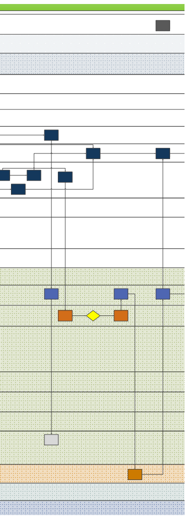
TRANSPORTATION SYSTEMS MANAGEMENT AND OPERATIONS (TSMO)



ATLANTA DISTRICT ITS MASTER PLAN

May 2021

Document Control

Date	Version	Description
April 16, 2021	Draft Version 1.0	Draft ITS Plan for District Review
May 28, 2021	Final Version	Final ITS Master Plan for Publication

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

Table of Contents

Document Purpose

The United States Department of Transportation (USDOT) requires that any intelligent transportation system (ITS) project funded through the Highway Trust Fund be developed using a systems engineering analysis (SEA) process, and that the project conforms to the National ITS Architecture and applicable standards. These requirements are codified in the Code of Federal Regulation (CFR) Title 23-Highways, Part 940-Intelligent Transportation Systems Architecture and Standards.

ITS projects are defined by the USDOT as any project that in whole or in part funds the acquisition of technologies or systems of technologies that provide or significantly contribute to the provision of one or more ITS user services as defined in the National ITS Architecture. Conformance to the National ITS Architecture includes the use of the National ITS Architecture to develop a regional or statewide ITS architecture and the subsequent adherence of the project to that regional or statewide ITS architecture.

This report is the master plan and concept of operations document for new ITS devices, including 19 closed-circuit television (CCTV) cameras and five dynamic message signs (DMS) in the Texas Department of Transportation (TxDOT) Atlanta District. Master Plan recommendations are located along and in the vicinity of Interstate 20 (I-20) from the Louisiana state line to approximately two miles west of SE Loop 281 outside of Longview, Texas; along Interstate 30 (I-30) from the Arkansas state line in Texarkana, Texas to approximately one mile west of Cleveland Street in Winfield, Texas; along Interstate 369 (I-369) from I-30 to US 59 in Texarkana, Texas; along US 59 from I-369 in Texarkana, Texas to approximately two miles north of US 84 in Tenaha, Texas; and at other spot bridge crossings throughout the District. The District plans to install this technology as part of future improvements to I-30, I-20, US 59, and I-369, and in other spot locations throughout the District.

The Atlanta District ITS Master Plan and Concept of Operations is being developed as part of a project focused on Transportation Systems Management and Operations (TSMO) initiatives throughout TxDOT. It serves as the first project document that guides the systems engineering analysis process for the proposed ITS device implementations.

This document describes the TxDOT Atlanta District proposed ITS device implementation scope and demonstrates conformance to regional plans, goals, and objectives. It describes the desired characteristics of the project and proposes high-level recommendations for system design, implementation, and operation. It also describes scenarios that show how the proposed ITS device deployments will assist the Atlanta District in responding to operational challenges throughout the District where devices are deployed.

