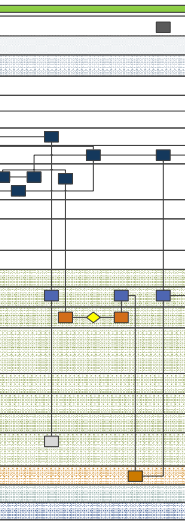
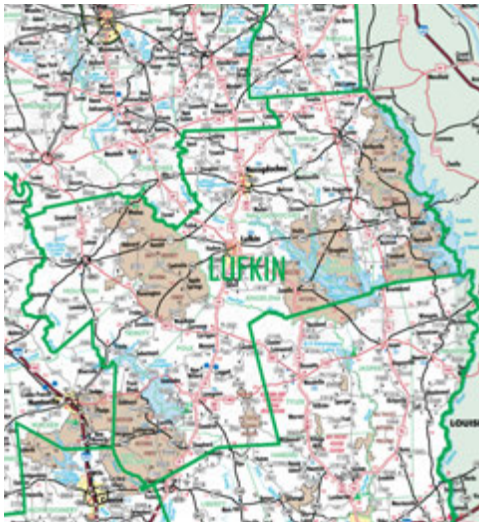
TRANSPORTATION SYSTEMS MANAGEMENT AND OPERATIONS (TSMO)





LUFKIN DISTRICT ITS MASTER PLAN

October 2021

Texas Department of Transportation

Document Control

Version	Date	Description of Change	Author
0.1	11/12/2020	Initial draft for Lufkin TSMO Working Group review	DKS Associates team
0.2	01/11/2021	Incorporated comments from 11/19/2020 Working Group Meeting	DKS Associates team
1.0	03/31/2021		

Disclaimer: ITS Master Plan represents recommended improvements. ITS will be deployed as funding is secured, project prioritization may change without notice.

Table of Contents

List of Figures

List of Tables

List of Acronyms

Acronym	Definition
APS	Accessible Pedestrian Signal
ATMS	Advanced Traffic Management Systems
CCTV	Closed-Circuit Television
DMS	Dynamic Message Sign
DUI	Driving Under the Influence
EA	Engineering Assistant
EQ	Equivalent
FHWA	Federal Highway Administration
FTE	Full Time Equivalent (referring to full-time staff position)
ITS	Intelligent Transportation Systems
LED	Light Emitting Diode
LFK	TxDOT Lufkin District
NHS	National Highway System
O&M	Operation and Maintenance
PCMS	Portable Changeable Message Sign
PIO	Public Involvement Office
PTZ	Pan-Tilt-Zoom
SH	State Highway
SL	State Loop
SOP	Standard Operating Procedure
TMA	Truck-Mounted Attenuator
TMS	Traffic Management System
TP&D	Transportation Planning & Development
TPP	TxDOT Transportation Planning and Programming Division (Central Office)
TRF	Traffic Division (Central Office)
TSMO	Transportation Systems Management & Operations
TxDOT	Texas Department of Transportation
US	United States Route
VIVDS	Video Imaging Vehicle Detection System
W	Watt

Executive Summary

The Lufkin District ITS Master Plan provides a roadmap to help identify opportunities to implement technology to meet the transportation needs in the district.

In conjunction with the district's Transportation Systems Management and Operations (TSMO) Program Plan, this ITS Master Plan helps prioritize and coordinate recommended technology projects to maximize the use of funding sources and provide the most benefit to travelers in the district.

It also identifies district workforce strategies to ensure that newly deployed technologies can be operated and maintained effectively.

WHAT IS *ITS*?

Intelligent Transportation Systems (ITS) are the application of innovative technology to provide more efficient, safe, and convenient travel. They focus on enhancing the existing transportation system by providing improved traveler information, traffic management systems, incident response, and goods movement. They employ state of the art traffic management practices coordinated across multiple jurisdictions, agencies, and modes.

Lufkin District TSMO Mission, Vision, Objectives, and Goals

The Lufkin District supports the statewide TSMO vision, mission and goals and has developed district-specific objectives to support the statewide goals as described in this document. These also extend to the district's ITS investments.

STATEWIDE TSMO VISION

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

STATEWIDE TSMO MISSION

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

STATEWIDE TSMO GOALS AIM TO IMPROVE:

ITS Deployment Plan Projects

This ITS Master Plan identifies different types of projects that align with the Lufkin TSMO vision and mission and support the district in achieving goals developed by the district. These projects include:

- Permanent count stations to monitor and measure traffic volumes and speed
- Signal controller upgrades to improve traffic control system reliability and cellular communications to provide remote access

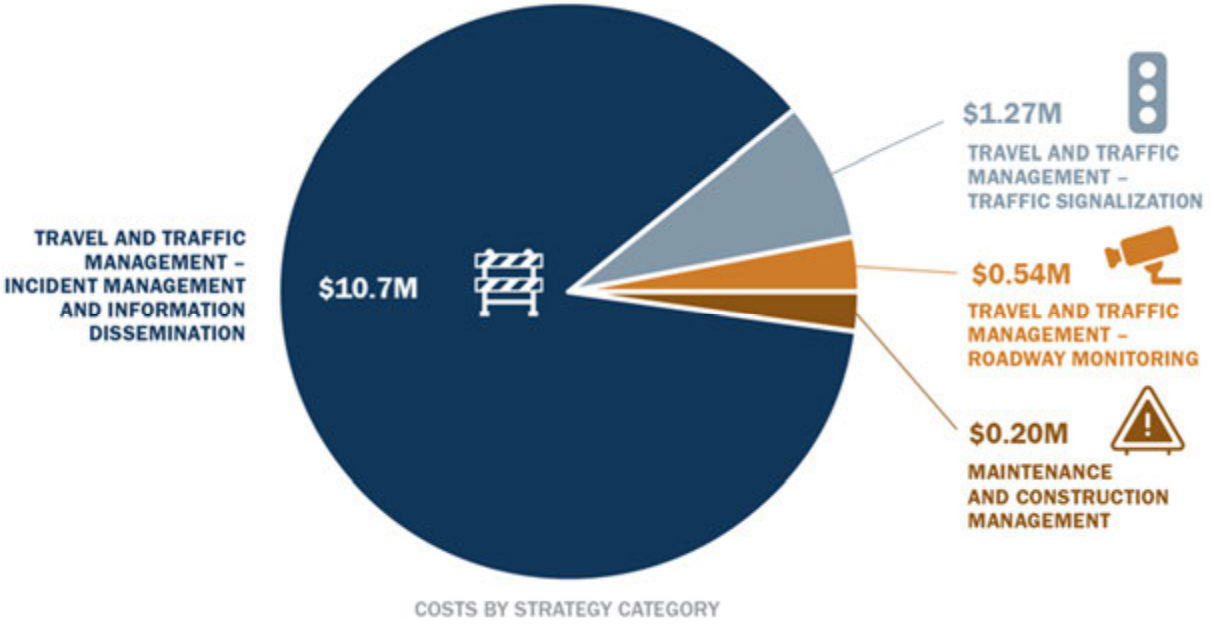
- Installing cellular communications at school flashers to identify issues more quickly and to reduce staffing hours spent individually monitoring devices
- Over-height warning systems to reduce bridge strikes
- Dynamic message signs (DMSs) to provide traveler information, route guidance in response to incidents, and public safety announcements
- Cameras associated with DMS to verify that information is correctly displayed on DMSs
- Additional cameras to monitor traffic
- Additional Truck-Mounted Attenuators (TMAs) to enhance the safety of TxDOT personnel and the traveling public
- Additional Portable Changeable Message Signs (PCMSs) with remote accessibility to better support maintenance

Proposed Early Action Projects

Project No.	Location	Description
Travel and Traffic Management — Roadway Monitoring		
1	Districtwide	Install 15 permanent count stations along major roadways to monitor traffic. Third party data efforts by the TxDOT Traffic Division (TRF) may reduce or eliminate the need for field devices
Travel and Traffic Management — Traffic Signalization		
3	Districtwide	Signal Controller Upgrades (*in progress*): Replace outdated signal controllers at 21 locations. The district already has signal controllers on hand and will have district signal technicians perform the work.
4	Districtwide	Signal Cellular Communications (*in progress*): Add cellular communications at 82 traffic signals
Travel and Traffic Management — Incident Management & Information Dissemination		
9	Districtwide	Install 13 cameras at intersections of major highways, freight routes and evacuation routes (10 at signalized intersections and three at interchanges)
Maintenance and Construction Management		
10	Districtwide	TMAs: Purchase two TMAs for reserve at the District Office to enhance the safety of TxDOT personnel and the traveling public

Project Costs

Fully implemented, all the deployment projects come to a total planning level capital cost (2020 dollars) of $12,739,000 and an annual operations and maintenance (O&M) cost of $190,000.



Some projects are more long-term and can be implemented over time, while those early action projects are recommended to be given higher priority for implementation.

Operations and Maintenance Workforce Plan

To ensure adequate operations and maintenance support for the recommended ITS projects in this plan, the following actions are recommended:

- Pursue formal O&M agreement with Houston District
- Consider hiring one full-time equivalent (FTE) maintenance technician in the future as more ITS assets are deployed

ITS Plan Content

This plan provides an overview of current and future transportation conditions, an assessment of user needs, a link to the current ITS architecture, and a prioritized ITS deployment plan.

Current & Future Transportation Conditions

This section provides an overview of the Lufkin District's state highway network, overall safety condition, and existing and planned ITS and traffic signal infrastructure. The information was used to facilitate discussions with district staff regarding current and expected challenges with potential to be addressed by ITS strategies.

