway facilities that are a part of the National Highway System (NHS) and regional transit systems.

Moving forward, long-range transportation plans and short range implementation programs (MTPs and TIPs) developed by the Waco MPO are required to demonstrate a performance based decision process that ties back to performance targets. The Waco MPO is required to establish performance standards for the Waco Metropolitan Area and to meet subsequent reporting requirements in order to measure whether the performance goals for the national transportation system have been achieved. The expectation of Congress is consideration of performance targets in project prioritization and selection will support desired outcomes, and continual monitoring, evaluating and performance reporting will better inform future decisions regarding the transportation system.

Performance measures focus on transportation system safety (PM1), condition of pavement and bridges (PM2), system reliability and freight movement (PM3), and transit safety and asset condition (PTASP, TAM). Regional performance targets are discussed throughout this section of the MTP.

5.1 – highways and bridges

With over 96% of the region's commuters using automobiles (American Community Survey 5-Year Estimate, 2013-2017), the highway mode is by far the current mode of choice for McLennan County residents to get from point A to point B. This section provides an overview on how the highway system is currently operating and identifies existing deficiencies both in terms of capacity and condition.

highway capacity, traffic congestion, and relationship to level of service

Capacity refers to the maximum rate of flow that can be accommodated on a roadway segment under prevailing conditions. Congestion occurs when demand exceeds the capacity of a roadway resulting in a reduction of the rate of flow. The Highway Capacity Manual (HCM), published by the Transportation Research Board, defines the relationship between congestion and service characteristics through the use of level of service (LOS) measurements. Roadways are described in terms that represent reasonable ranges in three dimensions: average travel speed, density, and flow rate. LOS measures are used to identify existing problem areas, to measure the effects of increased travel demand, to determine the number of lanes needed to achieve efficient movement, and to compare alternatives between proposed projects. Table 5.1 provides a definition of Level of Service and its relationship with congestion.

table 5.1 – level of service (LOS) definition

Level of Service	Estimated Maximum Volume to Capacity Ratio			Relationship to Congestion
	Collectors & 2 Lane Arterials	Multi-Lane Arterials	Freeways, Expressways, & Interstates	
A	0.10	0.35	0.35	Free Flow
B	0.25	0.50	0.50	Light Traffic
C	0.40	0.65	0.70	Moderate Traffic
D	0.60	0.80	0.85	Heavy Traffic
E	1.00	1.00	1.00	Congested
F	>1.00	>1.00	>1.00	Heavily Congested

5.1.1 – 2015 traffic service levels

About 60% of the roadway system in the Waco Metropolitan Area is operating at an 'acceptable' LOS or better. However, in 2015, 16.9% of the system was operating at an 'unacceptable' level (LOS F), an increase of 13.4% from 2010. Most of this increase can be attributed to IH-35. In 2010, 91.9% of IH-35 was operating at LOS D and E. In 2015 the LOS on IH-35 further deteriorated, with 57.8% of the facility operating at LOS F. Other portions of the system with 'unacceptable' LOS tend to be concentrated within the suburban and rural areas, whereas facilities with 'acceptable' or better LOS are primarily concentrated in the urban core.

With regards to specific classifications, IH-35 was the worst performing with nearly the entire system (88.7%) operating at 'marginal' or 'unacceptable' LOS. Principal arterials were next, with 40.9% operating at 'marginal' or 'unacceptable' LOS. Minor arterials and collectors were functioning somewhat better (see Chart 5.1). On the other hand, 34% of 'other freeways' were underused (LOS A) in 2015 (see Chart 5.2). Table 5.2 outlines the level of service characteristics for the functionally classified highway system.

table 5.2 – 2015 level of service (LOS) by classification

Classification	Underused (LOS A)	Good (LOS B or C)	Acceptable (LOS D)	Marginal (LOS E)	Unacceptable (LOS F)
Interstate	0%	0%	11.3%	30.9%	57.8%
Other Freeways	34.0%	39.3%	10.9%	15.8%	0%
Principal Arterials	10.2%	25.5%	23.4%	31.4%	9.5%
Minor Arterials	8.4%	39.8%	16.2%	24.8%	10.8%
Collectors	3.9%	46.7%	11.4%	19.6%	18.4%
Total System	6.6%	39.4%	14.2%	22.9%	16.9%

chart 5.1 – 2015 percent marginal or unacceptable level of service by classification

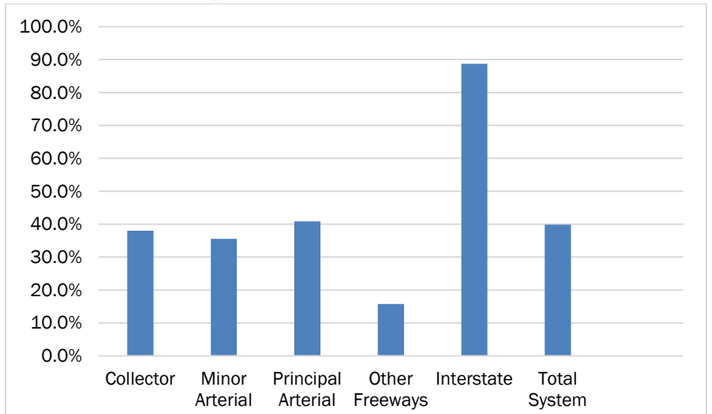


chart 5.2 – 2015 percent underutilized by classification

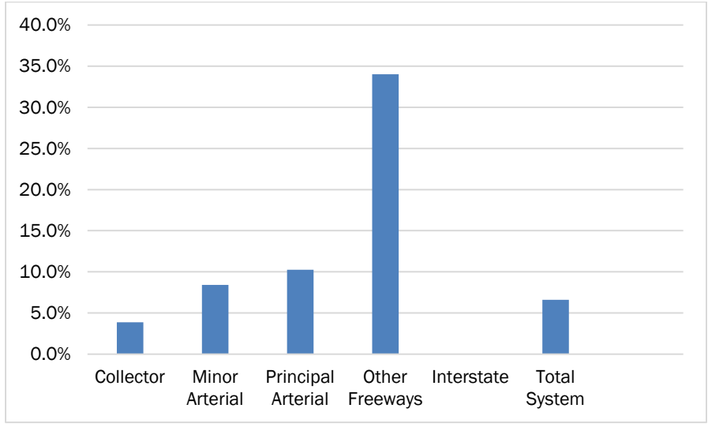


Table 5.3 identifies those highway segments (minor arterial or higher) that have the worst congestion levels within the Waco Metropolitan Area. Each facility in Table 5.3 is rated as having 'unacceptable' traffic conditions (LOS F). Several are suburban facilities where population growth has exceeded the capacity of the transportation network. These and other facilities considered marginal or unacceptable are identified on Map 5.1.

Traffic along China Spring Rd (FM 1637) in Waco, TX.
Source: Waco Tribune Herald

table 5.3 –top 10 most congested roads (arterial or expressways): 2015

Road	Limits	Lanes	Volume to Capacity Ratio
Steinbeck Bend Rd (FM 3051)	China Spring Rd (FM 1637) to Lake Shore Dr (FM 3051	2 lanes	1.46
South Loop 340/SH 6	SH 6/Old Marlin Hwy (Spur 484) to S University Parks Dr (FM 3400)	2 main lanes, with 2 frontage road lanes in either direction south of Brazos River	1.38
China Spring Rd (FM 1637)	N River Crossing (FM 185) to Wortham Bend Rd (FM 2490)	2 lanes	1.35
Texas Central Pkwy	Imperial Dr (FM 3223) to US 84	2 lanes	1.31
US 84	Farmview Pkwy (FM 939) to N Johnson Dr	2 lanes	1.28
SH 6	FM 1860 to E Loop 340/Spur 484	4 lanes	1.27
Park Lake Dr	N 25th St to N 19th St (FM 1637)	2 lanes with center turn lane	1.19
IH-35	Dallas Hwy (US 77) to Elm Mott Dr (FM 308)	6 main lanes with 2 frontage road lanes in either direction	1.15
US 77	Levi Pkwy (FM 2643) to Rosenthal Pkwy	2 lanes with center turn lane	1.15
New Rd	Bagby Ave to Beverly Dr	4 lanes with center turn lane	1.13

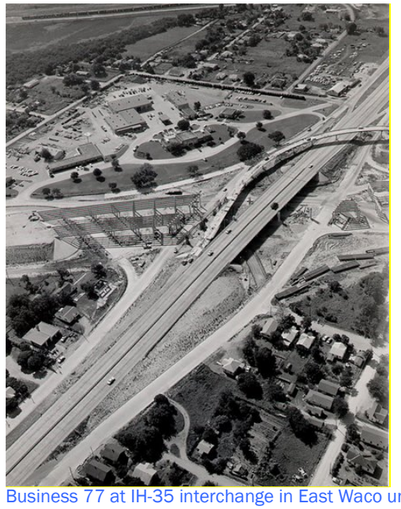
On the other hand, many of the facilities within the urban core of the Waco Metropolitan Area are operating well below their design capacity. Table 5.4 shows the top 10 underused roadways, and Map 5.1 shows all underused roadways as blue dashed lines. Relic expressways (such as Business 77 and Spur 484) and one-way pairs (such as Franklin Ave and Washington Ave; N 25th and N 26th St; and S. 17th and S 18th St) are among the facilities with the most excess capacity. Much of this can be attributed to changes in population and employment patterns (see sections 3.2.1 and 3.2.3) with the largest decreases observed in the general vicinity of these facilities.

Two of the goals of this plan are to encourage new development where supporting infrastructure already exists, and to make use of existing capacity to the extent practicable before investing in system expansions. Many prior long-range planning efforts have focused on the 'greater downtown Waco' geographic area with goals of attracting 10,000 to 20,000 new residents. With the significant excess capacity of many roadways within this region, the initial analysis suggests that the existing system is more than adequate to accommodate any increase in trips should these goals be realized.

Another issue with excess capacity is that these lane-miles must be maintained at substantial cost over time despite their lack of use. Instead of maintaining underused facilities, there may be an opportunity to 'right size' the facility, which could substantially reduce maintenance costs and potentially improve livability and multimodal travel. The Business 77 corridor study, completed in 2017, recommends a redesign of the expressway facility as a boulevard. In addition, the City of Waco is considering several conversions of one-way streets within downtown Waco. The advantage of conversion is that two-way access to each property is restored and some of the existing lanes can be repurposed to better support bicycle and pedestrian modes. As an example, Washington Ave from N 5th St to N 18th St (within the top three underused roadways in 2015), will be converted to two-way operation in the near future. The new two-way design will also include protected bike lanes and sidewalk improvements.

table 5.4 – the bottom 10 (arterials or expressways) with the greatest excess capacity: 2015

Road	Limits	Lanes	Traffic Volume as a Percent of Capacity
Martin Luther King Jr Dr (Loop 574)	IH-35 to La Salle Ave (US Bus 77)	6 lanes	9%
Washington Ave	N 11th St to 18th St (Spur 2)	4 lanes	13%
Washington Ave	N 4th St to N 11th St	4 lanes	14%
S 26th St	Dutton Ave to Clay Ave	4 lanes	14%
N Loop Dr (Bus 77)	IH-35 to E Waco Dr (US 84)	6 main lanes with 2-3 frontage road lanes in either direction	15%
Lake Air Dr	Franklin Ave (Spur 298) to W Waco Dr (US 84)	4 lanes	15%
E Waco Dr (US 84)	N Loop Dr (Bus 77) to IH-35	4 main lanes plus 2-3 frontage road lanes in either direction	15%
S Loop Dr (Bus 77)	Old Marlin Hwy (Spur 484) to IH-35	4-5 main lanes with 2 frontage road lanes in either direction	16%
N University Parks Dr	Washington Ave to Franklin Ave	4 lanes	16%
Airbase Rd (FM 2418)	Craven Ave to TSTC Entrance	4 lanes	17%



Business 77 at IH-35 interchange in East Waco under construction in 1970. While traffic was significant shortly after construction, travel patterns and changes in adjacent land use have resulted in Business 77 being underutilized. IH-35 reconstruction plans call for this interchange to be reconstructed as a simple diamond design with the elimination of the direct connects ramps.

5.1.2 – projected traffic service levels

The Waco MPO utilizes a travel demand forecast model to estimate future level of service for the functionally classified highway system. The results of this analysis represent a 'no build' scenario in which only those roads completed or under construction by 2020 or have a funding commitment identified within the Texas Unified Transportation Program are added to the highway network.

IMPORTANT NOTE: Much of the development of the Waco MPO travel demand forecast model is performed by the Texas Department of Transportation, Transportation Planning and Programming Division (TP&P). As of publication of the draft MTP, a validated 2045 model remained under development by TP&P with an anticipated delivery date of spring 2020. Therefore, MPO staff utilized the results of the 2040 model for initial analysis of highway project recommendations. The MPO staff intends to reevaluate each highway project recommendation after adoption of this plan using the 2045 model to determine if any significant changes in those recommendations are warranted. If so, then

the MPO staff will present an amendment to this plan for consideration by the MPO Policy Board. The following information provides the general process for development of both the 2040 and 2045 models with the primary difference being more up to date demographic and highway network information for the 2045 model.

travel demand forecast model development

Travel Demand Modeling is the process used to determine highway facility needs in the future. The Travel Demand Model is developed by TxDOT with assistance from the MPO staff using TransSCAD modeling software. This Plan update is based on an updated model. The Waco MPO staff provided TxDOT with 2010 base year data and highway network and two scenarios of forecasted 2040 population, income, employment and dwelling units by Traffic Analysis Zone (TAZ) to be used by TxDOT in the development of the model. Note that the 2045 model will use a 2015 base year and a 2045 forecast year with an interim 2030 forecast.

Travel demand modeling utilizes the following four-step process: 1) Trip Generation; 2) Trip Distribution; 3) Mode Choice; and 4) Traffic Assignment. The Waco Urbanized Area, due to its size and relatively low utilization of modes other than automobiles, does not utilize Mode Choice in the modeling process.

Modeling utilizes socioeconomic data (population, income, dwelling units, and employment by Standard Industrial Code) to forecast the number of trips from one given destination to another. This data is collected in Traffic Analysis Zones, which are small study areas. The Waco MPO Study Area was originally delineated into 206 analysis zones for the 1964 Metropolitan Transportation Plan. Since that time, the analysis zones have been revised several times as the arterial network and study area have changed. In 2003, the MPO expanded the Study Area to include all of McLennan County. For this Plan update, the model uses 431 TAZs delineated in 2005 after the latest Study Area expansion.

trip generation

Trip generation is the process by which socioeconomic variables (population, income, number of dwelling units, employment, land use, and special generators) are translated into numbers of trips. Based on the relationships mentioned above, this process determines the number of trips each TAZ will produce and the number of trips each TAZ will attract.

Detailed analyses of household trip-making characteristics, stratified by income, provides the basis for the development of zonal trip production rates. Trip attraction rates are based primarily on employment data in each TAZ, but also look at special generators and land use acreage found within each TAZ.

trip distribution

Trip distribution is the process by which the model determines where the trips produced in each TAZ will go. In other words it determines how the trips produced in each TAZ will be allotted among all the other TAZs in the area. In general, this model takes into account the relative attractiveness (based on employment, land use, and special generators) and accessibility (based on trip lengths in minutes, and socioeconomic and topographical barriers) of all TAZs in the area.

