FM 1488 Access Management Study Engineering Summary Report

CSJ Numbers: 0523-10-046
FM 1488, from I-45 to FM 149
Montgomery County, Texas
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1 Executive Summary

FM 1488 is a TxDOT maintained farm-to-market (FM) road in fast-growing Montgomery County, traversing east-northeast from US 290 in Hempstead to Interstate 45 (I-45) between Conroe and The Woodlands. The study corridor of this minor arterial stretches 14 miles from FM 149 to I-45. The existing roadway capacity has been insufficient to handle current traffic volumes along this rapidly developing portion of FM 1488. Highway Safety Improvement Program (HSIP) funding has been allocated to install a raised median on FM 1488 from I-45 to Mostyn Drive, which should address some of the current safety concerns. This Access Management Study was initiated to identify other potential opportunities for safety, mobility, multimodal, and economic improvements along the study corridor.

As of 2019, FM 1488 carried approximately 20,000 vehicles per day (vpd) near FM 149, 35,000 vpd near FM 2978, and 54,000 vpd near I-45. Currently, the typical roadway section has four travel lanes, a center two-way left-turn lane, and shared-use shoulders. There is limited transit service or multi-modal connectivity on the corridor itself, though nearby areas have bike routes and transit park-and-rides which primarily serve commuters into Houston. Safety concerns have been noted for the shared shoulder bike route along FM 1488, as well as any pedestrians walking outside the area near the FM 2978 intersection, which is the only location with sidewalks.

The nearby land use is primarily residential or agricultural, but a large amount of strip retail development is also located along FM 1488, particularly near the FM 2978 intersection. This has resulted in a high density of driveway access points, creating safety and mobility concerns. The nearly 2,000 acres of vacant developable land in the area suggests continued growth, which can be expected to augment these concerns if left unmitigated. Currently, there are 19 signalized intersections and six unsignalized stop controlled intersections, along with numerous driveway access points. Additional traffic signals are planned for the corridor at Forest West St, Sweet Gum Lane, and I-45.

Analysis of three years of traffic and crash data showed that 5.7 miles of the 14-mile corridor have crash rates higher than the statewide average for a comparable roadway type. The highest intersection crash rates were located at the FM 2978, FM 149, SH 242, and I-45 intersections, correlating with non-residential land use types and higher frequency of vehicles accessing or leaving the roadway.

Turning movement counts indicate that the peak periods at corridor intersections are between 6:30-9:00 am and 4:15-6:00 pm. Field review highlights the impact of high turning volumes on congestion at SH 242 intersection and between FM 2978 and Katy Lee Lane intersections, due in large part to inadequate turning lanes. Other notable causes of congestion include vehicles entering and exiting I-45 during peak periods, and Magnolia High School morning student drop-off times. Traffic simulation analysis shows that half of the signalized intersections experience heavy to moderate congestion, and that half of unsignalized intersections have heavy congestion.

Existing issues along FM 1488 were identified through the data collection and public involvement process and are summarized in the list below.

- Intersection congestion
- High speeds along the corridor
- Safety of center turn lane and closely spaced driveways
- Regular use of the shoulder by vehicles inhibits the safety of bicycles on the shared shoulder
- Safety concerns turning left onto FM 1488
- Aggressive driving at FM 1488 and I-45 interchange
- High traffic volumes east of FM 2978
- Unclear bicycle accommodations
- Discontinuous/nonexistent pedestrian accommodations
- Flooding concerns between Tamina Road and Kuykendahl Road
- Existing streets are not aligned across FM 1488

The following short-, medium-, and long-range improvements were identified, and planning level cost estimates were developed to address the existing issues.

- The short-range improvement recommendations include installing raised medians, improving signal timing, adding/extending turn lanes, installing continuous green T intersections, installing safety improvements at intersections, and other improvements with an estimated cost of about $20 million.
- The medium-range improvement recommendations include widening FM 1488 from four to six lanes between I-45 and FM 2978 (about 6.9 miles) with separated 10’ shared use paths on both sides, consolidating driveways, widening Carriage Hills Blvd., reversing I-45 southbound ramps near FM 1488, and connecting bicycle routes with an estimated cost of about $95 million.
- The long-range improvement recommendations include widening FM 1488 from four to six lanes between FM 2978 to Mill Creek Road (about 6.5 miles) with separated 10’ shared use paths on both sides, consolidating and sharing driveways, installing continuous lighting, performing a drainage study, and potential grade separation at FM 2978 with an estimated cost of about $115 million.

The proposed improvements were selected based on the safety and mobility benefits expected. The theoretical percent improvement and cost savings of the short-term improvements are referenced from various accepted, respectable sources based on before/after case studies. For the proposed short-term improvements, a 28% reduction in total crashes and a 46% reduction in pedestrian crashes is expected to save $3.3 million per year, and a 39% reduction in travel time with the proposed intersection improvements and raised median is expected to save 32 hours of time per year per roadway user and $54.1 million per year for all users. The results of the proposed Synchro traffic operational analysis show an 18% to 19% reduction in intersection delay with the implementation of the proposed short-term improvements.

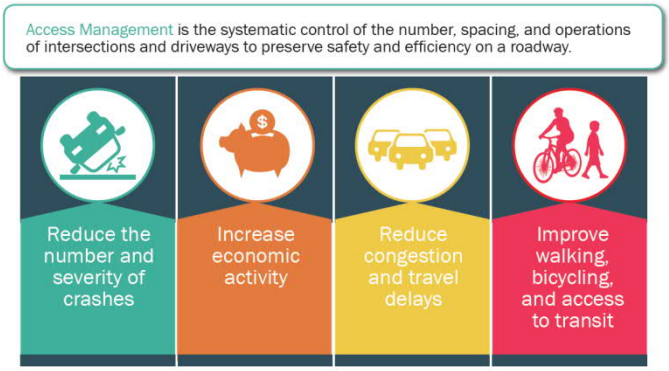
2 Introduction

Montgomery County is the 11th largest county in Texas and one of the fastest-growing counties in the state. The most recent data from the U. S. Census Bureau estimated the population to be 570,934, with a growth rate of 2.96% in 2017. The most recent employment figures from 2016 show a total of 155,450 jobs in the County, including 11,152 newly established employers. The increasing employment is largely driven by business development in The Woodlands and Conroe.

FM 1488 is a state-maintained farm-to-market road that runs east-northeast from U.S. Highway 290 in Hempstead to Interstate 45 (I-45) between Conroe and the Woodlands. The Texas Department of Transportation (TxDOT) classified FM 1488 as a minor arterial and it has a variety of cross-sections and different types of access control. It is an important local corridor for existing and future movement of people and goods in the northwest Houston. It connects people living in Magnolia, Conroe, and other cities and towns to SH 249 and I-45.

With rapidly growing residential and retail development during recent years along FM 1488 and surrounding areas, new challenges related to traffic delays and safety issues have arisen. In response to these growing challenges, funding has been approved through the Highway Safety Improvement Program to install a raised median on FM 1488 from I-45 to Mostyn Drive. The TxDOT Houston District also initiated and conducted this FM 1488 Access Management Study to identify potential opportunities for safety, mobility, and economic improvements that could be implemented by TxDOT and its partner agencies.

2.1 Project Purpose



The purpose of the study is to identify and evaluate potential access management improvements for the FM 1488 corridor between SH 149 and I-45. The recommended improvement concepts or techniques seek to instill many benefits for area residents, workers, and travelers. Such benefits include, for example, improving safety and mobility, reducing crash rates, decreasing congestion and motorist delay, ensuring a balance between land use intensity and transportation access, and preserving long-term property values along the corridor.

As defined by the Transportation Research Board, access management is the systematic control of location, spacing, design, and operation of driveways, median openings, interchanges, and street connections to a roadway (*Access Management Manual* 2003). The potential improvements will be specific to the existing conditions and opportunities along particular segments of the roadway, and may be implemented in a short-, medium-, or long-term horizon.

2.2 Study Process

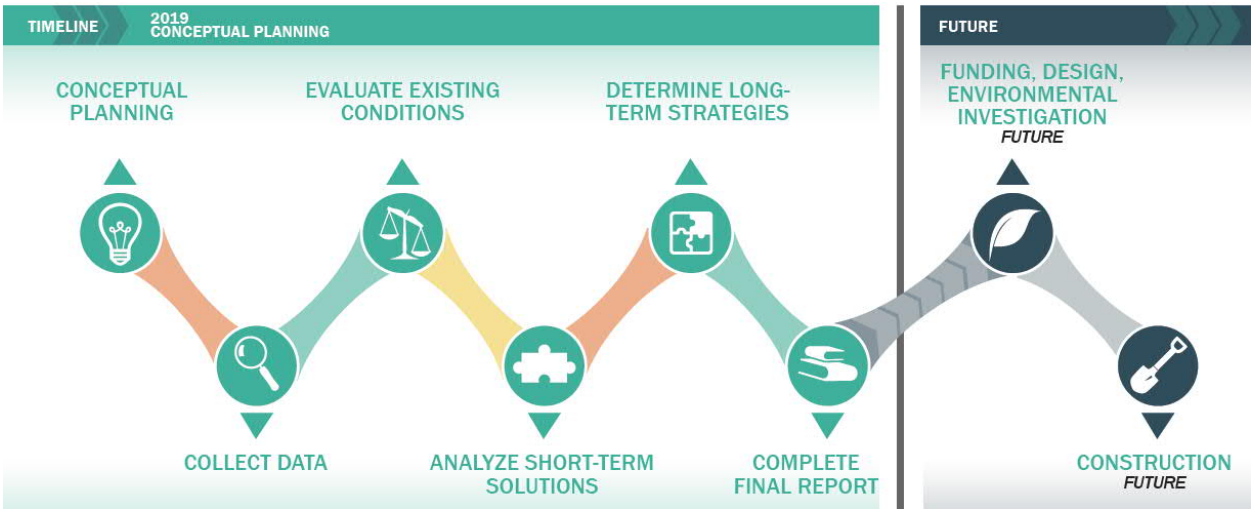
Public involvement plays a key role in access management studies to ensure that the specific needs of the community are addressed in the study recommendations. A steering committee comprised of the funding agencies and other affected agencies was formed to guide the technical and administrative aspects of the study. To obtain the community's input on critical issues and needs along the FM 1488 corridor, and to obtain feedback on the initial set of improvement alternatives, public meetings will be conducted. Comments from the public meetings and steering committee will help shape the final recommendations.

Steering committee agencies includes:

- Texas Department of Transportation
- Houston-Galveston Area Council (H-GAC)
- State Representatives (District 3 and District 15)
- Montgomery County
- City of Conroe
- City of Magnolia
- The Woodlands Development Company
- North Houston Association

Figure 2.1 provides an overview of the Access Management Study process. The process includes conceptual planning, data collection, analysis of existing conditions and short-term solutions, development of long-term strategies, and completion of a final report documenting all analysis and recommendations, including public input through public meetings, stakeholder meetings, and steering committee oversight throughout the process. Upon completion of this study, future steps will include investigating funding, design, and environmental conditions, and ultimately beginning on construction of the recommended projects or strategies.

Figure 2.1: Access Management Study Schedule



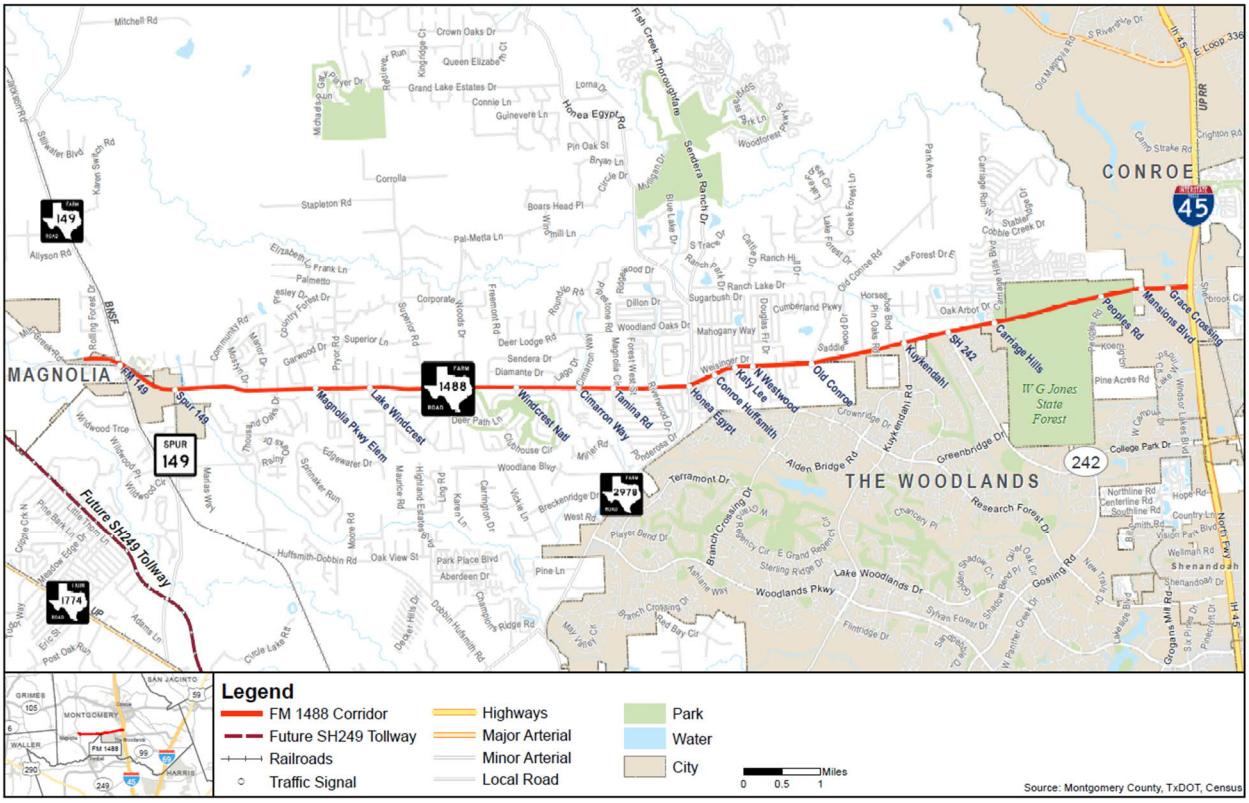
2.3 Study Goals

The overall goal of the study is to develop a plan that identifies short- to medium-term solutions that can be expected to improve mobility, reduce traffic delays, and improve safety. The plan will also provide a long-range vision for the corridor by developing access management guidelines that complement the land use and urban planning in and around the study area. Implementation of the short-, medium-, and long-term solutions should result in reduced congestion, fewer crashes, better multimodal connectivity, and improved mobility and air quality.

2.4 Study Area

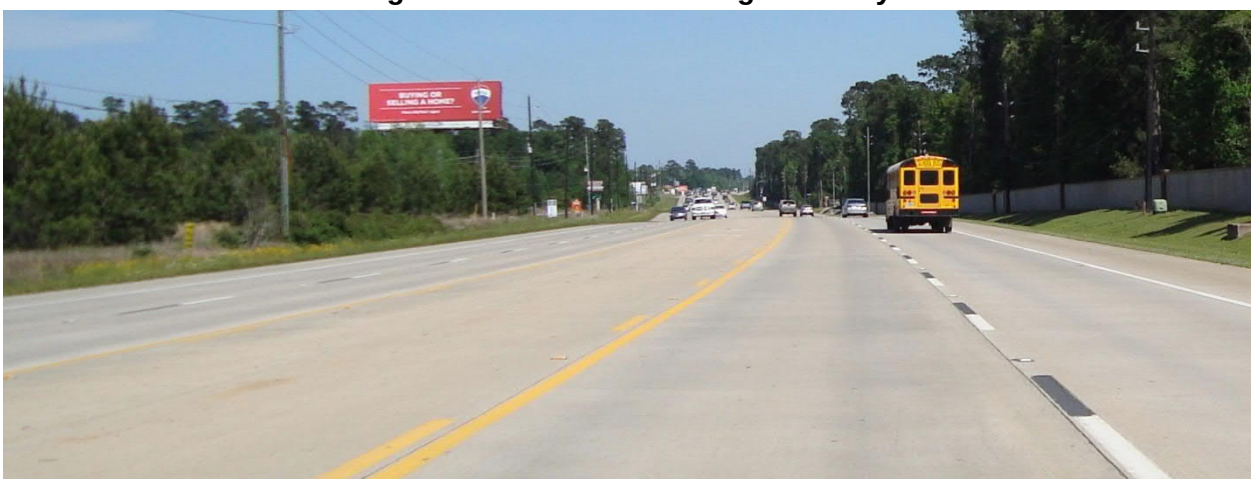
The study focuses on the approximately 14-mile segment of FM 1488 with its western limit at FM 149 and eastern limit at I-45. The FM 1488 study corridor is located entirely in the Montgomery County and travels through the fringes of Magnolia, The Woodlands and Conroe, as shown in **Figure 2.2**.

Figure 2.2: Vicinity Map



The typical roadway section primarily has four lanes, a center two-way left-turn lane, and shared-use shoulders with some variations throughout the corridor. **Figure 2.3** shows an image of the FM 1488 existing roadway.

Figure 2.3: FM 1488 Existing Roadway



Based on 2017 daily traffic volumes, the study corridor near FM 149 carries approximately 20,100 vehicles per day, while the section near FM 2978 carries 34,800 vehicles per day, and around 53,900 vehicles per day are served on the section near I-45.

3 Existing Roadway Corridor Characteristics

FM 1488 from I-45 to F 149, approximately 14 miles, has a typical roadway section primarily consisting of four lanes, a center two-way left-turn lane, and shared-use shoulders with some variations throughout the corridor. From FM 149 to 1,800 feet west of FM 2978 (about seven miles) and from Katy Lee Lane to I-45 (about six miles), FM 1488 has open ditch drainage. From 1,800 feet west of FM 2978 to Katy Lee Lane (about one mile), FM 1488 has curb and gutter with sidewalks.

Construction near FM 149 was completed in 2018, converting the at grade rail crossing and intersection to a partial cloverleaf interchange and expanded the number of lanes on FM 1488 near FM 149 from 2-lanes to 4-lanes. The crash analysis includes data prior to the completion of construction and was based on the previous road conditions.

3.1 Land Use

As illustrated in **Figure 3.1**, FM 1488 is surrounded by land that is primarily residential or agricultural in nature, in addition to a large area of conserved land—the W. G. Jones State Forest.[1] Within a half-mile of the roadway segment, 48% of the land is residential—the vast majority single-family rather than higher-density multi-family development. The next largest share (21%) is land that has been categorized as "vacant developable" by H-GAC; this category includes existing agricultural or vacant land that may be converted to a different land use as the area experiences demographic and economic growth. The W. G. Jones State Forest mentioned above, together with other area parks and open spaces, total 12% of corridor land. Various types of commercial (either single or mixed retail, services, office, or industrial) comprise a combined 11%. About 5% of land is classified as institutional (i.e., government, medical, or education) and 3% is another land use (e.g., undevelopable, unknown). See **Table 3.1** for the detailed figures.

Table 3.1: Current Land Use (0.5-mile)

Land Use Category	Sq. miles	Acres	% of Total
Residential	7.0	4,466	48%
Vacant Developable	3.1	1,990	21%
Parks / Open Spaces	1.7	1,087	12%
Commercial	1.6	1,055	11%
Institutional	0.7	418	5%
Other	0.4	256	3%
Grand Total	**14.5**	**9,272**	**100%**

Source: H-GAC Land Use

[1] For this analysis, the H-GAC Current Land Use data has been updated manually in the study area using aerial and Google Streetview imagery from 2018 to better reflect existing land use conditions along the corridor, as the study area has experienced rapid development since the H-GAC Land Use data was published. Due to insufficient data available, no updates were made to the H-GAC current and future housing unit counts.