ITS Master Plan Scope

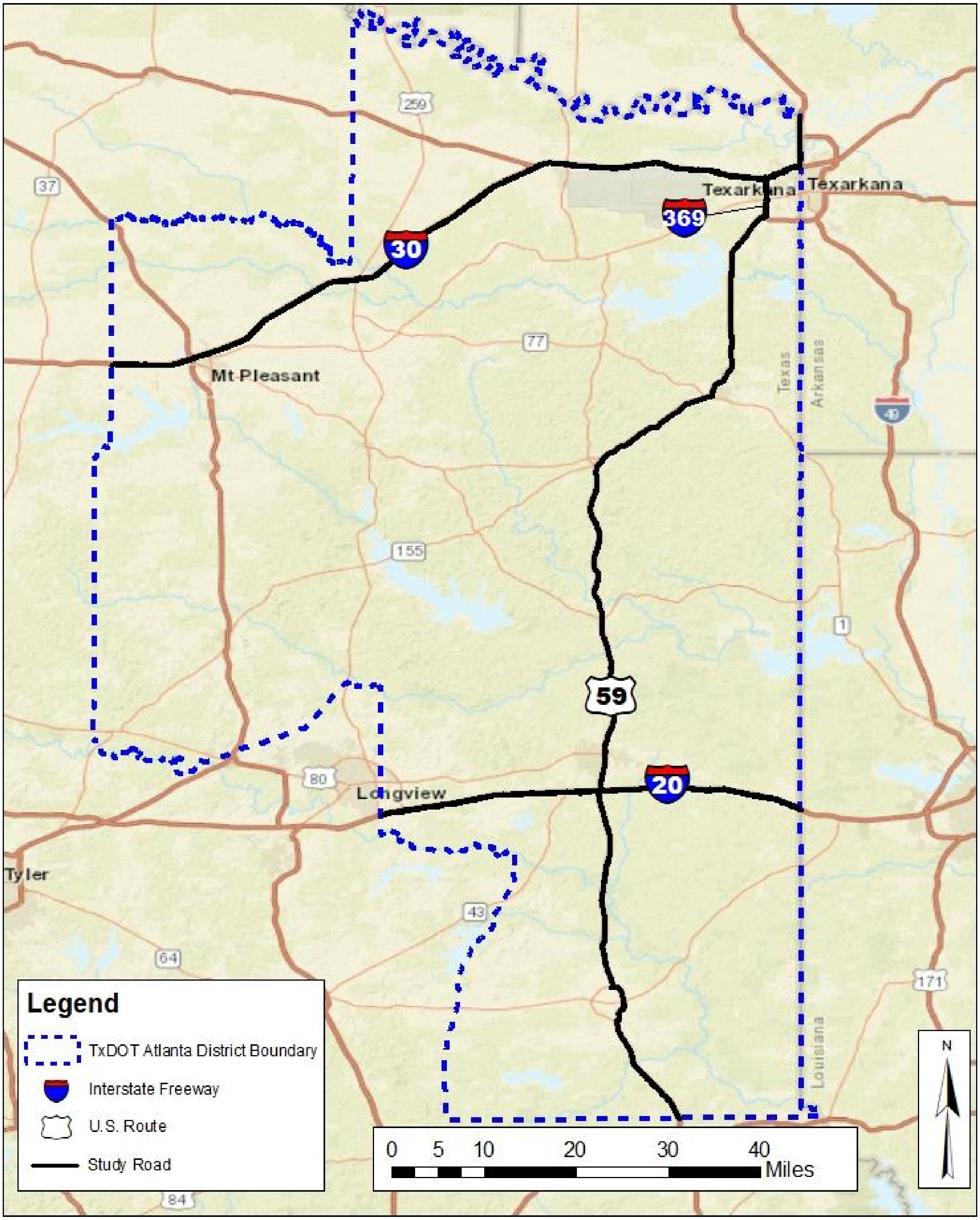
The TxDOT Atlanta District has contracted with Kimley-Horn to develop a TSMO Program Plan. One recommendation of the TSMO Program Plan is the deployment of ITS devices that will provide the District with surveillance and traveler information dissemination capabilities along and in the vicinity of I-20, I-30, I-369, and US 59, and in other spot locations throughout the District. The TxDOT Atlanta District boundary and key routes referenced throughout this document are shown in **Figure 1**.

The Federal Highway Administration (FHWA) defines TSMO as a set of strategies that focus on operational improvements that can maintain and even restore the performance of the existing transportation system before extra capacity is needed. TSMO Program Plans document the region's safety and operational goals, overall travel objectives and strategies, and performance measures through strategic, programmatic, and tactical planning. The TSMO Program Plan is developed through collaboration with internal and external stakeholders to ensure that it addresses region-wide concerns.