Once trip distribution is completed, the model is calibrated. Calibration is necessary to ensure the transportation network will have a balanced number of productions and attractions.

traffic assignment

After determining the number of trips between each TAZ (trip distribution), the next step in the modeling process is traffic assignment. Traffic assignment determines how the trips will get from the production TAZ to the attraction TAZ. Assignment is the process of assigning trips to the street network based upon the most likely route of travel between the trip's origin and destination. Trips are assigned to the available routes using a mathematical algorithm which determines the amount of traffic to allocate to each route. The traffic allocation is generally based on the relative time it takes to travel along each available path, and the design capacity of each street link.

One important step in the traffic assignment process is validation. Model validation establishes the credibility of the model by demonstrating its ability to replicate actual travel patterns. Validation is accomplished by comparing traffic volumes estimated by the model to actual base year ground counts. Traffic estimated by the model is typically compared to actual traffic counts at points where streets cross barriers called cordon lines, screenlines, and cutlines. Various model parameters are adjusted until the model satisfactorily replicates the ground counts. The 2040 Waco MPO model was validated using 2010 ground counts.

Once validation is completed, the model is used to assess the performance of the existing transportation system. The final traffic assignment is run on the existing network to produce a base year benchmark. The validated model is then provided to the MPO Staff to forecast future traffic conditions and to evaluate the effectiveness of proposed improvements.

year 2040 no-build traffic projections

Please refer to the important note at the beginning of this section regarding the use of 2040 model results versus 2045.

Without substantial capacity increases, 66.8% of the functionally classified highway network is projected to be operating at either a marginal or unacceptable level of service during the year 2040. This is a 27% increase compared to 2015 (see Table 5.5 and Chart 5.3).

Similar to 2015 conditions, Interstate 35 is projected to have the worst performance, with the entire interstate facility in the Waco Metropolitan Area projected to operate at a marginal or unacceptable level of service. This is despite several projects to add capacity that have either been completed or will be complete within the next five years. All other facility types show an increase in lane miles at a marginal or unacceptable level of service, with collectors showing the greatest increase (31.6%). See Map 5.2 for 2040 projected traffic level of service. In terms of location, nearly all of the facilities with significantly worse levels of service were found in the suburban areas such as Hewitt, Woodway, West Waco, or China Spring. These are also the regions expected to experience the greatest growth in population and employment during the planning period. See Table 5.6 for the 2040 projection of the top 10 most congested roadways.

table 5.5 –2040 projected level of service (LOS) by classification: existing and committed network

Classification	Underused (LOS A)	Good (LOS B or C)	Acceptable (LOS D)	Marginal (LOS E)	Unacceptable (LOS F)	Increase in Marginal or Unacceptable LOS*
Interstate	0.0%	0.0%	0.0%	5.6%	94.4%	11.3%
Other Freeways	4.9%	73.2%	4.5%	6.3%	11.1%	1.6%
Principal Arterials	1.5%	18.3%	9.2%	15.0%	56.1%	30.2%
Minor Arterials	3.3%	21.0%	17.1%	13.8%	44.8%	23.1%
Collectors	3.8%	16.7%	9.8%	24.6%	45.0%	31.6%
Total System	3.2%	19.1%	10.9%	18.6%	48.2%	27.0%

*Compared to percent marginal/unacceptable in 2015 (see Chart 5.1).

chart 5.3 – comparison of 2015 and 2040 percent marginal or unacceptable level of service by classification

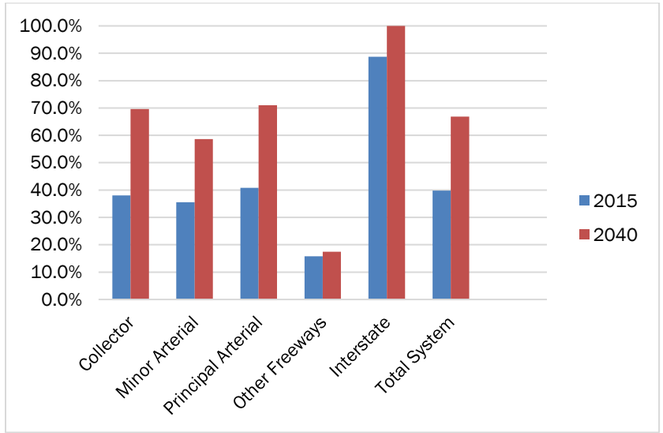


table 5.6 – projected top 10 most congested roads: 2040

Road	From	To	Volume to Capacity Ratio	Percent Change in Traffic from 2015
FM 107	FM 2113	SH 317	5.09	+214.2%
Spring Valley Rd (FM 2113)	Old Lorena Rd (FM 2837)	Hewitt Dr (FM 1695)	5.07	+115.5%
China Spring Rd (FM 1637)	Old China Spring Rd (Spur 1637)	Bob Johnson Rd	4.55	+350.6%
Old Robinson Rd	South Loop 340 / SH 6	Garden Ln / New Rd	4.45	+410.5%
FM 2114	IH-35	Reagan St	4.03	+76.8%
Spring Valley Rd (FM 2113)	Cotton Belt Pkwy (FM 2416)	Old Lorena Rd (FM 2837)	3.96	+96.4%
FM 107	IH-35	Mackey Ranch Rd	3.77	+167.5%
Speegleville Rd	George W Bush Pkwy (US 84)	Oak Rd	3.70	+43.0%
West Texas Ave (SH 164)	FM 1860	N Pearl St (FM 939)	3.64	+56.7%
SH 164	SH 6	FM 1860	3.60	+112.2%

5.1.3 – system resiliency and travel time reliability

Neither FAST nor federal regulations provide a precise definition of transportation system resiliency. The definition the MPO decided to follow is the ability of a transportation system to move people around in the face of one or more major obstacles to normal function. These obstacles can include, but are not necessarily limited to, extreme weather events, crashes, road construction or equipment / infrastructure failures.

For highway mobility, the most frequent obstacles faced within the Waco Metropolitan Area are flooding, crashes and unplanned highway construction. Sections 5.1.5, Flood Vulnerable Bridges and Low Water Crossings, and 5.1.7, Stormwater Impacts, discuss flooding impacts in more detail, including an assessment of flood vulnerable bridges and priority bridges for future work.

System reliability has been defined within the FAST Act as generally the variability between average travel time and the most extreme travel time for a particular road segment. Reliability was deemed by the Congress as sufficiently important to require the establishment of state and regional targets and periodic monitoring of progress towards those targets.

vehicle crashes as an impediment to mobility

Crashes are the next most significant obstacle to highway mobility as these often involve vehicles that have been disabled and therefore impede the movement of other vehicles through the closure of travel lanes. Section 5.1.6, Highway Crash Analysis, discusses safety performance targets for the Waco Region and MPO efforts to support state targets to reduce the more severe crashes.

According to TxDOT's Crash Record Information System (CRIS), in 2017 there were 5,544 crashes on public right of way reported to law enforcement within McLennan County. These crashes include everything from fatalities to minor-property-damage only crashes. In each case, however, there was at least some temporary closure of at least one lane of a public roadway. No statistics currently exist regarding incident clearance time for crashes within the State of Texas. Such data is not required to be identified on crash reports submitted by law enforcement. Texas State Law does state that if a vehicle can be moved after a crash and no one is injured, then they are to move the vehicle out of the right of way and wait for law enforcement in a safe area that does not impede traffic flow.

For more serious crashes, incident clearance time can vary considerably. Some of the circumstances that can significantly lengthen clearance time are multiple vehicle crashes, crashes with multiple injuries, crashes with a fatality, crashes that involve fire, and any hazardous material spill. Hazardous material spills can also introduce an evacuation requirement which could require closure of multiple highway facilities that would otherwise be considered for detours.

highway construction as an impediment to mobility

After vehicle crashes, lane closures due to road construction are the next most significant obstacle to highway mobility. Some lane closures are planned as a result of significant roadway widening or scheduled maintenance work. This work is often announced several days in advance by TxDOT along with the duration of the closure and sometimes discussing alternative routes for more significant closures. The website My35.org, maintained by the TxDOT Waco District, provides real time traffic alerts and construction updates for IH-35 work in McLennan County. The most significant construction occurring in the Waco Metropolitan Area is the reconstruction and widening of IH-35 from Bellmead to Waco. TxDOT has convened a committee of local stakeholder interests, including MPO staff, to help develop a public communication plan for use during construction. The goal of this plan is two-fold: 1.) Ensure timely public notification of lane, ramp or facility closures and, 2.) Real-Time notification of incidents within the construction zone, dissemination of queue backup alerts, and identification of alternative routes, if appropriate. Two significant ultimate goals of this strategy are to reduce travel delay through the construction zone and to reduce the secondary crashes that are common on high speed highway facilities, especially in construction zones.

The more challenging issues are those that involve unplanned construction which often have little or no advance warning, no notice of duration and little information regarding detours. These circumstances can arise out of failures from overhead and underground utilities, pavement failures, and adjacent construction on private property. The City of Waco water utilities department identifies road closures necessary for work on either water or sewer lines as part of their system via the City of Waco website. TxDOT will also send out notifications regarding emergency road or lane closures on their system as soon as practicable. Closures for utility work or roadway networks outside of the City of Waco are spotty and generally only for work that closes an entire roadway for a significant length of time, usually for multiple days or longer.

Within the City of Waco, lane or road closures due to private property construction are required to be applied for and approved in advance with a traffic control plan. With that said there is not currently a mechanism to then notify the public regarding these closures. Outside of the City of Waco, only a few cities have a permitting process and few, if any, requirements to identify closures for less than the entire facility for several days. Outside of the City of Waco, these closures are generally rarely known in advance.

impediments to transit mobility

Public transportation within McLennan County is entirely dependent upon the roadway network for their operations. As a result, many of the same impediments identified for highway mobility are also significant for transit mobility. After the highway impediments, transit is most significantly impacted by mechanical equipment failures of their vehicles. Section 5.2.4, Transit Asset Condition, discusses transit asset management of the Waco Transit fleet of vehicles, current condition of the fleet and efforts to maintain the fleet in a state of good repair.

In general, there are very few disruptions to Waco Transit operations as a result of equipment failure. Waco Transit meets or exceeds the minimum requirements identified by the Federal Transit Administration (FTA) regarding spare bus availability to address such circumstances. As a result, most disruptions due to equipment failure only impact one loop of one route at any given time and services almost always return to normal operations within one hour.

travel time reliability

Travel time reliability is an attempt to measure the variability in travel times for interstate, freeway and principal arterial class facilities and to determine whether the magnitude of variability is considered unreasonable. 'Reliability' references the level of consistency in transportation service for a mode, trip, route or corridor for a time period. Reliability contributes to the traveling public's transportation experience, and therefore is used as a way to measure service quality.

The FAST Act System Performance rule (PM3) establishes performance measure requirements to assess the performance of the NHS and to assess freight movement on the Interstate System. These measures focus on evaluating travel time reliability and travel delay on interstate, freeway and principal arterial class facilities to determine whether the magnitude of travel time variability is considered unreasonable. The objective of the rule is to ensure efforts to improve unreasonable travel delay and expedite the movement of people and goods guide funding prioritization, furthering the national goal of improving the efficiency of the surface transportation system. Reliability references the level of consistency in transportation service over a specific time period and is the most important service quality attribute for travelers and freight transporters.

As part of FAST Act compliance, the Waco MPO is required to establish three separate targets for 'unreasonable' travel time:

1. Percent of 'reliable' travel for all traffic on the Interstate System
2. Percent of 'reliable' travel for all traffic on Other Freeways and Principal Arterials
3. Ratio of unreliable truck travel to average truck travel – Interstate System

TxDOT contracted with the Texas A&M Transportation Institute (TTI) to collect travel time reliability and travel delay data for all NHS facilities in Texas. Similar to MPOs, TxDOT is also responsible for setting system performance targets for two federally required travel time reliability measures and one freight reliability measure.

TTI performed an analysis of past unreliable travel for all Texas MPOs. The Waco MPO used TTI's analysis to help establish specific regional travel time and freight reliability targets for Interstate and NHS roadways in the Waco Metropolitan Area. These targets were adopted by the Waco Policy Board in June 2018, and are shown in Table 5.7. TxDOT and the Waco MPO will report on travel time reliability and travel delay performance towards targets every four years. The MPO has opportunity to review and adjust these targets every two years.

table 5.7 – travel time reliability targets adopted by waco MPO

System	2017 Reliability	2020 Target Recommendation *	2022 Target Recommendation *
Interstate All Traffic	100%	97%	95%
Other Fwy / Principal Arterials All Traffic	97%	88%	85%
Interstate Truck Ratio	1.17	1.35	1.40

* Texas A&M Transportation Institute (TTI)
Sources: National Performance Measure Research Data Set (NPMRDS) Phase 2, University of Maryland

5.1.4 – pavement condition

Proper maintenance will keep a road or bridge in good operating condition for many years beyond a normal useful life of 40 years. Even with proper maintenance, at some point the road or structure will deteriorate to the level of requiring reconstruction. This section reviews the condition of the highway system to help determine which facilities are in need of reconstruction.

The FAST Act's Pavement and Bridge performance rule (PM2) establishes performance requirements to assess pavement conditions on the NHS and the Interstate System relative to a U.S. Department of Transportation (USDOT) definition of State of Good Repair (SGR). SGR is the condition in which a capital asset is able to operate at a full level of performance. The premise of the rule is to ensure roadway maintenance guides funding prioritization in order to further the national goal of strategically and systematically maintaining the nation's transportation system in good condition.

The PM2 rule also outlines the process for State DOTs and MPOs to establish and report 2- and 4-year pavement condition targets, and the process that the Federal Highway Administration (FHWA) will use to assess whether State DOTs and/or MPOs have met or made significant progress toward meeting their pavement and bridge condition targets. MPOs are required to support their State DOT's 4-year targets or establish their own targets.

Specifically, targets are required for the following performance measures:

1. Percent of interstate pavements in good condition
2. Percent of interstate pavements in poor condition
3. Percent of non-interstate NHS pavements in good condition
4. Percent of non-interstate NHS pavements in poor condition

In June 2018, TxDOT adopted 4-year pavement condition targets for Texas, which are applicable to all roadways on the NHS. NHS roadways within McLennan County are shown on Map 5.3. The Waco MPO Policy Board adopted TxDOT's pavement condition targets in October 2018, as shown in Table 5.8.

table 5.8– 2022 pavement condition targets adopted by waco MPO

NHS System	Target for Percent Good	Target for Percent Poor
Interstate	66.4%	0.3%
Non-Interstate	48.0%	14.3%

NHS = National Highway System

The MPO staff evaluated pavement conditions for NHS and non-NHS roadways within the Waco Metropolitan Area and assigned a 'good', 'fair', or 'poor' rating. The analysis for NHS roadways included a condition assessment of three factors: international roughness index (IRI), cracking, and rutting or faulting. 'Good' pavements require a 'good' condition assessment for all three factors. 'Poor' pavements must have a 'poor' condition assessment for two of the three. For non-NHS roadways, MPO staff looked at IRI only.