Figure 3.1: Existing Land Use Map (Study Area and Half-mile Radius)

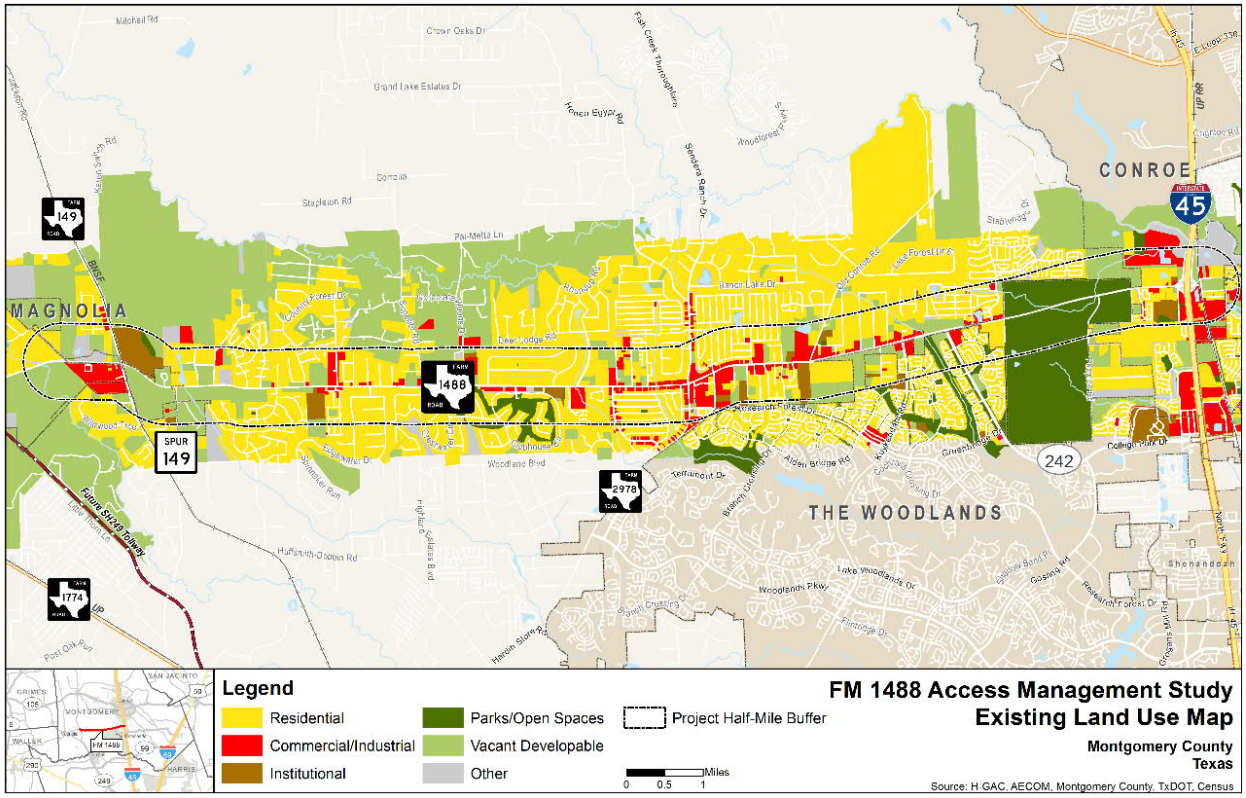
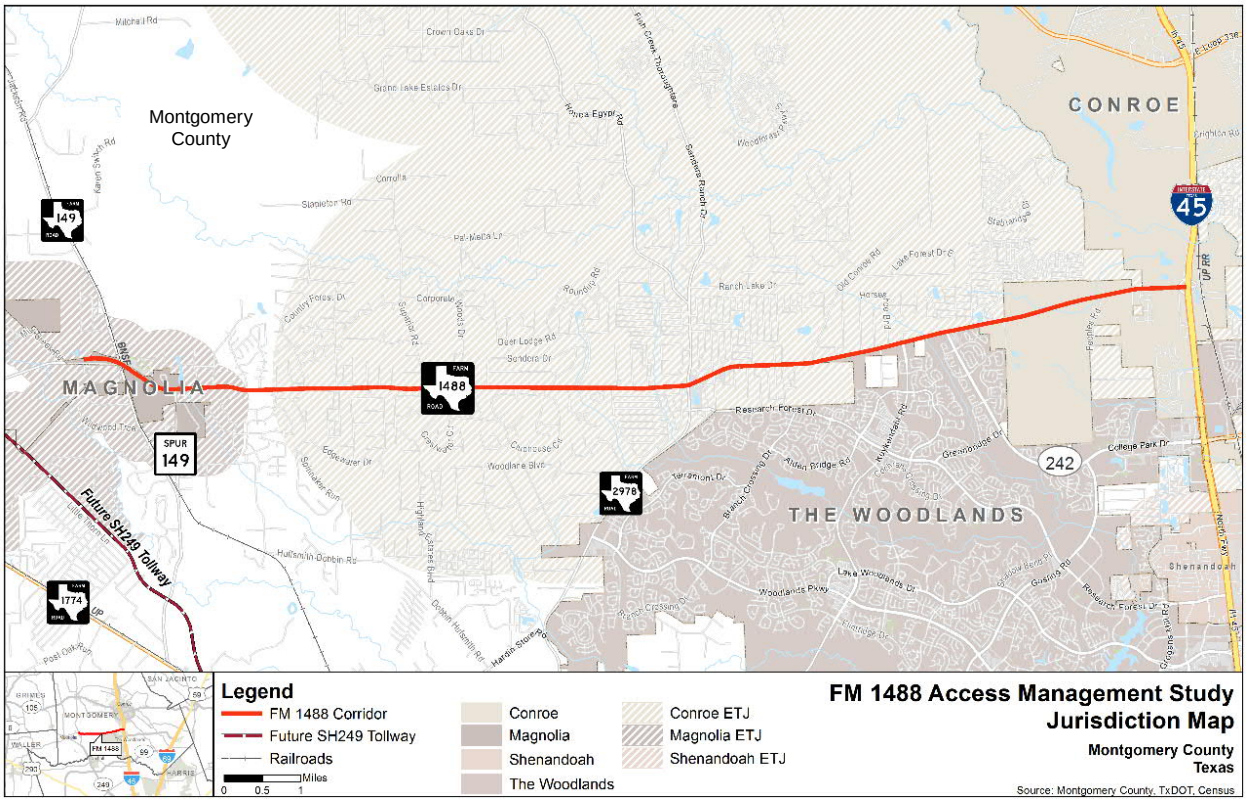


Figure 3.2: Jurisdiction Map, including Extra-Territorial Jurisdiction



The high share of vacant developable land nearby suggests that the area may experience increased transportation demand in the future as these areas are developed. The location, large contiguous parcel size, access to FM 1488 frontage, proximity to future SH 249 toll road extension, along with the lack of zoning restrictions due to location outside of an incorporated municipality in Montgomery County, further support future development along this corridor. Note that much of the corridor lies within the extraterritorial jurisdiction of Conroe and—to a lesser extent—Magnolia (**Figure 3.2**).

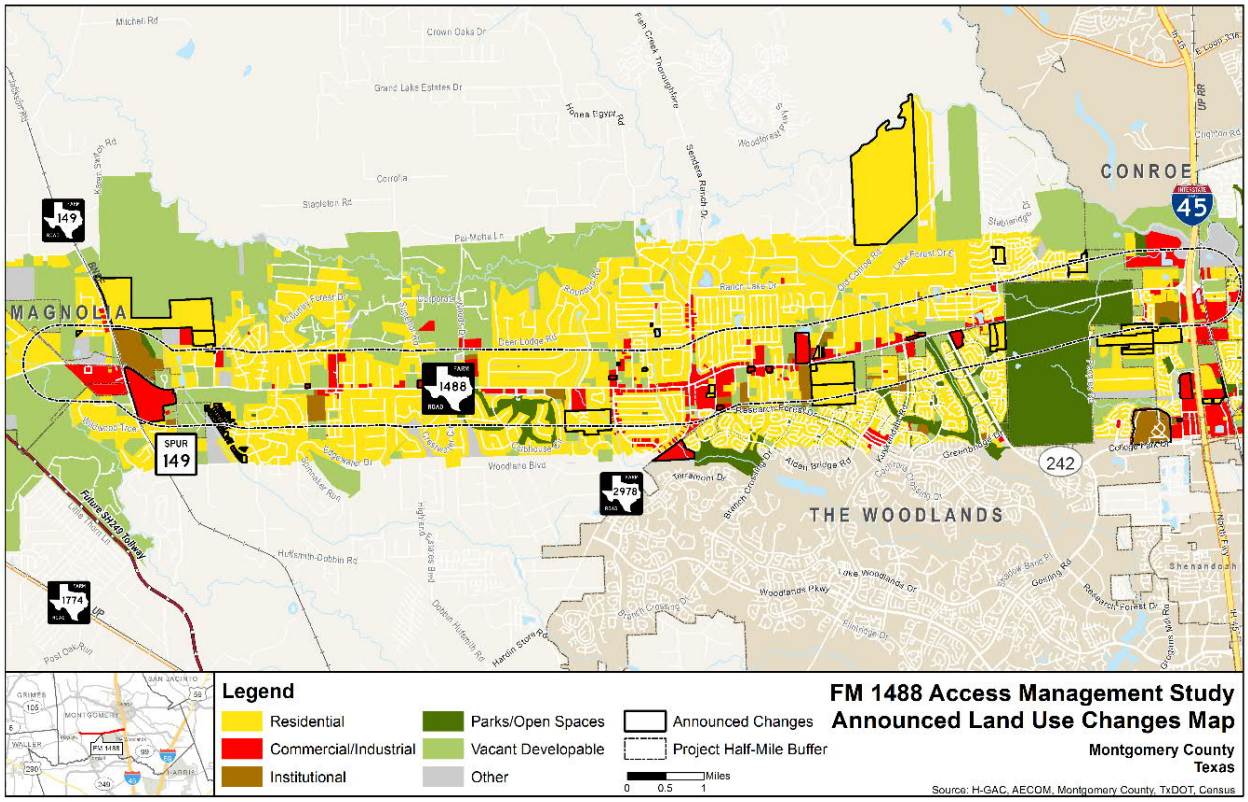
Several developments have already been announced, as depicted in **Figure 3.3** with thick borders; some of these projects are already under construction. In terms of acreage, within the half-mile radius of the FM 1488 segment, residential development has been announced for 386 acres and commercial development (which may include a portion of residential development, such as an apartment complex in a larger mixed-use retail development) has been announced for 257 acres (**Table 3.2**). Example projects in the study area include: the large parcel southeast of the intersection of FM 1488 and FM 149 converting from agricultural to mixed retail and multifamily (1,200 units); the large parcel just north of Magnolia High School along FM 149 changing from agricultural to single-family development (35 units); at Del Webb Blvd., construction of a single-family development on 200 acres of land.

Table 3.2: Announced Development (0.5-mile)

Land Use Category	Sq. miles	Acres
Residential	0.6	386
Commercial	0.4	257
Total Development	**1.0**	**643**

Source: H-GAC Land Use

Figure 3.3: Announced Land Use Changes



In terms of overall expected growth in housing units within the half-mile radius, the H-GAC travel demand model includes an additional 11,151 units in 2045 over the existing 2,719 units—five times as many (or 6% annualized growth rate). As seen in **Figure 3.3**, a great deal more developable land is available outside of the half-mile radius, and this area is likely to see development as well.

3.2 Planned Projects in the Vicinity

The planned projects in the vicinity of the FM 1488 Corridor are shown in **Figure 3.4** and a summary table of project attributes is listed in **Table 3.3.** A more detailed list of project attributes such as project identification (CSJ), project limits, length, and cost is located in **Appendix A**.

Figure 3.4: Planned Projects Map

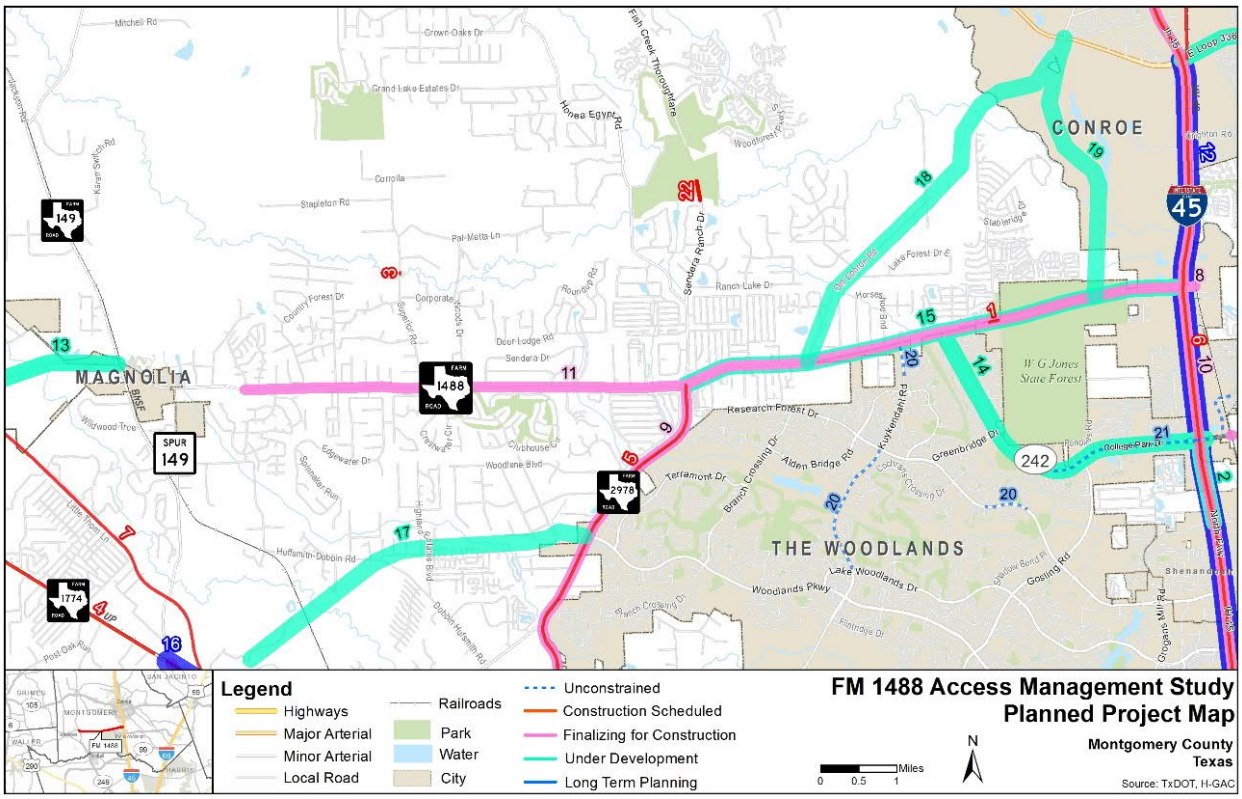


Table 3.3: Planned Project List

ID	Roadway	Description	Let Year
1	FM 1488	Add Right Turn Lane at Carriage Hills	2018
2	IH 45	Intersection & Drainage Improvements	2026
3	Superior Rd	Replace Bridge and Approaches at Lake Creek	2018
4	FM 1774	Widen to 4-Lane with Two-Way Left Turn Lane	2014
5	FM 2978	Widen from 2 to 4 Lanes	2016
6	IH 45	Landscape Development	2015
7	SH 249	Construct 4 Lane Tollway in Sections	2017

ID	Roadway	Description	Let Year
8	FM 1488	Intersection Improvements	2020
9	FM 2978	New Fiber/Radio Systems	2020
10	IH 45	Scenic Enhancements	2019
11	FM 1488	Install Raised Median	2022
12	I-45	Preliminary Environmental Linkage (PEL) Study	2030
13	FM 1488	Reconstruct Pavement 2 Lanes to 4-Lane Divided Rural	2022
14	SH 242	Widen from 4 to 6 Lanes	2022
15	FM 1488	Widen from 4 to 6 Lanes	2024
16	SH 249	Widen from 4 to 6-Lane Tollway	2030
17	Woodlands Pkwy	Construct New 2-Lane Divided	2023
18	Old Conroe Rd	Widen to 4-Lanes and Extend Roadway to SL 336 S	2022
19	Longmire Rd	Construct New 4-Lane Road	2023
20	Multiple	The Woodlands Township Safe School Access Project	-
21	College Park Dr	Install Shared-Use Path	-
22	Sendera Ranch Dr	Construct Lake Creek Bridge Expansion	2018

Perhaps the most significant project is the construction of the SH 249 four-lane tollway (Project ID 7 and 16), with construction currently scheduled or being finalized. Upon completion of this project, increased mobility is expected to intensify development pressure on this growing area, and the resulting demographic and economic growth would create additional roadway demand in turn.

Another major project is the widening and extension of Old Conroe Road, including a bridge over the west fork of the San Jacinto River (Project ID 18). This project is currently under development, and its construction would have a significant impact on FM 1488, as it creates a new four-lane roadway connection between FM 1488 and Loop 336 in the City of Conroe. This connection would enable travelers to avoid using I-45 to travel between the communities of Conroe and The Woodlands, for example. An additional roadway connection between FM 1488 and Loop 336 is under development with a let year of 2023—the creation of four-lane roadway extending from Loop 336 at Sergeant Holcombe Ed Road to FM 1488 (Project ID 19), which would add redundant capacity to this connection.

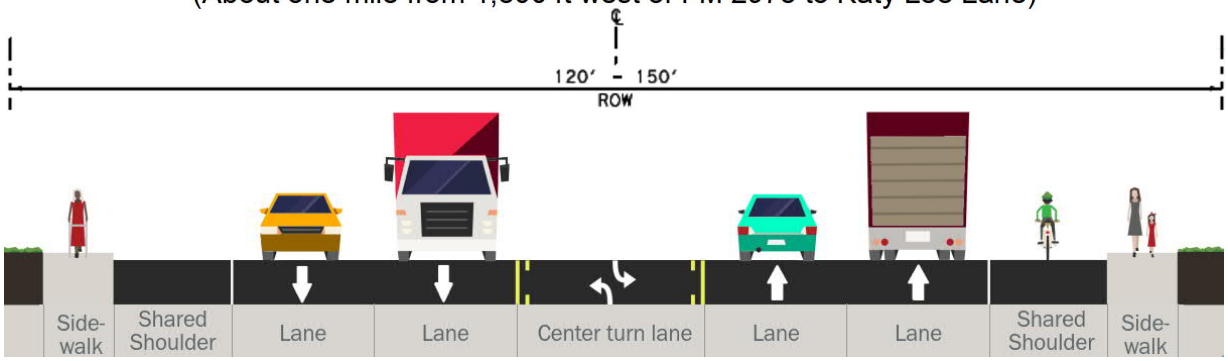
Projects along FM 1488 itself include: installing a median the 12.4-mile segment between I-45 and Mostyn Drive (ID 11), adding a right-turn lane at Carriage Hills (ID 1), widening from four to six lanes the 8.2-mile segment between I-45 and FM 2978 (ID 15), and adding improvements at the interchange at I-45 (ID 8).

3.3 Existing Typical Sections and Right of Way (ROW)

FM 1488 typically has two existing typical sections shown in **Figure 3.5** and **Figure 3.6**.

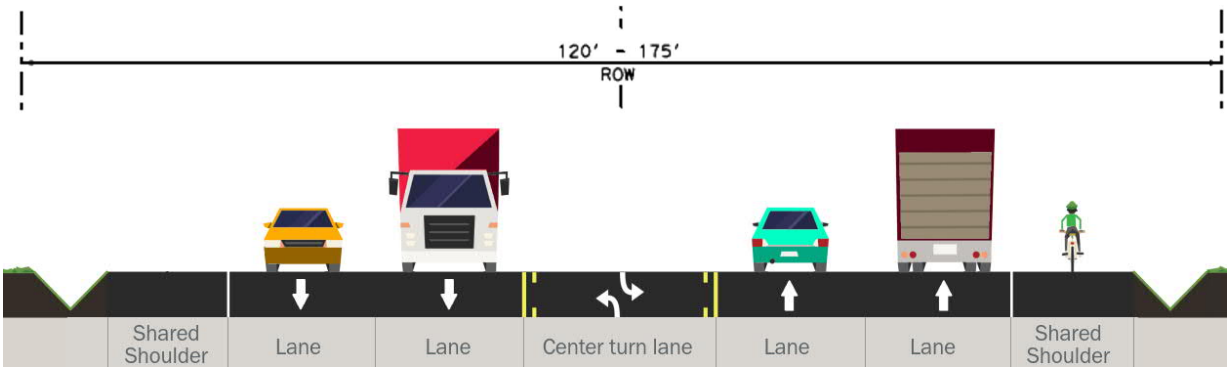
Existing typical section 1 (**Figure 3.5**) represents a one-mile section near the intersection of FM 1488 and FM 2978. This roadway section includes 6-foot sidewalks with a curb and gutter. There are two 12-foot travel lanes in each direction, a 16-foot center turn lane, and a 10-foot shared-use shoulder in either direction. The typical right-of-way for this section ranges from 120 feet to 150 feet.