State Highway Network Overview

This section highlights the key features of the state highway network in the Lufkin District such as interstates, national highway system (NHS) routes, freight routes, hurricane evacuation routes, energy sector corridors, and major connectors to the nearest metropolitan areas. Table 1 includes state highways with at least two of these designations. US 59, US 69, and US 96 have at least four of these designations. The development of an I-69 corridor is in various planning and preliminary design phases and will use portions of US 59 and US 84 (TxDOT, 2019). Figure 1 shows the state highways within the Lufkin District that connect metropolitan areas (Houston and Beaumont to the south, Waco to the west, and Dallas/Fort Worth, Tyler, and Texarkana to the north) and Figure 2 depicts the NHS, freight, and hurricane evacuation routes in the district.

TABLE 1. KEY STATE HIGHWAYS IN THE LUFKIN DISTRICT

State Highway	Interstate	National Highway System (NHS)	Freight Route	Hurricane Evacuation Route	Energy Sector Corridor	Metro Area Connector
I 69	Future	✓	✓	✓*	✓	✓
US 59		✓	✓	✓*	✓	✓
US 69						
US 96		✓	✓	✓	✓	✓
US 84						
US 259		✓	✓	✓	✓	
US 287						
US 190		✓	✓			
SH 146						
SH 7		✓	✓		✓	
SH 21						

State Highway	Interstate	National Highway System (NHS)	Freight Route	Hurricane Evacuation Route	Energy Sector Corridor	Metro Area Connector
SH 87				✓		✓
SH 103		✓	✓			
SL 304			✓	✓		
SL 224			✓	✓		
SL 287			✓	✓		

* Future I-69, US 59, and US 69 throughout the district are also identified as potential contraflow routes for hurricane evacuations.

Connection with Metropolitan Areas

The Lufkin District is a rural district that does not include any areas large enough to qualify for a metropolitan planning organization, but there are numerous state highways that run through the Lufkin District that provide connections to metropolitan areas as shown in Figure 1. The major cities in the Lufkin District are Lufkin and Nacogdoches. They are connected by US 59, which runs north and south through the district. The City of Lufkin is located closest to the Houston and Beaumont metropolitan areas. The City of Lufkin can be accessed from the south via US 59 for Houston and via US 69 for Beaumont. Both US 59 and US 69 have typical roadway sections that vary from a four-lane divided roadway to a four-lane undivided roadway that runs through many small rural cities. These two US highways also serve as hurricane evacuation routes out of the Houston and Beaumont areas.

Interstate

I-69 is a proposed north/south interstate that will run through the Lufkin District (TxDOT, 2019). The Lufkin District has specified that US 59 between Shepherd and Tenaha and US 84 between Tenaha and Joaquin will become the future I-69 corridor through the district. The I-69 corridor on these two highways total approximately 150 miles. The purpose of the corridor is to relieve traffic congestion, improve driver safety, improve evacuation routes, and support economic growth.

Upgrading to interstate standards along I-69 will require improvements to the existing highways as well as constructing new roadway locations around high impact areas.

Current Lufkin District I-69 projects include[1]:

- Angelina County
  - US 59 - Upgrade Moffett Road to SH 103 (construction underway or will begin soon)
  - US 59 - Diboll Relief Route (construction underway or will begin soon)
  - US 59 - Redland (construction begins within 4 years)
- Nacogdoches County
  - US 59/SL 224 - South Interchange (construction underway or will begin soon)
- Polk County

[1] Project status are based on the Project Tracker system last updated on 11/11/2020

- US 59 - Corrigan Relief Route (construction begins within 4 years)
- San Jacinto County
  - US 59 - Upgrade Shepherd to Cleveland Upgrades (construction begins within 4 years)

National Highway System (NHS)

The NHS is a series of roadways designated by the US Department of Transportation that are critical to the nation's defence, economy, and mobility. As shown in Figure 2, north-south roads US 69, US 96, US 59, and US 259 are a part of the NHS. These roadways are of national importance as hurricane evacuation routes and as intermodal freight connections to the Houston region. Portions of the east-west roads of SH 103, SH 7, and SH 21 are designated as part of the NHS. These facilities provide critical connectivity for the movement of people and goods.

Freight Routes

TxDOT designates roadways as part of the state's Highway Freight Network. Those roadways that are included are shown in Figure 2 and Table 1. The 2018 Texas Freight Mobility plan outlines the planned improvements to these facilities (TxDOT, 2018).

Hurricane Evacuation Routes

Hurricane evacuation routes have been identified for the Lufkin District to aid in the evacuation from the Gulf Coast for both the Houston and Beaumont Districts. US 59 has been identified as the primary evacuation route impacting the Lufkin District. When the Houston area is required to evacuate its residents, local officials working with the State Operations Center determine the need for contraflow through the district based upon the strength of the storm and projected landfall. US 59 may be converted to contraflow with the southbound travel lanes being converted to the northbound direction at Fostoria Road at the south end of the district. When used, contraflow will be maintained through the district and north of the City of Nacogdoches where it will be split between US 259 and US 59. Some of the contraflow traffic will be diverted to US 69. Additional evacuation routes include:

- US 287 from US 59 to the northern district line
- US 96 from the southern district line to the northern district line
- SH 8 from the southern district line to the northern District line
- SH 21 from US 96 to US 59