As shown in Table 5.9, results indicate that NHS interstate roadways in the Waco Region exceed the 2022 'good' pavement condition target (68.2% compared to 66.4%), and fall short of the 'poor' pavement condition target (1.3% compared to 0.3%). Non-interstate NHS roadways do not meet either the 'good' or 'poor' pavement targets.

table 5.9 –NHS pavements percent good and poor: 2017

Facility Type	Total Lane-Miles	Good Lane-Miles	Percent Good	Poor-Lane Miles	Percent Poor
Interstate	214.20	146.13	68.2%	2.70	1.3%
Non-Interstate NHS	604.54	305.06	50.5%	50.07	8.3%

MPO staff performed additional analysis beyond that required by the FAST Act, including an assessment of non-NHS roadways, and an assessment of 'barely good' and 'nearly poor' pavement conditions. Table 5.10 shows that non-NHS roadways are far short of the 66.4% target for 'good' pavement and 0.3% target for 'poor' pavement condition.

table 5.10 –non-NHS pavements percent good and poor: 2017

Facility Type	Total Lane-Miles	Good Lane-Miles	Percent Good	Poor-Lane Miles	Percent Poor
State System	553.62	303.10	54.7%	37.21	6.7%
Off System	50.93	1.96	3.9%	12.86	25.3%

Sources: TxDOT Pavement Management Information System; City of Waco Department of Public Works

Tables 5.11 and 5.12 summarize the percent of NHS and non-NHS lane-miles that are 'barely good' and 'nearly poor.' The purpose of this analysis is to demonstrate that if overall pavement conditions are not maintained or improved, the Waco Region could fall short of FAST Act pavement condition targets. For example, just over 20% of interstate NHS lane-miles are 'barely good' meaning that these roadways are at risk of downgrading to a 'fair' rating by 2022. Similarly, 7.3% of non-interstate NHS lane miles currently rated 'fair' are at risk of downgrading to a 'poor' condition.

table 5.11 –NHS pavements percent barely good and nearly poor: 2017

Facility Type	Total Lane-Miles	Barely Good Lane-Miles	Percent Barely Good	Nearly Poor Lane-Miles	Percent Nearly Poor
Interstate	214.20	29.72	20.3%	0	0.0%
Non-Interstate NHS	604.54	65.82	21.6%	18.21	7.3%

table 5.12 –non-NHS pavements percent barely good and nearly poor: 2017

Facility Type	Total Lane-Miles	Barely Good Lane-Miles	Percent Barely Good	Nearly Poor Lane-Miles	Percent Nearly Poor
State System	553.62	63.87	21.1	11.34	5.3%
Off System	50.93	1.96	100%	6.86	19.0%

Sources: TxDOT Pavement Management Information System; City of Waco Department of Public Works

A map of pavement condition rating is not provided in this MTP, because pavement management data is considered confidential highway safety information subject to 23 USC Section 409. As such, the MPO may utilize this information to asses overall regional pavement condition, but may not show or make available condition information for specific roadways or segments of roadways.

Example of poor road conditions that significantly impact ride quality.

5.1.5 – bridge condition

bridge condition targets

The FAST Act Pavement and Bridge Condition Rule (PM2) also establishes performance requirements to assess the condition of bridges on the NHS, and outlines the process for State DOTs and MPOs to establish targets and report conditions. Required performance measurements include:

1. Percent of NHS bridges in good condition
2. Percent of NHS bridges in poor condition
3. Percent of bridge deck area defined as poor

TxDOT will collect condition data for all NHS facilities in Texas, regardless of ownership, and set condition targets for Texas for the three bridge performance measures. In June 2018, TxDOT adopted 4-year bridge condition targets for Texas and in October 2018, the Waco MPO Policy Board adopted TxDOT's bridge condition targets (see Table 5.13). Every four years, TxDOT and the Waco MPO will report on significant progress toward meeting these targets. The MPO has opportunity to review and adjust these targets every two years.

table 5.13 – 2022 bridge condition targets adopted by waco MPO

NHS System	Target for Percent Good	Target for Percent Poor
Bridges	50.42%	0.80%

The MPO staff evaluated bridge conditions for NHS and non-NHS bridges within the Waco Metropolitan Area. The analysis for NHS bridges included a condition assessment of three factors: superstructure, substructure, and bridge deck, for a total possible score of 1 through 10. A score of 7 or greater received a 'good' rating, and a score of 4 or less received a 'poor' rating. 'Good' bridges have all three elements with a score of at least 7, while 'poor' bridges have at least one element with a score of less than 4.

As shown in Tables 5.14 and 5.15, NHS bridges in the Waco Region exceed the 2022 'poor' condition target (0% compared to 0.80%), and fall short of the 'good' condition target (46.6% compared to 50.42%). Phase 4B of IH-35 construction, which broke ground in 2019, will reconstruct or significantly rehabilitate all bridges within its project limits. When this project work is complete, it will increase the 'good' bridge deck area for interstate NHS from 57.7% to 93.3%, which will improve overall 'good' deck area to 55.09%.

table 5.14 –NHS bridges with poor condition rating: 2016

Facility Type	Total Bridges	Total Deck Area	Deck Area Poor	Percent Poor	2022 State Target
Interstate NHS	100	1,341,289.7	0.0	0.0%	n/a
Non-Interstate NHS	161	1,717,125.3	0.0	0.0%	n/a
Total NHS	261	3,058,415.0	0.0	0.0%	0.80%

table 5.15 –NHS bridges with good condition rating: 2016

Facility Type	Total Bridges	Total Deck Area	Deck Area Good	Percent Good	2022 State Target
Interstate NHS	100	1,341,289.7	77,392,040.0	57.7%	n/a
Non-Interstate NHS	161	1,717,125.3	65,026,880.0	37.9%	n/a
Total NHS	261	3,058,415.0	142,418,920.0	46.6%	50.42%

MPO staff performed additional analysis beyond that required by the FAST Act, including an assessment of non-NHS bridges. Tables 5.16 and 5.17 show that non-NHS bridges do not have poor conditions, however, only 40.4% of state system and 9.9% of off-state system bridges are in good condition.

table 5.16 –non-NHS bridges with poor condition rating: 2016

Facility Type	Total Bridges	Total Deck Area	Deck Area Poor	Percent Poor	2022 State Target
State System	154	1,577,031.2	0.0	0.0%	n/a
Off-System	7	140,094.1	0.0	0.0%	n/a

table 5.17 –non-NHS bridges with good condition rating: 2016

Facility Type	Total Bridges	Total Deck Area	Deck Area Good	Percent Good	2022 State Target
State System	154	1,577,031.2	63,647,390.0	40.4%	n/a
Off-System	7	140,094.1	1,379,490.0	9.9%	n/a

structurally deficient and functionally obsolete bridges

Every two years TxDOT evaluates the structural condition of every public use bridge within Texas to help determine priorities for bridge rehabilitation and reconstruction. Each bridge receives a score based on a maximum of 100 points with scores of 50 or below an indication of structural deficiency. Bridges scoring below 50 points are eligible for replacement using federal funds whereas those scoring below 75 points are eligible for rehabilitation.

The 2018 results show that nearly all bridges significantly exceed minimum standards for structural integrity. Of the 686 public use bridges in McLennan County, only 17 or 2.5% were considered structurally deficient. The percentage of deficient bridges is nearly unchanged from 2012. Of the structurally deficient bridges, 13 or 76.5% were maintained either by McLennan County or a local municipality.

Previously, bridges were also evaluated every two years based on a definition for functional obsolescence. Bridges identified as functionally obsolete failed to meet one or more of the following design or operational standards: lane width, absence of or too narrow shoulders, vertical clearance, travel lane banking through curves (also known as superelevation) or one of several safety features such as guardrail condition. As of 2016, however, the USDOT eliminated identifying bridges for functional obsolescence. As these conditions may still represent a safety point of concern, MPO staff continues to identify bridges that previously failed to meet current design standards and have not had work performed to correct those deficiencies. For 2018, 95 bridges, or 13.8% of the total, had one or more design insufficiencies that previously would've identified the bridge as being functionally obsolete. Compared to 2012, 18 bridges previously identified as being functionally obsolete are no longer considered substandard.

Table 5.18 provides a review of bridge condition for McLennan County and identifies how condition and bridge design concerns vary by roadway classification. Structurally deficient and functionally obsolete bridges are shown on Map 5.4. In general, higher order facilities such as the Interstate system and Other Freeways are in better condition with newer bridges than other portions of the system. Since the reconstruction work performed on IH-35 has removed many bridges and created several new bridges, a direct comparison of bridge ratings from 2012 to 2018 to assess changes in sufficiency ratings could not be performed.

table 5.18 – 2018 bridge sufficiency ratings by functional classification

Classification*	Bridges	Average Rating	Percent Structurally Deficient	Percent Functionally Obsolete
Interstate	109	84.8	0.9%	6.4%
Other Freeways	52	80.1	2.9%	21.7%
Principal Arterials	108	85.6	0.9%	2.8%
Minor Arterials	107	85.1	0.9%	18.7%
Collectors	174	87.7	0.0%	9.8%
Frontage Rds / Ramps	43	85.9	4.7%	11.6%
Local	197	82.3	6.1%	12.7%
Total	686	84.5	2.5%	13.8%

*Bridges may carry and cross over highways of different classifications, thus the number of bridges exceeds the county total.

The Washington Ave Bridge over the Brazos River was built in 1901 and rehabilitated in 2010. This rehabilitation work helped strengthen the bridge to once again accommodate two-way traffic. Additional work has taken place since but despite this, the bridge scored a sufficiency rating of 47.1 in 2018. As a result it is still classified as 'structurally deficient' and is thus unable to accommodate heavy trucks.

flood vulnerable bridges and low water crossings

The primary interface between flood conditions and the transportation system are the bridges that carry roadways across the various flood zones. While the Federal Emergency Management Agency (FEMA) identifies flood zone risk areas, these zones only identify areas that have either a 1% or 0.2% risk of flooding in any given year, a relatively infrequent occurrence. The National Bridge Inventory (NBI), managed by the US Department of Transportation, provides an assessment of the annual risk that a bridge could be overtopped by flood waters. The maximum risk identified by the NBI is 10%. MPO staff determined the NBI assessment to be the most relevant assessment for bridge vulnerability.

In addition to being overtopped by water, the NBI also provides data that gives an indication of risk that a bridge could be damaged by flood conditions: overall structural rating and a scour rating. Bridge scour is the removal of sediment such as sand and gravel from around bridge abutments or piers. Scour, caused by swiftly moving water, can scoop out scour holes, thereby compromising the integrity of a structure.

To identify and prioritize flood vulnerable bridges, MPO staff scored each bridge within McLennan County based on the criteria identified in Table 5.19.

table 5.19 – flood vulnerable bridge scoring criteria

Criterion	Definition	Points
Hwy Classification	Interstate or Freeway	5
	Principal Arterial	4
	Minor Arterial or Fwy Collector	3
	Other Collectors	2
	Local Roads	1
Traffic Volume	Average Daily Traffic (ADT)	1 point for every 500 ADT Maximum of 15 points ADT < 100 not evaluated
FAST Bridge Rating	Good	1
	Fair	3
	Poor	5
Structural Condition	0 to 100 100 = Perfect 0 = Closed	Subtract score from 100 then divide by 20
Scour	Good	1
	Unstable but immediate action not required	5
	Unstable and immediate action required	10
Annual Overtopping Risk	Less than 10%	Bridge not Evaluated
	10%	10
	20% or Greater	20
Detour	Miles to access other side of bridge	1 point for each mile Maximum of 5 points

Note that bridges with less than 100 daily vehicles and/or less than a 10% annual risk of being overtopped were not evaluated. As a result, of the 689 bridges in McLennan County during 2017 only 54 bridges met both criteria (7.9% of total). Of these bridges, two were defined as critical (score greater than 25) and 30 were defined as a concern but not critical (score between 20 and 25). The other 22 bridges were defined as either stable or reasonable alternatives exist during flood events. Map 5.5 shows the location of the two critical bridges and the 22 bridges of concern. Fortunately, none of the 32 bridges identified as critical or as a concern are part of facilities utilized by the Waco Transit fixed route system. Note that NBI data from 2018 did not change any flood vulnerability classifications.

In addition to bridges, there are also 17 low water crossings within McLennan County that by definition are considered 'flood vulnerable.' In general, these crossings have very low traffic volumes, cross water features that are dry except during significant rainfall events and drain quickly after significant rainfall. As a result, the expense of constructing a bridge at these locations is not considered feasible. For every MTP update, MPO staff reviews traffic volume trends for these locations to assess whether these locations warrant bridge construction. As of this 2019, none of the low water crossings met those warrants. Low water crossing locations are identified on Maps 5.4 and 5.5.

5.1.6 – highway crash analysis

state and MPO FAST act targets

The FAST Act Safety Performance rule (PM1) establishes safety performance measure requirements to assess fatalities and serious injuries on all public roads. The objective of PM1 is to ensure safety improvements guide funding prioritization in order to advance the national goal of maintaining safe roadway networks.

Required performance measurements include:

1. Number of fatalities
2. Fatalities per million vehicle miles traveled (fatality rate)
3. Number of serious injuries (incapacitating injuries)
4. Serious injuries per million vehicle miles traveled (incapacitating injury rate)
5. Number of non-motorized fatalities and non-motorized serious injuries

Each year, TxDOT sets safety performance targets for Texas for these five federally required safety performance measures. The targets are applicable to all public roads in Texas regardless of functional classification or ownership. In support of these measures, the Waco MPO chose to support the Texas safety targets in February 2018. At the close of each year, TxDOT and

the Waco MPO will report on significant progress toward meeting these targets. TxDOT's 2018 safety targets were continued in 2019. These targets are as follows:

- To reduce the expected rise of fatalities by 2% over current baseline forecast
- To reduce the expected fatality rate by 2% over current baseline forecast
- To reduce the expected rise in incapacitating injuries by 2% over current baseline forecast
- To maintain the current downward trend in the incapacitating injury rate
- To reduce the expected rise of non-motorized fatalities and non-motorized incapacitating injuries by 2% over current baseline forecast

Baseline forecasts are calculated using historical 5-year rolling averages, as shown in Table 5.20. The baseline is used to determine expected trends if the MPO chose to use available funding to maintain the local transportation system without implementing safety intervention projects. The mix of projects selected by the Waco MPO for inclusion in the MTP is intended to support TxDOT in achieving its safety targets for the State of Texas transportation system given the availability of necessary funds.

table 5.20 – texas 2019 safety performance targets 5-year annual average (2015 to 2019)

2019 Safety Targets	Number of Fatalities	Rate of Fatalities *	Number of Serious Injuries	Serious Injury Rate*	Number of Non-Motorized Fatalities and Serious Injuries
2015	3,582	1.39	17,110	6.63	2,036
2016	3,776	1.39	17,602	6.49	2,301
2017	3,726	1.36	17,546	6.39	2,148
2018	3,891	1.46	18,130	6.64	2,309
2019 Target	3,980	1.47	18,367	6.60	2,394
2019 Target as a 5- Year Average	3,791	1.414	17,751	6.550	2,237.6

*rate per 100 million vehicle miles of travel

regional crash and hot spot analysis

While the regional targets identified as part of the FAST Act performance criteria are useful in improving transportation safety, it is difficult to identify specific issues or problem areas from only a metropolitan area statistic. In order to better identify problem locations and strategies or projects to reduce crash numbers and severity, MPO staff collected performed a regional hot spot analysis of crash data from the Texas Department of Transportation Crash Records Information System (CRIS) within McLennan County for the period between 2016 and 2018. The CRIS system incorporates all crashes reported to peace officers within the State of Texas since 2010 and includes all non-personal information for each reported crash.