Figure 3.5: FM 1488 Existing Typical Section 1
(About one mile from 1,800 ft west of FM 2978 to Katy Lee Lane)



Existing typical section 2 (**Figure 3.6**) represents much of the remainder of the project corridor. Within a right-of-way of 120 feet to 175 feet, there is the same lane configuration with open ditch drainage.

Figure 3.6: FM 1488 Existing Typical Section 2
(About seven miles from FM 149 to 1,800 ft west of FM 2978;
About six miles from Katy Lee Lane to I-45)



3.4 Railroads

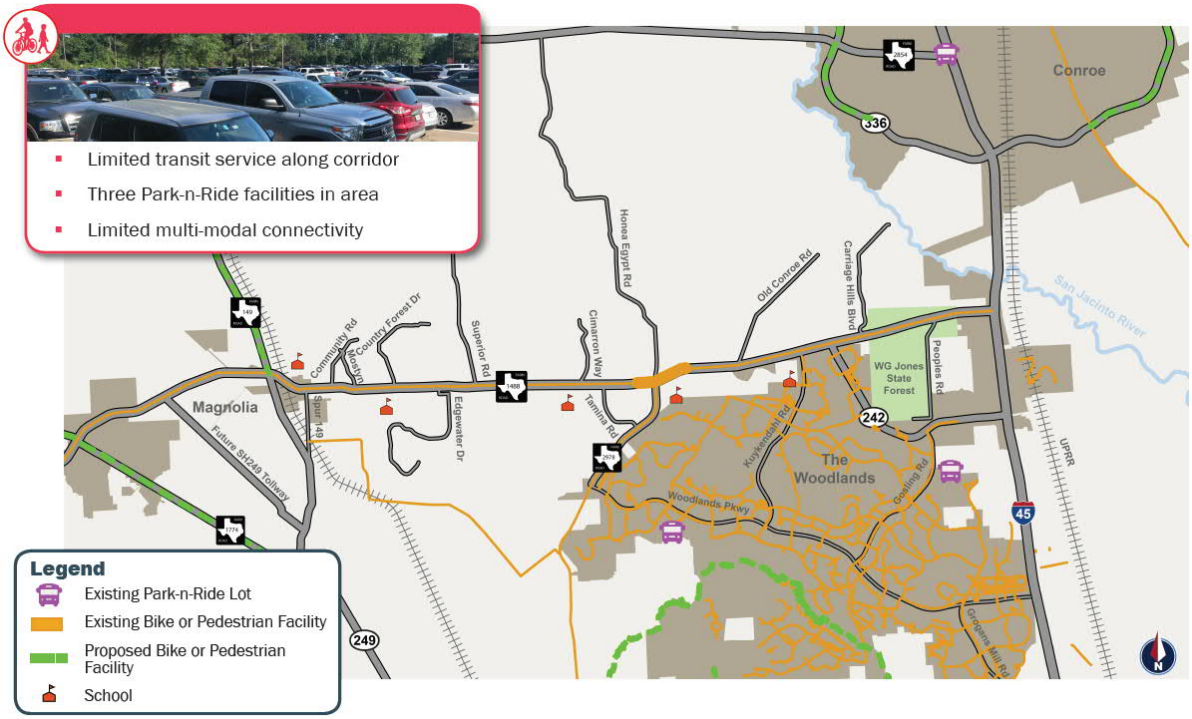
At either end of the FM 1488 corridor are Class I main line railroads. At the western edge of the FM 1488 corridor, a Class I (BNSF-owned) single-track main line runs parallel to FM 149 on the eastern side. Data from the Federal Railroad Administration (FRA) as of a 2013 count indicates that there are 6 day thru trains and 6 night thru trains. This is now a grade-separated crossing, negating any potential congestion or safety impacts.

At the eastern edge of the study corridor is an at-grade crossing with a single-track Class I (Union Pacific (UP)-owned) main line, less than 1,000 feet to the east of the I-45 centerline (U.S. DOT crossing inventory number 435477J). FRA data indicates that as of 2017, there were 5 day thru trains and 5 night thru trains traversing this signalized crossing with a typical speed between 30 and 60 miles per hour. There is no passenger rail traffic on the line. There is a significant amount of potentially redevelopable land to the east of I-45, and thus if development were to occur, this grade crossing may require improvements to mitigate the potential safety impacts. Since 2000, three accidents have occurred at this location, two of them fatal, involving motorists driving around the gates.

3.5 Multi-modal Facilities

As depicted in **Figure 3.7**, there is no transit service directly accessible from the study corridor. There are three Park-n-Ride facilities in the vicinity—two in The Woodlands and one in Conroe—but they would require vehicular access. Existing pedestrian and bicycle facilities along the corridor are also limited, despite the presence of five schools along with numerous shopping centers and other commercial trip attractions. Multi-modal connectivity is generally poor. The non-motorized network is described in further detail below.

Figure 3.7: Existing Multi-modal Network



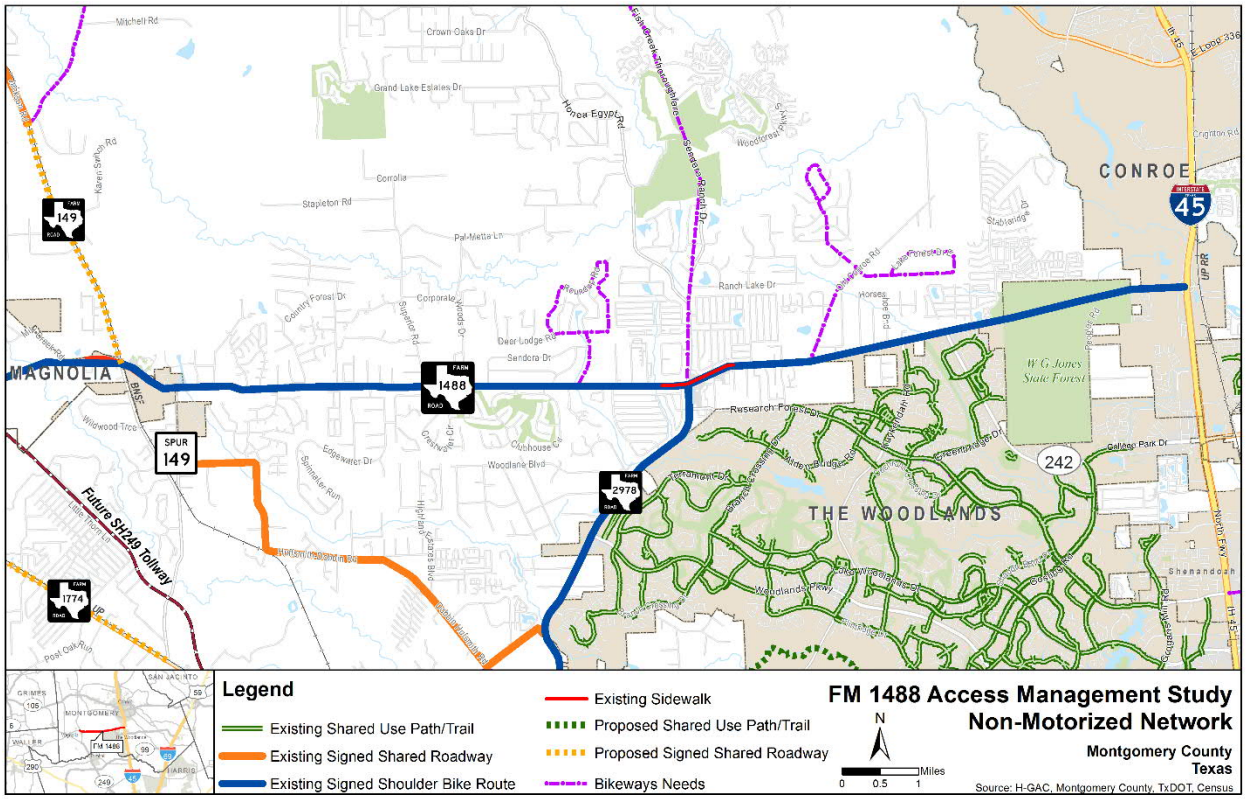
Source: H-GAC

3.6 Pedestrian and Bicycle Infrastructure

As shown in **Figure 3.8**, FM 1488 is provided with an existing shared shoulder bike route along the entire length of the study corridor. This shared route, while classified as signed, lacks signage as noted in a windshield survey. It is also unbuffered and thus does not provide a physical separation between cyclists and motorists, which may deter usage. A proposed signed shared roadway has been identified along FM 149 north of the intersection with FM 1488, starting at Magnolia High School and ending at Jackson Road. Sidewalks are present along segments of the roadway, including near the intersection with FM 2978.

A bicycling needs assessment as part of the *H-GAC 2040 Regional Pedestrian and Bicycle Plan* identified several roadways adjacent to FM 1488 that need improvements, including Honea Egypt Road, Old Conroe Road, and Cimarron Way; these needs were sponsored by the Woodlands Cycling Club. Opportunities exist to create safe pedestrian or bicycling connections between residential areas within the FM 1488 corridor and both the W.G. Jones State Forest recreational area and the robust network of shared-use paths in The Woodlands.

Figure 3.8: Bikeway Map



To better understand cycling activity on area bikeways, 2018 data from the fitness app Strava was gathered and analyzed. This data should not be considered a statistically valid sampling of cycling activity, as it only includes cyclists actively using the cell phone app, but it is useful for identifying travel patterns and heavily used routes. **Figure 3.9** and **Figure 3.10** depict the roadways by count of annual cyclists using the road on weekdays and weekends of 2018.

Figure 3.9: Cyclist Concentration Map – 2018 Weekday

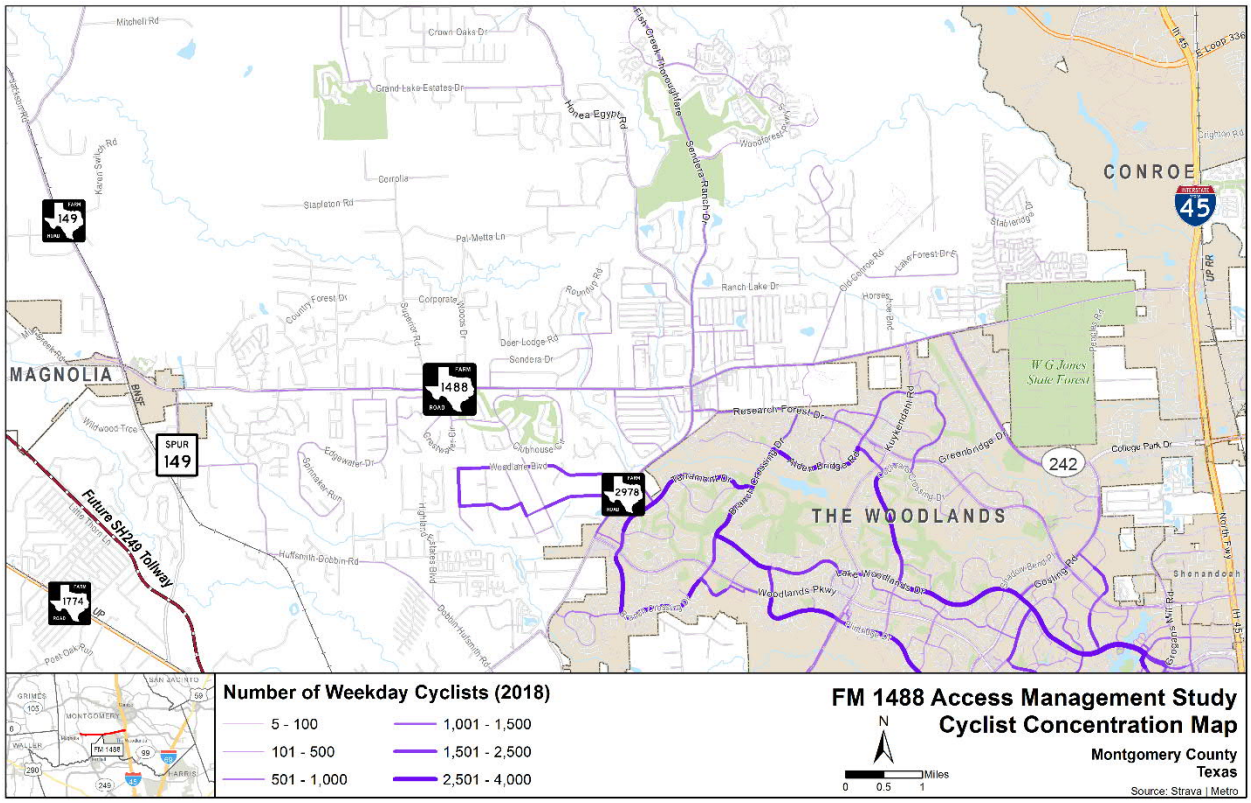
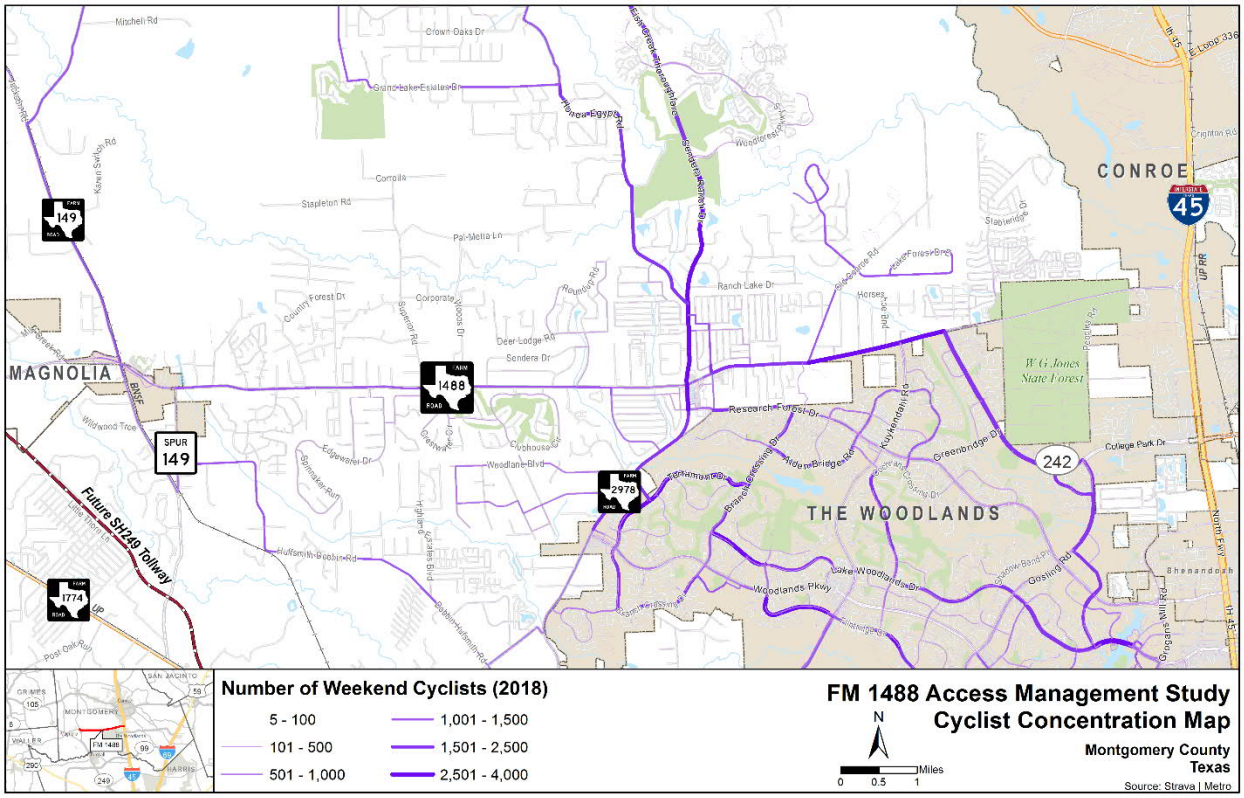


Figure 3.10: Cyclist Concentration Map – 2018 Weekend



Analyzing Strava cycling activity, several gaps emerge in the cycling network where bike routes are not currently provided or proposed, and yet a great deal of cycling is recorded in the Strava app:

- College Park Drive south of 1488
- Research Forest Drive between FM 2978 and Branch Crossing Drive
- Honea Egypt Rd north of FM 1488, as well as Sendera Ranch Drive at the right fork.

In addition to these segments—and given the amount of development occurring on FM 1488 near Old Conroe Road—there also appears to be a suitable location to connect FM 1488 with the cycling network in The Woodlands to the south, beginning on Research Forest Drive. An additional benefit would be that such a link would also connect to the previously identified bikeway needs area north of FM 1488 along Old Conroe Magnolia Road. As noted above (Planned Project ID 18), this roadway segment is due to be widened to 4-lanes and extended north to Loop 336.

3.7 Signage

Signage conditions along the study corridor were documented during a windshield survey in spring 2019. It was noted that much of the signage had an aging appearance, and some signs may need renewal in the near term. There are few advanced street name signs, which may have an adverse impact on safety as drivers react hastily in response to the (potentially sudden) approach of cross streets. As discussed in **Section 3.6**, the signed shoulder bike route that is designated along the entire length of the study corridor in fact lacks any signage.

Speed limit signs along the corridor currently range from 45 mph to 50 mph. Previously, they ranged from 45 mph to 55 mph, but in April 2019 speed reductions were made along two segments and the appropriate signage was installed:

- From Conroe Huffsmith Rd. to N. Westwood Dr., speed limit reduced from 50 to 45 mph
- From Old Conroe Rd to The Mansions Blvd., speed limit reduced from 55 to 50 mph

A 35-mph school zone is present on FM 1488 between Country Forest Drive and Business Park Drive, indicated with flashing signs.

3.8 Study Intersections

All signalized intersections, and many unsignalized intersections were assessed for the existing conditions analysis. Along the FM 1488 corridor there are 19 signalized intersections. The corridor includes the interchanges of FM 149 and I-45 at FM 1488. FM 149 at FM 1488 is a signalized partial cloverleaf interchange with 2 quadrants on the same side. I-45 at FM 1488 is an unsignalized, full cloverleaf interchange. Intersections located in the project area and analyzed are listed below, and a summary of signalized intersection details, including signal control type and cycle length, are listed in **Table 3.4**.

Signalized intersections:

1) FM 149 @ FM 149 West Access Rd (N)
2) FM 149 @ FM 149 West Access Rd (S)
3) FM 1488 @ Spur 149
4) FM 1488 @ Magnolia Parkway Elementary School
5) FM 1488 @ Lake Windcrest Blvd
6) FM 1488 @ Windcrest National
7) FM 1488 @ Cimarron Way
8) FM 1488 @ Tamina Rd
9) FM 1488 @ Honea Egypt Rd/FM 2978
10) FM 1488 @ Conroe Huffsmith Rd/Egypt Ln
11) FM 1488 @ Katy Lee Lane
12) FM 1488 @ N Westwood Dr.
13) FM 1488 @ Old Conroe Magnolia Rd/Del Webb Blvd
14) FM 1488 @ Kuykendahl Ct/ Kuykendahl Rd
15) FM 1488 @ SH 242
16) FM 1488 @ Carriage Hills Blvd
17) FM 1488 @ Peoples Road
18) FM 1488 @ Mansions Blvd
19) FM 1488 @ Grace Crossing Dr/W. Walter Woodson Dr

Unsignalized stop controlled intersections:

1) FM 1488 @ Mostyn Dr
2) FM 1488 @ Manor Dr
3) FM 1488 @ Thousand Oaks Blvd
4) FM 1488 @ Cimarron Creek
5) FM 1488 @ Commercial Driveway 2
6) FM 1488 @ Home Depot Driveway

Table 3.4: Existing Signalized Intersection Details

Intersection	Signal Control Type	Cycle Length (in sec)	Pedestrian Features
FM 149 @ FM 149 W Access Rd	Actd- Uncrd	133	Yes
FM 149 @ FM 1488	Actd- Uncrd	170	Yes
FM 1488 @ Magnolia Elementary	Actd- Uncrd	140	Yes
FM 1488 @ Lake Windcrest	Actd- Uncrd	95	Yes
FM 1488 @ Cimarron Way	Actd-Coord	140	Yes
FM 1488 @ Tamina Rd	Actd-Coord	140	Yes
FM 1488 @ Honea Egypt/FM 2978	Actd-Coord	140	Yes
FM 1488 @ Conroe Huffsmith	Actd-Coord	140	Yes
FM 1488 @ Katy Lee Ln	Actd-Coord	140	Yes
FM 1488 @ N Westwood	Actd-Coord	140	No
FM 1488 @ Old Conroe Rd	Actd-Coord	140	No
FM 1488 @ Kuykendahl Rd	Actd-Coord	140	Yes
FM 1488 @ SH 242	Actd-Coord	140	Yes
FM 1488 @ Carriage Hills Blvd	Actd-Coord	130	No
FM 1488 @ Peoples Rd	Actd- Uncrd	140	Yes
FM 1488 @ Mansions Blvd	Actd-Coord	120	No
FM 1488 @ Grace Crossing Dr	Actd-Coord	120	Yes

4 Traffic Characteristics

A variety of data was collected in the study area for inputs to traffic models, for calibration of models, and for safety/density analysis. Data collected includes existing signal timing and phasing, lane configurations, traffic counts, travel time runs, crash records, and access point density.