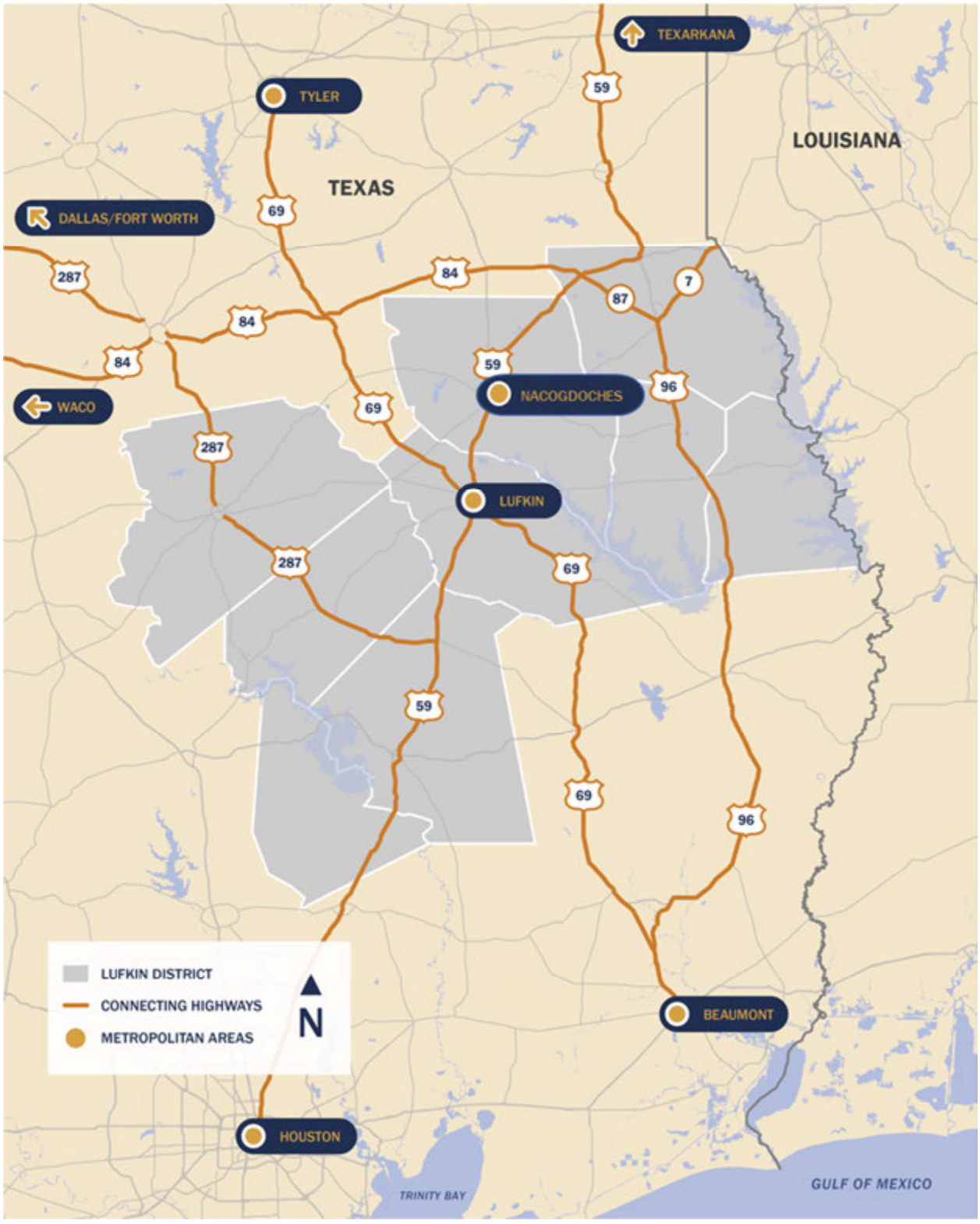


FIGURE 1. CONNECTION OF LUFKIN DISTRICT WITH METROPOLITAN AREAS

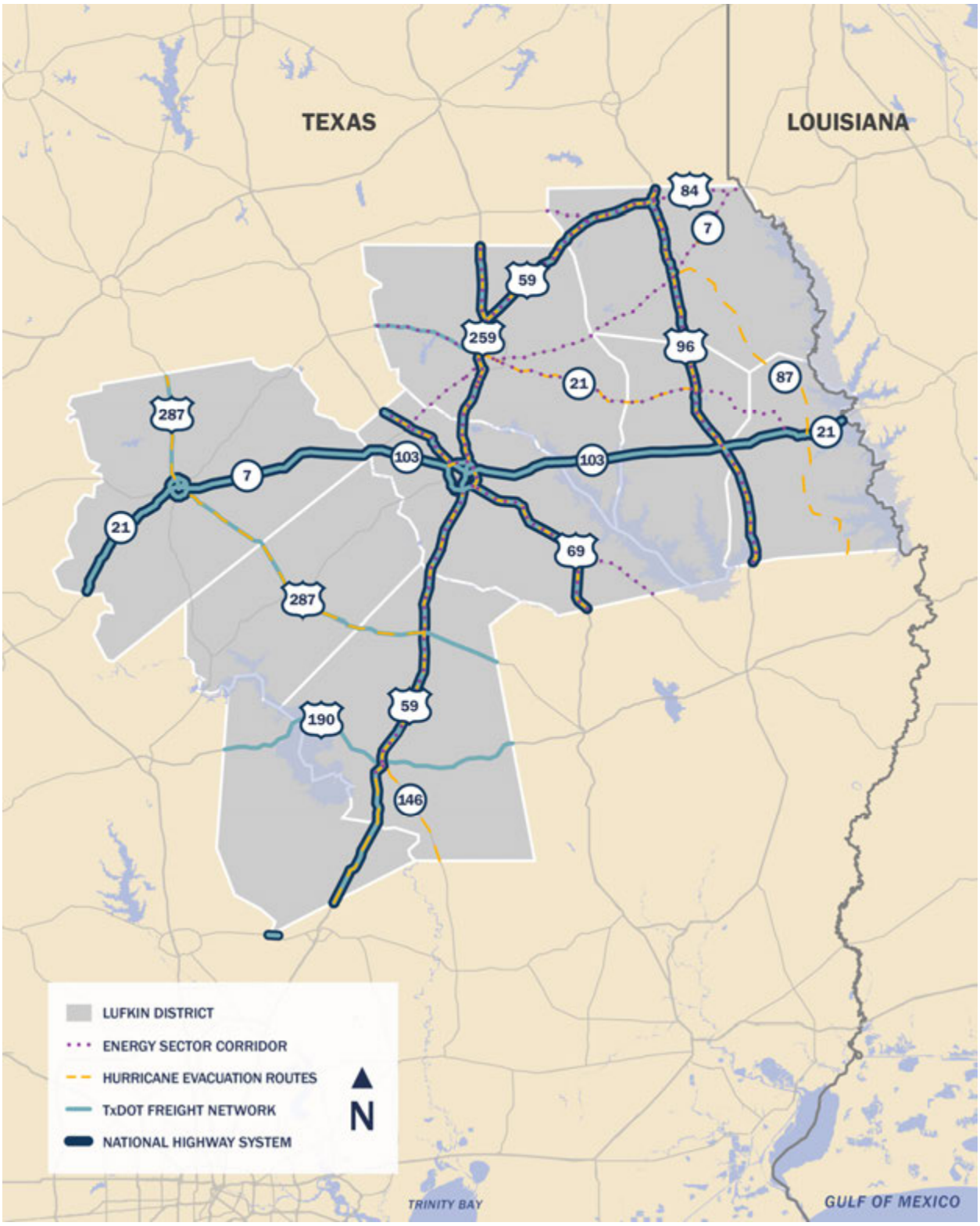


FIGURE 2. LUFKIN DISTRICT ROADWAY NETWORK OVERVIEW

Crash Summary

During the period of 2016 to 2019, the Lufkin District experienced more than 19,870 crashes on all public roadways (TxDOT Lufkin District, 2020). These crash events resulted in 305 fatalities and 917 suspected serious injuries. In fiscal year 2018, the Lufkin District had a fatality rate of 2.28[2] (third worst in the state) and a serious injury rate of 6.50 (sixth worst in the state). Some of the most common attributes of these district crashes include:

- 28 percent occurred at intersections or were related to nearby intersections
- 47 percent were considered segment crashes
- 25 percent were associated with driveways

The Lufkin District also identified common contributing factors to fatal and suspected serious injury crashes:

- Failed to drive in a single lane (16%)
- Driving under the influence (DUI) of alcohol (9%)
- Unsafe speed (9%)
- Wrong side – not passing (8%)
- Failed to control speed (6%)

The combined DUI and unrestrained (i.e., not wearing a seatbelt) accidents account for 40% of all the Lufkin District fatalities from 2016 to 2019. The district recently received TxDOT Road to Zero funding to add four dynamic message signs for use in various locations to provide public safety announcements to help deter some of these behaviors. The signs will support many of the district's TSMO goals and objectives.

ITS and Traffic Signal Infrastructure

Table 2 provides a summary of the existing and planned ITS and traffic signal infrastructure in the Lufkin District, including number of devices. Detailed information about these devices is contained in the district's Traffic Management System (TMS) Status Report (TxDOT Lufkin District, 2020), Traffic Engineering Equipment Maintenance Survey (TxDOT Lufkin District, 2019), and Traffic Engineering Equipment Maintained by Total Maintenance Contracts Survey (TxDOT Lufkin District, 2019). Additional information on TSMO strategies and supporting documentation is summarized in the district's TSMO State of the Practice (TxDOT Lufkin District, 2020).

The Lufkin District uses 4G cellular communications to connect with their various TMS assets. Due to the large number of rural assets and low-bandwidth requirements, fiber optic connectivity is not cost-effective for the ITS infrastructure. Radio communications was used in the past but resulted in poor performance due to the dense trees and foliage in the district.

The Lufkin District is currently working on traffic signal improvements. They recently installed cellular modems at 11 intersections and will have a total of 40 installed before the end of 2021. Approximately one-quarter of the district's signal controllers are outdated. The district has new traffic signal controllers in stock and are working on replacing them as scheduling allows.

[2] Crash rate measured as number of crashes per 100 million vehicle miles travelled (VMT)

TABLE 2. SUMMARY OF ITS AND TRAFFIC SIGNALS DEPLOYED IN THE LUFKIN DISTRICT

Device	# of Existing Devices	# of Programmed Devices	Purpose	Management Strategies				
				Travel and Traffic	Information	Maintenance/ Construction	Incident and Emergency	Road Weather
CCTV Cameras								
Dynamic Message Signs (DMSs)	0	10	Traveler information at key state highway junctions	✓		✓	✓	✓
Portable Changeable Message Signs (PCMSs)			work zones or events (incidents,					
Radar Sensors (aka Permanent Count Stations)	6	-	Collect volume and speed data for network monitoring, traveler information, and project planning	✓		✓	✓	
Lonestar Access								
Traffic Signals	122	-	Traffic control at warranted intersections: 122 operated by TxDOT	✓				
Central Signal Control	N/A	1	System (under development by Traffic Division) to remotely operate traffic signals and measure performance	✓	✓			

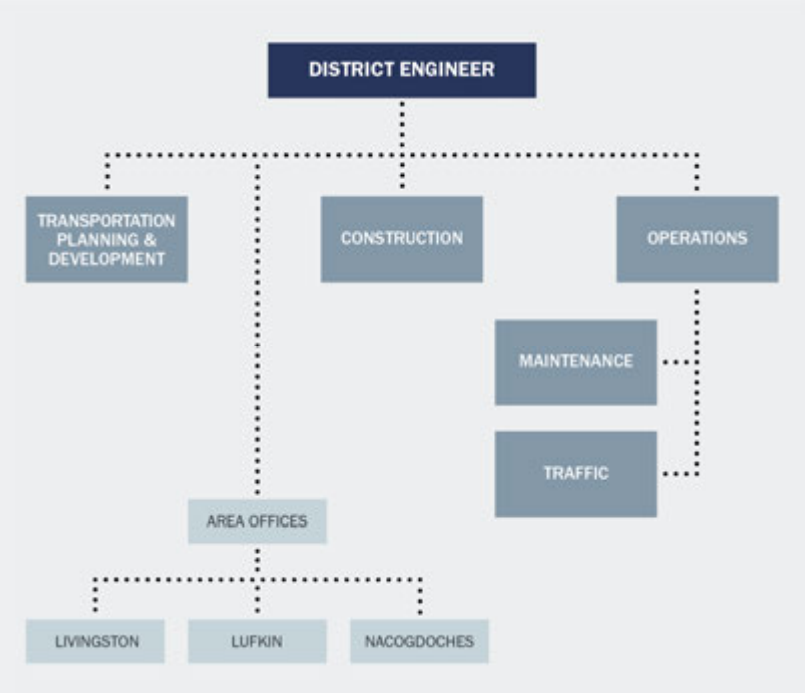
User Needs Assessment

This section provides a summary of transportation system user needs for the Lufkin District gathered from district staff through stakeholder workshops, meetings with each practice area, and discussions with the district's Operations section. The assessment of current and future transportation user needs provides a basis for the development and evaluation of potential ITS projects.

The Stakeholders and System Users section identifies the stakeholder and key system users for this ITS plan. These users participated in the stakeholder workshop and individual interviews to identify and confirm key user needs. The Summary of User Needs section summarizes these user needs, organized by the following areas of interest:

Stakeholders and System Users

To ensure the success of this ITS Master Plan, a coalition of stakeholders and system users was created to gather input and build consensus on regional needs. Personal interviews with key stakeholders in each practice area of the district were conducted in May and June 2020 to identify their transportation needs. These individual interviews were followed by three virtual workshop sessions held in July 2020 to discuss and verify the transportation needs that had been identified, determine any additional needs, and facilitate discussion between the Plan's stakeholders.