For the analysis period, 18,098 crashes were reported within McLennan County resulting in 108 fatalities and 569 serious or life threatening injuries. Additionally during this period there were another 2,879 non-serious injuries resulting from these crashes. Non-serious injuries are defined as those that required significant medical attention but were not considered life threatening. See Table 5.21 for crash injury severity for the period of 2016 to 2018.

table 5.21 – crash injury severity for mclennan county: 2016-2018

Injury Severity	Persons
Fatal	108
Serious (Life-Threatening)	569
Non-Serious (Not Life Threatening)	2,879
Possible Injury	4,485
Total	8,041

Source: Texas Department of Transportation; Crash Records Informational System

When evaluating crash location in terms of roadway classification, higher order facilities generally have higher absolute crash numbers but also have higher traffic volumes which results in a lower crash rate. These facilities include the Interstate system, Expressways, and Principal Arterials. Lower order facilities such as Collectors and Minor Arterials, may also have very significant numbers of crashes but due to the lower traffic volumes generally have much higher crash rates.

When comparing crash severity, it's interesting to note that despite the higher speeds, higher order facilities do not have significantly higher absolute numbers of fatalities or serious injuries. Table 5.22 provides some of the more important factors in explaining the differences in crash rates and severity between highway classifications. Tables 5.23 and 5.24 provide a summary of highway crash rates and severity by functional classifications. Locations of fatal and serious injury crashes are shown on Map 5.6.

table 5.22 – crash and severity factors for highway classifications

Classification	Access Control	Intersection Control	Typical Speed	Primary Manners of Collision
Interstate / Expressway	On & Off Ramps Only	Grade Separated	65 mph or greater	Single Vehicle or Rear-End
Principal Arterials*	Fewer Driveways	Traffic Signals	40 to 55 mph	T-Bone or Opposite Left-Turn
Minor Arterials	More Driveways	Traffic Signal or Stop Signs	35 to 45 mph	T-Bone or Opposite Left-Turn
Collectors	No access control	Generally Stop Signs	35 mph or less	T-Bone or Opposite Left-Turn
Local Streets	No access control	Stop Signs or no traffic control	30 mph or less	T-Bone, Opposite Left-Turn, Parked Vehicles

*Older principal arterials that have not been retrofitted often have access control similar to minor arterials.

Interstate and Expressway design significantly restrict access when compared to lower order facilities. In addition, cross access is accomplished only via the separation of grades. This serves to eliminate nearly all high angle collisions associated with at-grade intersections. In addition, nearly all traffic is flowing in the same direction which greatly reduces, but notably does not eliminate crashes by vehicles travelling in opposite directions. When opposite direction crashes do occur however, those crashes tend to be much more severe than with lower order facilities due to the higher speeds associated with these facilities.

In comparison, lower-order facilities, such as Minor Arterials and Collectors, have limited to nearly no access control to other roadways or properties. While this makes property access convenient, the tradeoff is that there are few, if any, physical impediments to high angle or opposite direction crashes. Despite the lower speeds associated with lower order facilities, this factor is offset with high angle or opposite direction crashes in which the direction of the force is generally more concentrated on structurally weaker areas of the vehicle such as side doors. The result is more of the crash force being applied to the vehicle passengers than having that force absorbed by the vehicle.

table 5.23 – highway crash rate by functional classification: 2016-2018

Classification	Total Crashes*	Crashes per Million Vehicle Miles Traveled	Percent of Crashes	Percent of VMT
Interstate	4,469	1.28	24.7%	43.3%
Other Expressways	2,005	2.18	11.1%	11.8%
Principal Arterials	4,746	3.35	26.3%	17.6%
Minor Arterials	7,696	5.36	42.5%	17.8%
Collectors	3,564	4.66	19.7%	9.4%

*Crashes occurring at the intersection of differing classification types were counted in both classifications, thus the sum for the classifications will be greater than the regional total.

table 5.24 – highway crash severity by functional classification: 2016-2018

Classification	Fatalities & Serious Injuries*	Fatalities & Serious Injuries per Million VMT	Percent of Fatalities & Serious Injuries	Percent of VMT
Interstate	190	0.05	28.1%	43.3%
Other Expressways	65	0.07	9.6%	11.8%
Principal Arterials	186	0.13	27.5%	17.6%
Minor Arterials	318	0.22	47.0%	17.8%
Collectors	186	0.24	27.5%	9.4%

*Crashes occurring at the intersection of differing classification types were counted in both classifications, thus the sum for the classifications will be greater than the regional total.

economic impact of waco region crashes

One crash or fatality is unacceptable. The fact that 108 persons died in McLennan County and another 3,448 required medical treatment in the previous three years should be a cause for alarm. In addition to the human cost of these crashes, there is a significant economic impact for which the National Safety Council provides estimates. Using their cost estimate per crash by severity, the regional economic impact of McLennan County crashes totals to over $460 million for the period between 2016 and 2018 (see Table 5.25). This results in an estimated $614 impact for every man, woman and child in McLennan County every year. This number is a little less than compared to the previous MTP, which estimated the impact at $721 per person. That difference, however, was almost entirely due to more persons currently residing in McLennan County than due to any improvement in crash totals or severity.

While the direct economic impact is applied to those involved in each crash, these costs are eventually distributed to all citizens through higher auto liability and medical insurance rates as well as the cost of providing emergency services. Those costs, in the form of additional police, fire and medical personnel, is almost always borne by local taxpayers. Additional to these costs are damages to transportation infrastructure such as traffic signals, lampposts, guardrails and signage. While these costs are sometimes recovered through insurance, many times taxpayers must bear the cost of repairs. This is especially true for those crashes resulting from an uninsured motorist or a vehicle that fled the scene.

table 5.25 – estimated crash costs by severity: 2016-2018

Crash Severity	Total Crashes	Estimated Cost*
Fatal	98	$158,270,000
Serious Injury	490	$45,962,000
Non-Serious Injury	2,078	$56,314,000
Possible Injury	2,772	$61,816,000
Non-Injury	11,214	$133,447,000
Property Damage Only	1,446	$6,362,000
Total	18,098	$462,170,000

*Estimates based upon average cost per crash by severity rating from the National Safety Council for 2017.

primary factors in regional crashes

Depending upon which study is cited, between 80% and 90% of all motor vehicle crashes are primarily the result of driver error. The most common errors involve: speeding or driving too fast for conditions, failing to yield the right of way, or distracted driving. Although disregarding red lights or stop signs are identified as a separate factor, often this issue is identified as failing to yield right of way especially in cases where there are no independent eyewitnesses. These three factors combined account for approximately 60% of all crashes within McLennan County.

Regarding the most severe crashes (involving fatalities and serious or life threatening injuries), these three factors account for slightly more than 60% of these crashes. Driving under the influence of alcohol or drugs, however, i cited as a primary factor for only 3.6% of all crashes, but represent nearly 1 out of every 7 (14.3%) fatal or serious injury crashes. Tables 5.26 and 5.27 provide a summary of common primary crash factors for all crashes, and fatal or serious injury crashes (these tables do not, however, provide a full accounting of all crashes during the 2016-2018 period).

table 5.26 – most common primary crash factors* for all crashes: mclennan county (2016-2018)

Crash Factor*	Total Crashes	Percent of Total
Speeding / Failed to Control Speed	4,596	25.4%
Failed to Yield Right of Way	3,156	17.4%
Driver Distraction	3,114	17.2%
Disregard Red Light or Stop Sign	1,296	7.2%
Followed Too Closely	1,217	6.7%
Under Influence Alcohol or Drugs	645	3.6%
Wrong Way or Wrong Side of Road	201	1.1%

*Cited as either a primary or secondary factor. Crashes may also cite more than one factor.

table 5.27 – most common primary crash factors* for fatal or serious injury crashes: mclennan county (2016-2018)

Crash Factor*	Total Crashes	Percent of Total
Speeding / Failed to Control Speed	179	29.7%
Driver Distraction	99	16.4%
Failed to Yield Right of Way	98	16.3%
Under Influence Alcohol or Drugs	89	14.8%
Disregard Red Light or Stop Sign	39	6.5%
Followed Too Closely	14	2.3%
Wrong Way or Wrong Side of Road	14	2.3%

*Cited as either a primary or secondary factor. Crashes may also cite more than one factor.

hot spot analysis

To analyze the worst crash locations, the MPO staff focused on highway corridors, identifying the worst locations by the absolute number of crashes and then by crashes per one million vehicle miles traveled (VMT). The VMT analysis is used in order to compare highways and intersections with differing traffic volumes and segment lengths. Additionally the VMT analysis is limited to corridors for which a minimum of 50 crashes were observed between 2016 and 2018. Map 5.7 shows the highway segments identified in Tables 5.28 and 5.29.

table 5.28 – worst 10 highway segments: total crashes (2016-2018)

Street	From	To	Total Crashes	Crashes per Million VMT	Percent Fatal or Serious Injury
IH-35	South 17th St (US 77)	S Univ Parks Dr	437	2.24	2.7%
IH-35	Lake Shore Dr Loop 340	Craven Ave	379	2.27	1.8%
IH-35	S Valley Mills Dr (Loop 396)	South 17th St (US 77)	358	3.35	5.9%
IH-35*	McLennan County Line	Woodlawn Dr	304	1.12	4.3%
SH 6	West Waco Dr (US 84)	Bosque Blvd (Loop 396)	300	3.56	2.3%
IH-35	Behrens Cir	Lake Shore Dr (FM 3051) / Loop 340	295	4.27	3.4%
IH-35	New Rd	South Valley Mills Dr (Loop 396)	292	1.84	4.8%
W Loop 340 / SH 6	Bagby Ave (FM 3476)	Imperial Dr (FM 3223)	268	2.99	3.0%
IH-35	S Loop Dr (US Bus 77)	East Waco Dr (US 84)	237	3.61	2.5%
N 17th / N 18th Sts	Franklin Ave	West Waco Dr (US 84)	232	18.54	1.3%

VMT = Vehicle Miles Traveled
*Roadway under construction between 2016 and 2018.

In terms of absolute number of crashes, Interstate 35 consistently has the most crashes. This is not a surprise as IH-35 also has the most traffic and is the longest single facility

designation within the region. In addition, one of the segments with the worst totals, the section between Woodlawn Drive and the McLennan County Line, was under construction until late 2018. Numerous studies show that construction zones have significantly greater number of crashes compared to non-construction zones.

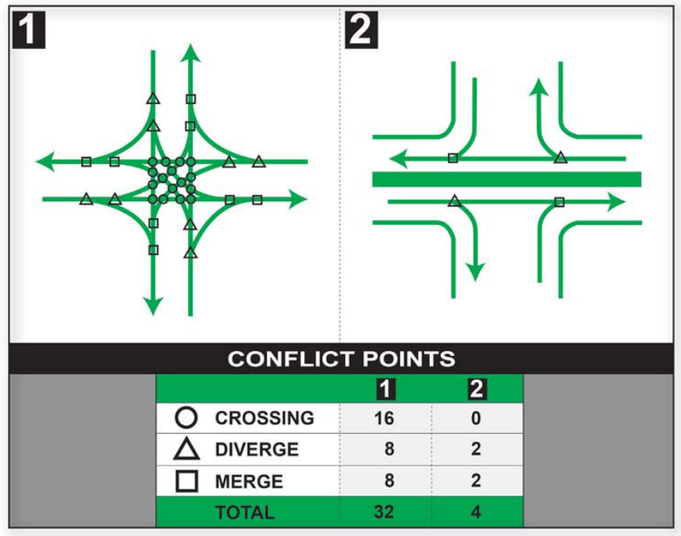
The general issues with IH-35 crashes are two-fold: 1.) Speeding or driving too fast for conditions, and 2.) Unsafe lane changes. The widening and reconstruction of IH-35, which adds travel lanes, improves sight distances, reduces the number of on and off ramps and lengthens those ramps, should reduce the number of crashes in the future. Much of the Interstate work outside of the Waco Urbanized Area has been completed as of 2019. The phase of this project between North Loop 340 and 12th Street in Downtown Waco is currently under construction and is scheduled for completion in late 2022 or early 2023.

table 5.29 – worst 10 highway segments*: crashes per million vehicle miles traveled (2016-2018)

Street	From	To	Total Crashes	Crashes per Million VMT	Percent Fatal or Serious Injury
Lake Air Dr	West Waco Dr (US 84)	Franklin Ave (Spur 298)	55	117.69	0.0%
Austin Ave	N 26th St	N 17th St	88	50.62	1.1%
Sanger Ave	N Valley Mills Dr (Loop 396)	N New Rd	62	41.38	4.8%
Franklin Ave	N 5th St	S Univ Parks Dr	88	37.80	3.4%
Clay Ave	S 11th St	S 4th St	53	36.94	3.8%
W Waco Dr (US 84)	N Valley Mills Dr (Loop 396)	N New Rd	140	32.36	2.1%
N 25th & 26th Streets	West Waco Dr (US 84)	Franklin Ave	129	27.82	7.0%
Franklin Ave	S 11th St	S 5th St	63	24.67	3.2%
N New Rd	West Waco Dr (US 84)	N Valley Mills Dr (Loop 396)	69	21.85	2.9%
Wooded Acres Dr	N Valley Mills Dr (Loop 396)	Bosque Blvd	57	21.64	10.5%

VMT = Vehicle Miles Traveled
*Minimum 50 crashes

When factoring in VMT, a different picture emerges regarding crashes. Instead of limited access facilities (such as IH-35) being near the top, the worst performing facilities are arterial roadways with moderate traffic volumes. The primary issue here is that there are significantly more conflict points for these facilities as every access point is at-grade with only paint, signage or at most, a traffic signal providing traffic control. As a result, these facilities are unforgiving in instances of distracted driving, disregard for red signals or stop signs and especially driving under the influence of alcohol or drugs. Crashes on these facilities are especially severe at speeds greater than 40 mph since the majority of collisions are the high angle 'T-Bone' manner. Traditional efforts at reducing crashes on these facilities have focused on limiting access by some means, such as grade separating high volume intersections or replacing center turn lanes with a center median especially for facilities with six or more travel lanes.



Conflict points for a roadway / driveway intersection with full cross access versus the same intersection with cross access restricted. While incorporating access control on new facilities is encouraged for the Waco Region, retrofitting existing corridors in such a manner is no longer a point of emphasis.

Discussions with regional business and citizen interests, however, strongly suggest that while incorporating such designs into new facilities is encouraged, retrofitting existing corridors in such manners would result in unacceptable negative impacts to property owners and economic interests. As a result, for existing corridors, the focus of the MPO has shifted to efforts to right sizing corridors for future traffic volumes which has the effect of lowering speeds and providing better access for transit, bicycle and pedestrian modes. The Waco Metropolitan Area Thoroughfare Plan, adopted in 2012, provides recommendations regarding conceptual thoroughfare design which varies depending upon the urban, suburban or rural context of the

facility. In general, the more urban the context, appropriate speeds are slower and provisions for non-automotive modes increases along the thoroughfares.

MPO staff has conducted further analysis for each of these corridors by analyzing details about the manner of collisions and primary crash factors. This provides insights on possible corrective actions to reduce the number of crashes. TxDOT produces a table of crash reduction factors to estimate the impact of various highway improvements upon crash rates and severity. These factors are based upon comparisons of crash rates before and after improvements were made for past highway improvements across Texas. These crash reduction factors were then incorporated into the MTP project selection criteria to assess the effect proposed projects may have on reducing total crashes and severity. The MTP project selection criteria can be found in Appendix B.

5.1.7 – stormwater impacts

The Waco Metropolitan Area includes portions of six significant, regional watersheds, all within the Brazos River Basin. Three of these watersheds, the North Bosque River, the Middle Bosque River, and the South Bosque River all converge into the region's primary water supply reservoir: Lake Waco. A fourth watershed, Tehuacana Creek, is the primary drainage feature for the eastern portion of McLennan County and drains into the Brazos River approximately two miles downstream from Loop 340. A fifth watershed, Bullhide Creek, is the primary drainage feature for southern McLennan County and drains into the Brazos River near the Falls County line.