4.1 Crash Data Analysis

FM 1488 corridor safety analysis was conducted to improve operational safety and efficiency and suggest improvements. Crash data of the corridor was collected from TxDOT's Crash Records Information System (CRIS) for a period of three years from January 1, 2015 to December 31, 2017. Statewide traffic crash rates from Texas Motor Vehicle Crash Statistics was taken from 2015 to 2017 for the study. Annual Average Daily Traffic (AADT) for the crash analysis was tabulated from TxDOT Traffic Count Database System (TCDS).

The FM 1488 corridor was divided into six segments based on rural/urban condition, lane configuration, and crash/access density.

Roadway segment crash rates were calculated using the formula,

$$R = \frac{100{,}000{,}000 \times C}{365 \times N \times V \times L}$$

$R =$ Crash rate for the road segment expressed as crashes per 100 million vehicle-miles of travel (VMT)

$C =$ Total number of crashes in the study period

$N =$ Number of years of data

$V =$ Number of vehicles per day (both directions) (AADT)

$L =$ Length of the roadway segment in miles

Intersection crash rates were calculated using the following formula.

$$R = \frac{1{,}000{,}000 \times C}{365 \times N \times V}$$

$R =$ Crash rate for the intersection expressed as accidents per million entering vehicles (MEV)

$C =$ Total number of intersection crashes in the study period

$N =$ Number of years of data

$V =$ Traffic volumes entering the intersection daily

A buffer of 500 feet for each intersection approach was used to identify intersection related crashes along the corridor.

Corridor segment crash analysis showed segment crash rates ranging from 2015 to 2017 varying from 70.2 crashes per hundred million vehicle miles (along the State Forest) to 421.9 crashes per

hundred million vehicle miles (near FM 149, which was a construction zone for much of that time). The statewide average crash rate is shown in **Table 4.1** for urban farm-to-market roadway averaged over three years.

Table 4.1: Statewide Average Crash Rates

Year	Statewide Average Crash Rate Urban Farm-to-Market
2017	295.61
2016	301.87
2015	289.55
Three Year Average	**295.68**

Three of the segments representing about 5.7 miles of the 14-mile corridor have corridor crash rates higher than the statewide average for the highway system type.

Table 4.2 lists the top ten intersection crash rates ranked from highest to lowest. Detailed crash analysis data can be found in **Appendix B**.

Table 4.2: Ranked Intersection Crash Rates

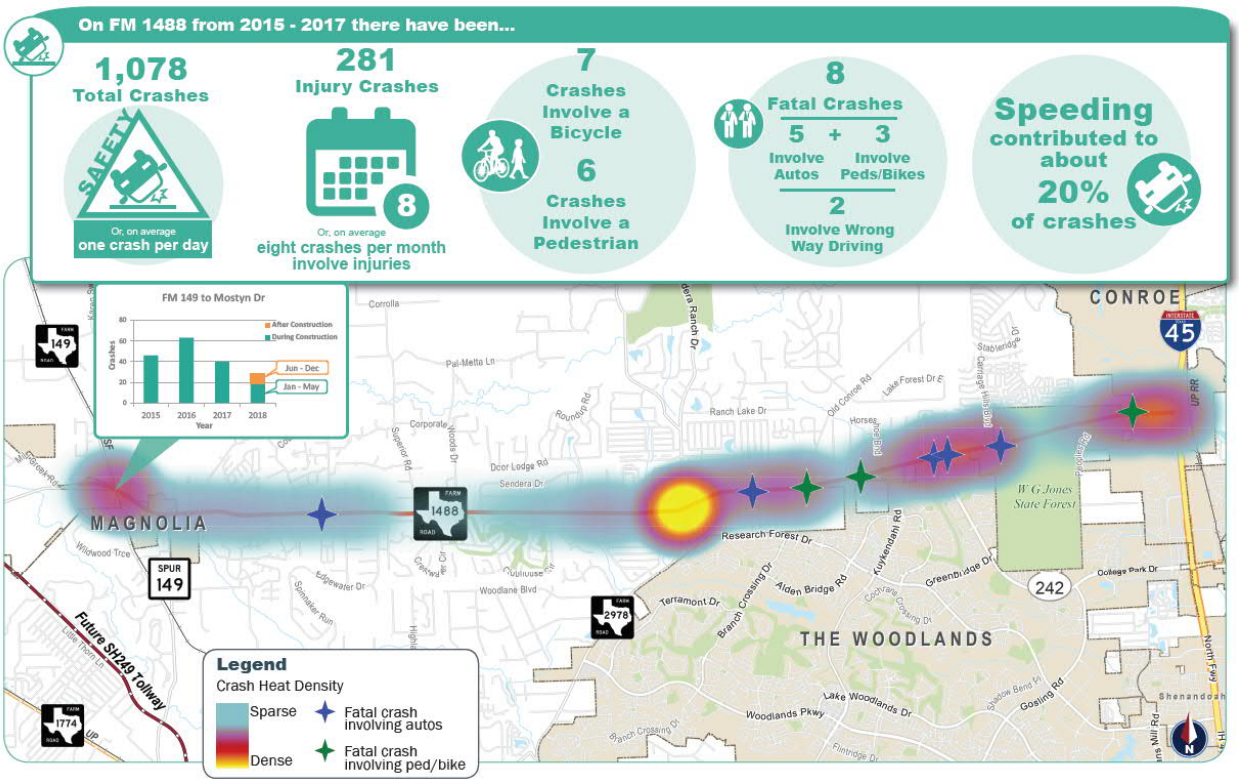
Rank	FM 1488 Cross Street	Average Intersection Crash Rate
1	Honea Egypt Rd / FM 2978	2.94
2	FM 149	2.59
3	SH 242	1.21
4	I-45	1.05
5	Carriage Hills	0.98
6	Conroe Huffsmith Rd / Egypt Ln	0.86
7	Old Conroe Rd	0.83
8	Tamina Rd	0.73
9	Kuykendahl Rd	0.56
10	N Westwood Dr	0.48

From the calculated crash rates, high severity and fatal crashes were tabulated and the locations were pinned for further analysis. Characteristics such as location (intersection, non-intersection, driveway) and manner of collision (rear end, sideswipe, fixed object) were analyzed. The time of day with frequent and fatal collisions occurring at locations and pertaining to weather conditions during the day contributing to crashes are summarized. Locations with higher crash rates were identified as hotspots and those with higher rates involving pedestrian/bike crashes were identified.

This spatial distribution of crashes along the study corridor between 2013 and 2017 is provided in **Figure 4.1**. All but one of the fatal crashes occurred in the roadway segment between FM 2978 and I-45, which, as noted above, experiences much higher traffic volume counts compared to the western portion of the roadway. The map also depicts the density of all crashes, including crashes that involved injuries or property damage but no fatalities. This heat

map shows that the highest overall density is near the intersection between FM 1488 and FM 2978. Other significant concentrations include the intersection with I-45, with SH 242 / College Park Drive, and with FM 149. These concentrations generally correlate with non-residential land use types along the corridor, and thus a higher frequency of vehicles accessing or leaving the roadway.

Figure 4.1: Crash Heat Map



4.2 Crash Rates vs. Access Point Density

Existing driveway and intersection access points were identified along the corridor using aerial data and confirmed with field verification to calculate access point density (number of access points per mile) along key segments for the corridor. Access point density varied from 5.3 access points per mile (along the State Forest) to 47 access points per mile (near FM 2978/Honea Egypt Rd. Using the data collected, the number of conflict points were also calculated.

An analysis was performed comparing the segment crash rates with access point density. As shown in **Figure 4.2** and **Figure 4.3**, the access point density (grey line) typically corresponds with the segment crash rate (blue bars) similar to previous studies referenced in the Transportation Research Board (TRB) Access Management Manual.

Although the western segment from FM 149 to Mostyn Drive has the highest segment crash rate, this segment was under construction during the crash analysis period and previously had a higher access point density. The segment is expected to support the data that a reduction in access points reduces crashes once more crash data is available post-construction of the railroad grade

separation and FM 1488 widening. Year 2018 crash data, shown in **Figure 4.4**, shows that there were less crashes after construction ended from June to December 2018 than during construction from January to May 2018.

Figure 4.2: FM 1488 Access Density & Crash Rate Comparison (2015-2017)

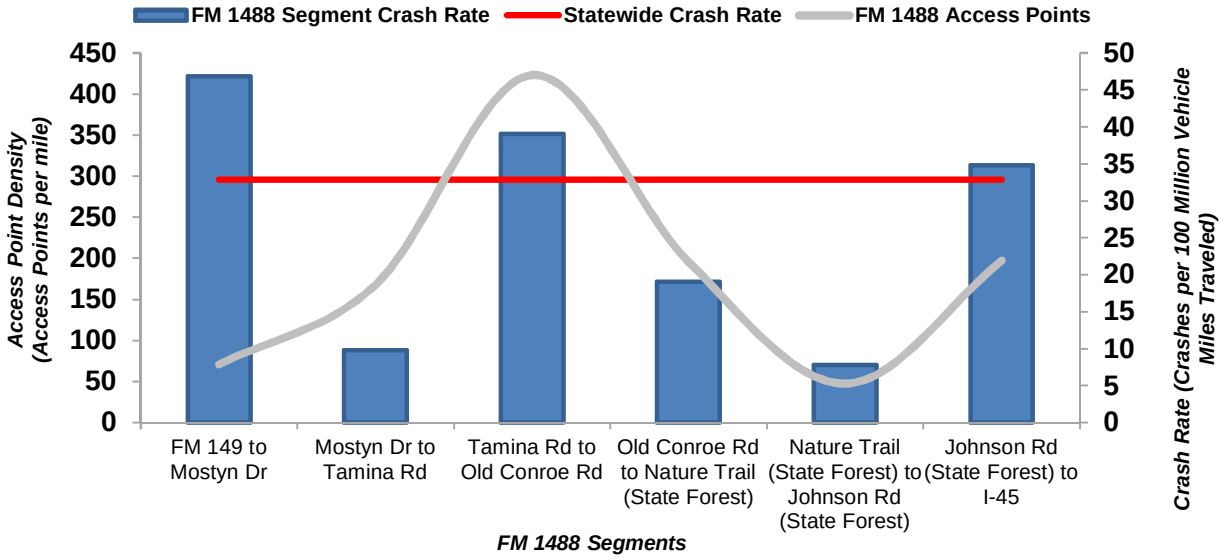


Figure 4.3: Segment Crash Rate vs. Access Point Density

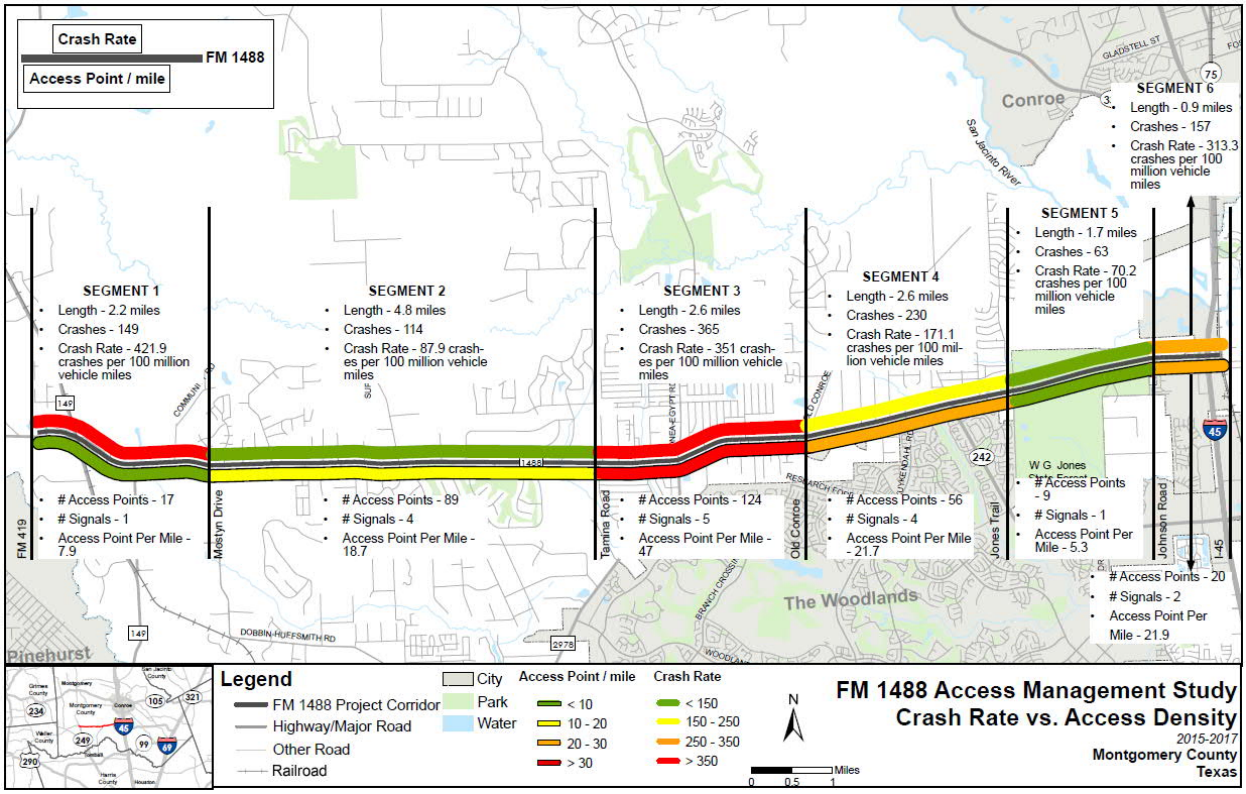
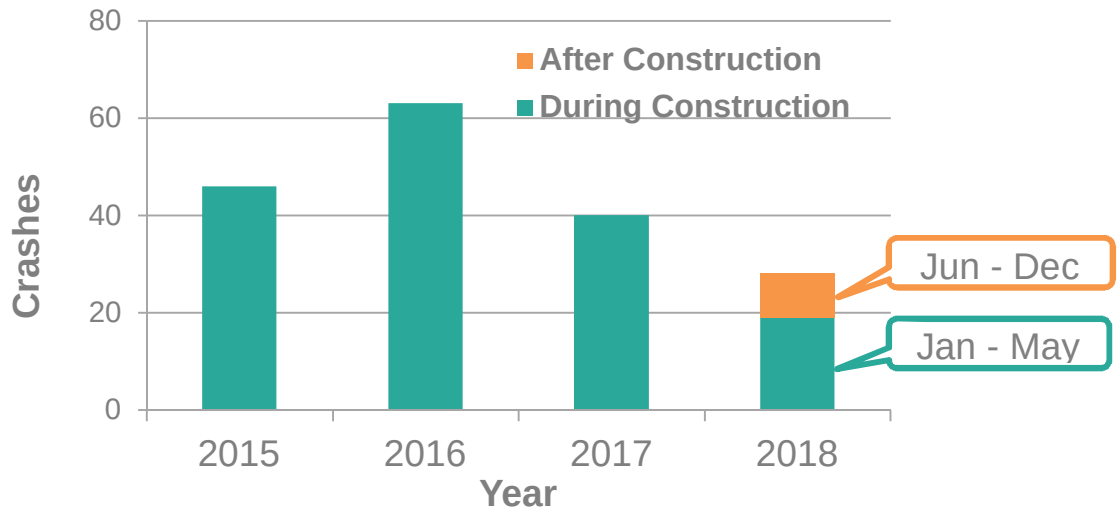


Figure 4.4 Segment 1 Crashes (FM 149 to Mostyn Dr)

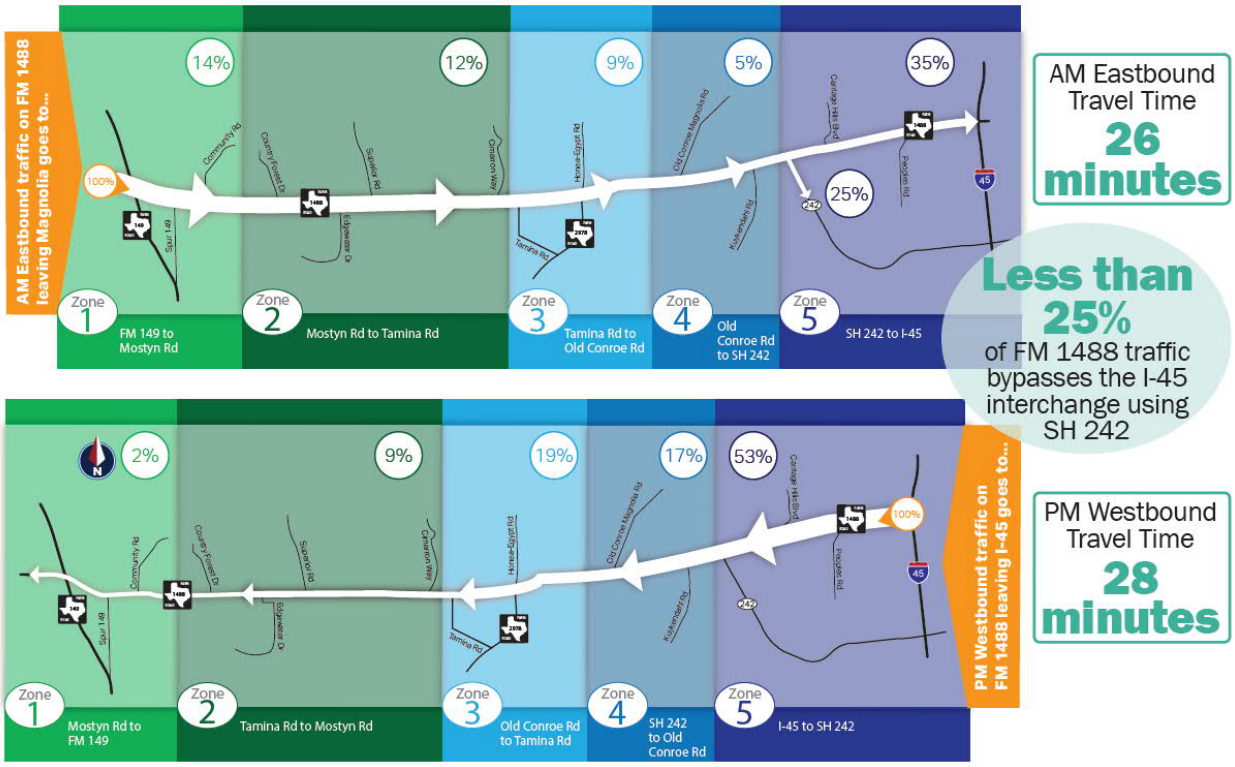


4.3 O-D Analysis

Origin-destination data for the project corridor was gathered from transportation analytics firm StreetLight to better understand corridor travel patterns. As shown in **Figure 4.5**, among vehicles traveling eastbound and entering this segment of FM 1488 during the AM period, only 40% are traveling to destinations closer than SH 242 (shown as zones 1-4). Zone 5 includes vehicles either turning right onto SH 242 College Park Drive (25% of trips) or continuing to I-45 interchange (35% of all trips).

During the PM period, westbound vehicles entering FM 1488 from I-45 are largely destined for locations not distant from the Interstate: 53% of trips are traveling to locations in Zone 5 (i.e., east of the intersection with SH 242). A further 36% are traveling to locations in Zones 3 and 4 (roughly between Tamina Rd and SH 242), while the remaining 11% travel onward to Zones 1 and 2, from Tamina Rd to the western terminus of the study corridor or beyond.