Both internal and external stakeholders provided input. Internal ITS Plan stakeholders include district staff from all core departments, as shown in Figure 3. External stakeholders include cities, counties, emergency responders, and other applicable agencies. The appendix includes a list of specific stakeholders.

FIGURE 3. KEY INTERNAL LUFKIN DISTRICT STAKEHOLDERS

Vision, Mission, Goals and Objectives

The vision, mission, goals, and objectives described in this section were developed as part of the Lufkin District TSMO Program Plan. These served as the basis for identifying ITS strategies and projects described in the Deployment section of this plan.

The Lufkin District supports the statewide TSMO vision, mission and goals and has developed district-specific objectives under each goal to support ongoing monitoring of the effectiveness of the TSMO Program Plan. Table 3 includes the objectives for each goal.

Goals and Objectives

The Lufkin District supports each of the six statewide TSMO goals (safety, reliability, efficiency, customer service, collaboration, and integration) and has developed measurable objectives for the district.

TABLE 3. LUFKIN DISTRICT TSMO GOALS AND OBJECTIVES

Goal	Strategic Statewide Objectives	Strategic Lufkin District Objectives
Reliability	Optimize travel times on transportation systems in critical corridors to ensure travelers are reaching their destinations in the amount	▪ Improve travel time reliability of person-miles traveled on US 59/Future I-69. ▪ Increase TMS assets in use for incident and emergency detection/response on hurricane evacuation routes.

Goal	Strategic Statewide Objectives	Strategic Lufkin District Objectives
	of time they expected for the journey.	▪ Reduce delay caused by work zones or system maintenance. ▪ Reduce average incident clearance time on highways.
Efficiency 	Implement projects that optimize existing transportation system capacity and vehicular throughput.	▪ Maintain a program of evaluating 100 percent of signals for retiming every three years.
Customer Service 	Provide timely and accurate travel information to customers so they can make informed mobility decisions.	▪ Increase number of repeat visitors to Lufkin District section of DriveTexas.org during major events (e.g., flooding, tornadoes, hurricanes, crashes where roads/lanes are closed). ▪ Increase number of subscribers to Lufkin District social media platforms by at least 10 percent by the end of Fiscal Year 2022.
Collaboration 		
Integration 	Prioritize TSMO as a core objective in the agency's planning, design, construction, operations, and maintenance activities.	▪ Maintain 90 percent TMS asset operational uptime annually. ▪ Expand network monitoring to 100 percent of traffic signals by 2030. ▪ Conduct joint training exercises in the district and/or region that support shared implementation of TSMO strategies.

Summary of User Needs

This section contains a summary of transportation system user needs for the Lufkin District based on input gathered from the user needs workshop and individual stakeholder interviews.

User needs are grouped into the following four categories:

1. Travel and Traffic Management
2. Information Management
3. Maintenance & Construction Management
4. Incident & Emergency Management

Travel and Traffic Management

Stakeholders identified the following travel and traffic management needs:

- Need to replace outdated controllers and have cellular modems in all controllers
- Need for communication to ITS devices, particularly on US 69 and US 59
- Need for permanent count stations to help with funding applications
- Need for more monitoring capabilities (e.g., pan-tilt-zoom (PTZ) or fish-eye cameras)
- Need capability to verify status and performance of DMSs (e.g., via monitoring cameras)
- Need for more data to support real-time travel information (e.g., travel time along I-610 north of Houston to Nacogdoches)
- Need to update ITS architecture

Information Management

Stakeholders identified the following information management needs:

- Need high-speed communications on I-69 (e.g., fiber)
- Need to install communications at school zone flashers throughout the region to support remote access to change flasher operating parameters
- Need better capability to monitor uptime performance of traffic management system (TMS) assets (e.g. ITS devices, traffic signals)
- Need more corridor-focused operational and technology assessments that span multiple districts

Maintenance & Construction Management

Stakeholders identified the following maintenance and construction management needs:

- Need a database to track maintenance projects
- Need standard operating procedures (SOPs)/maintenance guidelines
- Need real-time traffic conditions data to inform maintenance crew before they head to the field
- Need speed trailers to detect and encourage travelers to reduce travel speed through work zones
- Need to consider applicable smart work zone applications for construction projects

- Need about two more truck mounted attenuators (TMAs) to reserve at the district office to enhance safety of district maintenance crews
- Need about six to 10 additional PCMSs to support maintenance crew operations
- Need better maintenance access to cameras, which are currently mounted too high for bucket truck access

Incident & Emergency Management

Stakeholders identified the following incident and emergency management needs:

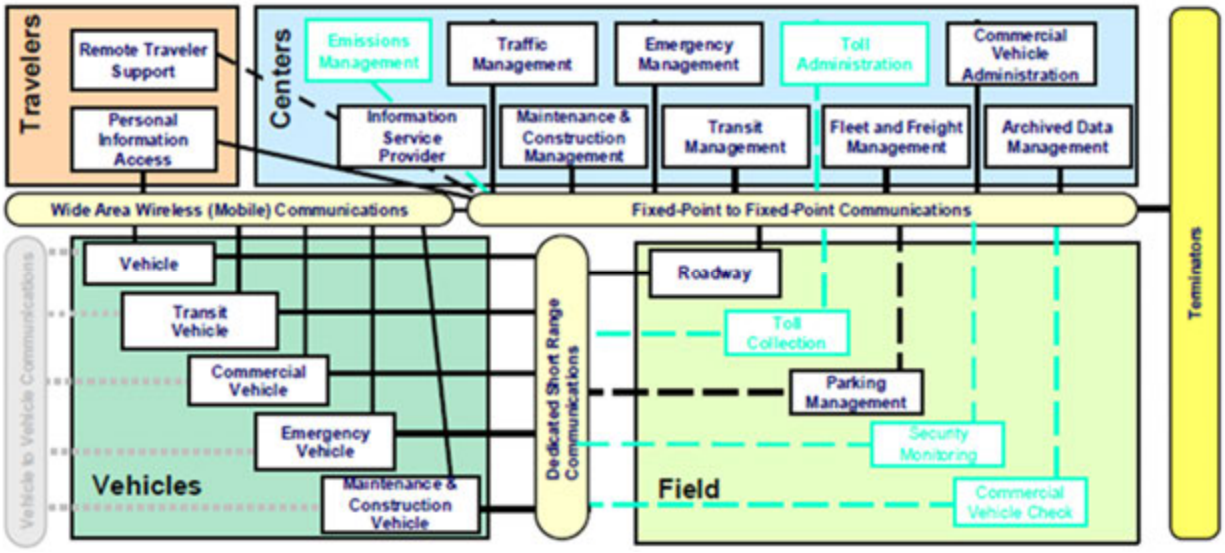
- Need signal upgrades and communications to signals on evacuation routes (e.g., US 59 and US 69) to support hurricane evacuation response plans
- Need traveler information dissemination capability (e.g., DMSs) at key decision points to support alternate routing during incidents and emergencies
- Need greater density of detection or access to third party data and information dissemination through social media or other platforms to improve incident response capabilities
- Need to reduce bridge strikes and identify ITS and operational strategies to address (e.g., over-height detection and alerts)
- Need queue detection and warning in key locations (e.g., on evacuation routes such as US 59 and US 69) and consider alternate data sources (e.g., crowd-sourced) to calculate performance metrices such as incident clearance time

ITS Architecture

The Traffic Division is currently considering developing a statewide architecture or several multi-regional architectures, to include Lufkin and other districts. The Lufkin District supports this approach and will roll its architecture into this statewide initiative.

One major factor in the future of the district's ITS architecture will be the Chief Engineer's memo from July 2016 (TxDOT, 2018), which states that all new roadway construction projects should include infrastructure that supports TMS, including the underground conduit that supports a fiber optic-based communications network.

The most current ITS architecture for the Lufkin District was developed in 2005 and can be reviewed online (ConSysTec, 2005). An overview "sausage diagram" from the 2005 Regional ITS Architecture is shown below.



ITS Deployment Plan

This ITS Deployment Plan identifies ITS strategies and projects to address the user needs and goals and objectives of the Lufkin District described earlier in this document. The ITS Deployment Plan includes project maps, descriptions, and costs.

ITS Strategies

Through the user needs workshop and interview process, stakeholders highlighted various strategies and areas of focus to address their needs. This section highlights the key focus areas and strategies of interest as identified by the Lufkin District ITS Plan stakeholders. These preliminary strategies, organized by functional areas, were refined and used as a basis to define specific projects for the Deployment Plan.

ITS STRATEGIES FOR THE LUFKIN DISTRICT

TRAVEL & TRAFFIC MANAGEMENT	• Traffic monitoring cameras • Traffic signal controller upgrades	• Dynamic message signs • Pre-trip information
INFORMATION MANAGEMENT	• Communications infrastructure gap closure • Data integration with third-party transportation data providers	• Traffic monitoring video sharing with multiple partners
MAINTENANCE & CONSTRUCTION MANAGEMENT	• Smart work zone system (en-route warnings) • Regionwide construction work zone and detour management and monitoring	• Infrastructure monitoring technology
INCIDENT & EMERGENCY MANAGEMENT	• Scenario planning for emergency response	• Evacuation planning, route designation, and enhancements

Communications Plan

The purpose of this communications plan is to identify general guidelines and specific actions to support transportation requirements for data and video transmission for the district. Cellular communications and fiber optic communications are discussed. Radio communications are not an option due to past performance issues with dense tress and foliage.

Cellular Communications

Communications to remote ITS devices and traffic signals is currently done via cellular modems. The Lufkin District should continue to use commercial cellular networks to enable communications to remote devices, prioritizing those traffic signals and ITS devices supporting hurricane and other emergency evacuation routes.