Regional drainage is generally characterized by well-established channels that carry stormwater runoff quickly to the Brazos River and then to the Gulf of Mexico. The notable exceptions to this are areas within East Waco, Bellmead and Lacy-Lakeview which were developed on the alluvial plain of the Brazos River. As a result, these areas are relatively flat with less than good drainage. Highway projects within these areas generally require significant accommodation for stormwater runoff. The US Business 77 corridor study, completed and accepted in spring 2017, identified several areas of potential poor drainage along the corridor and provided several conceptual recommendations for a future design phase prior to any reconstruction.

As a rule, the TxDOT thoroughly reviews stormwater and cross drainage deficiencies for all proposed construction projects requiring additional pavement. All project recommendations identified in section 7 of the MTP require a stormwater analysis as part of the engineering phase of development prior to programming within the Transportation Improvement Program (TIP).

As of publication of this MTP, no regional stormwater master plans have been developed identifying specific problem areas and proposed projects. With that said, the City of Waco is in the process of developing a stormwater master plan. This plan would identify areas where highway runoff is considered problematic and suggest recommendations to mitigate.

5.2 – public transportation

As the urban and rural areas of McLennan County continue to change, so do the transportation needs of its residents. To evaluate the public transit needs of McLennan County residents and those who travel through the County, the Waco MPO, in partnership with Waco Transit, conducted a Transit Need Study, adopted by the Waco MPO Policy Board in 2018.

The purpose of the study is to ensure that the provision of public transportation services meets the needs of the County to the fullest extent possible, especially for individuals with limited transportation options. The study also helps the Waco MPO and Waco Transit take the necessary steps to plan for the future public transportation needs of the County and the region.

The overall goal of the Transit Need Study is to improve the availability, quality, and efficiency of transportation services for seniors, individuals with disabilities, those with low income, and other population groups with limited transportation options. This study is likewise developed to create a plan for McLennan County that will fit seamlessly into the Heart of Texas Regionally Coordinated Transportation Plan. The following discussion is informed by the Transit Need Study.

5.2.1 – transit need

The Transit Need Study analysis was conducted by collecting and assessing data representing both the availability and need for transportation services within the region. This general assessment helped determine what transportation resources were available, where they were available, and where these resources would likely be needed based on supportive demographics.

A demographic analysis was performed to identify 'transit-dependent' and 'at-risk' populations. Transit-dependent population as a percent of the total population is an indicator for transit demand and measures captive riders (i.e., those whose mobility is almost entirely dependent on public transportation). Transit-dependent population identifies transit need based primarily on age (those too young/old to drive), number of drivers in the household, group quarters populations, and household vehicles.

Although transit-dependent population is an important metric to estimate the need for public transportation services, there are other population groups who may have special needs when it comes to transportation. At-risk population may also be used as an indicator of transit demand. At-risk population differs from transit-dependent population in that it represents those who are more likely to need transit in comparison to the general population, including citizens over the age of 65, the disabled, household units with no automobile, minorities, and those living below the poverty line.

The demographic and transportation need analysis was completed using 2015 block group population data from the US Census Bureau American Community Survey (ACS) 5-year estimates. Data on institutionalized / non-institutionalized group quarters population and urban / rural population data were derived from 2010 Census records.

transit need index - methodology

To estimate need, several characteristics were identified for persons for whom use of a motor vehicle is either a financial burden or a physical impossibility. The primary characteristics included the following:

- Median Household Income
- Persons in Poverty
- Persons Age 65 and Above

- Persons with a Self-Care or Stay at Home Disability

Although not a population characteristic, occupied housing units with no automobiles was also used to estimate those households that have no access to a motor vehicle. Even though high transit usage by minorities is generally related to overall lower household incomes or higher poverty rates for minorities, minority population was also utilized within the index primarily because there was not a direct relationship between minority population and low income or high poverty. Some block groups within the region had relatively high minority populations but relatively high household incomes or relatively low poverty rates and vice-versa. Minority population was not emphasized within the index, however, and was weighted accordingly.

Each population characteristic was weighted within the index to reflect its relative importance or unimportance. Table 5.30 identifies the relative weights for each characteristic.

table 5.30 – population characteristics and weights

Population Characteristic	Weight
Median Household Income	1.0
Persons in Poverty	2.0
Persons Age 65 or Over	2.0
Persons with a Self-Care or Stay at Home Disability	1.5
Occupied Housing Units with No Automobiles	1.5
Minority Population	1.0
Population Density	0.5

While the goal of the transit need index is to identify places where the population may have a greater need for transit, regardless of the size of the population, the quantity of service would be greater for areas with a high need index and high population densities. For this reason, population size classes were used within the index to provide a slightly higher score for those areas with greater population. Table 5.31 identifies the population size classes used within the index.

table 5.31 – population size classes

Population Density (Persons per Square Mile)	Size Class
0 to 500	1
500.1 to 1000	2
1000.1 to 3000	3
3000.1 to 6000	4
Over 6000	5

In constructing the transit need index, each population characteristic for each block group was compared to the averages for the entire region. The average for the Waco Region was indexed at 1.0. Scores for individual block groups were based on a percentage of the regional average. For instance, the regional average for percent of persons in poverty is 18.87%. A block group with a percentage of 37.74% (double the regional average) would achieve a score of 2.0 for this population characteristic. For population density, the size class would be the score for the block group. Once a score is determined, the score is multiplied by the weight for that population characteristic to determine the final, weighted score. The weighted scores are then added together to calculate the transit need index. Table 5.32 identifies the regional averages for the Waco Region.

table 5.32 – regional averages and weighted scores

Population Characteristic	Regional Average	Initial Score	Weighted Score
Median Household Income	$40,031	1.0	1.0
Percent of Persons in Poverty	18.87%	1.0	2.0
Percent of Persons Age 65 or Over	12.39%	1.0	2.0
Percent of Persons with a Self-Care or Stay at Home Disability	10.16%	1.0	1.5
Percent of Occupied Housing Units with No Automobiles	5.44%	1.0	2.0
Percent Minority Population	36.4%	1.0	1.0
Population Density	60.41	1	0.5
		Regional Score:	10.0

Source: McLennan County Transit Need Study, 2018

After the index scores had been determined for each block group, the relative demand for transit was then determined based upon their score. Table 5.33 identifies the score classifications and Maps 5.8 and 5.9 show the final transit need classifications.

table 5.33 – transit need classifications

Classification	Minimal	Some	Moderate	Severe
Transit Need Index Score	Less than 9.17	9.18-14.0	14.1-20	20.1 or Greater

Source: McLennan County Transit Need Study, 2018

transit need index - analysis

According to the Transit Need Index, the most significant concentration of transit demand exists near Downtown Waco, East Waco and portions of South Waco (See Map 5.9). Other areas within the region with high demand can be found in the vicinity of McLennan Community College, Texas State Technical College (TSTC), in Hewitt near Chapel Rd, and along portions of the Franklin Ave/Waco Drive, Hwy 6 and Bosque Blvd corridors (see Map 5.8). Most other areas were generally classified as having ‘Some’ or ‘Minimal’ transit need. Generally, the lowest scores were found near Lake Waco, and in Woodway. Low scores were also found in parts of Hewitt, Robinson and the China Spring areas.

Transit need only measures half of the equation for determining the location and type of public transportation service. Locating primary destination points (large employers, retail shopping center, doctor's offices, etc.) and how to connect these to the high demand areas, is the other half of the equation. Section 5.2.3 identifies the most important destinations within the region and provides this analysis.

5.2.2 – transit coverage and gap analysis

In order to determine transit coverage and perform a gap analysis, the Transit Need Index was mapped and compared to Waco Transit Service (WTS) fixed-route network coverage. A 1/4 mile buffer (roughly five minutes walking) was used to represent coverage, as it is the standard assumption for how far people are willing to walk to transit. This gap analysis revealed geographic areas that have moderate or severe transit need, but are not served by fixed-route service (see Map 5.10).

The results of the transit coverage and gap analysis indicate that roughly 37% of the total population and 36% of jobs in McLennan County are located within 1/4 mile of WTS fixed-route service. Fixed Routes 3 and 8 serve the most population, each reaching more than 20,000 people, while Route 6 serves the fewest people (5,901). Route 10, WTS' rural service, covers roughly 9,300 people within 1/4 mile of the route. Table 5.34 summarizes transit coverage for McLennan County.

table 5.34 – mclennan county transit coverage

Population Group	Percent Served by Transit (within ¼ mile of fixed transit route)
McLennan County Total Population	37%
Transit Dependent Population	46%
Total Employment	36%
Persons Age 65 or older	32%
Disabled Persons	39%
Minority Population	55%
Persons in Poverty	57%

Source: McLennan County Transit Need Study, 2018

Understanding where transit service duplication exists is as equally important as understanding who it serves. The Transit Need Study determined that the transit-dependent population and at-risk populations experience duplicate service within the urban fixed-route system. Some fixed routes naturally intersect with other routes as they utilize similar roadways, resulting in portions of the city having access to several services. Roughly 59% of McLennan County's total population falls within an area served by either three or four routes. Similar results are seen regarding the county's transit-dependent population (61%). At-risk population subgroups saw the most duplication with most areas served by three routes. See Map 5.11 for areas with transit service duplication.

5.2.3 – destination analysis

A key component to understanding transportation needs within McLennan County is to analyze the number of attractors, or potential destinations, that are served by transit. Transit attractors are businesses and other destinations where residents need and want to travel to daily. The Transit Need Study included a destination analysis that identified the number and percentage of transit attractors served by both the Waco Transit fixed-routes service and the Waco Transit Americans with Disabilities Act (ADA) service. Any attractor within walking distance (1/4 mile) of a transit route was determined to be adequately served by the Waco Transit fixed-routes. Any attractor within the ADA service area (3/4 mile) was deemed adequately served.

The Transit Need Study combined the different types of attractors into seven groups:

- Government & Public Services: Courthouses, Libraries, Social Services, Post Offices, Utilities Offices;
- Medical & Health Services: Hospitals, medical centers, dentists, outpatient facilities;
- Shopping Centers: Grocery stores, shopping malls, convenience stores;
- Job Locations: Office buildings, hotels, manufacturing;
- High-Density Residential: Apartment complexes and senior housing;
- Services: Childcare facilities, movie theaters, pharmacies, hair salons; and
- Parks and Community Centers: Public parks, sports and recreation complexes, museums, churches.

Note that the data shown in Tables 5.35, 5.36, and 5.37 are grouped as they were for the 2015 MTP to allow for comparison.

The number of attractors and percentage of overall attractors by type is shown in Table 5.35. While most attractors are near the main population centers in central McLennan County, several key attractors are in communities outside of the census-defined urban area. Tables 5.36 and 5.37 illustrate the number and percent of attractors served by Waco Transit fixed-routes and ADA service. Only 65% of attractors are within ¼ mile of a WTS fixed bus route, with parks / recreation / tourism locations and industrial / manufacturing being the least served (52% each) and hotels / motels and medical / dental the most served (85% and 82% respectively). Within the ADA service area, 80% of attractors are served. The 'all others' category, which includes locations such as churches, movie theaters, pharmacies, post offices, and other services, is the least served at 68%. Apartment complexes, hotels / motels, and medical / dental are all served at a rate of 90% or greater.

table 5.35 – mclennan county transit attractors by type

Attractor Type	Totals
Apartment Complexes	144
Banks / Financial	75
Child Day Care	86
Government / Public Assistance	103
Hotels / Motels	55
Industrial / Manufacturing	136
Medical / Dental	122
Nursing Home / Assisted Living	22
Parks / Recreation / Tourism	114
Retail / Office Centers	158
All Others	388
All Destinations	1,403

Source: McLennan County Transit Need Study, 2018

table 5.36 – mclennan county transit attractors served by waco transit fixed-routes

Destination	Number Served by WTS Fixed-Route	Percent of Attractors Served
Apartment Complexes	96	67%
Banks / Financial	53	71%
Child Day Care	58	67%
Government / Public Assistance	77	75%
Hotels / Motels	47	85%
Industrial / Manufacturing	71	52%
Medical / Dental	100	82%
Nursing Home / Assisted Living	15	68%
Parks / Recreation / Tourism	59	52%
Retail / Office Centers	125	79%
All Others	215	55%
All Destinations	916	65%

Source: McLennan County Transit Need Study, 2018

table 5.37 – mclennan county transit attractors served by waco transit ADA service

Destination	Number Served by WTS ADA Service	Percent of Attractors Served
Apartment Complexes	130	90%
Banks / Financial	56	75%
Child Day Care	69	80%
Government / Public Assistance	85	83%
Hotels / Motels	51	93%
Industrial / Manufacturing	104	76%
Medical / Dental	112	92%
Nursing Home / Assisted Living	19	86%
Parks / Recreation / Tourism	98	86%
Retail / Office Centers	134	85%
All Others	262	68%
All Destinations	1,120	80%

Source: McLennan County Transit Need Study, 2018

Public transportation services from the surrounding rural counties make daily trips into the Waco Metropolitan Area primarily for medical or school trips. As these services are primarily demand response services, providing curb-to-curb service, access to other destinations within the Waco Metropolitan Area can only be accomplished through a transfer to one of the fixed routes for Waco Transit. Below is a discussion of the medical and educational services which serve as the primary destination points for these rural services and connectivity to the Waco Transit fixed route system.

hospitals / medical offices / kidney dialysis

The Waco Metropolitan Area is served by three hospitals, Providence Healthcare Network and Baylor Scott & White Hillcrest Medical Center both of which are located along SH 6 / Loop 340

and the Central Texas Veterans Health Care System located on New Rd near Beverly Hills. Waco also has two stand-alone emergency rooms -- Premier ER & Urgent Care, located on the IH-35 southbound frontage road, near S 2nd Street, and Express Emergency Room, on Valley Mills Drive near Wooded Acres Drive.

The following are the more important medical destinations within the region, all of which are served by one or more Waco Transit fixed routes.

- Central Texas Veterans Health Care System, Waco
- Baylor Scott & White Hillcrest Medical Center, Waco
- Providence Healthcare Network, Waco

Fresenius Kidney Care operates four locations in Waco and one in Bellmead. All except the Lake Shore Drive location are within ¼ mile of a WTS fixed route service. However, the Lake Shore Drive location is within ¾ mile, which meets the ADA service requirement. The two stand-alone emergency room facilities are also served by one or more WTS fixed routes.

education

Three institutions of higher education exist within the Waco Region. Baylor University in Waco is the only four-year university within the region. TSTC provides two-year degrees focusing on technical trades. McLennan Community College (MCC) provides two-year associate degrees in a number of disciplines as well as the City College program which offers four-year and graduate degrees through Tarleton State University and the University of Texas at Arlington. Baylor University is served by a shuttle service that circulates through the campus and immediate vicinity. The WTS fixed route service serves all three schools with one or more fixed routes.

5.2.4 transit asset condition

In addition to transit service, it is important to maintain adequate transit facilities and equipment. As with roadways, proper maintenance will preserve and expand public transit investments. Having well maintained, reliable transit infrastructure (e.g., track, signal systems, bridges, tunnels, vehicles, or stations) helps ensure safe, dependable and accessible services. At some point, transit assets will deteriorate to the level of requiring reconstruction or replacement. This section reviews the condition of the regional transit network to help determine which vehicles and equipment are in need of replacement and which facilities are in need of reconstruction.