Figure 4.5: Origin-Destination Travel Patterns (AM Eastbound and PM Westbound)



4.4 Daily Traffic Volumes

Traffic counts include turning movement counts, 24-hour counts (classified and non-classified), and 7-day 24-hour counts. Traffic count locations are listed in **Table 4.3** and **Table 4.4**. 24-hour counts were used to determine approximate peak hours for the turning movement counts (TMC) data collection. Weekday turning movement counts were collected during 2-hour AM and 2-hour PM periods. TMC data used for traffic modeling includes volumes, peak hour factors, and heavy vehicle percentages. A summary of TMC volumes can be found in **Appendix C**. Travel time runs along the corridor were collected on the same day during AM and PM peaks. Travel times were used to calibrate the models. Floating car method used to collect travel time runs along the corridor.

Table 4.3: Traffic Count Locations - TMC

Weekday 2-HR AM & 2-HR PM Peak Intersection TMC (4 Hours)			
Count ID	**Main Street**	**Cross Street**	**Sig (S) Unsig (U)**
1	FM 149	FM 149 West Access Rd (N)	S
2	FM 149	FM 149 West Access Rd (S)	S
3	FM 1488	Spur 149	S
4	FM 1488	Mostyn Dr	U
5	FM 1488	Manor Dr	U
6	FM 1488	Thousand Oaks Blvd	U
7	FM 1488	Magnolia Parkway Elementary School	S
8	FM 1488	Lake Windcrest Blvd	S
9	FM 1488	Windcrest National	S
10	FM 1488	Cimarron Creek	U
11	FM 1488	Cimarron Way	S
12	FM 1488	Tamina Rd	S
13	FM 1488	Honea Egypt Rd/FM 2978	S
14	FM 1488	Commercial Driveway 2	U
15	FM 1488	Conroe Huffsmith Rd/Egypt Ln	S
16	FM 1488	Home Depot Driveway	U
17	FM 1488	Katy Lee Lane	S
18	FM 1488	N Westwood Dr.	S
19	FM 1488	Old Conroe Magnolia Rd/Del Webb Blvd	S
20	FM 1488	Kuykendahl Ct/ Kuykendahl Rd	S
21	FM 1488	SH 242	S
22	FM 1488	Carriage Hills Blvd	S
23	FM 1488	People's Road	S
24	FM 1488	Mansions Blvd	S
25	FM 1488	Park Woodland *(prev. Woodland Apt Driveway)*	S
26	FM 1488	I-45 West Access Rd (W)	U
27	FM 1488	I-45 West Access Rd (E)	U
28	FM 1488	I-45 East Access Rd (W)	U
29	FM 1488	I-45 East Access Rd (E)	U
30	I-45 SB Frontage Rd	I-45 West Access Rd	U
31	I-45 NB Frontage Rd	I-45 East Access Rd	U

Table 4.4: Traffic Count Locations - 24-Hour

24-Hour Automated Tube Counts - Classified (24 Hours)	
Count ID	**Count Location**
32	Eastbound FM 1488 west of Spur 149
33	Westbound FM 1488 east of Spur 149
34	Eastbound FM 1488 west of SH 242
35	Westbound FM 1488 west of SH 242
36	Eastbound FM 1488 west of FM 2978/Honea Egypt Rd west of FM 2978
37	Westbound FM 1488 east of FM 2978/Honea Egypt Rd east of FM 2978
38	Eastbound FM 1488 west of I 45
39	Westbound FM 1488 west of I 45
40	Westbound FM 1488 east of FM149
41	Eastbound FM 1488 east of FM 149
24-Hour Automated Tube Counts - Non-Classified (24 Hours)	
Count ID	**Count Location**
42	Eastbound FM 149 East Access Rd (North)
43	Westbound FM 149 East Access Rd (North)
44	Eastbound FM 149 East Access Rd (South)
45	Westbound FM 149 East Access Rd (South)
46	Eastbound FM 149 West Access Rd (North)
47	Westbound FM 149 West Access Rd (North)
48	Eastbound FM 149 West Access Rd (South)
49	Westbound FM 149 West Access Rd (South)
24-Hour Automated Tube Counts - Non-Classified (7 Days)	
Count ID	**Count Location**
50	Eastbound FM 1488 west of FM 2978/Honea Egypt Rd
51	Westbound FM 1488 west of FM 2978/Honea Egypt Rd
52	Eastbound FM 1488 east of Conroe Huffsmith Rd/Egypt Ln
53	Westbound FM 1488 east of Conroe Huffsmith Rd/Egypt Ln

From the 2-hour turning movement counts, the AM and PM peak periods were determined for each intersection. These observed peak periods range from 6:30 to 900 AM and 4:15 to 6:00 PM. Details for each intersection can be found in **Appendix C**.

Table 4.5 lists the 24-Hour count data at the major intersections along the corridor.

Table 4.5: Existing and Historical Average Daily Traffic

Count Location	Average Daily Traffic (Both Directions)
East of Spur 149	20,100
West of Honea Egypt Rd / FM 2978	34,800
West of SH 242	53,200
West of I-45	52,300

4.5 Observations

Qualitative assessments are generally conducted in the field in order to evaluate the existing operational conditions and traffic flow patterns at a location, and to identify areas where improvements are potentially beneficial to the overall safety and efficiency of the corridor. Based on field review, the following field observations were noted for informational purpose:

- Queues were observed westbound on FM 1488 during the morning peak hour to near Spur 149 intersection due to the morning drop-off at Magnolia High School.
- At FM 1488 and Honea Egypt R/FM 2978, long queues were noted for the westbound left in the afternoon. Additionally, northbound and southbound directions had heavy traffic volumes.
- At FM 1488 and Old Conroe Magnolia Rd/Del Webb Blvd., heavy traffic volumes were noted for the southbound approach. The northbound approach had very little traffic.
- At FM 1488 and SH 242, the northbound approach had heavy left turn volumes
- Wide right shoulders on FM 1488 served as a right turn lane in several locations along the corridor, especially near shopping centers between FM 2978 and Katy Lee Ln. It was noted particularly that while there is no striped right turn lane at FM 1488 and Conroe Huffsmith Rd/ Egypt Ln, vehicles making a right turn frequently used the shoulder.
- Heavy congestion was noted west of I-45 in both directions during both peak hours, especially during the evening peak hour.

5 Traffic Simulation Analysis

Model coding and calibration for the signal network was done after all data was collected and reviewed to ensure accuracy. Synchro 10 software was used to code and calibrate the network. Existing coordinated signal timing parameters were used to set up the initial model. Synchro was used to assist in the signal timing plan development. The Synchro model provides a practical method of determining the optimal combination of cycle length, phase sequence and offsets for a series of intersections. This includes through traffic as well as Minor Street and turning traffic. Model coding and calibration including entry of traffic counts, signal phasing, lane geometries, speed limits for the study area intersections took place after all data was collected and compiled. Once all the information was coded, the Synchro model was reviewed and calibrated to simulate actual field conditions. The field collected travel time data was used to calibrate the existing model to replicate existing field conditions.

To analyze the existing conditions on FM 1488, Synchro base models for AM and PM weekday scenarios were created by entering lane settings, volume settings, and timing and phasing settings.

Lane/simulation settings used are listed below:

- Lane configuration
- Link distance (links were drawn graphically over aerial image)
- Link speed
- Storage length
- Number of storage lanes
- Median width
- Median type (TWLTL or non-TWLTL)
- Link offset

Volume settings used are as follows:

- Traffic volume
- Peak hour factor
- Heavy vehicles %

Timing/Phasing settings used are listed below:

- Signal phasing
- Ring & barrier structure
- Turn type
- Protected/permitted phases
- Control type
- Minimum initial green
- Minimum split
- Yellow time
- All-red time
- Walk time
- Flashing don’t walk time
- Maximum split
- Vehicle extension
- Recall mode
- Cycle length
- Offset

Signal timing information was provided by TXDOT and was field verified. The signal timing data used for Synchro are as follows:

- Phasing/turn type (Ring & Barrier)
- Control type (Pretimed, Actd-Uncrd., Actd-Coord., etc.)
- Minimum initial/green
- Yellow time
- All-red time
- Walk time
- Flashing Don't Walk
- Minimum splits
- Vehicle extension
- Recall mode
- Splits/cycle length
- Offset

5.1 Existing Average Travel Time and Speed

AM and PM travel time runs were collected for the eastbound and westbound directions on FM 1488 from FM 149 to IH 45. Data was collected at 17 nodes on the corridor.

Travel times between 15 of these nodes (from Mansions Blvd to Spur FM 149) were used for comparison with the Synchro models. An average of 3 travel time runs for each peak period and direction was calculated between each node. These values were compared the travel time values to use to comparison the Synchro base models. The average running speed was also calculated for the same 3 travel time runs. A travel time comparison of initial existing and calibrated conditions for AM and PM peaks are presented in **Table 5.1**.

Synchro-generated travel times were compared with average field travel times. The target for simulated total travel time is ±15% of the field total travel time. The target for simulated travel times between nodes is at least 85% of cases to be within ±15% of field travel times between nodes.

To meet targeted travel time values, link speeds were adjusted between intersections. After adjustment, field and simulation travel times were compared to see if the values were now within the target range. Further iterations were completed if necessary.

In addition to travel times, arterial speeds were also compared. The Synchro arterial speed was checked against the field actual average speed to verify that link speed calibration reflected field conditions. The target for simulated arterial speeds is ±10 minutes of field measured speeds for at least 85% of cases.

Travel time data is detailed in **Appendix D**.

Table 5.1: Field and Synchro Travel Time Comparisons

Eastbound FM 1488 Travel Times (Seconds)													
		AM						PM					
Segment	Segment Length (Miles)	Existing Field	Existing Synchro Initial	Δ Initial - Field	Existing Synchro Calib.	Δ Calib. - Field	% Change	Existing Field	Existing Synchro Initial	Δ Initial - Field	Existing Synchro Calib.	Δ Calib. - Field	% Change
Spur 149 to Lake Windcrest	2.5	191.7	213.0	21.3	196.6	4.9	3%	196.7	210.3	13.6	210.3	13.6	7%
Lake Windcrest to Tamina	3.2	261.0	272.1	11.1	264.8	3.8	1%	291.3	293.4	2.1	293.7	2.4	1%
Tamina to Old Conroe	2.6	299.0	338.8	39.8	331.8	32.8	11%	307.3	307.6	0.3	330.9	23.6	8%
Old Conroe to Carriage Hills	2.4	319.7	241.9	-77.8	313.8	-5.9	-2%	364.3	234.8	-129.5	338.6	-25.7	-7%
Carriage Hills to Mansions	2.0	299.0	153.6	-145.4	260.2	-38.8	-13%	174.3	157.0	-17.3	177.0	2.7	2%
Total Travel Time (Seconds)		1370.3	1219.4	-150.9	1367.2	-3.1	-0.2%	1334.0	1203.1	-130.9	1350.5	16.5	1.2%
Total Travel Time (minutes)		22.8	20.3		22.8			22.2	20.1		22.5		

Westbound FM 1488 Travel Times (Seconds)													
		AM						PM					
Segment	Segment Length (Miles)	Existing Field	Existing Synchro Initial	Δ Initial - Field	Existing Synchro Calib.	Δ Calib. - Field	% Change	Existing Field	Existing Synchro Initial	Δ Initial - Field	Existing Synchro Calib.	Δ Calib. - Field	% Change
Mansions to Carriage Hills	2.0	247.7	165.2	-82.5	241.7	-6.0	-2%	401.7	160.3	-241.4	407.6	5.9	1%
Carriage Hills to Old Conroe	2.4	217.0	193.4	-23.6	213.2	-3.8	-2%	287.3	221.4	-65.9	282.7	-4.6	-2%
Old Conroe to Tamina	2.6	273.0	311.6	38.6	303.5	30.5	11%	418.0	355.1	-62.9	398.8	-19.2	-5%
Tamina Road to Lake Windcrest	3.2	256.7	248.2	-8.5	248.1	-8.6	-3%	231.5	250.3	18.8	243.4	11.9	5%
Lake Windcrest to Spur 149	2.5	195.0	209.1	14.1	197.2	2.2	1%	200.0	198.5	-1.5	198.5	-1.5	-1%
Total Travel Time (Seconds)		1189.3	1127.5	-61.8	1203.7	14.4	1.2%	1538.5	1185.6	-352.9	1531.0	-7.5	-0.5%
Total Travel Time (minutes)		19.8	18.8		20.1			25.6	19.8		25.5		

5.2 Existing Intersection Level of Service

The level of service (LOS) criteria from the Highway Capacity Manual at signalized and unsignalized intersections are provided in **Table 5.2**. TxDOT considers LOS D or better to have acceptable operations.

Table 5.2: Intersection Level of Service (LOS) Criteria

Table 1. Level of Service Criteria for Signalized Intersections

Level of Service	Average Control Delay (seconds/vehicle)	General Description
A	≤10	Free Flow
B	>10 – 20	Stable Flow (slight delays)
C	>20 – 35	Stable flow (acceptable delays)
D	>35 – 55	Approaching unstable flow (tolerable delay, occasionally wait through more than one signal cycle before proceeding)
E	>55 – 80	Unstable flow (intolerable delay)
F[1]	>80	Forced flow (congested and queues fail to clear)

Source: *Highway Capacity Manual 2010*, Transportation Research Board, 2010.
1. If the volume-to-capacity (v/c) ratio for a lane group exceeds 1.0 LOS F is assigned to the individual lane group. LOS for overall approach or intersection is determined solely by the control delay.

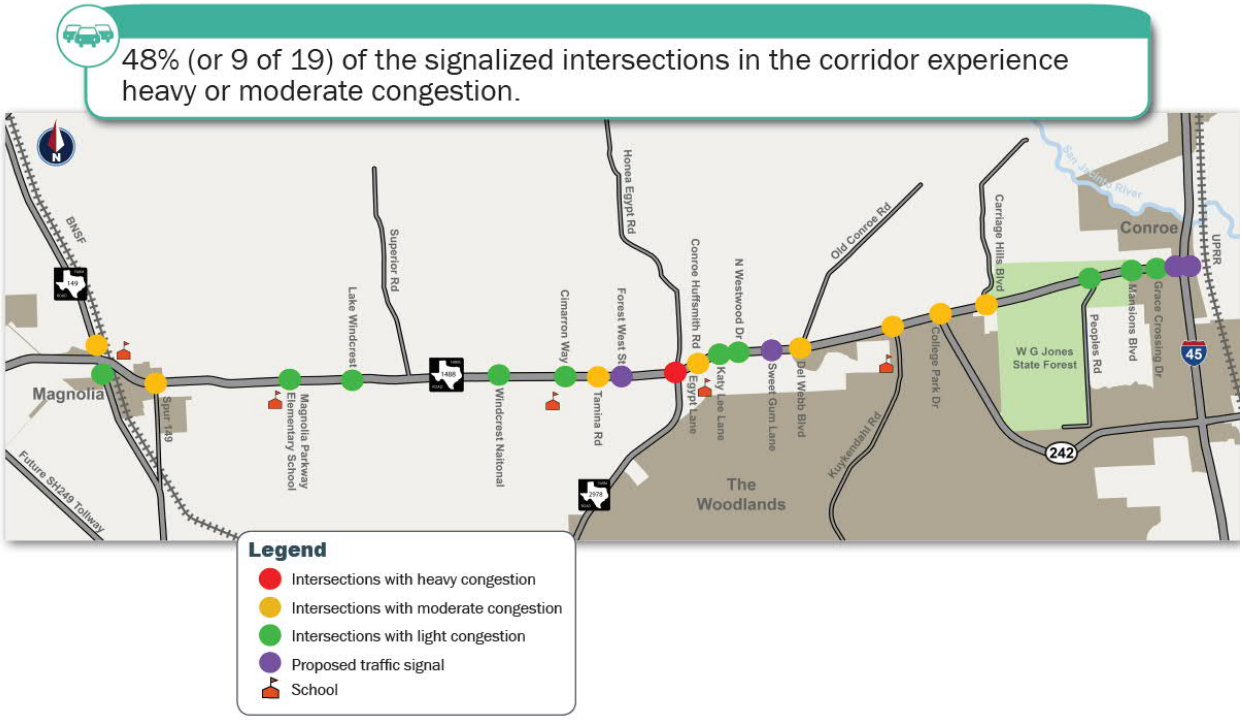
Table 2. Level of Service Criteria for Unsignalized Intersections

Level of Service	Average Control Delay (seconds/vehicle)
A	0 – 10
B	>10 – 15
C	>15 – 25
D	>25 – 35
E	>35 – 50
F[1]	>50

Source: *Highway Capacity Manual 2010*, Transportation Research Board, 2010.
1. If the volume-to-capacity (v/c) ratio exceeds 1.0, LOS F is assigned an individual lane group for all unsignalized intersections, or minor street approach at two-way stop-controlled intersections. Overall intersection LOS is determined solely by control delay.

Based on Synchro traffic modeling software, as shown in **Figure 5.1**, one of the signalized intersections (FM 1488 at Honea Egypt Road/FM 2978) is flagged as suffering from heavy congestion (LOS E or F). Intersections suffering from moderate congestion (LOS C or D) include FM 149 (WB), Spur 149, Tamina Rd, Conroe Huffsmith Rd, Old Conroe Rd, Kuykendahl Rd, College Park Dr, and Carriage Hills Blvd—8 in total, or 42% of corridor intersections. The remaining 52% of signalized intersections experience light congestion (LOS A or B). Four proposed traffic signals are also displayed on the map. Synchro results at Spur 149 display moderate congestion because queues are not factored into this model; however, Vissim traffic analysis results show LOS F at Spur 149 due to queues from Magnolia High School.

Figure 5.1: Existing Signalized Intersection Congestion



The calibrated Synchro intersection LOS analysis results show all the unsignalized intersections operating at acceptable LOS D or better except at the following three intersections:

- FM 1488 at Mostyn Dr – LOS F (AM peak hour)
- FM 488 at Manor Dr – LOS F (AM peak hour)
- FM 1488 at Thousand Oaks Blvd - LOS E (AM and PM peak hours).

The existing LOS summary prior to and after calibration is shown in **Table 5.3**. Measures of effectiveness are detailed in **Appendix E**, and existing Synchro intersection LOS results are detailed in **Appendix F**.

Table 5.3: Existing Intersection LOS Summary

Intersection	AM				PM			
	Existing - Initial		Existing - Calibrated		Existing - Initial		Existing - Calibrated	
	LOS	Delay[1]	LOS	Delay[1]	LOS	Delay[1]	LOS	Delay[1]
FM 149 @ FM 149 West Access Rd (N)	C	22.1	C	22.1	C	23.2	C	23.2
FM 149 @ FM 149 West Access Rd (S)	B	11.0	B	11.0	B	10.0	B	10.0
FM 1488 @ Spur 149	C	30.9	C	30.9	C	25.8	C	25.8
FM 1488 @ Mostyn Dr[2]	D	33.6	D	33.6	C	20.0	C	20.0
FM 1488 @ Manor Dr[2]	E	37.8	E	37.8	C	23.0	C	23.0
FM 1488 @ Thousand Oaks Blvd[2]	E	38.8	E	38.8	E	41.1	E	41.1
FM 1488 @ Magnolia Parkway Elementary School	B	12.2	B	12.2	B	10.2	B	10.2
FM 1488 @ Lake Windcrest Blvd	B	12.0	B	12.0	B	11.4	B	11.4
FM 1488 @ Windcrest National	B	18.7	B	18.4	A	6.5	A	6.3
FM 1488 @ Cimarron Creek[2]	C	23.8	C	23.8	C	19.6	C	19.6
FM 1488 @ Cimarron Way	A	8.0	A	8.0	B	10.6	B	11.0
FM 1488 @ Tamina Rd	C	27.4	C	27.6	D	49.4	D	46.5
FM 1488 @ Honea Egypt Rd/FM 2978	D	49.7	D	49.7	D	50.8	E	63.6
FM 1488 @ Commercial Driveway 2[2]	C	16.3	C	16.3	C	16.2	C	18.9
FM 1488 @ Conroe Huffsmith Rd/Egypt Ln	C	33.6	C	32.2	C	31.6	C	28.9
FM 1488 @ Home Depot Driveway[2]	C	17.1	C	17.1	C	19.5	C	19.5
FM 1488 @ Katy Lee Lane	A	7.1	A	7.3	B	10.4	A	9.2
FM 1488 @ N Westwood Dr.	B	12.7	B	12.6	B	14.8	B	15.2
FM 1488 @ Old Conroe Magnolia Rd/Del Webb Boulevard	C	22.7	C	23.6	C	24.3	C	25.6
FM 1488 @ Kuykendahl Ct/ Kuykendahl Rd	C	27.0	C	32.9	C	30.6	C	33.4
FM 1488 @ SH 242	C	21.1	C	20.8	C	33.9	D	40.1
FM 1488 @ Carriage Hills Blvd	D	42.4	D	42.4	D	36.4	D	36.9
FM 1488 @ People's Road	A	7.8	A	7.8	A	7.6	A	7.6
FM 1488 @ Mansions Blvd	B	11.3	B	11.3	B	12.3	B	12.3
FM 1488 @ Grace Crossing Dr/W. Walter Woodson Dr	B	12.3	B	12.3	B	14.0	B	14.0
FM 1488 @ I-45 West Access Rd (W)[3]	N/A							
FM 1488 @ I-45 West Access Rd (E)[3]	N/A							
FM 1488 @ I-45 East Access Rd (W)[3]	N/A							
FM 1488 @ I-45 East Access Rd (E)[3]	N/A							
I-45 SB Frontage Rd @ I-45 West Access Rd[3]	N/A							
I-45 NB Frontage Rd @ I-45 East Access Rd[3]	N/A							

[1] Delay is presented in seconds per vehicle

[2] Unsignalized Intersection - HCM 6th Edition Critical Lane LOS Used

[3] Unsignalized Intersection - All Movements Free

5.3 Existing Traffic Simulation Analysis

The existing VISSIM models were built for the interchange of FM 1488 and FM 149, including AM peak and PM peak. The signal timing, TMC and floating car travel time data at the interchange area were processed and used as input data in the Vissim models. Model traffic volumes and travel times were calibrated to reflect existing field operation conditions. **Figure 5.2** is a screenshot of the Vissim model simulation at the interchange. LOS, delay, and queue length results were summarized in **Table 5.4** and detailed in **Appendix G**. Calibration tables are also included in **Appendix G**.