Fiber Optic Communications

The TxDOT Chief Engineer has identified fiber optic cable as the recommended communications medium for traffic management systems because of its capacity, reliability, redundancy, and cost benefits (TxDOT, 2016). It is recommended that in conjunction with any road widening or other significant roadway project (e.g. I-69) that the district consider installing conduit to accommodate future fiber optic cable installation. The cost to install conduit during a major construction project is much less than if it were added later. While cellular communications support the Lufkin District's current and planned ITS assets, fiber optic cable may be a consideration in the future if bandwidth needs change for new strategies such as connected and automated vehicle applications.

ITS Deployment Plan Projects

Projects in this ITS Deployment Plan are documented in Table 3. Note that an editable spreadsheet of this table is also available to the district to use and update as needed between ITS Plan updates to help track status or adjust priorities as conditions change.

Figure 4 to Figure 8 provide the approximate locations of proposed devices. An interactive map with an online interface is provided as well.

Table 4 provides the following information for each project, which will be led by the Lufkin District:

- Project number
- Project location
- Project description
- Partners/supporting agencies
- Priority (high/medium/low)
- Planning level cost estimate (capital cost and annual operations & maintenance cost)

Fully implemented, the plan comes to a total planning level cost estimate (2020 dollars):

- Capital costs: $12,739,000
- O&M costs: $190,000/year

Some projects are long-term goals and can be implemented over time, while those early action projects are recommended to be given higher priority for implementation.

TABLE 4. ITS DEPLOYMENT PLAN PROJECT LIST

Project No.	Location	Description	Partners	Priority	Planning Level Cost Estimate (Capital/ Annual O&M)
Travel and Traffic Management — Roadway Monitoring					
1	Districtwide	Install 15 permanent count stations (see Figure 4 for approximate locations); Third party data efforts by TRF may reduce or eliminate the need for field devices	TxDOT Transportation Planning and Programming (TPP)	High	$254,000/$14,000
2	City of Lufkin and City of Nacogdoches	Install 11 detectors in/around City of Lufkin and six detectors around City of Nacogdoches to complement the permanent count stations (see Figure 5 for approximate locations); Third party data efforts by TRF may reduce or eliminate the need for field devices	TPP, City of Lufkin and City of Nacogdoches	Medium	$288,000/$15,000
Travel and Traffic Management — Traffic Signalization					
3	Districtwide	Signal Controller Upgrades: Replace outdated signal controllers at 21 locations; District already has signal controllers on hand and will have district signal technicians perform the work.	TRF	In progress	O&M captured in annual signal maintenance budget
4	Districtwide	Signal Cellular Communications: Add cellular communications at 82 traffic signals	TRF	In progress	O&M captured in annual signal maintenance budget
5	Districtwide	Central Signal Control Software	TRF	Medium	$150,000/$15,000
6	Districtwide	School Flasher Cellular Communications: Add cellular communications at all school flashers (170+)	School Districts	Medium	$1,122,000/$7,000
Travel and Traffic Management — Incident Management & Information Dissemination					
7a	Districtwide	Install over-height vehicle warning system at six bridges that have been struck in recent years (see Figure 6 for bridge locations)	TRF	Medium	$1,277,000/$30,000
7b	Districtwide	Install over-height vehicle warning system at 16 bridges with vertical clearance less than 16 feet (see Figure 6 for bridge locations)	TRF	Low	$3,406,000/$81,000

Project No.	Location	Description	Partners	Priority	Planning Level Cost Estimate (Capital/ Annual O&M)
8a	US 59 and US 69	Install one DMS along US 59 and two DMSs along US 69 to inform the public about travel conditions. Install queue detection to detect incidents for display on DMSs. Install a closed-circuit television (CCTV) camera at each DMS location for message verification and to monitor travel conditions. (See Figure 7 for approximate locations)	TRF	Medium	$2,331,000/$7,000
9	Districtwide	Install 13 cameras at intersections of major highways, freight routes, and evacuation routes (10 at signalized intersections and three at interchanges, see Figure 8 for approximate locations)	TRF	High	$644,000/$10,000
Maintenance and Construction Management					
11	Districtwide	PCMSs: Purchase five PCMSs with remote access capability. The goal is that each Maintenance Office has at least one PCMS and each Area Office has at least one PCMS to support maintenance, work zones, and incident/emergency activities		Low	$136,000/$3,000
				Total Planning Level Cost (rounded, 2020 dollars):	**$12,739,000/ $190,000**