The FAST Act Transit Asset Performance Management Rule (TAM) establishes requirements to assess the condition of regional transit networks relative to a USDOT definition of State of Good Repair (SGR). SGR is the condition in which a capital asset is able to operate at a full level of performance. The premise of the rule is condition of assets should guide funding prioritization in order to meet the national goal of strategically and systematically maintaining the nation's transit networks in good condition.

The TAM rule outlines the process for State DOTs, MPOs, and transit systems to establish and report their transit asset condition targets, and the process FTA will use to assess whether transit systems have met or made significant progress toward meeting their transit asset condition targets. Waco Transit first approved TAM targets for four federally required transit asset performance measures in 2018, and updated them on Jan 1, 2019. The performance measures focus on assessing the condition of rolling stock (e.g., buses and passenger vans), the condition of equipment (e.g., maintenance vehicles), the condition of transit facilities (e.g., transit stations, maintenance shops), and the condition of transit infrastructure (e.g., track for commuter rail or streetcar).

The MPO can either adopt a separate set of targets for transit assets or support the targets approved by Waco Transit. The MPO Policy Board acted to support the Waco Transit targets as they are the only public transportation operator within the Waco Region required to establish asset condition targets. In support of the Waco Transit targets, the MPO will evaluate projects within the MTP based on whether they assist Waco Transit in achieving their targets for asset condition. In February 2019, the Waco MPO resolved to support the Waco Transit System's 2019 asset condition targets for:

- Rolling Stock - Percent of revenue vehicles that exceed the Useful Life Benchmark (ULB) (see Table 5.38)
- Equipment - Percent of non-revenue maintenance vehicles that exceed the ULB (see Table 5.38)
- Facilities - Percent of facilities rated less than 3.0 on the Transit Economic Requirements Model (TERM) Scale (see Tables 5.39 and 5.40)
- Infrastructure – Percentage of track segments by mode that have performance restrictions (applies to nine types of fixed guideway modes)*

*No passenger rail modes such as light rail or bus rapid transit currently operate in the Waco Region, so no infrastructure performance targets are currently required.

table 5.38 – 2019 rolling stock and equipment condition targets: waco transit system

Fleet	Vehicle Class	Vehicle Type	Total Fleet Size	No. of Vehicles Exceeding ULB*	Vehicle Type or Fleet Group % Exceeding ULB* in 2018	2019 Target
Urban Stock	Bus	Bus	24	12	50%	50%
Urban Stock	Other Passenger Vehicle	Cutaway	18	18	100%	100%
		Van	3	3	100%	100%
		Auto	9	9	100%	100%
		Service Vehicle	6	6	100%	100%
Rural Stock	Other Passenger Vehicle	Cutaway	10	10	100%	100%
		Van	3	3	100%	100%
		Auto	8	0	0%	0%
Urban Equip	Non-Revenue Service	Utility Vehicle	3	2	67%	67%
Rural Equip	Non-Revenue Service Vehicle	Supervisor Vehicle	1	0	0%	0%

**Useful Life Benchmark* (ULB): defined by FTA as the expected amount of time in years that a vehicle type is estimated to function, when acquired new and assuming routine maintenance is practiced.

table 5.39 – 2018 facility condition targets: waco transit system

System	Facility Class	Facility Type	Age	Facility Type Condition FY 2019 **	Facility Performance Target FY 2019
Urban	Support Facility	Transit Administration Maintenance Building	12	4.4	12%
Urban	Passenger Facility	Transit Intermodal Terminal	18	4.4	12%

**Transit Economic Requirements Model (TERM Scale): a 5-point scale used by FTA as a tool to assess facility conditions. A transit asset is deemed to be in good repair if it has a TERM rating of 3, 4 or 5.

table 5.40 – USDOT TERM scale: facility condition assessment

TERM** Rating	Condition	Description
Excellent	4.8-5.0	No visible defects, near-new condition
Good	4.0-4.7	Some slightly defective or deteriorated components
Adequate	3.0-3.9	Moderately defective or deteriorated components
Marginal	2.0-2.9	Defective or deteriorated components in need of replacement
Poor	1.0-1.9	Seriously damaged components in need of repair

**Transit Economic Requirements Model (TERM Scale): a 5-point scale used by FTA as a tool to assess facility conditions. A transit asset is deemed to be in good repair if it has a TERM rating of 3, 4 or 5.

The mix of transit projects selected by the Waco MPO for inclusion in the MTP is intended to support the Waco Transit System in achieving its asset condition targets for the Waco regional transportation system given the availability of necessary funds.

Waco Transit is expected to approve updated TAM targets by February 2020. The MPO Policy Board will act to support those 2020 TAM targets or to adopt a separate set of targets within 180 days of action by Waco Transit.

5.2.5 – transit safety measures

The FAST Act Public Transportation Agency Safety Plan Rule (PTASP) establishes requirements to assess safety risks within regional transit networks. Each year, the National Transit Database (NTD) reports safety events from across the U.S. that involve a transit system's property, along with the number of fatalities and injuries that result from those events. Examples of NTD defined safety events include collisions, derailments, fires, hazardous material spills and life-safety evacuations. The objective of PTASP is to improve public transportation safety by guiding transit agencies to more effectively and proactively manage safety risks in their systems, to better predict and reduce the frequency of safety events, and to ensure safety improvements guide funding prioritization in order to advance the national goal of maintaining safe transit networks.

The PTASP rule requires each public transportation operator that receives federal grants to develop and implement a safety plan based on principles of Safety Management Systems (SMS) to reduce the likelihood of safety events. SMS is a comprehensive approach to safety management involving both transit management and labor in earlier detection and correction of safety problems, more effective analysis of safety data, and more precise measurement of safety performance.

Safety Plan Components include the following:

- Safety Management Policy
  - Safety objectives
  - Employee reporting program
  - Organizational accountabilities & safety responsibilities
  - Safety Officer designation
- Safety Risk Management Program

    - Processes for hazard identification
    - Risk assessment processes
    - Mitigation development processes
- Safety Assurance Program
    - Safety performance monitoring & measurement
    - Change management processes
    - Continuous improvement processes
- Safety Promotion Program
    - Comprehensive safety training program
    - Safety communication processes
- Performance targets based on the safety performance measures established in FTA's National Public Transportation Safety Plan (NSP):
    - Fatalities
    - Injuries
    - Safety Events
    - System Reliability (State of Good Repair)
- Emergency Preparedness and Response Plan
- Process and timeline for conducting an Annual Safety Plan Update

The PTASP rule outlines the process for State DOTs, MPOs and transit operators to establish and report their transit safety targets, and the process FTA will use to assess whether transit systems have met or made significant progress toward meeting their transit safety targets. The final rule became effective on July 19, 2019 and requires transit providers to have their certified agency safety plans in place and share their required safety performance targets with their MPO no later than July 20, 2020.

Each year, TxDOT drafts and certifies safety plans on behalf of small public transportation providers in Texas, unless one of those small provider opts to draft and certify their own safety plan. Waco Transit meets the requirements defined by FTA to be considered a small provider, and as such, can opt to be a part of the TxDOT sponsored PTASP. Waco Transit has notified the MPO that the Waco Transit Advisory Board is in the process of reviewing the state sponsored plan, and a final decision is expected in May 2020. Because Waco Transit is the only public transportation operator within the Waco Region, the Waco MPO will then incorporate Waco Transit's safety performance targets and performance plans into MPO planning processes and planning documents within 180 days of adoption by Waco Transit.

5.2.6 – security of the system

Ever since the terrorist attacks of September 11, 2001, ensuring adequate security of the transportation system has been a top priority of the US Government. To emphasis this, SAFETEA-LU legislation separated security into a stand-alone planning consideration. In Waco, the public transportation system is the most obvious first line of defense in securing the transportation system, as this is the mode with the largest concentration of travelers in one place at one time. It is not terrorism, however, but crimes such as robbery, theft or assault that pose the most realistic, although uncommon, threat to users of Waco Transit. It is important to note, however, that due to the very nature of topic, some details regarding the security of the system cannot be discussed in a public forum. Both Waco Transit and the McLennan County Rural Transit District (rural and elderly and disabled programs) coordinate with local first responders and Waco / McLennan County Emergency Management to minimize potential threats to their respective systems. The details provided below are such that a public discussion does not jeopardize their effectiveness in minimizing threats to the users of the system.

The first line of defense for users of Waco Transit is the buses themselves. As of 2010, Waco Transit completed replacement of the existing fleet with buses equipped with an audio / video surveillance system to record all activities inside and outside of the bus as well as all sound inside the bus. This system can be monitored remotely in real time should the driver declare an emergency or a threat be made against the system. The buses also include Geographical Positioning System (GPS) technology which allows Waco Transit to track the buses' location. Finally, each bus is equipped with an emergency switch that can be activated by the driver that automatically sends an emergency signal to the Waco Police department and Waco Transit and activates an emergency indicator on the bus for easy identification.

The next line of defense is the facilities maintained by Waco Transit, including the Intermodal Center and the Maintenance and Administration Facility. Both facilities have video surveillance to monitor activities in and around these buildings. In addition, electronic door locks have been installed to restrict access to certain areas of each facility. Access to restricted areas can only be provided through magnetic ID cards which records the employee's name, date, time, and area of the facility the employee is accessing. This system can also be programmed to restrict the access of employees to only those areas within each facility where access is necessary for their position.

Bus shelters are another area being targeted by Waco Transit for additional security measures. During the winter months, Waco Transit fixed route operations begin and end during darkness. To provide a level of comfort for system users, future shelters are proposed to be lit with solar powered lights. In addition to these measures, emergency call boxes are proposed for installation at each shelter. Once activated by a user being threatened, video and audio surveillance of the shelter would begin and then would connect to E-911 and to local first responders.

5.3 – bicycle and pedestrian

5.3.1 – bicycle suitability

Many adults are interested in bicycling for transportation, but are discouraged by the potential for stressful interactions with motor vehicles. The Waco MPO has developed a Bicycle Suitability Index for arterial and collector roadways within McLennan County. The target cyclist (or the design user profile) for this index is a novice rider (otherwise known as 'interested, but concerned' or 'willing but wary'). The FHWA recommends designing for this type of bicyclist, because the resulting bikeway network will serve bicyclists of all ages and abilities.

The MPO's Bicycle Suitability Index is a tool to help bicyclists map a route that best matches their comfort level and ability. It is especially helpful in areas without defined or designated bikeways. The index was initially developed in 2015, and updated in 2017 for the MPO's Active Transportation Plan (ATP). The scoring criteria are modified from a system first developed by the USDOT. Table 5.41 summaries the criteria used in scoring bicycle

suitability and Table 5.42 lists the scores used to define the levels of comfort for novice bicyclists.

table 5.41 – bicycle suitability criteria

Criteria	Add / Subtract from Beginning	Score
Beginning Score	n/a	3.67
Presence of 15' Curb Lane	Subtract	Speed Score*
Curb Lane Width	Subtract	Width x Speed Score
Curb Lane Volume	Subtract	Volume x 0.002
Other Lane Volume	Subtract	Volume x 0.004
Per Hour Truck Volumes	Add	< 10 = 0 10 to 19 = 0.1 20 to 29 = 0.2 30 to 59 = 0.3 60 to 119 = 0.4 >120 = 0.5
Speed Limits**	Add	Posted Speed x 0.22
Presence of On-Street Parking	Add	0.506
Parking Type	Add	Parallel = 0.2 Angle = 0.6
Rural / Residential / Undeveloped Land Use	Add	0.264
Driveway & Street Intersections per Mile	Add	<20 = 0 >20 = 0.1 every 10/mi
Railroad Crossing	Add	0.2
Steep Slope	Add	0.3

*Speed Score: Less than 50 mph = 0.966, 51 to 55 mph = 0.8, 56 to 60 mph = 0.6, Greater than 60 mph = 0.4.
**Facilities with posted speed limits of 70 mph were automatically given a comfort level of 'Not Recommended.'

table 5.42 – bicycle comfort level score

Score	Comfort Level
Less than 2.5	Easy
2.51 to 5.00	Moderate
5.01 to 10.00	Difficult
10.01 to 15.00	Not Recommended
Greater than 15.00	Not Recommended (Extremely Challenging)

Map 5.12 shows the bicycle suitability scores for the Waco Urbanized Area. Scores outside of the urbanized area were generally rated 'Easy' if the posted speed limit was below 70 mph or 'Not Recommended' if above 70 mph. In conversations with the local bicycling community, roadways with speed limits of 70 mph or greater are generally avoided unless no other option is available. Map 5.12 also identifies roadways that prohibit bicycle use. For example, state law prohibits the use of IH-35 main lanes and other expressways by bicycles. Additionally, frontage road use, although permitted, is generally discouraged due to the high number of merging movements, speed, and significant number of driveway access points.

Section 7 identifies recommended bikeway projects for the Waco Region. Recommended bikeways along corridors identified as either 'Moderate' or 'Difficult' were more likely to include some degree of separation from motor vehicle traffic, such as conventional or buffered bicycle lanes, or separated / protected bikeways.

5.3.2 – sidewalk condition inventory

MPO staff conducted a desktop sidewalk condition inventory. Staff looked first for the existence of sidewalks and then estimated the sidewalk condition as either 'poor', 'fair', or 'good'. 'Good' means a sidewalk is in good condition and ADA accessible. 'Fair' means a sidewalk is in mostly good condition and mostly ADA accessible, but may have less-than-ideal characteristics, such as narrow width, minor cracking, or out-of-date curb ramps. 'Poor' condition means a sidewalk is not ADA-accessible and/or is in serious disrepair. While this methodology is not as robust as a dashboard survey or walking audit, it does offer a helpful estimate of the extent of the existing sidewalk network in McLennan County, the overall condition of the network, where sidewalk improvements have been concentrated, and which areas need urgent attention.

As of 2019, there are approximately 481 miles of existing sidewalk in McLennan County. Of the existing sidewalks, approximately 54.5% is in 'Good' condition; 33.5% is in 'Fair' condition; and 12% is in 'Poor' condition (see Table 5.43).

Overall, the sidewalk network has seen steady improvement since the last iteration of the MTP. For example, in 2017, 26% of existing sidewalk was rated 'Poor' out of a total of 356 sidewalk miles (refer to the Active Transportation Plan). This improvement can be attributed to several factors: 1) new sidewalk construction; 2) replacement of sidewalk in poor condition; and 3) a more refined desktop analysis using higher quality satellite imagery. See Map 5.13 for the sidewalk condition inventory in the Waco Urbanized Area.

table 5.43 – 2019 sidewalk inventory

Sidewalk Condition Rating	Sidewalk Miles (2019)	Percentage of All Sidewalks (2019)
Poor	58	12%
Fair	161	33.5%
Good	262	54.5%
Total	481	100%

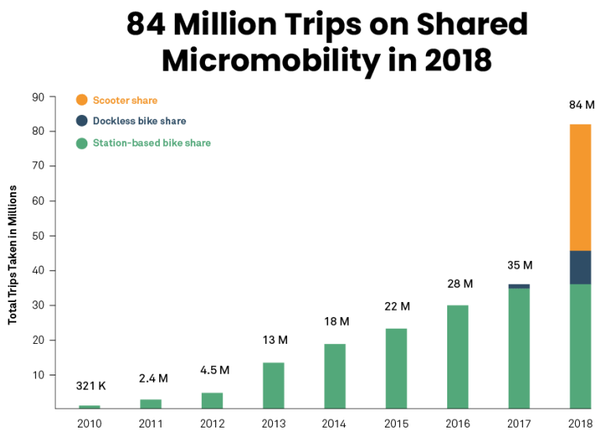
5.3.3 – micromobility

Shared micromobility has emerged as an affordable, convenient, and accessible first- and last-mile transportation solution. Micromobility is characterized by very light transportation vehicles / devices, such as bicycles, electric scooters (e-scooters), electric-assist bicycles (e-bikes), and other fully or partially human-powered small vehicles. Shared micromobility includes shared-use fleets of micromobility devices often managed through a mobile app.