During the AM peak, heavy congestion occurred near Magnolia High School during the morning drop-off period. The westbound traffic on FM 1488 using the off-ramp to the high school were queued on to FM 1488 and spilled back to east of Spur 149, and further impacted the northbound left turning traffic on Spur 149. Westbound through traffic on FM 1488 was less impacted since only one of the two through travel lanes was blocked. The area near Magnolia High School should be evaluated for potential solutions.

During the PM peak, slight congestion occurred at the northbound left-turn and eastbound left-turn movements at the signalized intersection of West Access Rd North and FM 149.

Figure 5.2: Vissim Model Simulation - Existing AM Peak at FM 1488 and FM 149

Table 5.4: Existing Vissim Model Simulation Results

Intersection	Approach	AM Peak			PM Peak		
		Delay by Approach (s/veh)	LOS by Approach	Max. Queue (ft)	Delay by Approach (s/veh)	LOS by Approach	Max. Queue (ft)
West Access Rd N	WB	0.1	A	0	0	A	0
	EB	0.2	A	0	0.1	A	0
West Access Rd S	EB	0.1	A	0	0.1	A	0
	WB	0.1	A	0	0	A	0
East Access Rd N	EB	0	A	0	0	A	0
	WB	83.4	F	1669	0.1	A	0
East Access Rd S	EB	0.1	A	0	0	A	0
	WB	0.1	A	0	0	A	0
Spur 149 (Signalized)	SB	25.4	C	11	0	A	0
	NB	65.7	E	358	18.8	C	201
	EB	13.3	B	327	14.4	B	223
	WB	34.2	C	1485	11	B	250
FM 149 N (Signalized)	SB	9.6	A	310	9.4	A	257
	NB	11.2	B	122	11	B	278
	EB	24.4	C	136	35.1	E	187
FM 149 S (Signalized)	NB	14	B	234	7.7	A	230
	SB	8.3	A	253	7.5	A	163
	EB	24.8	C	137	24.6	C	157

6 Design Criteria

The design criteria used for the design of the FM 1488 Access Management Study improvements are shown in **Table 6.1**.

Table 6.1: Design Criteria

Item	Design Value (Meets Min Requirements)	Reference
Functional Class	Arterial	RDM
Roadway Elements		
Travel Lane Width	12'	RDM Table 3-1
Turn Lane Width	12'	RDM Table 3-1
Shoulder Width	10'	RDM Table 3-1
Offset to Face of Curb	1'	RDM Table 3-1
Clear Sidewalk Width	6'	RDM Table 3-1
Medians		
Median Width (Based on existing roadway width)	14'	RDM Chapter 3, Section 2
Median Width at Turn Lane	2'	RDM Chapter 3, Section 2
Channelizing Island Area (Urban)	50 ft^2	RDM Chapter 7, Section 7
Turn Lane Taper Length	100' single left turn 150' for dual left turn	RDM Table 3-3
Turn Lane Deceleration Length (55 MPH)	510'	RDM Table 3-3
Turn Lane Deceleration Length (50 MPH)	425'	RDM Table 3-3
Turn Lane Deceleration Length (45 MPH)	345'	RDM Table 3-3
Design Vehicle		
Design Vehicle for Turns at major intersections	WB-67	AASHTO Chapter 2
Design Vehicle for Turns at minor intersections	S-BUS-40	AASHTO Chapter 2
Design Vehicle for Truck Loon within ROW	SU-30	Calculated
Design Vehicle for U-turns within shoulder	Passenger	Calculated
Miscellaneous		
Clear Zone Width	30'	RDM Table 2-12
Stopping Sight Distance (55 MPH)	495'	RDM Table 2-1
Stopping Sight Distance (45 MPH)	360'	RDM Table 2-1
Crest Curve K-value (open ditch; 60 mph)	151	RDM Figure 2-5
Sag Curve K-value (open ditch; 60 mph)	136	RDM Figure 2-6
References: RDM - TxDOT Roadway Design Manual, April 2018 AASHTO - A Policy on Geometric Design of Highways and Streets, 2011, 6th Edition		

7 Short-Range Improvements

Short-range improvements have a low cost, high impact, require no additional ROW, and can typically be implemented within 5 years. The short-range improvements and typical application techniques are described in this section. The proposed short-term improvement layouts are in **Appendix H**.

7.1 Raised Median

Reducing conflict points can potentially reduce crashes. By adding raised medians in appropriate places, the proposed improvements can potentially reduce the number of conflict points on the corridor by 80%.

Where average daily traffic (ADT) exceeds 20,000 vehicles per day and the demand for mid-block turning movements is high, a raised median design should be considered (TxDOT RDM, 2018). The ADT on the study section of FM 1488 exceeds the threshold between 20,000 and 50,000 daily vehicles.

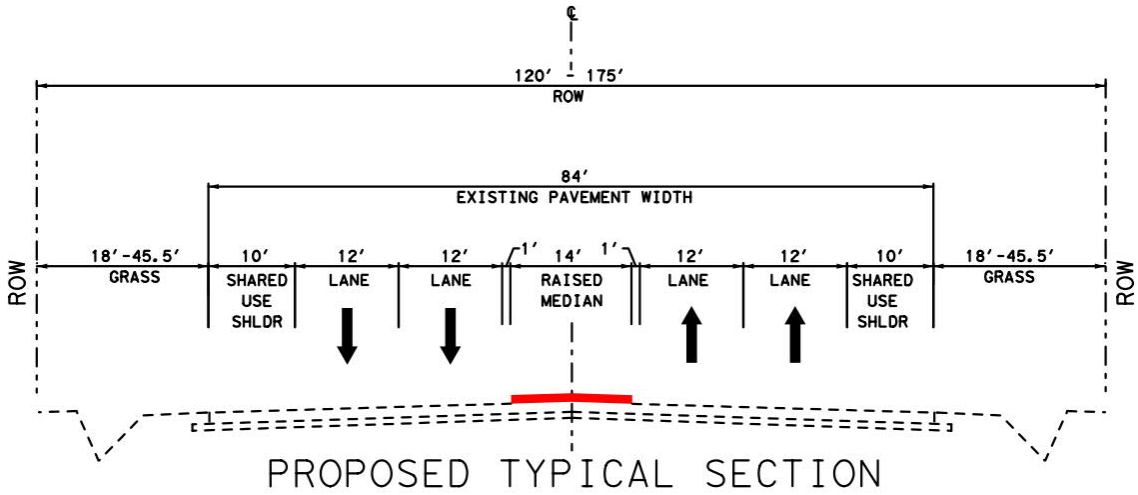
The Transportation Research Board (TRB) has compiled research over a three-year period about the effect of implementing median improvements on crashes. **Table 7.1** provides examples of the observed percent reduction in crashes as a result of median and turn-lane treatments (TRB, 2014).

Table 7.1: Crash Reduction by Median Treatment

Access Management Treatment	Reduction in Crashes
Add raised median	>55%
Replace continuous left-turn lane with median	15% to 57%
Add left-turn bay within median	25% to 50%
Source: *Access Management Manual, Second Edition. Transportation Research Board, 2014*	

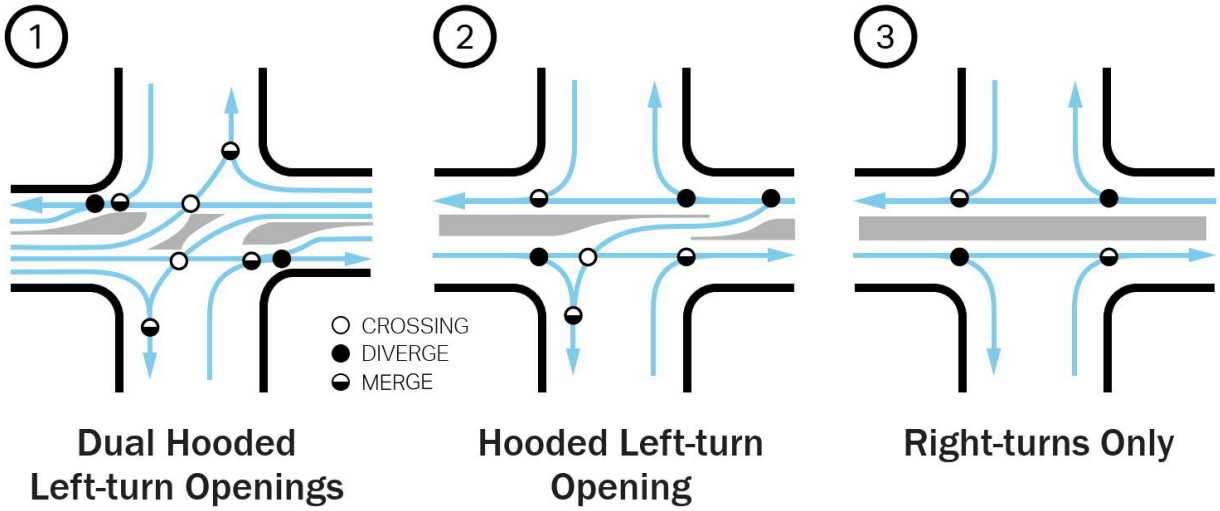
A 14-foot wide raised median with 1-foot curb offset on each side is proposed to replace the existing 16-foot two-way left-turn lane (TWLTL) as shown in the typical section in **Figure 7.1**. This identified locations of median openings based on existing land use. At locations where a left turn lane is within the median, a 12-foot turn lane with a 2-foot median can be accommodated.

Figure 7.1: Proposed Typical Section with Raised Median



In order to reduce conflict points and improve safety, most of the left turn openings are recommended to be hooded left turn openings. A standard four-leg intersection has 32 conflict points, and dual hooded left-turn openings (shown in graphic 1 in **Figure 7.2**) have only eight conflict points, a 75% reduction in conflict points. Hooded left turn openings (graphic 2 in **Figure 7.2**) restrict the cross street left out maneuver; therefore, traffic would find an alternate route to a signalized intersection or make a right turn and continue to U-turn at a downstream median opening.

Figure 7.2: Conflict Points at Medians



A passenger vehicle can make a U-turn within the existing pavement utilizing the shoulder area. A single unit truck (SU-30) is the largest vehicle that would be able to make a U-turn at the truck loons due to the width of the existing right-of-way.

7.2 Add/Extend Turn Lanes

Based on the results of the existing conditions analysis and comments from the public involvement process, left and right turn lanes were added and lengthened to improve traffic operations at intersection.

- Dual left turn lanes are proposed at five intersections along the corridor with extremely high left turn volume.
- Right turn lanes were added where right turn volume exceeds 60 vehicles per hour during the peak hour and where the public/stakeholder comments suggested a right turn lane would improve safety.
- Turn lanes were extended beyond queue lengths resulting from the proposed traffic model in many locations.

Table 7.2 summarizes the locations where left/right turn lanes were added or extended.

Table 7.2: Left/Right Turn Lane Improvements

Intersection	Add Turn Lane		Extend Turn Lane	
	Left	Right	Left	Right
Mill Creek Rd		WB		
Spur 149		EB		
Community Rd	WB	WB		
Manor Dr		WB		
Thousand Oaks Blvd	NB	EB		
Magnolia Pkwy		EB		
Magnolia Circle		WB		
FM 2978	EB*/WB*		EB	EB/WB
Egypt Ln		EB		
Home Depot Driveway		EB		
Katy Lee Ln				EB
Westwood Dr		WB		
Sweetgum Ln		WB		
Old Conroe Rd/Del Webb Blvd	EB*/SB	EB		WB
Kuykendahl Rd	WB*			EB
HEB Driveway		EB		
SH 242	WB*		NB	
Carriage Hills Blvd	EB*	SB		WB
The Mansions Blvd		EB		
Grace Crossing Dr		EB		
I-45	EB*	EB*		EB

* Dual turn lane

** Approach Direction: NB - northbound, SB-southbound, EB - eastbound, WB - westbound

7.3 Signal Timing and Equipment Upgrades

Traffic signal operations on the corridor are recommended to be analyzed for signal timing improvements and equipment upgrades including:

- Optimize signal timing to maximize mobility along FM 1488. For example, requests to improve signal timing at Grace Crossing was a recurring public comment as well as improving signal detection at intersections.
- Signal Coordination for intersections within 0.5-mile (FHWA Signal Timing Manual, 2nd edition, Section 3.2.1.4) to improve mobility along FM 1488.

Consider flashing yellow left turn operations (protected/permissive) based on guidelines in the TxDOT Traffic Signals Manual Chapter 5, Section 6 Flashing Yellow Arrow (FYA) Display for Left-Turn Operations. For example, a few public comments requested flashing yellow left-turn operations at low left-turn volume intersections or during off-peak periods, as per the note below.

"*Installing FYA protected-permissive mode at a location that previously operated in protected-only mode should be considered only after careful study of the intersection. One research study of locations that were converted from protected-only mode to FYA protected-permissive mode saw an increase in the crash frequency. Do not remove protected-only left-turn phasing if opposing sight distance is inadequate for permissive left turns, operating speed is too great, roadway geometry is complicated, or there are too many opposing through lanes. If the protected-only left turn was installed for other safety reasons (crash prevention when under less restrictive phasing), care should be used in operating a possible FYA protected-permissive installation*." (TxDOT Traffic Signals Manual, 2019)

Guidelines vary for when flashing yellow (protected/permissive) left turn phasing should be implemented. Typically, left-turn flashing yellow (protective/permissive) phasing may be considered when:

1. Previous crash history does not meet the thresholds for correctable crashes.
2. Adequate sight distance for left -turning vehicles and opposing through traffic is available.
3. There are no more than two lanes of opposing through traffic. Some guidelines state no more than three opposing lanes.
4. Operating speeds are not too great.
5. The cross product of traffic volumes for left turn and opposing through volumes do not meet threshold values.

On FM 1488, the posted speeds are between 45-50 mph which can be considered high speed. Once FM 1488 is widened to six lanes, some guidelines would not recommend flashing yellow left turns. In addition, the TxDOT Traffic Signals Manual provides guidelines to for a pilot project installation of flashing yellow left turns in a region without current implementation. It is better to be consistent in the application of left-turn treatment along a corridor for driver expectation.

- During off-peak and peak periods, flashing yellow left turn operations (protected/permissive) could be considered at the low volume left turn intersections for a pilot period shown in **Table 7.3**.

Table 7.3: Potential Flashing Yellow Intersection with Low Left Turn Volumes

FM 1488 Intersection	Peak Hour Left Turn Volume
Magnolia Parkway	44
Cimarron Way	24
Katy Lee Ln	22
Peoples Rd	14

- After a study of off-peak traffic volumes, flashing left-turn operations (protected/permissive) during off-peak periods only could be considered at the following intersections in **Table 7.4**. Protected only left-turn phasing is recommended to remain during peak hours due to high left turn volumes during peak periods.

Table 7.4: Potential Flashing Yellow Intersections for Additional Study

FM 1488 Intersections for Additional Study
Spur 149
Thousand Oaks Blvd
Lake Windcrest Blvd
Tamina Road
Windcrest National
Egypt Ln/Conroe Huffsmith Rd
Grace Crossing Dr
The Mansions Blvd
I-45 SBFR
I-45 NBFR

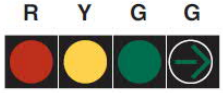
- Consider installing green arrow right turns at high volume right turn movements. The intersections with the highest right turn volumes from the cross street are listed in **Table 7.5** for consideration to install right turn signal heads.

Table 7.5: Potential Right Turn Signal Locations

FM 1488 Intersection	Peak Hour Right Turn Volume	Movement
SH 242	504	NBR
Spur 149	494	NBR
Carriage Hills Blvd	409	SBR
Kuykendahl Rd	343	NBR
FM 2978/Honea Egypt	277	SBR
FM 149	245	SBR
Egypt/Conroe Huffsmith	231	NBR
FM 2978/Honea Egypt	198	NBR
The Mansions Blvd	166	NBR
Old Conroe Rd	92	SBR

Table 7.6 below shows typical arrangements of signal faces with a circular red signal face to allow a legal right-turn on red. A red arrow prohibits right-turns on red.

Table 7.6: Typical Right Turn Signal Arrangements

Operation	Signal Face
Dedicated Lane Protected Only Right Turn	
Shared Lane Protected Only Right Turn Note: Shared signal faces shall only be used for a protected-only mode right turn if the circular green and green right-turn arrow indications always begin and terminate together.	

- Upgrade street name signs on signals to meet current TMUTCD standards as needed.
- Check yellow clearance time based on speed limit.

7.4 I-45 Interchange Configuration

The TxDOT schematic at the I-45 at FM 1488 interchange to install traffic signals was enhanced to improve safety and operations. The proposed configuration for the short-term is to remove three of the cloverleafs, install traffic signals, add pavement, and other minor intersection improvements. The benefits of the proposed design include:

- By keeping the northeast quadrant cloverleaf, the weave movement on the northbound frontage road would be removed and allows more green time for the eastbound to northbound movement at the traffic signal.
- Two lanes connecting to the southbound frontage road simplifies the weaving movement from the I-45 southbound exit ramp from two to one lane changes.
- Two right turn lanes (eastbound to southbound) are proposed to improve mobility to the frontage road.
- The reconfiguration with a traffic signal at the southbound frontage road provides more convenient and safer access from the businesses (near the soccer fields) on the small access road to I-45.

It would be beneficial to **prioritize the reversal of the southbound ramps** adjacent to FM 1488 as discussed in the medium to long range improvements.

An intersection traffic study is recommended at the minor intersection on the northeast quadrant of the interchange. There is an option to go left (north) onto an access road from the northeast quadrant cloverleaf, and a traffic study could determine if additional queue storage is needed. If needed, the intersection may be realigned, and the outer lane of the northbound frontage road could be used for additional storage.

7.5 Signing Improvements

Signing improvements along FM 1488 will provide the necessary information to drivers to enhance safety. The following signs are recommended to be installed along FM 1488.

- Install advance street name signs (**Table 7.7**) in advance of all signalized intersections to enhance safety and provide more time for drivers to react.

Table 7.7: Advance Street Name Signs

Sign	TMUTCD Section	Size	Image
D3-2 Advance Street Name Signs	2D.44	Varies x 30”	

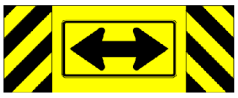
- Install signs for shared bicycle shoulder and bicycle lanes at intersections (**Table 7.8**).

Table 7.8: Bicycle and Shoulder Signs

Sign	TMUTCD Section	Size	Image
R4-4 Begin Right Turn Lane Yield to Bikes	9B.05	36” x 30”	
D11-1 Bike Route	9B.20	24” x 18”	
R4-17 Do Not Drive on Shoulder	2B.36	24” x 30”	

- Install warning sign (**Table 7.9**) at the far side of signalized T-intersections (Thousand Oaks Blvd and Community Blvd) to alert drivers that they must turn right or left.