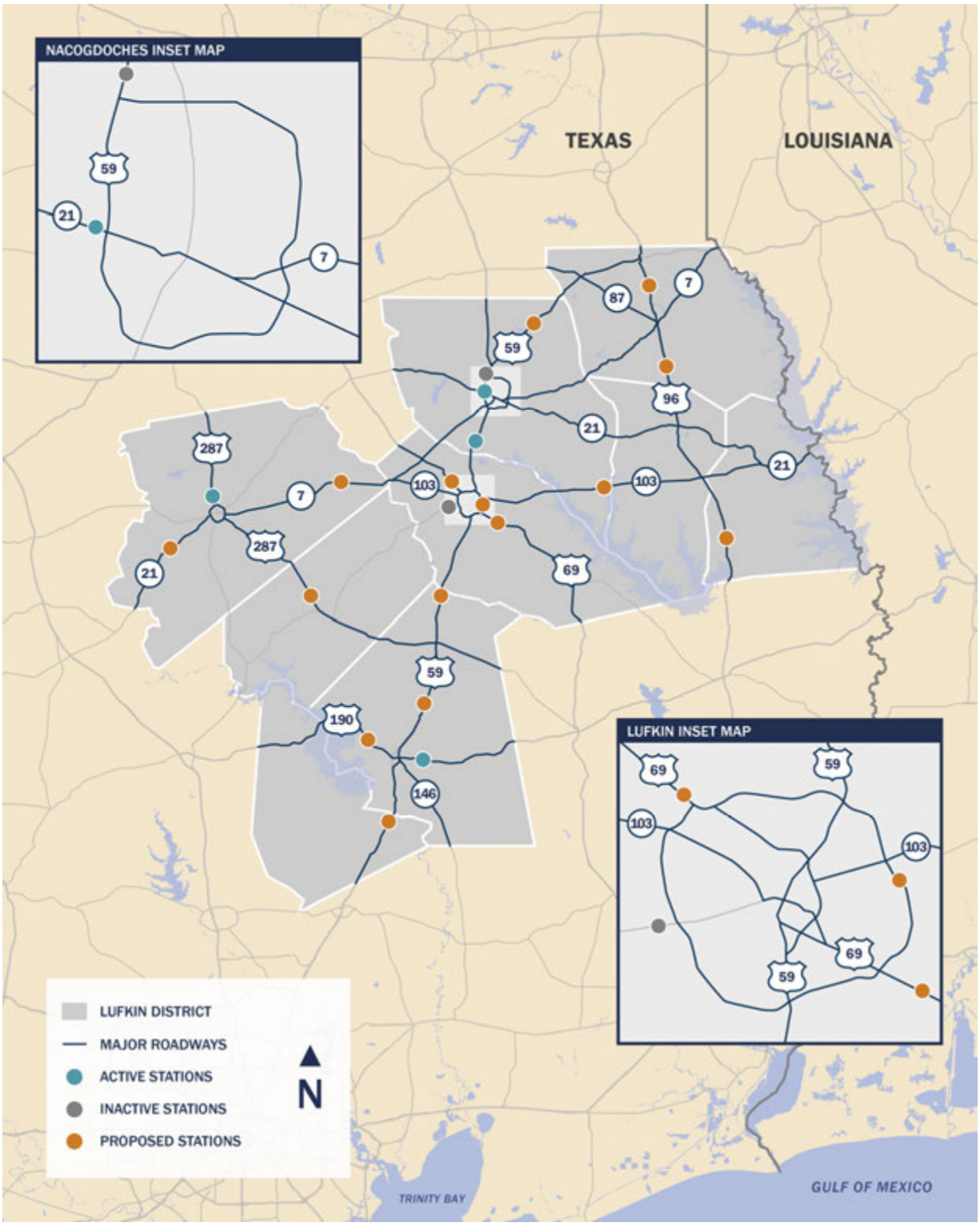


FIGURE 4. ITS DEPLOYMENT PLAN PROJECT MAP – PERMANENT COUNT STATIONS

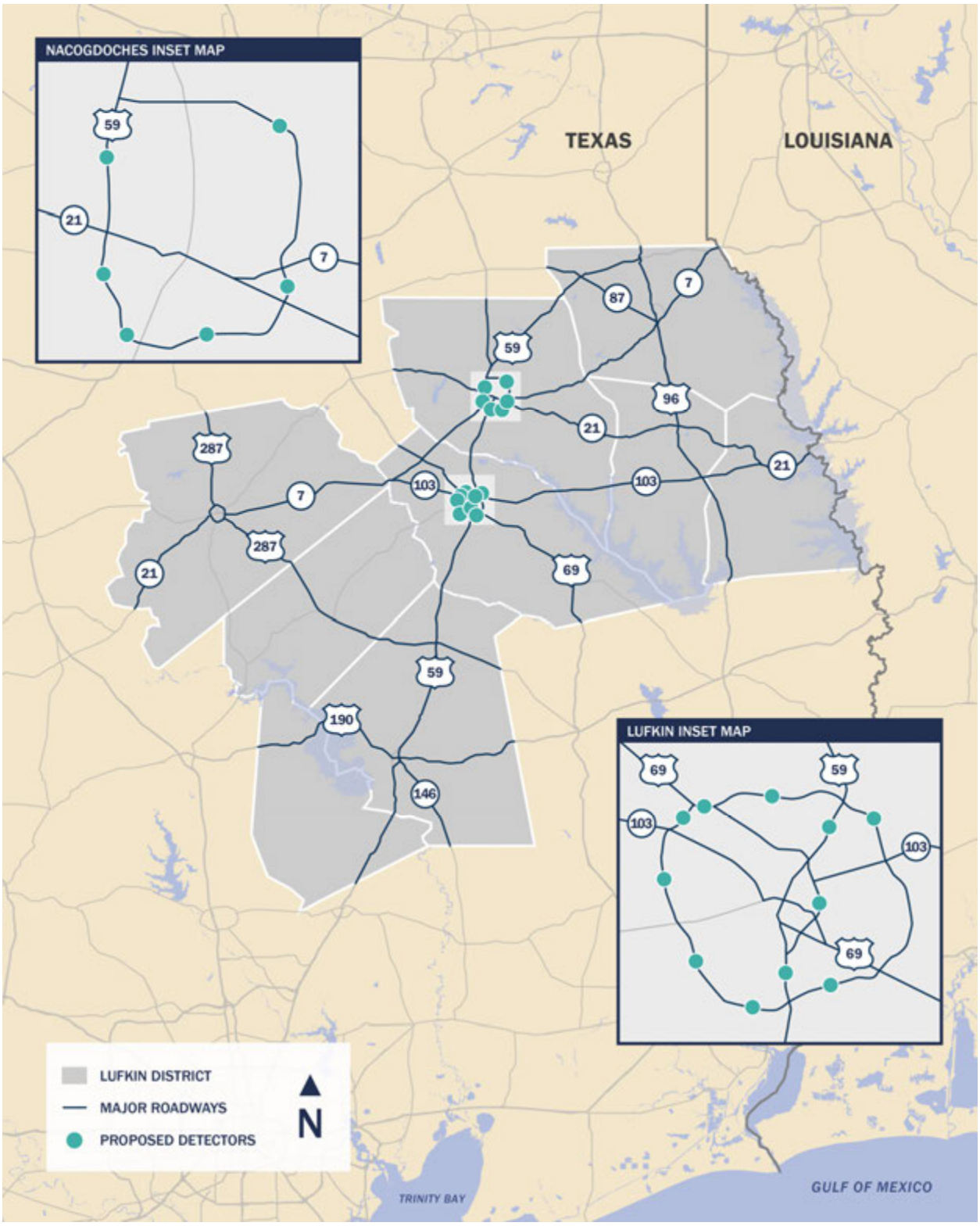


FIGURE 5. ITS DEPLOYMENT PLAN PROJECT MAP – DETECTORS

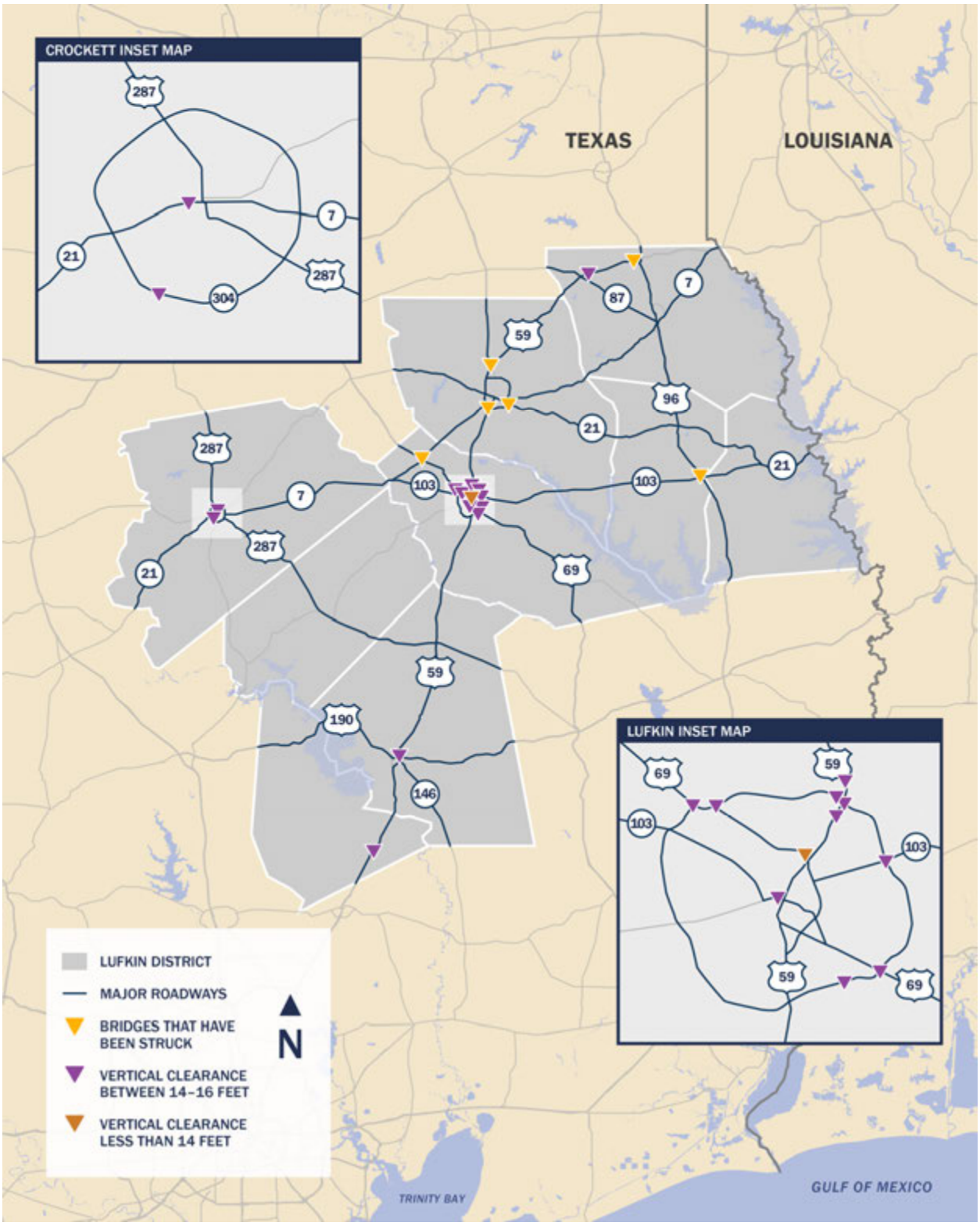


FIGURE 6. ITS DEPLOYMENT PLAN PROJECT MAP – OVER-HEIGHT VEHICLE WARNING SYSTEMS

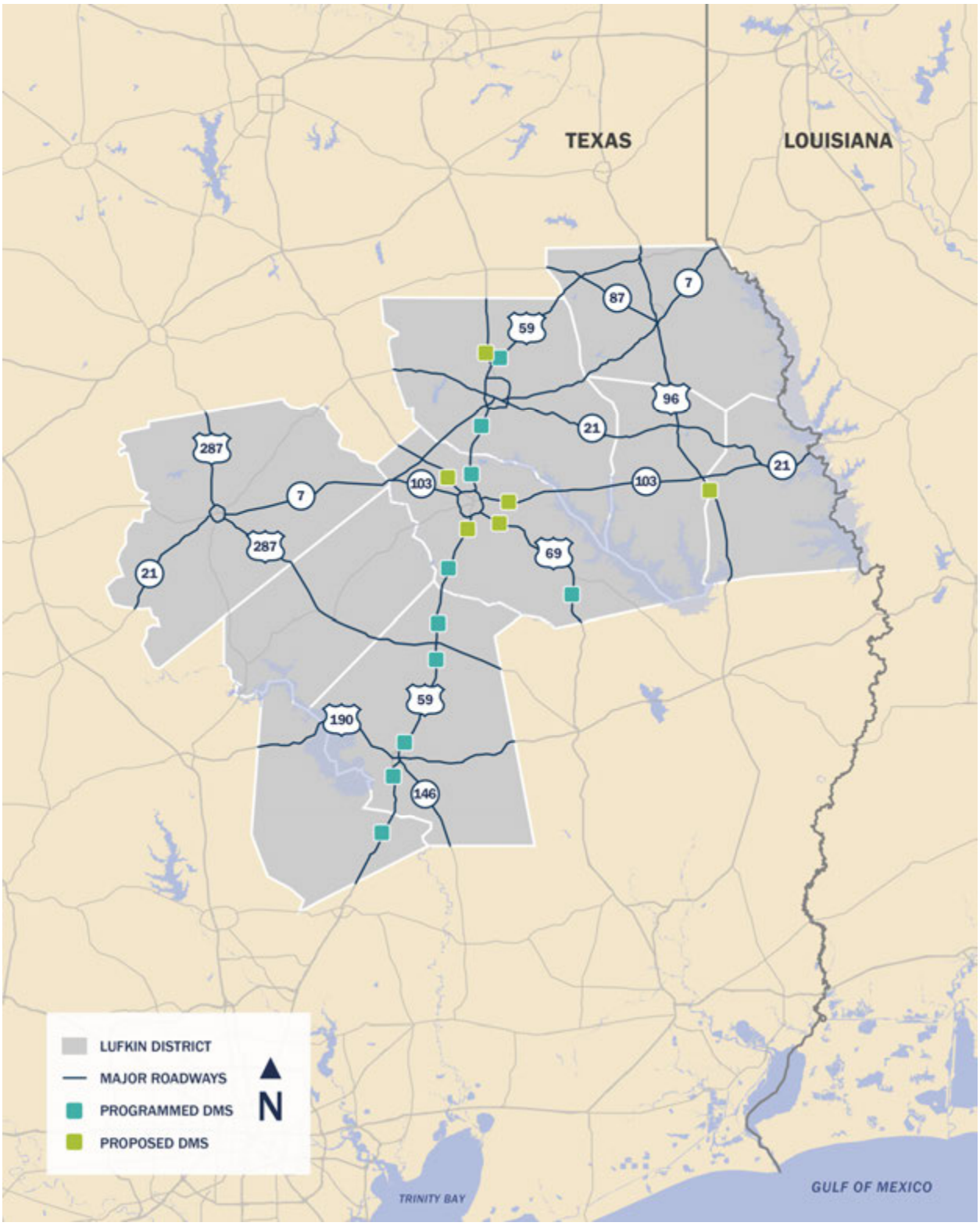


FIGURE 7. ITS DEPLOYMENT PLAN PROJECT MAP – DYNAMIC MESSAGE SIGNS

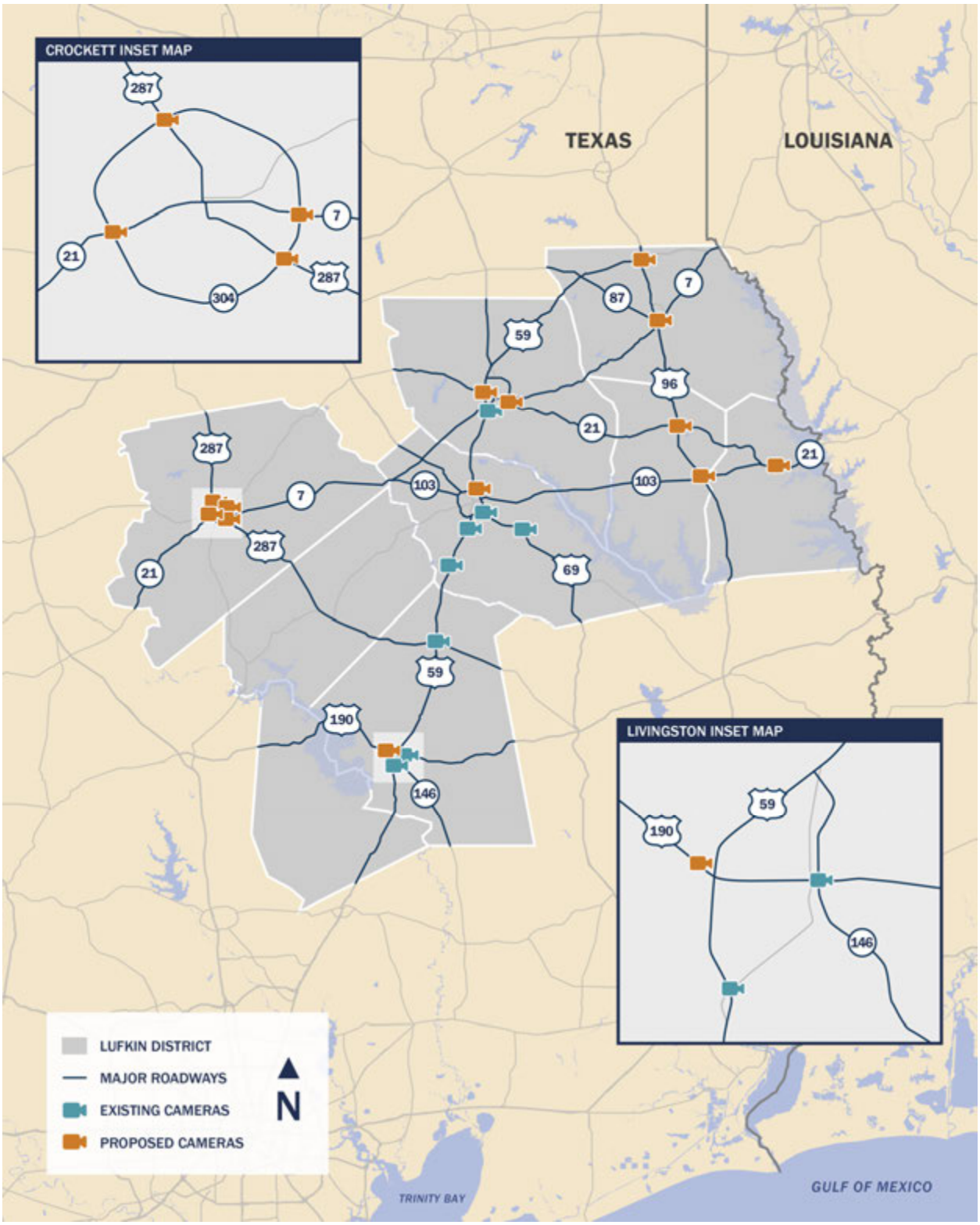


FIGURE 8. ITS DEPLOYMENT PLAN PROJECT MAP – CAMERAS

Operations and Maintenance Workforce Plan and Equipment Upgrades

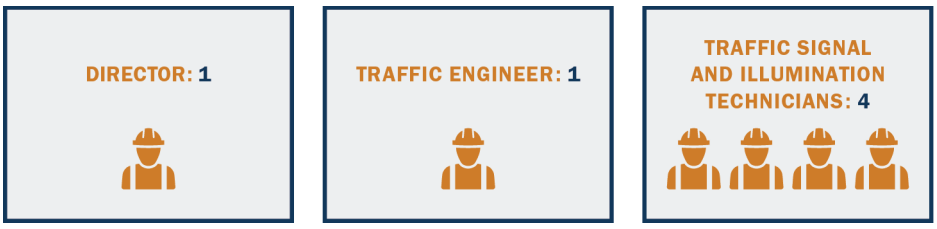
This section describes existing O&M requirements for Lufkin District resources, anticipated O&M needs, a proposed O&M staffing plan, and proposed equipment upgrades. In addition to the core departments located at the District Office, the Lufkin District has three Area Offices and nine Maintenance Offices (one located in each county within the district) as listed in Table 5.

TABLE 5. OFFICES WITHIN THE LUFKIN DISTRICT

District Office	Area Offices	Maintenance Offices	
Lufkin		Center Crockett Groveton Hemphill Livingston	Lufkin Nacogdoches San Augustine Shepherd

Existing Operations and Maintenance Responsibilities

This section describes existing O&M responsibilities. The district has a program that rotates engineering assistants (EAs) into the TP&D, Construction, and Operations sections and Area Offices. This allows staff to cross-train and collaborate between sections, which is critical to successful TSMO practice. District FTE for Operations and Maintenance:



The district expresses difficulty in recruiting and retaining experienced staff including ITS/TSMO skills and experience. Retaining staff is difficult in the current competitive market especially after they have gained enough experience and training. Experienced staff that retire are also difficult to replace.

The Lufkin District staff are responsible for the operations of the TSMO/ITS strategies for the region:

- Providing traveler information via the district's public information office (PIO), which manages the media, including the district Twitter account (@TxDOTLufkin), and posts updates to DriveTexas.org and HoustonTranstar.org
- Responding to weather-related traffic events (i.e., evacuations, flooding, snow, ice)
- Working with adjacent districts and partner agencies to coordinate and integrate systems and projects
- Managing traffic for construction and maintenance work zones
- Responding to traffic incidents when support is requested by law enforcement