The shared micromobility space is continuously evolving. Station-based bike share dominated the micromobility market in the early 2010s. Dockless pedal bikes briefly appeared in 2017 and 2018.

However, many dockless fleets have transitioned from pedal bikes to e-bikes, largely in response to e-scooters, which captured most of the new market share in 2018 – a trend that is continuing in 2019. See Chart 5.4 for micromobility market trends from 2010 to 2018.

chart 5.4 – shared micromobility trends: 2010 - 2018



Source: NACTO, 2019, Shared Micromobility in the US: 2018

The value of shared micromobility is truly realized when it's integrated with other travel modes (e.g., transit) via connected infrastructure and mobility-as-a-service (MaaS) – the result is a seamless trip chain that is not reliant on personal automobile ownership. While it is reasonable to assume that shared micromobility is a viable transportation mode that is here to stay, micromobility design / technology, and best practices in operation and management of shared micromobility programs, are iterative and in flux.

Micromobility needs are similar to bicycle and pedestrian needs. Micromobility users benefit from connected bicycle and pedestrian infrastructure designed for all ages and abilities. Bikeway maintenance – such as keeping bike lanes free of debris, potholes, and obstructions – is especially important for e-scooters, which have smaller wheels that are more sensitive to pavement condition. Future needs for shared micromobility include developing local regulatory frameworks to accommodate and manage the deployment of micromobility devices in the public realm; managing micromobility parking in the right-of-way; equitable access to shared programs; managing interaction of micromobility devices with cars, pedestrians, and pedal bicycles; promoting safe riding practices; and integrating micromobility into the regional transportation network.

5.3.4 – barriers to active transportation connectivity

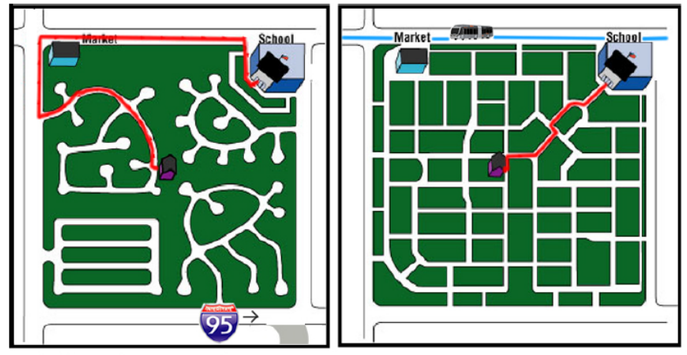
Travel by walking, biking, and micromobility modes must feel sufficiently safe and convenient. Safety concerns, particularly the fear of riding in traffic, are often a primary obstacle for those who are 'willing but wary' or 'interested but concerned.' This category of travelers often includes women, youth, and older adults. Convenience simply requires that the trip not take too long.

Some streets act as barriers to a safe and convenient active transportation network. These streets are often characterized by high traffic volumes, high vehicle speeds, wide right-of-ways, and limited signalized intersections. These roads are designed to move many cars (and sometimes freight traffic) as quickly as possible, and can be inhospitable to bicyclists and pedestrians attempting to travel along the road, or even just trying to cross the street. Barrier streets are shown on Maps 5.14 and 5.15 in red-black lines.

In some cases, there may be opportunities to provide safe active transportation infrastructure on or along these barrier streets. For example, a road diet and/or conversion from one-way to two-way operation may be desirable, because the average daily traffic (and projected future average daily traffic) does not warrant the current configuration. In these instances, unused pavement or right-of-way can be repurposed for active transportation infrastructure. Other times, there may be enough vacant land along the corridor to widen the public right-of-way to accommodate an off-street shared-use path, or add a sidewalk and on-street protected bike lane.

However, within the Urbanized Area, the roadway corridor is frequently built out and there isn't a simple way to add safe bicycle and pedestrian infrastructure without significant in-depth study and right-of-way acquisition. Right-of-way acquisition could impact adjacent businesses (by affecting driveways, parking, signage, and landscaping) which may be incompatible with current zoning requirements and business operations. Examples include portions of Bosque Blvd and Homan Ave, Lake Air Dr, Wooded Acres Dr, and New Rd in the city of Waco. It's very possible that some of these roadway segments may never be suitable to recommend as a bikeway, even though they might be the most convenient and direct (and sometimes the only) connecting route.

Non-grid suburban street design can also serve as a barrier to (or at least hinder) safe and convenient biking, walking, and rolling. Studies have shown that cul-de-sacs and other disconnects (such as non-aligned intersections) make it less efficient to walk, roll, and bike, while simultaneously concentrating vehicular traffic on a smaller number of streets, making it even less desirable for non-vehicular travel.



Driving-only transportation pattern Walkable connected transporation network

As shown in the first image below, if a pedestrian or bicyclist wants to travel from their home to school, they would be forced to use a higher-traffic-volume roadway that is circuitous to their destination. In the second image, the same person could use local streets (with less vehicle volume and slower speeds), and also take a more direct route to their destination.
Source: Congress for New Urbanism

Waterways such as the Brazos and Bosque Rivers and Lake Waco, active rail lines, and interstates and highways, also hinder connectivity due to the limited number of crossings and the associated expense of retrofitting existing, or constructing new, crossings to accommodate active transportation modes. The best opportunity in these situations is to implement a process that ensures that bicycle, pedestrian, and micromobility modes are

thoroughly considered when existing bridges are retrofitted or reconstructed, and when new crossings are under development and design.

5.3.5 – universe of need

The Waco ATP, adopted in 2019, provides recommendations for expanding and improving the bicycle and pedestrian network in McLennan County. This includes recommended projects, policies and best management practices (BMPs), outreach and education programs, and recommendations for future studies. The final list of ATP recommendations are based on: 1) an evaluation of the existing bicycle and pedestrian network, crash data analysis, and local priorities described in other long-range plans; 2) public comment and feedback; and 3) research on best practices (from transportation, recreation, and public health fields), and other adopted active transportation plans. The ATP recommendations are framed in the context of the Six E's -- Engineering, Education, Encouragement, Enforcement, and Evaluation and Planning, and Equity.

The engineering project recommendations are intended to construct and maintain safe and convenient bicycle and pedestrian infrastructure for people of all ages and abilities. This includes a diverse, connected network of bikeways; a connected network of ADA-compliant sidewalks; enhanced crosswalks or overcrossings; wayfinding signage and bicycle/micromobility parking; convenient public transit connections; and road diets and other physical alterations to existing roadways. The ATP includes an extensive list of over 200 recommended engineering projects throughout McLennan County, representing the 'universe of need' to build a connected and comprehensive active transportation network.

The universe of need projects are shown on Maps 5.14 and 5.15. These maps identify specific project types. For example, a bike lane vs. an off street shared-use path, or a sidewalk on one side of the street vs. both sides. In making these determinations, MPO staff started with the most separation or accommodation (such as sidewalks on either side or a separated bikeway). Then, existing roadway constraints were considered, such as available public right-of-way, development density vs. vacant/agricultural land, type of surrounding land uses, vehicle traffic volume and speed, and anticipated users. The recommended projects reflect these constraints to the extent possible for a planning-level document.

Protected Bike Lane in Chicago, IL
Source: People for Bikes

Two-Way Protected Bike Lane in Washington, DC
Source: People for Bikes

Bicycle Boulevard in San Luis Obispo, CA
Source: Pedestrian & Bicycle Info Center

Bike Route with Sharrows in Seattle, WA
Source: Seattle DOT

5.3.6 – priority recommended projects

The 'universe of need' represents about $370 million of improvements, and would take decades to implement at the current rate of investment in active transportation. Therefore, the ATP also includes a short-list of priority projects that help achieve the plan's objectives and respond to community priorities. These priority projects provide regional and cross-town connectivity through the Urbanized Area (for bicycles and micromobility devices) and within cities (for pedestrians), and connect residential areas to parks, schools, and commercial areas.

The priority projects are divided into two groups. The first group includes Regional Priority active transportation corridors that have strategic importance to the Waco MPO planning area. These projects create multi-modal connections across municipal boundaries, with the goal of providing continuous corridors within the Urbanized Area. These Regional Priority projects require coordination between multiple jurisdictions and may require state or federal funding in addition to local dollars. The second group includes Local Priority projects and corridors, which will build upon the investments made in the first group, and expand the active transportation network at the local (neighborhood, intra-city) level. Individual cities may choose to initially invest in Local Priority projects, and then connect these local investments to the regional active transportation corridor/Regional Priority projects. Together, these priority projects represent about one-third of the universe of need. For the purposes of this MTP, priority recommended projects were evaluated against the project selection criteria, which can be found in Appendix B. Often times, stand-alone projects from the ATP were incorporated into larger highway projects in this MTP.

5.4 – freight

From the food we eat and the clothes we buy, to the fuel we consume in our daily commute, people need goods to sustain their daily lifestyles. Goods and people are connected across a network of city streets, regional highways and rail networks, and intermodal ports and airports, all part of a transport industry and system that is invisible to most people. But when those streets and highways become congested creating unsafe conditions, when the costs of reconstructing and maintaining those roadways are out of reach, when rail or air traffic experience bottlenecks, individuals and individual businesses feel the impacts. So too do regional economies which are dependent on their ability to accommodate the movement and delivery of goods. Freight operators and transportation planners are increasingly addressing the challenges of freight movement as a key component of livability and efficiency in our metropolitan areas. Through recent legislation, Congress has placed particular emphasis on freight movement in the federal transportation planning process.

The FAST Act and its predecessor MAP-21 identified freight flows as a priority for the federal program and tasked state DOTs and MPOs with identifying impediments to these flows and projects to address these problem areas. States were tasked with

developing a freight plan that inventoried freight origins and destinations, facilities utilized in moving that freight, and developing a freight investment plan that identified how federal funds would be used for improving freight mobility. The second iteration of TxDOT's Texas Freight Mobility Plan that addressed FAST Act requirements was formally adopted in November 2017.

One of the primary efforts of the Texas Freight Mobility Plan was to designate a multi-modal freight network to include the most important freight facilities for each transportation mode. For highways, four designations of facilities were identified, with the first three being eligible for federal funds from the National Highway Freight Program (NHFP). The federal program restricts the mileage states can designate as part of the freight network and thus have as eligible for the NHFP. The fourth highway designation represents the Texas Highway Freight Network. These are facilities deemed important for freight transportation, but beyond the mileage restrictions placed on Texas for the federal program. See Table 5.44 for highway system priorities identified in the Texas Freight Mobility Plan.

table 5.44 – highway system priorities identified within the texas freight mobility plan

Highway Priority	Geography	Facilities	NHFP Eligibility
Primary Highway Freight System	Statewide	Interstate Only	Yes
Critical Urban Freight Corridor	Large MPOs*	Designated by MPO	Yes
	Small MPOs**	Designated by TxDOT with MPO consultation	Yes
Critical Rural Freight Corridor	Statewide outside of MPOs	Designated by TxDOT	Yes
Texas Highway Freight Network	Statewide	Designated by TxDOT with MPO consultation	No

NHFP = National Highway Freight Program
*Large MPOs are defined as having an urbanized population greater than 200,000.
**Small MPOs are all other MPOs. The Waco MPO is defined as a small MPO.

first and last mile challenges

The Texas Freight Mobility Plan identifies the most important corridors to move freight through the Waco Region, as well as potential conflict points and design deficiencies for the freight network. Most zones of high freight activity within McLennan County, identified on Maps 4.3 and 4.4, and especially individual industries, are not directly accessed by state freight network facilities. Section 4.1.2, Regionally Significant Freight Corridors, and Map 4.2, identify roadways that were deemed regionally important to provide that direct connection to the state network. While a majority of these facilities are state highways designed to accommodate heavy trucks, there are several local arterials identified that were not designed for such traffic. As a result, many of these local arterials are in very poor structural condition and require very expensive reconstruction work in order to continue serving as an important freight access point.

Other challenges off of the state network are that highway access and roadway condition are not often a consideration when large freight generators are given site location approval. Additionally, infrastructure availability is not always a factor when approving industrial or high intensity commercial zoning and land use designations.

A final wrinkle in the freight industry is the explosion of direct home delivery of retail goods as a result of online shopping. Parcel delivery is no longer restricted to small packages under 20 pounds, but can now be of virtually any size, shape or weight. The result of this is a significant increase in delivery trucks using local streets which were never designed for more than an occasional heavy truck. Nearly all residential streets are not eligible for federal or state dollars and are thus maintenance and reconstruction needs for these facilities are not identified within the MTP. Member municipalities and McLennan County may need to reconsider street design for new subdivisions and reconstruction of existing streets to account for this new activity. Section 5.6, regarding connected and automated vehicles, discusses the possibility of other technologies that may impact freight delivery beyond the short term.

truck parking: or lack thereof

As covered in Section 4.1.2, Regionally Significant Freight Corridors, there are no public truck parking facilities located within McLennan County. The only legal long-term parking for semi-trucks within the Waco Region are at the handful of truck stops located along IH-35. In addition, there are no requirements for high activity freight industries or businesses to provide for long-term truck parking on their property. With the new federal restrictions regarding hours of rest and use of electronic logbooks for commercial drivers, the demand for truck parking within McLennan County has increased significantly within the past two years. The result is a host of less-than-ideal situations where trucks park wherever they can find space. Often, trucks may end up parking illegally due to the lack of options, such as on a roadway (but not in a legal parking space) or on private property without the owner's permission, such as underutilized portions of a parking lot.

The issue of truck parking is a relatively new one for the Waco Region, one which is only beginning to be discussed at a policy level. One of the important policy conversations is whether the public sector has a role in providing parking solutions or if this is better addressed by the private sector. As of the publication of this document, TxDOT is developing a truck parking study to provide policy and infrastructure recommendations on this topic. Once finalized, the Waco MPO will consider recommendations from the TxDOT plan for incorporation into the MTP.

commercial vehicle safety

Between 2016 and 2018 there were 1,424 crashes involving commercial vehicles within McLennan County. This represents 7.9% of all regional crashes. Of these crashes, 15 resulted in a fatality and another 46 resulted in a serious or life threatening injury, or 4.3% of all commercial vehicle crashes. Compared to all regional crashes during the same time period, commercial vehicle crashes were slightly more likely to result in a fatality or serious injury (3.2% versus 4.3% respectively). The is not an unexpected result due to commercial vehicles being significantly heavier than personal vehicles which result in greater force being applied to the vehicle occupants during a collision.

Most collisions involving commercial vehicles physically occurred either on State Freight Network designated facilities or facilities identified as part of the regional network (62.3%). This is not an unexpected result as most regional commercial vehicle traffic utilizes one of these facilities. Commercial vehicle crashes on a

freight designated facility, however, were more than twice as likely to result in a fatality or serious injury as crashes occurring off of the network. Again, this is not an unexpected result as posted speeds for freight network facilities are often much higher than for the rest of the highway network. Table 5.45 summarizes commercial vehicle crashes and severity by freight network facilities.

table 5.45 – mclennan county commercial vehicle crashes and severity by freight network: 2016 to 2018

Network Designation	Crashes	Percent of Commercial Crashes	Fatal & Serious Injury	Percent Fatal & Serious Injury
Primary (IH-35)	642	45.1%	33	5.1%
State	177	12.4%	10	5.6%
Regional	68	4.8%	4	5.9%
Total Freight Network	887	62.3%	47	5.3%
Off Network	537	37.7%	14	2.6%
All Crashes	1,424	100.0%	61	4.3%

Source: Texas Department of Transportation: Crash Records Information System

water port and inland port facilities

Being nearly 200 miles inland and located on a non-navigable waterway, no water ports exist within the Waco Metropolitan Area. As of publication of this document, no inland ports currently exist within the Waco Metropolitan Area and none have been proposed through the planning horizon year of 2045. For a discussion on airports and air travel, please refer to Section 5.5.1, Aviation.