Table 7.9: T-Intersection Warning Sign

Sign	TMUTCD Section	Size	Image
W1-7T Chevron/Two-Direction Large Arrow	2C.47	96” x 36”	

- Truck crossing sign (**Table 7.10**) to be installed adjacent to roadway in both directions to alert road users of unexpected entries in to the roadway at the end of the raised median near the state forest. Flashing beacons (TMUTCD Section 4L.03) may be considered for installation only and only in operation during times when trucks are expected. The impact of lights to the environment should be considered if flashing beacons are considered.

Table 7.10: Truck Crossing Warning Sign

Sign	TMUTCD Section	Size	Image
W11-10 Truck	2C.49	36” x 36”	

- School bus warning signs (**Table 7.11**) may be considered on side of road in advance of school bus stops on FM 1488 or where the school bus is not visible to road users for an adequate distance. Based on information provided by the Magnolia and Conroe Independent School Districts, school busses currently stop on westbound FM 1488 at The Towers Apartments, Cedar Ridge St., Hackberry St., Mapleleaf St., Creekside Dr., and Gable Circle.

Table 7.11: School Bus Warning Sign

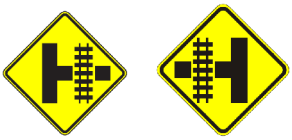
Sign	TMUTCD Section	Size	Image
S3-1 School Bus Stop Ahead	7B.13	36” x 36”	

- For the at-grade railroad crossing east of I-45, additional signing and striping would improve safety. Currently, automatic gates are present, but there are limited approach signing and pavement markings from the east side which is outside of TxDOT right-of-way. Coordination with the local agency would be required.

Figure 7.3: At-Grade Railroad Crossing

  - Stop Lines are required before active control devices. Add westbound stop line and improve the eastbound stop line (TMUTCD Section 8B.28).
  - Consider stop control for both Sherbrook (northbound) and Lexington (southbound) approaches east of the railroad to treat as a T-intersection with railroad within 100' of parallel street.
  - Improve railroad pavement markings on all approaches. Add railroad pavement markings on Lexington Road approach.
  - Improve signing based on TMUTCD guidelines. Examples are shown in **Table 7.12**.

Table 7.12: Railroad Signs

Sign	TMUTCD Section	Size	Image
R8-8 Do Not Stop on Tracks (In case traffic backs up from the traffic signal at the I-45 NBFR)	8B.09	24" x 30"	
Grade Crossing Advance Warning	8B.06	36" x 36"	
W10-3R, W10-3L Grade Crossing and Intersection Advance Warning	8B.06	36" x 36"	

7.6 Flashing Signals

Emergency Vehicle Traffic Control Signals are recommended to permit access for emergency vehicles at three locations listed in **Table 7.13**. Intersection Control Beacons are recommended to improve safety at full raised median openings at the three locations listed in **Table 7.13**. The beacon would flash yellow along FM 1488 and flash red along the cross street until a full traffic signal warrant is met at the location.

Table 7.13: Proposed Flashing Signal Locations

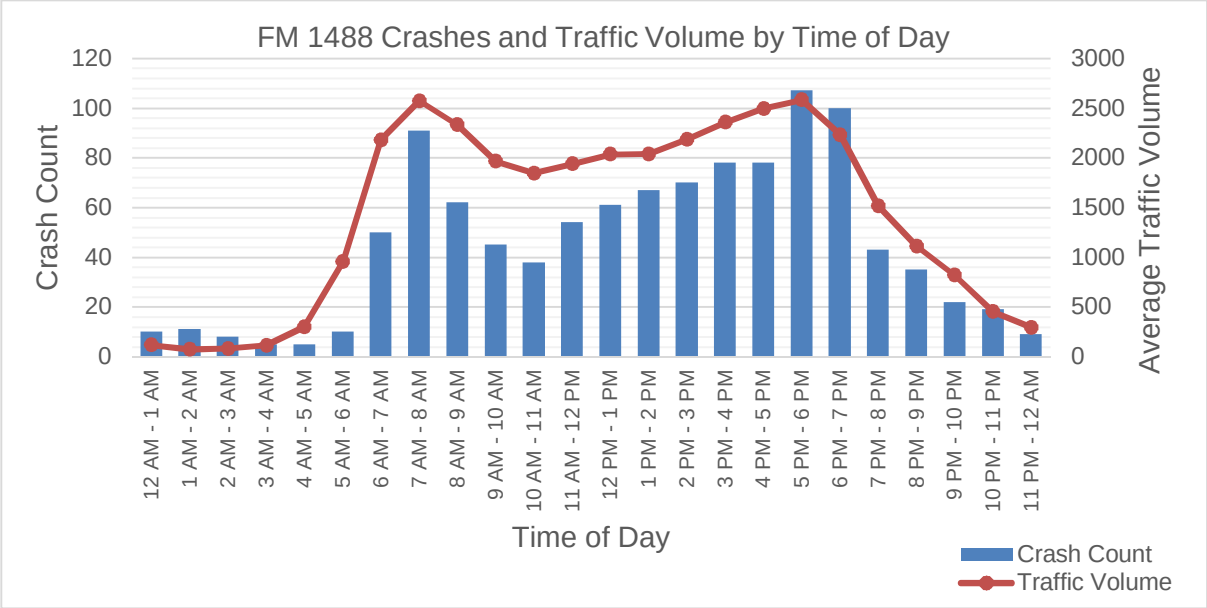
Type	Intersection	Purpose
Emergency Vehicle Traffic Control Signal (TMUTCD 4G)	West of FM 149	Access to EMS Station 40
	East of Magnolia Parkway	Access to Magnolia Volunteer Fire Dept Station 185
	Lake Lamond Rd	Fire Station 46
Intersection Control Beacons (TMUTCD 4L.02)	Community Rd	Safe access at full median opening prior to warranting signal
	Superior Rd/Crestlake Blvd	Safe access at full median opening prior to warranting signal
	Lago Dr	Bus access from Bear Branch Elementary School and adjacent properties

7.7 Illumination

FM 1488 currently does not have any street lighting along the corridor except safety lighting at signalized intersections. Commercially developed areas emit light from the adjacent parcels, but most of the corridor is generally dark. Lighting can improve bicycle and pedestrian visibility to drivers along the corridor.

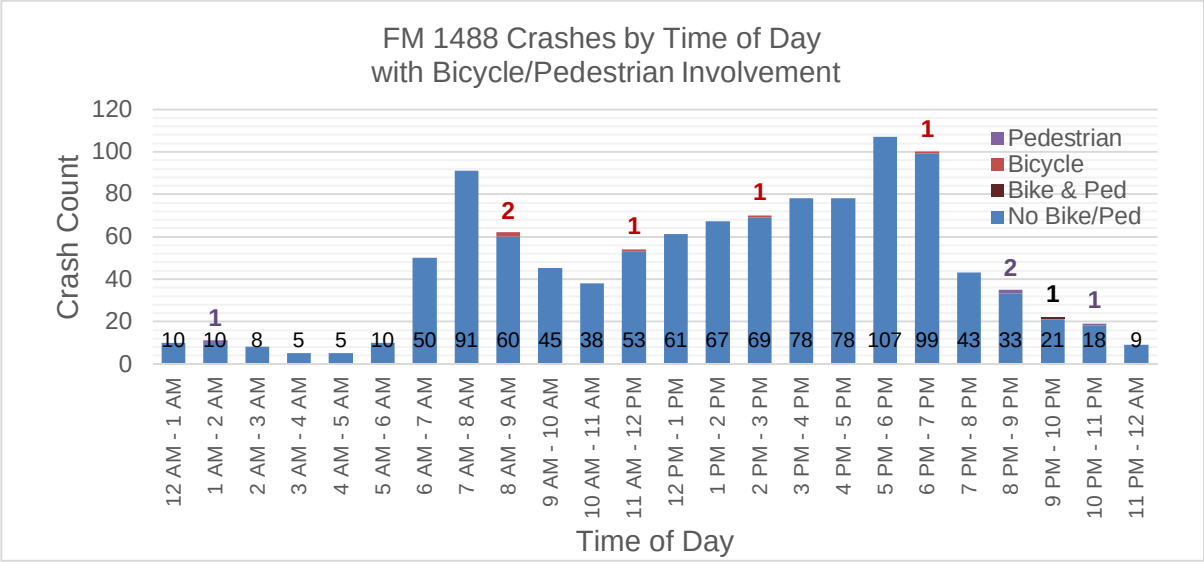
Between 2015 and 2017, the percentage of crashes to the hourly traffic volume averages about three to four percent between 3:00 am and midnight, and the percent averages about to eight to 15 percent between 12:00 am and 3:00 am. **Figure 7.4** shows the number of crashes and traffic volume by time of day along FM 1488.

Figure 7.4: Crashes and Traffic Volume by Time of Day



Between 2015 and 2017, 50% of the bicycle/pedestrian involved crashes were during dark hours. **Figure 7.5** classifies bicycle and pedestrian crashes separately by time of day.

Figure 7.5: Crashes by Time of Day with Bicycle/Pedestrian Involvement



Based on the TxDOT Highway Illumination Manual, FM 1488 is eligible for a continuous lighting system because it is a multi-lane arterial highway with partial control of access with access to abutting property, at-grade crossings at minor streets, and grade separation structures at major highway crossings. Lighting may be considered for locations where relevant government agencies agree that lighting would contribute substantially to the safety, efficiency, and comfort of vehicular and pedestrian traffic.

- Safety lighting, lighting near the ramp connections, at the FM 1488 at FM 149 connection to the access roads east and west of the railroad would is recommended.
- Continuous lighting (excluding the Forest area) can be considered to improve safety for cyclists and pedestrians. Once shared use path or sidewalk facilities are installed, the lighting would improve safety, especially near the elementary schools.
- An environmental lighting study should be completed near the state forest. There are minimal crashes within the Forest limits. If lighting is provided, there are options for shorter poles, not using bright white color, limiting candelas, pedestrian bollards, and other options.

7.8 Traffic Signal Warrant Analysis Studies

Traffic signal warrant analysis studies are recommended at six intersections along FM 1488 based on expected adjacent land use and comments from the public involvement process:

1. Mill Creek Rd
2. Community Rd
3. Superior Rd/Crestlake Blvd
4. Sendera Dr
5. Lago Dr/Bear Branch Elementary School
6. Horseshoe Bend (West)

8 Medium to Long-Range Improvements

Medium-term improvements typically require coordination and can typically be implemented within 5 to 10 years. Long-range improvements have a higher cost and can typically be implemented within 10 or more years. The medium and long-range improvements are described in this section.

8.1 Southbound I-45 Ramp Reversals

Although additional study is needed, it would be beneficial to prioritize the reversal of the southbound ramps adjacent to FM 1488. A Google Earth (.kmz) file of potential locations is included with the submission of this report.

- The eastbound to southbound volume is high (about 1,500 vph during the morning peak hour) and lengthening the weaving distance to the entrance ramp is needed.
- The southbound to westbound volume is high (about 1,000 vph during morning and evening peak hours) and lengthening the weaving distance to the southbound exit ramp to FM 1488 is needed.

8.2 Widen to 6-Lanes

The proposed project is to reconstruct and widen the 7-mile corridor of FM 1488 between I-45 and FM 2978 from four lanes to six travel lanes. Drainage design will be completed to mitigate the flooding hazard after a comprehensive drainage study is finished. A closed-drainage system with curb and gutter will be implemented along the corridor to replace the existing open ditch system. The sub-surface utilities will be relocated as needed for the widened typical section.

The proposed project will enhance the mobility and accessibility for both pedestrians and bicyclists by constructing two 10-foot shared use paths along the northern and southern portion of FM 1488 from I-45 to FM 2978. Pedestrian and bicycle safety enhancements will be implemented along the corridor, especially at intersections, to ensure the safety for all roadway users including Americans with Disabilities Act (ADA) compliant ramps, high visibility crosswalks, and signing and striping for bicycles.

Traffic volumes are expected to continue to increase along FM 1488 and similar improvements with six-lanes with shared use paths are recommended from FM 2978 west to FM 149 in the future.

8.3 Innovative Intersections

Innovative intersection options are recommended to be evaluated at three locations along FM 1488: FM 2978, I-45 and SH 242 due to the high traffic volumes at these intersections.

A continuous green T intersection is proposed as part of this study at SH 242 since it can be implemented in the short-range. Once a timeline and a plan for the land to the north is available, the geometry of the intersection could be reconsidered in coordination with TxDOT.

At the interchange of FM 1488 at I-45, a complete interchange reconstruction should be studied for a long-term solution.

At the intersection of FM 1488 and FM 2978, additional study could be performed for potential innovative intersections. A Cap-X analysis, included in **Appendix I**, was completed for the intersection of FM 1488 at FM 2978 to identify potential types of innovative intersections, and the results are summarized below.

The intersection of FM 1488 and FM 2978 is expected to operate at LOS F for both AM and PM peak hours in year 2045 based on a Synchro analysis with intersection turn lane improvements, which suggests the roadway users will experience unacceptable traffic congestion and delay. To evaluate the performance of different types of junctions (intersections and interchanges) as compared to traditional traffic signal-controlled intersections, the CAP-X tool was utilized which takes lane configurations and traffic volume as the input and produces the output v/c ratio as the performance measure. Page 1 and Page 2 in **Appendix I** summarize the junction analysis results including v/c ratio and the evaluation of other factors such as ROW requirement, accessibility, circulation and stakeholder/public input. The v/c ratio of the signal-controlled intersection was used as a baseline for comparing the v/c ratio of other types of junctions.

- **V/C Ratio -** 10 out of 16 junction types of junctions show improved v/c ratio as compared to a traffic signal for both AM and PM peak hours in existing and future scenarios.

- **Evaluation of Other Factors –** 4 of the 10 types of junctions show desirable or neutral ratings in terms of ROW, Accessibility, and circulation. The junctions in the interchange category are rated undesirable in terms of ROW, accessibility and circulation. The rating of stakeholder/public input will be evaluated based on the input collected in the upcoming stakeholder and public meetings.

8.4 Sidewalk at Redeveloped Parcels

The local agency should require new developments to install sidewalk along FM 1488 when redeveloped to promote walkability along FM 1488. For example, at the proposed large commercial development near Spur 149, the developer should be required to install sidewalks along the FM 1488 access road because it is highly likely that students from the high school would be walking in the vicinity.

8.5 Align Off-Set Intersections

Many cross streets and driveways are not aligned across FM 1488 making access more restrictive with the implementation of a raised median. Additional roadway users could benefit from improved access if off-set intersections can be aligned. Approving agencies should enforce access management guidelines and before approving new driveway and street connections. Consider requiring multiple access points for new subdivisions in the region.

This study recommends the intersections in **Table 8.1** for consideration to be aligned which would require coordination with landowners and local agencies.

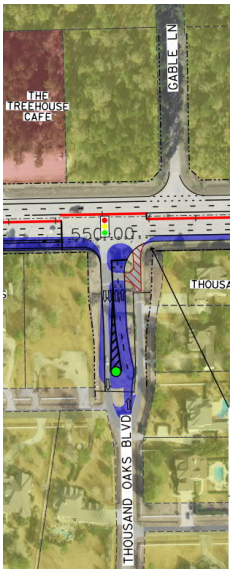
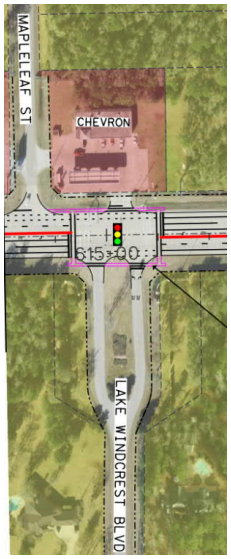
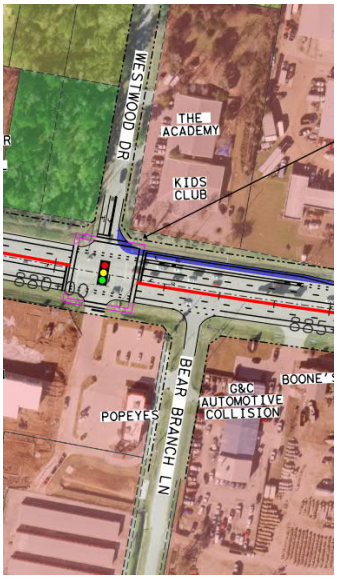
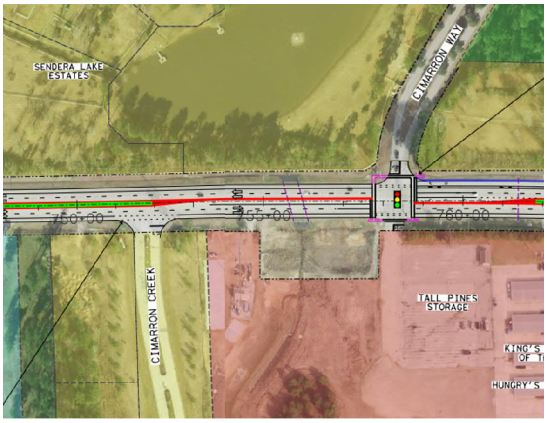
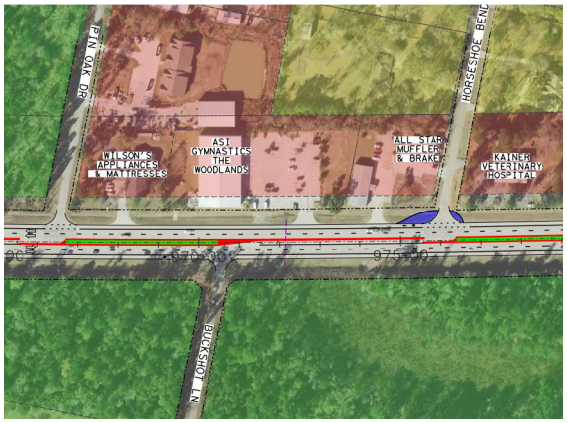
8.6 Driveway Consolidation

Driveway consolidation and driveway sharing involves relocation, removal, consolidation, or sharing of existing driveways to limit the number and location of access points and provide internal circulation. As the number of access points reduces the number of conflict points reduce and crash rates decrease. This medium-term solution requires agreement between property owners and regulating agencies.

This study recommends locations for driveway consolidation, driveway sharing, cross access on private property, and islands to promote right-in, right-out movements. The recommendations focus within functional areas of signalized intersections and at closely spaced driveways.

One of the planned projects under development is the widening of Old Conroe Road by a local agency. During the improvements to Old Conroe Road, the agency should local agency should consider center turn lanes in areas with high commercial development and potential adjustments to driveways located within the influence area of the FM 1488 at Old Conroe Road intersection.