Currently, the Lufkin District has limited maintenance staff with ability to perform ITS equipment maintenance. The Houston District currently operates and maintains the ITS devices (eight cameras) in the Lufkin District. Operations is handled out of Houston TranStar, a four-agency consortium (TxDOT Houston District, Harris County, City of Houston, and METRO) that operates a shared traffic management center and operates around the clock. The Lufkin District has some maintenance staff that assists the Houston District with ITS repairs and

troubleshooting via phone support from Houston District staff or by investigating power or communications outages. The Lufkin District's operations and maintenance requirements (preventive and corrective) include the devices listed in Table 6 (TxDOT Lufkin District, 2019).

TABLE 6. EXISTING LUFKIN DISTRICT O&M RESPONSIBILITIES

Device	Quantity	Additional Details
Portable Traffic Signals	2	▪ Solar-powered
Cameras	413 Non-School: ▪ 311 ground-mounted ▪ 102 overhead	▪ 17 are solar-powered
	168 School Zone: ▪ 149 ground-mounted ▪ 19 overhead	▪ Small portion have cellular modems
	8	▪ PTZ capabilities ▪ On hurricane evacuation routes
	6	▪ Also called permanent count stations
	12	
Illumination	1,039 Breakaway Poles	771 Single Arm: ▪ 748 with 250-Watt (250W) or LED equivalent (EQ) ▪ 23 with 400W or LED EQ 268 Double Arm: ▪ 236 250W or LED EQ ▪ 32 400W or LED EQ
	98 Non-Breakaway Poles	▪ Single Arm with 250W or LED EQ
	109 Lighting Fixtures Mounted on Signal Poles	▪ 250W
	60 High Mast Poles	
	58 Underpass Fixtures	
	28 Sign Light Fixtures	

Anticipated Operations and Maintenance Needs

While TSMO relies upon technology investments, delivering a robust TSMO program is heavily dependent on having a workforce with the right background and capabilities. Transportation agencies are being called on to expand their activities beyond the more traditional design and construction functions most closely associated with civil engineering to the broader and more diverse tasks of TSMO. While many transportation agencies view TSMO as a priority, they are encountering a shortage of management, professional, and technical staff with appropriate skills and knowledge in their agencies. Specific skills and capabilities within TSMO are evolving to include emerging technologies, data management, data and statistical analysis, and emergency management. Consequently, staff position descriptions may need to be updated and new roles defined within the organization. Staffing and workforce development may require close coordination with human resources to identify and develop these new capabilities.