5.5 – intercity passenger services

5.5.1 – aviation

The City of Waco completed a Waco Regional Airport, Airport Master Plan, in 2017. The Airport Master Plan defines the current and future role of the Waco Regional Airport (ACT) in the local, regional, and national aviation system, and provides a capital improvement program for future airport development. The Airport Master Plan includes forecasts for passenger enplanements and airport operations, utilizing a baseline year of 2014 and projections through the year 2036. The following discussion is summarized from the Airport Master Plan, unless otherwise noted.

ACT is a non-hub, primary commercial service airport and is served solely by American Eagle, a regional carrier for American Airlines. American Eagle provides five or six daily non-stops to Dallas-Fort Worth International Airport (DFW) via regional jet aircraft with up to 50-passenger seats. Passenger enplanements at ACT are forecast to grow from 67,565 in 2015 to 99,642 by 2036 for a compound annual growth rate (CAGR) of 1.9%.

Regional carriers such as American Eagle are expected to reduce their use of 50-seat jet aircraft and instead grow their fleet of 70- to 90-seat regional jet aircraft. Larger aircraft will require expanded and upgraded terminal space at ACT (to accommodate a larger number of passengers at one time) and greater runway distances for takeoff and landing. The Airport Master Plan recommends examining the potential to extend Runway 1-19 to 8,500 ft. Other runway upgrades such as pavement strength, visual approach aids, lighting, marking, and signage may also be considered.

Commercial aviation has transitioned to the use of regional jets similar to the one pictured above for markets such as Waco. Future trends suggest transitions to even larger aircraft, but with fewer daily flights for markets such as Waco.

operations and based aircraft

General aviation is trending toward a greater usage of business jets as they are capable of traveling longer distances before refueling, and are faster than the turboprop aircraft. These aircraft also require greater runway distances than their turboprop cousins for takeoff and landing. General aviation operations at ACT are forecast to increase modestly, growing from 21,801 in 2015 to 31,500 by 2036 for a CAGR of 1.8%. Additional facilities will be required at ACT to accommodate the projected growth in general aviation. This includes additional aircraft storage hanger requirements, terminal space, and parking spaces. ACT, Texas State Technical College (TSTC) Waco Airport (CNW), and Mcgregor Executive Airport (PWG) all currently accommodate business jets with sufficient runway length, parking aprons, refueling and power plant services.

Military operators routinely utilize ACT for various training operations and activities. Control tower records indicate a wide variety of military aircraft utilizing ACT in recent years, including turboprops such as the Lockheed C-130 and Lockheed P-3 Orion, jet aircraft such as the C-17 Globemaster and KC-135 Stratotanker, and occasionally, fighter aircraft such as the F-18. Itinerant military operations are assumed to remain static through 2040.

Based aircraft are forecast to increase from 49 in 2015 to 75 in 2036, for a CAGR of 2.0%, with an increase in turbine aircraft. Total annual operations at ACT are forecast to grow from 33,739 in 2015 to 44,200 in 2036 for a CAGR of 1.3%. See Chart 5.5 for the Waco Regional Airport forecast through year 2036, as determined by the Waco Regional Airport's Airport Master Plan (2017).

enplanements

The ACT market share of domestic enplanements has remained fairly consistent over the past 15 years at about 0.009%; ACT is ranked 20th for enplanements in the state of Texas as of 2015. The Waco metropolitan statistical area (MSA) represents approximately 1.0% of the state's population but only 0.08% of the state's enplanements. The availability of various flight options from Dallas, Austin or Killeen/Fort Hood, as well as the direct links via interstate 35, leads to a significant level of passenger leakage to these airports.

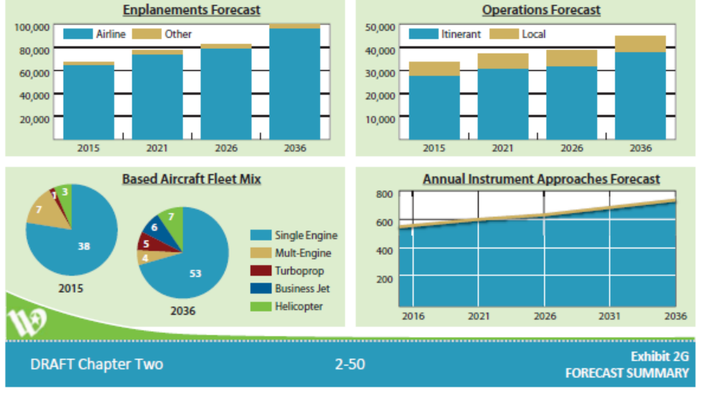
In addition to passenger leakage, there are two additional future challenges for commercial aviation in smaller markets such as

Waco. The first challenge is that short distance routes, such as ACT to DFW, are difficult to be profitable. In general to be profitable, a route should have an air distance of at least 500 miles; the ACT to DFW route is 89 miles by air. The second is that as air traffic increases, airspace and terminal space at hubs such as Dallas / Fort Worth eventually become saturated. Although technology such as NextGen which utilizes GPS equipment can permit more aircraft to safely operate within a smaller airspace, there remains practical limits. This leads to a greater emphasis on larger aircraft from larger markets.

chart 5.5 – forecast for waco regional airport

WACO REGIONAL AIRPORT — AIRPORT MASTER PLAN

	2015	2021	2026	2036
ENPLANEMENTS				
Airline Enplanements	63,581	73,004	78,459	95,642
Other Enplanements	3,984	4,000	4,000	4,000
Total Enplanements	**67,565**	**77,004**	**82,459**	**99,642**
OPERATIONS				
Itinerant				
Air Carrier Airline	-	152	1,530	3,400
Air Carrier Charter	117	150	150	150
Air Taxi/Commuter Airline	3,358	3,648	1,870	-
Other Air Taxi	1,793	2,050	2,210	2,550
General Aviation	16,822	18,900	20,900	25,700
Military	5,298	5,300	5,300	5,300
Itinerant Subtotal	*27,388*	*30,200*	*31,960*	*37,100*
Local				
General Aviation	4,979	5,100	5,275	5,800
Military	1,372	1,300	1,300	1,300
Local Subtotal	*6,351*	*6,400*	*6,500*	*6,700*
Total Operations	**33,739**	**36,600**	**38,535**	**44,200**
BASED AIRCRAFT				
Single Engine Piston	38	46	49	53
Multi-Engine Piston	7	7	6	4
Turboprop	1	2	3	5
Business Jet	-	1	2	6
Helicopter	3	4	5	7
Total Based Aircraft	**49**	**60**	**65**	**75**
ANNUAL INSTRUMENT APPROACHES				
Total Annual Instrument Approaches	**548**	**604**	**639**	**742**



Source: Waco Regional Airport, Airport Master Plan, in 2017

5.5.2 – passenger rail

The only passenger rail service for the Waco Metropolitan Area is through the McGregor Amtrak depot, approximately 20 miles west of Downtown Waco. Although usage of the depot has increased substantially since 2000, its location many miles west of the region's center of population severely limits the potential ridership in and out of the depot. Although the station has recently been upgrade to meet the requirements of the Americans with Disabilities Act, the depot provides no services. Despite the shortcomings of the depot, it does provide the City of McGregor its primary non-automotive connection to the outside world. As a result, the MPO has adopted a policy that if Amtrak service is discontinued, then another service should be established providing a connection that is as good as or better than the current Amtrak service.

The population of the Dallas / Houston / San Antonio triangle is anticipated to nearly double during the MTP planning period to a population approaching 30 million. This would create significant strains on the highway and aviation systems even with the projects recommended within the various transportation plans for MPOs within the triangle. The limitations of existing rail service using existing freight rail lines limits the ability of existing Amtrak services to meet future interregional mobility needs. Section 5.5.3, High-Speed Rail / Ground Transportation, discusses efforts by the Waco MPO, in coordination with TxDOT and other MPOs along the IH-35 corridor to identify other interregional mobility options that can better serve future populations and keep the Texas Triangle region economically competitive.

5.5.3 – high-speed rail / ground transportation

In late 2017, the Federal Railroad Administration (FRA) published the Record of Decision (ROD) and Tier 1 Texas-Oklahoma Passenger Rail Service (TOPRS) Final Environmental Impact Statement (EIS). The document evaluated conventional, higher speed, and high-speed passenger train alignments and included six alternatives that varied in type of service and corridor alignment. The Tier 1 alternatives were developed to a level of detail appropriate for a service-level analysis and need to be refined to optimize performance, reduce cost, and/or avoid specific properties or individual environmental resources. The TOPRS ROD and Final EIS recommended the six alternatives be evaluated further in future (Tier 2) National Environmental Policy Act (NEPA) document(s).

The TOPRS study determined that conventional high-speed rail service south of Fort Worth along the IH-35 corridor is

economically feasible. High-speed rail is defined as any rail service operating at or above a maximum speed of 150 mph. As a result, the high-speed service option can proceed to further concept development including identification of alignments, station locations and appropriate technology. Since completion of the study, a new technology has been identified as a potential option; the Hyperloop concept being developed by the SpaceX corporation.

In 2019, six MPOs along the IH-35 corridor, including the Waco MPO, jointly funded and commissioned a high-speed transportation study for passenger service connecting Fort Worth, Waco, Killeen-Temple, Austin, San Antonio, and Laredo. The purpose of the study is to help expedite future Tier 2 project-level NEPA document(s), and to prepare a set of alternative recommendations to be evaluated in a Tier 2 NEPA document(s). This study will review and refine previously studied alignments, evaluate various technology options such as conventional high-speed rail, next generation magnetic levitation or Hyperloop, and identify potential station locations to include in future NEPA documents. The study is ongoing and is expected to be completed in late 2019.

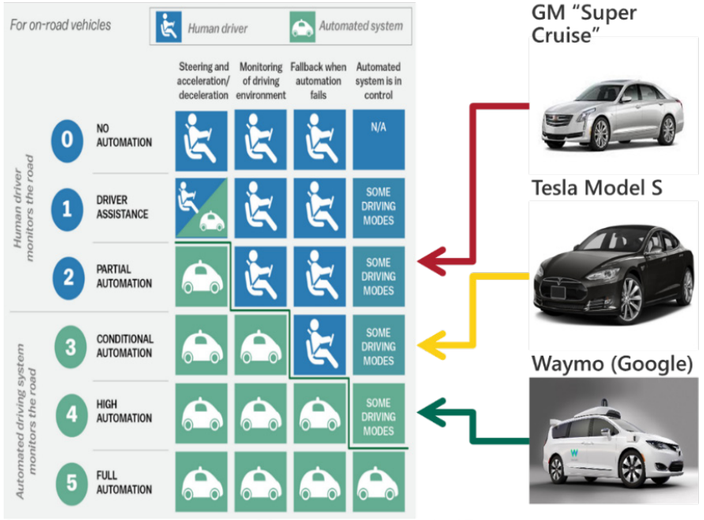
5.6 – discussion regarding connected and automated vehicles (CAV)

In regards to how we connect point A to point B, nothing stands to alter the landscape more than the prospect of vehicles that drive themselves. The potential from this technology includes a large range of benefits which, if implemented well, could address or improve on many of the more vexing challenges we currently face with existing transportation options. Some of these challenges with which connected and automated vehicles (CAV) technology can assist are:

- Reducing an unacceptably high number of fatalities or serious injuries.
- Making transportation more affordable for those on limited incomes.
- Reducing the cost and improving the reliability of freight deliveries.
- Providing better mobility options for the very young or elderly or those with some type of physical impairment who cannot operate a motor vehicle.
- Allow individuals to make more productive use of travel time instead of actively operating a motor vehicle.
- Reduce the need for massive parking lots or structures making more efficient use of urban land uses
- Reduce the negative environmental impacts associated with internal combustion engines by more widespread deployment of electric propulsion systems.

With that said, how and when CAV technology is deployed is still very much an unknown. As of publication of the MTP, widespread implementation of vehicle automation has only been applied to certain functions of vehicle operation. These functions include features such as parallel parking, adaptive cruise control or lane departure assistance. More advanced functions, such as hands free controls have had limited deployment but still require significant monitoring by the human operator who needs to be able to take control of the vehicle very quickly during complex situations for which the computer cannot adequate assess. The figure below identifies the various levels of vehicle automation and the level of human input required for each level. The most 'automated' vehicle currently available for retail sale, the Tesla Model 'S', generally falls between automation level 2 or 3, depending upon who's definition is used. Fully automated vehicles, or level 5, are currently only in prototype development. See Chart 5.6.

chart 5.6 – vehicle automation levels and human vs vehicle task operations



Source: Maricopa Association of Governments; Phoenix, AZ

A prototype automated vehicle under development. This vehicle uses a bank of computers and sensors with which to operate and does not require a human operator. Nevertheless, the vehicle generally does not travel faster than 10 mph and requires constant recalculations to assess potential collision threats. Threats that could be as benign as a small bird or plastic bag. As a result, this vehicle may take 5 to 10 minutes to make a complete trip across the parking lot used as a test facility, approximately ¼ mile.

Not all aspects of CAV deployment will be considered positive as the technology will be disruptive across a wide spectrum of the economy and society. The extent to which these disruptions would be negative, neutral or even positive will depend upon the individual and each community.

Some of the more likely potential disruptions include:

- Empty vehicle circulation and resulting increase in VMT and congestion
- Congestion at high volume pick up and drop off points
- Urban sprawl resulting from longer commutes no longer being considered arduous
- Inequity from vehicles serving only 'profitable' areas
- Decline in transit usage
- Privacy concerns from data used to monitor vehicle operations and trip destinations
- Cyber-attacks and hacking which could compromise safety and security

To wrestle with some of these topics and provide recommendations for the MTP, the MPO Policy Board convened a subcommittee composed of three Policy Board members and regional transportation stakeholders including transit and the private sector. That committee made the following conclusions and recommendations regarding this MTP update:

- Full automation of vehicles is progressing slower than previously advertised and much of the short-term efforts are towards automating certain vehicle functions. As a result, it is unlikely that a significant percentage of vehicles operating within the Waco Region will beyond automation level 3 prior to 2030.
- Automakers are designing vehicles to operate within the existing transportation network regardless of the automation level of vehicles under development. As such they would not require different roadway designs or features.
- Prior to 2030, it is anticipated that most CAV operating within the Waco Region will be at level 3 automation or less; at the same time, a significant number of vehicles using the region's roadways will have little or no automated features. Both automated vehicles and human operators of non-automated vehicles are highly sensitive to pavement condition, roadway markings, traffic signals and signage. As such, the most effective effort to support CAV deployment and a safe mixed-automation environment within the Waco Region through 2030 is to focus on improving roadway and signal condition.
- After 2030, deployment of higher levels of vehicle automation are likely and market penetration may occur very quickly along with the potentially disruptive impacts. The CAV committee recommended additional study to assess and provide recommendations regarding CAV readiness for the Waco region prior to the next update of the MTP in 2025.