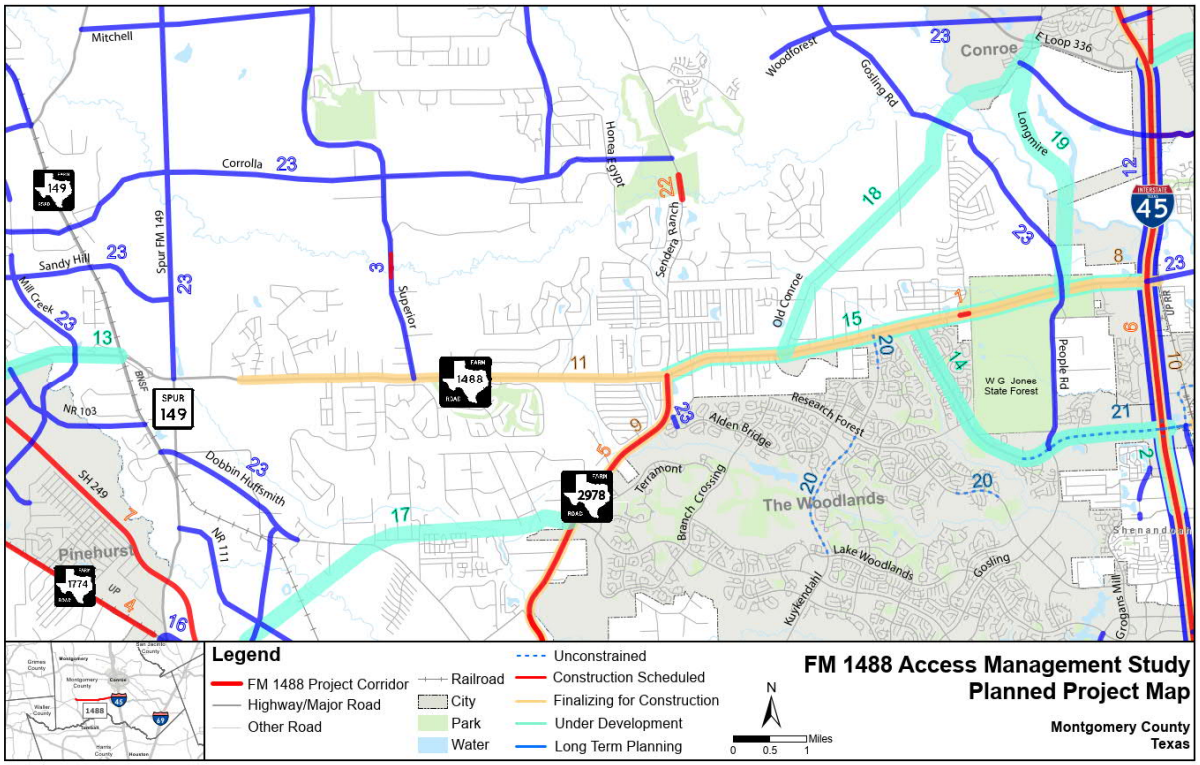
Table 8.1: Off-Set Intersections

Gable Ln and Thousand Oaks Blvd	Mapleleaf St and Lake Windcrest Blvd	Westwood Dr and Bear Branch Ln
		
Cimarron Creek and Cimarron Way		
Buckshot Ln and Pin Oak or Horseshoe Bend		

8.7 Provide Parallel Routes

Currently there is limited east-west access as an alternate to FM 1488 on the west half of the corridor, from FM 2978 to FM 149. The public comments suggest that more east-west connections are needed. The Houston-Galveston Area Council (H-GAC) and Montgomery County Thoroughfare Plan show several parallel routes in the long-term plan (shown in dark blue) that would improve access in the region, as shown in **Figure 8.1**.

Figure 8.1: Planned Projects



9 Project Benefits

The recommended improvements were selected based on safety and mobility benefits expected.

9.1 Case Studies

For the short-term improvements, crash modification factors were analyzed to anticipate the reduction in crashes, reduction in travel time, and the total user savings. **Table 9.1** presents theoretical percent improvement and cost savings of the short-term improvements from various accepted, respectable sources based on before/after case studies.

Table 9.1: Proposed Short-Range Improvement Benefits

Access Management Benefit	Percent Improvement	Savings
Safety	**28%** reduction in total crashes[1] **46%** reduction in pedestrian crashes[2]	**$3.3** million per year[3]
Travel time	**39%** reduction with intersection improvements and raised median[4]	**32** hours of time per year per roadway user **$700** per year per roadway user[5] **$54.1** million per year for all users[5]

Sources:
1. The Crash Modification Factors Clearinghouse
2. Safety Benefits of Raised Medians and Pedestrian Refuge Areas, FHWA, 2010
3. Costs based on 2017 Nation Safety Council cost by injury severity or crash
4. TRB Access Management Manual, Transportation Research Board, 2004
5. 2015 Urban Mobility Scorecard, Texas A&M Transportation Institute, 2015

9.2 Proposed Traffic Simulation Analysis

The year 2019 existing calibrated Synchro model was revised to incorporate the short-term improvements identified from the FM 1488 Access Management Study to determine the anticipated intersection delay improvements. The volumes remained the same for the proposed analysis since only short-term improvements are being analyzed. The improvements incorporated into Synchro include added turn lanes at intersections, added raised median, optimized intersection cycle lengths and splits at closely spaced intersections, and added proposed traffic signals. Additionally, the signal timings were optimized for the entire corridor for the purpose of this planning-level analysis.

The left turn lane length on the design layouts were maximized within geometric limits to meet and exceed, where possible, estimated queue lengths. U-turn volumes along FM 1488 were not added to every signalized intersection since those volumes would purely be an estimate. The delay and left turn queue length could be higher than reported due to additional U-turn volumes at intersections. **Table 9.2** lists the intersection LOS and delay results for the short-term improvements. The results of the analysis show an 18% to 19% reduction in intersection delay with the implementation of short-term improvements.

The proposed short-term Synchro intersection LOS results are detailed in **Appendix J**.

Table 9.2: Proposed Short-Term Intersection LOS Summary

Intersection	Existing - Calibrated				With Short-term Improvements			
	AM		PM		AM		PM	
	LOS	Delay[1]	LOS	Delay[1]	LOS	Delay[1]	LOS	Delay[1]
FM 149 @ FM 149 West Access Rd (N)	C	22.1	C	23.2	C	22.0	C	23.2
FM 149 @ FM 149 West Access Rd (S)	B	11.0	B	10.0	B	11.1	B	10.0
FM 1488 @ Spur 149	C	30.9	C	25.8	C	26.8	C	21.5
FM 1488 @ Mostyn Dr[2]	D	33.6	C	20.0	C	22.9	C	15.1
FM 1488 @ Manor Dr[2]	E	37.8	C	23.0	E	37.8	C	24.2
FM 1488 @ Thousand Oaks Blvd[3]	E	38.8	E	41.1	A	9.9	C	27.0
FM 1488 @ Magnolia Parkway Elementary School	B	12.2	B	10.2	A	7.2	A	5.9
FM 1488 @ Lake Windcrest Blvd	B	12.0	B	11.4	A	7.5	A	5.1
FM 1488 @ Windcrest National	B	18.4	A	6.3	B	11.4	A	3.8
FM 1488 @ Cimarron Creek[2]	C	23.8	C	19.6	C	19.6	C	17.9
FM 1488 @ Cimarron Way	A	8.0	B	11.0	A	7.7	A	6.3
FM 1488 @ Tamina Rd	C	27.6	D	46.5	C	22.1	C	27.5
FM 1488 @ Forest West	Future Intersection				A	8.0	B	18.2
FM 1488 @ Honea Egypt Rd/FM 2978	D	49.7	E	63.6	D	43.5	D	40.0
FM 1488 @ Commercial Driveway 2[2]	C	16.3	C	18.9	C	15.9	B	14.5
FM 1488 @ Conroe Huffsmith Rd/Egypt Ln	C	32.2	C	28.9	C	30.7	C	33.9
FM 1488 @ Home Depot Driveway[2]	C	17.1	C	19.5	C	17.1	C	15.6
FM 1488 @ Katy Lee Lane	A	7.3	A	9.2	A	5.7	A	9.8
FM 1488 @ N Westwood Dr.	B	12.6	B	15.2	A	9.2	B	14.7
FM 1488 @ Sweetgum Ln	Future Intersection				A	9.3	B	11.8
FM 1488 @ Old Conroe Magnolia Rd/Del Webb Boulevard	C	23.6	C	25.6	B	13.7	B	14.3
FM 1488 @ Kuykendahl Ct/ Kuykendahl Rd	C	32.9	C	33.4	C	27.7	C	32.3
FM 1488 @ SH 242	C	20.8	D	40.1	B	13.7	C	28.6
FM 1488 @ Carriage Hills Blvd	D	42.4	D	36.9	C	31.5	C	28.4
FM 1488 @ People's Road	A	7.8	A	7.6	A	4.5	A	3.2
FM 1488 @ Mansions Blvd	B	11.3	B	12.3	B	10.8	A	8.8
FM 1488 @ Grace Crossing Dr/W. Walter Woodson Dr	B	12.3	B	14.0	A	6.6	A	9.5
FM 1488 @ I-45 West Access Rd (W)	Future Intersection				B	12.8	B	16.4
FM 1488 @ I-45 East Access Rd (E)	Future Intersection				C	24.8	B	12.4
Total Delay (Corridor-wide)		**562.5**		**573.3**		**453.9**		**471.1**
Percent Reduction in Delay		N/A		N/A		**19%**		**18%**

[1] Delay is presented in seconds per vehicle

[2] Unsignalized Intersection - Two Directions Movements Free

[3]Existing Unsignalized Intersection to Proposed Signalized Intersection

10 Planning-Level Implementation and Cost Estimate

A preliminary planning level cost estimate was prepared for the proposed improvements.

The Westwood Improvement District is interested in partnering with TxDOT and other local entities to install landscaping within the proposed median. An estimate of the area and length of landscaping is shown in **Table 10.1**.

Table 10.1: Raised Median Landscaping Estimate

FM 1488 Segment	Area (SF)	Length (LF)
From Mill Creek Road to Western Edge of Jones State Forest	99,060	12,148
From Western Edge of Jones State Forest to I-45	45,250	5,160
Total Project Landscaping	**144,310**	**17,308**

The planning level cost estimate developed for the short-, medium-, and long-range proposed improvements is shown in **Table 10.2**. The estimated cost is about $20 million for the short-range improvements, about $95 million for medium-range improvements, and about $115 million for long-range improvements.

Table 10.2: Planning-Level Improvement Cost Estimate

Period	Improvement	Quantity	Unit	Unit Cost	Total Cost	TxDOT Cost	Montgomery County Cost	City of Conroe Cost	TOTALS (In Millions)
		Primary Funding Source >>							
SHORT-RANGE	**CORRIDOR-WIDE IMPROVEMENTS:**								$19.96
	Add raised median	15	MI	$ 276,000	$ 4,140,000	$ 4,140,000			
	Add truck loons (to facilitate midblock u-turns)	1	LS	$ 828,000	$ 828,000	$ 828,000			
	Add advance street name signs	1	LS	$ 60,000	$ 60,000	$ 60,000			
	Maintenance per year (minor)	12	MO	$ 8,500	$ 102,000	$ 102,000			
	INTERSECTION IMPROVEMENTS:								
	Improve signal timing and synchronization	24	EA	$ 12,000	$ 288,000	$ 228,000		$ 60,000	
	Widen for intersection turn lanes	1	LS	$ 1,848,000	$ 1,848,000	$ 1,848,000			
	Modify traffic signals (street name signs, audible pedestrian signals)	17	EA	$ 150,000	$ 2,550,000	$ 2,100,000		$ 450,000	
	Perform traffic signal warrant analysis studies	6	EA	$ 36,000	$ 216,000	$ 216,000			
	Install Flashing Signals	6	EA	$ 300,000	$ 1,800,000	$ 1,800,000			
	Install continuous green T intersections	2	EA	$ 1,188,000	$ 2,376,000	$ 2,376,000			
	Extend access road west of FM 149	1	LS	$ 564,000	$ 564,000	$ 564,000			
	Add safety lighting at FM 149 access roads	1	LS	$ 228,000	$ 228,000	$ 228,000			
	Reconfigure I-45 Interchange	1	LS	$ 1,164,000	$ 1,164,000	$ 1,164,000			
	PEDESTRIAN / BICYCLE IMPROVEMENTS:								
	Add ADA accessible pedestrian crossings at traffic signals	1	LS	$ 972,000	$ 972,000	$ 972,000			
	Install signing and new shoulder stripe for bicycle shared shoulder	15	MI	$ 24,000	$ 360,000	$ 360,000			
	Improve connectivity to existing sidewalks (limited locations)	1	LS	$ 396,000	$ 396,000	$ 396,000			
	Add edgeline rumble strips (narrow design with bicycle gaps)	15	MI	$ 2,400.00	$ 36,000	$ 36,000			
	BARRICADES, SIGNS, TRAFFIC CONTROL:	12	MO	$ 18,000	$ 216,000	$ 216,000			
	MOBILIZATION (at 10% of Total Cost):		LS		$ 1,814,400	$ 1,763,400		$ 51,000	
	TOTAL FOR SHORT-RANGE IMPROVEMENTS				**$ 19,958,400**	**$ 19,397,400**	**$ -**	**$ 561,000**	
MEDIUM-RANGE	**CORRIDOR-WIDE IMPROVEMENTS:**								$95.67
	Widen FM 1488 to 6 lanes from I-45 to FM 2978	6.9	MI	$ 11,400,000	$ 78,660,000	$ 78,660,000			
	- Add separated 10' SUP	6.9	MI	$ 408,000	$ 2,815,200	$ 2,815,200			
	- Consolidate and share driveways	1	LS	$ 600,000	$ 600,000	$ 600,000			
	INTERSECTION IMPROVEMENTS:								
	Widen Carriage Hills	1	LS	$ 420,000	$ 420,000		$ 420,000		
	I-45 Southbound Ramp Reversals near FM 1488 (4 ramps)	1	LS	$ 1,680,000	$ 1,680,000	$ 1,680,000			
	Connect bicycle routes	1	LS	$ 276,000	$ 276,000	$ 276,000			
	BARRICADES, SIGNS, TRAFFIC CONTROL:	42	MO	$ 60,000	$ 2,520,000	$ 2,520,000			
	MOBILIZATION (at 10% of Total Cost):		LS		$ 8,697,120	$ 8,655,120	$ 42,000		
	TOTAL FOR MEDIUM-RANGE IMPROVEMENTS				**$ 95,668,320**	**$ 95,206,320**	**$ 462,000**	**$ -**	
LONG-RANGE	**CORRIDOR-WIDE IMPROVEMENTS:**								$115.04
	Widen FM 1488 to 6 lanes from FM 2978 to Mill Creek	6.5	MI	$ 8,880,000	$ 57,720,000	$ 57,720,000			
	- Add separated 10' SUP	6.5	MI	$ 408,000	$ 2,652,000	$ 2,652,000			
	- Consolidate and share driveways	1	LS	$ 1,032,000	$ 1,032,000	$ 1,032,000			
	Add continuous street lighting	13.4	MI	$ 276,000	$ 3,698,400	$ 3,698,400			
	Drainage study along FM 1488	1	LS	$ 600,000	$ 600,000	$ 600,000			
	Grade separation at FM 2978	1	LS	$ 36,000,000	$ 36,000,000	$ 36,000,000			
	BARRICADES, SIGNS, TRAFFIC CONTROL:	48	MO	$ 60,000	$ 2,880,000	$ 2,880,000			
	MOBILIZATION (at 10% of Total Cost):		LS		$ 10,458,240	$ 10,458,240			
	TOTAL FOR LONG-RANGE IMPROVEMENTS / OPPORTUNITIES				**$ 115,040,640**	**$ 115,040,640**	**$ -**	**$ -**	

NOTES:
1. These are planning-level cost estimates only, and are subject to change.
2. Funding and construction coordination will be required between TxDOT and the following entities: Montgomery County, City of Conroe, City of Magnolia, and potential partners.
3. Joint funding may occur for several improvements including traffic signals, illumination, driveway consolidation, and landscaping.
4. Some improvements such as widening, sidewalks, and lighting are listed under medium-range or long-range since they are driven by funding, construction schedule, and additional study.
5. Cost estimates are based on unit costs as of August 2019 from various sources, primarily TxDOT. Contingencies have been included in all costs.
6. Abbreviations: LS - Lump Sum; LF - Linear Feet; SY - Square Yards; MI - Mile; EA - Each; MO - Month
7. Estimates do not include ROW acquisitions.

11 Summary of Public Involvement

The public involvement plan for the FM 1488 Access Management Study comprised of a variety of activities and components intended to proactively obtain public input that would inform the public, agencies with jurisdiction, and community stakeholders, as well as obtain input that influenced the decision making. The public involvement activities included five steering committee meetings, four stakeholder meetings, and two public meetings. Public involvement goals integrated open, relevant, timely, and appropriate identification of project needs of all stakeholders and to ensure stakeholders understood key decision points.

The goals of the public involvement program included:

- Establishing and maintaining extensive community involvement by providing timely, frequent, and current information.
- Providing opportunities for the public to provide input.
- Being considerate of minority populations and persons with low English proficiency, low incomes, and persons who may require special communication or physical accommodations.
- Publishing materials in English and Spanish to accommodate the Spanish-speaking community members and providing Spanish-speaking staff at all meetings
- Ensuring that all persons who wished to participate were given an opportunity to comment and to have their comments reviewed
- Employing the use of visually informative presentation materials and handouts
- Coordinating with Transportation Planning and Programming (TPP) Division's Public Involvement Section and the Houston District Public Information Officer (PIO) office to ensure best practices, messaging and branding compliance for public information, environmental and public involvement activities.

11.1 Contract Steering Committee

TxDOT and other potentially impacted government entities, subject matter experts, and policy decision-makers met regularly to oversee the study. The Contract Steering Committee's role was to:

- Provide information about existing conditions, needs of the community, and any proposed development
- Asses reports on the study's progress and provide comments on the schedule
- Provide technical oversight of the major activities of the study while coordinating with their respective agencies
- Review and provide comments on proposed improvements
- Serve as champions by moving policies and projects toward implementation

The Contract Steering Committee was composed of representatives from TxDOT, City of Conroe, H-GAC, Montgomery County, Strand Associates, Texas State of Representatives, City of

Magnolia, North Houston Association, The Woodlands Development Company, and Westwood Magnolia Parkway Improvement District (WMPID):

- Catherine McCreight (TxDOT)
- Dr. Qing Li (TxDOT)
- Abe Guzman (TxDOT)
- Dr. Ana Ramirez Huerta (TxDOT)
- Jeffrey English (TxDOT)
- Julie Beaubien (TxDOT)
- Yue Zhang (TxDOT)
- Sergio Rodriguez (TxDOT)
- Adam Galland (TxDOT)
- Emily Black (TxDOT)
- Susanna Scott (TxDOT)
- Chuck Carnohan (TxDOT)
- Denetia Robinson (TxDOT)
- Ethan Beeson (TxDOT)
- Tommy Woolley (City of Conroe)
- Carlene Mullins (H-GAC)
- Rick Wong (MCTX)
- Don Dean (MCTX)
- Commissioner Charlie Riley (MCTX)
- Trent Williams (State Rep., Dist. 15)
- Vivian Lapaglia (State Rep., Dist. 3)
- Robert Heineman (The Woodlands Development Company)
- Tana Ross (City of Magnolia)
- Daniel Miller (City of Magnolia)
- Marlisa Briggs (North Houston Association)
- Rob Eissler (WMPID)
- Kelly Hamann (WMPID)
- Kelly Hajek (Strand Associates)

The Project Team met with the Contract Steering Committee five (5) times on the following dates:

1. April 11, 2019: Establishment of the study goals and objectives
2. May 2, 2019: Discussion of the existing conditions and planned projects; Presentation of public meeting 1 materials
3. July 31, 2019: Presentation of reasonable alternatives and summary of public meeting 1
4. September 23, 2019: Presentation of improvement concepts and public meeting 2 materials
5. December 18, 2019: Summary of public meeting 2 and presentation of final recommendations

11.2 Stakeholder Meetings

The FM 1488 corridor has many unique stakeholders. Stakeholder meetings were held to review specific recommendations in more detail.

The Project Team met with stakeholder groups on the following meeting dates:

- August 12, 2019: Bicycle Stakeholders
- August 21, 2019: School District and Forestry Stakeholders
- August 29, 2019: First Responder Stakeholders
- October 15, 2019: Forestry Stakeholders (2nd meeting)

11.3 Public Meetings

To promote transparent, active, and continuous communication between TxDOT and the public, the Project Team invited community leaders, agencies, businesses and members of the public to participate in two public meetings near the FM 1488 corridor. These meetings allowed community

members to express concerns while actively engaging in two-way communication and providing comments for the Project Teams consideration.

The Project Team held two separate public meetings. Using an open house format, the public meetings allowed community members to come-and-go while engaging with Project Team and interacting with the study exhibits. These meetings allowed the public to learn about the proposed improvements, ask questions, and provide feedback.

Public meetings were held at the Mitchell Intermediate School Cafeteria on the following dates:

- Thursday, May 23, 2019
- Thursday, October 24, 2019

A public meeting summary report was prepared for each public meeting including documentation of public meeting materials and public comments.

12 H-GAC Transportation Improvement Plan (TIP) Application

The gap in funding for the current planned projects and the new recommendations will be requested through the H-GAC Call for Transportation Projects. Using information collected and evaluated as part of the FM 1488 Access Management Study, a draft application for the 2021 H-GAC Call for Transportation Projects was prepared based on the requirements in the 2018 Call for Transportation Projects. The preliminary cost estimates are based on year 2019 dollars.

Two applications, located in **Appendix K**, were prepared for the following improvements:

- FM 1488 Access Management – for short-term access management improvements
- FM 1488 Widening – for widening FM 1488 to six-lanes from I-45 to FM 2978

13 Electronic Files

Electronic files from the FM 1488 Access Management Study are included in **Appendix L** including:

- Raw Traffic Volume Data
- Microstation files of the short-term design
- Cost Estimate
- TIP Application and supporting excel files