Operations and maintenance are needed as projects recommended in this ITS Plan are implemented. In addition to field maintenance of devices, district staff will need to learn how to operate the devices and systems remotely (e.g., post messages to DMS) and establish protocols and agreements internally and with adjacent districts and external partners for collaborative operations such as video sharing or alerts that trigger the need to notify personnel (e.g., signal alerts about equipment failures, DMS message needed to detour traffic around an incident).

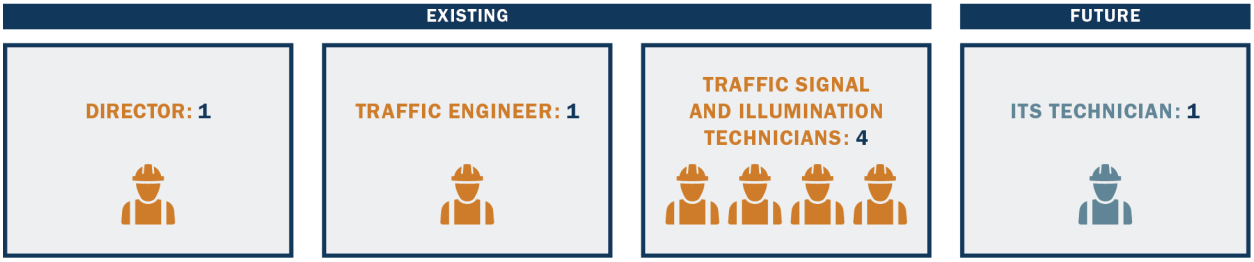
Proposed Operations and Maintenance Staffing Plan

Based on the FTE guidelines from *Traffic Signal Operations and Maintenance Staffing Guidelines*, (Federal Highway Administration (FHWA), 2009), an engineer can optimally operate an average of 75 to 100 traffic signals, which includes timing plans and day-to-day response to real-time conditions and citizen calls. A technician optimally operates an average of 40 to 50 traffic signals. Given that the Lufkin District operates approximately 122 signals, approximately two engineers and three technicians are necessary for optimum traffic signal operations and maintenance. These five FTE are currently covered by the districts one engineer and 4 technicians. Traffic signal maintenance is typically done with two-person crews and one bucket truck.

As responsibilities of operations staff increase, one additional full-time maintenance technician will be needed to focus exclusively on ITS operations and maintenance. Existing signal technicians should also be cross-trained. Technicians will need to focus on ITS maintenance such as:

- Configuring cameras and real-time signs
- Performing regularly scheduled maintenance including annual maintenance and preventive maintenance
- Troubleshooting configuration and operational issues
- Replacing equipment as needed.

All maintenance staff should be provided with technical training on ITS devices/systems. With one additional technician, the Lufkin District's proposed traffic and ITS FTE includes:



In addition to signal operations, engineers and technicians may also be responsible for:

- Monitoring cameras and posting incident updates
- Coordinating traveler information with the district's PIO
- Posting messages on permanent DMSs and PCMSs
- Apprising other stakeholders (cities, counties, first responders) of current travel conditions including hurricane and storm evacuation and coordinate as appropriate.

Currently the Houston District and Houston TranStar operates and maintains the ITS devices/systems in the Lufkin District. The Lufkin District prefers to continue this agreement at the present time. The Houston District is open to an agreement to continue ITS device operations and maintenance with funding support. The Lufkin District TSMO Program Plan includes a high-priority action item to formalize an agreement between the two districts.

Proposed Equipment Upgrades

This section includes lifecycle equipment estimates and district needs associated with equipment. The support structure lifecycle for signal and camera poles and DMS supports is typically 50 years while the lifecycle of the technology components is typically shorter:

Traffic Signals – 20+ years for controller. The district is currently in the process of upgrading 21 signal controllers.

DMS – 10 years. The district has fixed messaging signs programmed and also uses portable messaging signs for incidents or work zones but there is no remote access. The District needs remote capability to the PCMSs. Cameras are also needed at the permanent DMS to verify message posting.

Traffic Cameras – 10 years. The district would like to have more PTZ and/or fish-eye cameras at high priority intersections and are currently installing additional cameras with new and upgraded traffic signals. Many of the district's existing cameras are mounted at 60 feet, which is higher than the district's bucket trucks can reach for maintenance. Lowering systems or lower mounting heights are being considered. Currently, the Lufkin District does not have any video walls or monitors. At the present time the district plans to access camera feeds through existing workstations through the planned statewide video control sharing system.

Communications Equipment – Varies (5 – 10 years). The district primarily uses cellular communications but may consider some fiber optic cable plant with major roadway projects.

ITS Plan Update Process

This ITS Master Plan is part of the overall Lufkin District TSMO program. This plan will be maintained by performing a semi-annual check-in of ITS deployment project status during the District Engineer's Staff/ Area Engineer Meeting. This staff meeting includes the District Engineer; Directors of TP&D, Construction, and Operations; Area Engineers; and other supervisors. As shown in Figure 9, the TSMO Plan will receive minor updates every three years as needed, and this ITS Master Plan will receive an update every six years.

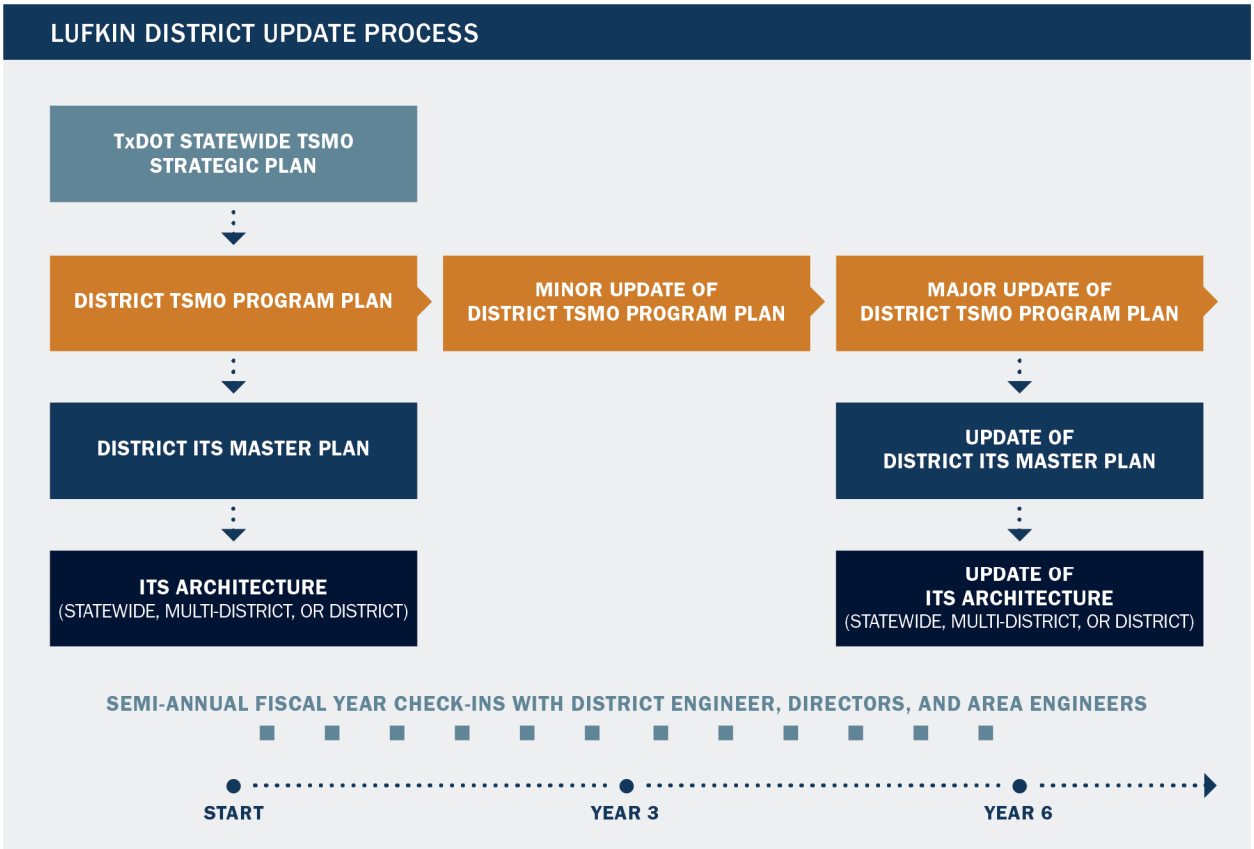


FIGURE 9. LUFKIN DISTRICT TSMO AND ITS MASTER PLAN UPDATE PROCESS

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- TxDOT (2020) *Hurricane Information*
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- TxDOT (2020) *Project Tracker*
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- TxDOT (2020) *DriveTexas.org*
- TxDOT (2020) *Hurricane Information*
- TxDOT Lufkin District (2020) *@TxDOTLufkin Twitter Feed*
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- TxDOT (2005) *Lufkin Regional ITS Architecture*
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- TxDOT Lufkin District (2019) Traffic Management System Status Report
- TxDOT Lufkin District (2019) Traffic Engineering Equipment Maintenance Survey

Lufkin District TSMO Program

ITS Master Plan

APPENDIX

Appendix A: List of Stakeholders and Acknowledgments

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Matt Brazil (Nacogdoches)

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Jianming Ma

City of Lufkin

Kevin Gee
Gerald Williamson

Lufkin Police Department

Corporal Bradley Davis

City of Nacogdoches

Steve Bartlett

Houston County

Roger Dickey

Deep East Texas Council of Governments (DETCOG)

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