These Atlanta District ITS devices will be deployed according to the systems engineering analysis process. The International Council on Systems Engineering (INCOSE) defines systems engineering as "an interdisciplinary approach and means to enable the realization of successful systems which focuses on defining customer needs and required functionality early in the development cycle, documenting requirements, then proceeding with design synthesis and system validation while considering the complete problem." The FHWA requires that any ITS projects funded by the Highway Trust Fund utilize this analysis method for system implementation. The concept of operations comes early within the process as the first step for system validation. According to FHWA, the concept of operations documents the environment of a system from multiple viewpoints and connects documented stakeholder needs to system-level requirements for the proposed project.

The TxDOT Atlanta District is bordered by Oklahoma to the north; Louisiana to the east; and Red River County and Franklin County in the TxDOT Paris District to the northwest; Wood County, Smith County, Gregg County, and Rusk County in the TxDOT Tyler District to the southwest; and Shelby County in the TxDOT Lufkin District to the south. The TxDOT Atlanta District plans to coordinate with all relevant jurisdictions in the planning and implementation of the Atlanta District ITS project.

Figure 1: Project Location Map



The improvements proposed in this plan would add ITS infrastructure to the existing roadway system, as summarized in **Table 1**. Other proposed improvements related to work zone ITS and traffic data collection are included on a programmatic basis, without specific location recommendations provided. Future designs of other corridor segments may also include ITS infrastructure.

Table 1: Proposed ITS Deployments

Roadway	CCTV	DMS
I-20	3	0
US 59	7	2
US 271	2	1
I-30	2	1
I-369	1	1
SH 149	1	0
US 259	1	0
SH 8	1	0
SH 155	1	0
Total	**19**	**5**

Agency Roles and Responsibilities

The TxDOT Atlanta District will be the lead agency responsible for the design, implementation, operation, and maintenance of the ITS devices included in this plan. However, the successful operation of ITS along this corridor will require the cooperation of several other stakeholders. **Table 2** summarizes the primary stakeholders associated with this project and the roles and responsibilities of each stakeholder.

Table 2: Stakeholders

Agency / Stakeholder	Roles and Responsibilities
TxDOT Atlanta District Office	• Design, install, operate, maintain, and monitor performance of ITS system • Design and install the traffic signal system on TxDOT roadways in the TxDOT Atlanta District
TxDOT Dallas District DalTrans TMC	• Operate and monitor TxDOT Atlanta District ITS resources outside of normal business hours • Coordinate with the TxDOT Atlanta District on operational responses to events along I-30 near the District border
Arkansas Department of Transportation (ARDOT)	• Coordinate with the TxDOT Atlanta District on operations responses that occur along US 59, I-369, I-30, and near the state border
Louisiana Department of Transportation and Development (LADOTD)	• Coordinate with the TxDOT Atlanta District on operations responses that occur along I-20 and near the state border
Oklahoma Department of Transportation (ODOT)	• Coordinate with the TxDOT Atlanta District on operations responses that occur near the state border
City of Texarkana, Texas	• Coordinate with the TxDOT Atlanta District on operations responses that occur along I-30, I-369, and US 59 within city limits
City of Marshall, Texas	• Coordinate with the TxDOT Atlanta District on operations responses that occur along US 59 within city limits
City of Mount Pleasant, Texas	• Coordinate with the TxDOT Atlanta District on operations responses that occur along I-30 within city limits
Federal Highway Administration (FHWA)	• Review project systems engineering analysis documents • Provide financial support for implementation

System Justification, Needs, and Objectives

The TxDOT Atlanta District has already deployed a total of 13 dynamic message sign (DMS) units and 19 closed-circuit television (CCTV) cameras. In identifying potential locations for the installation of new devices, the District indicated a need to prioritize new device deployments near crash hotspots, at key decision points on routes with relatively high traffic volumes for the region, and in other locations in response to anecdotal accounts from maintenance section staff of need for better traffic surveillance capabilities in certain locations.

Description of Existing ITS Deployments

The TxDOT Atlanta District operates and maintains Interstate 30 from the Arkansas state line in Texarkana, Texas to approximately one mile west of Cleveland Street in Winfield, Texas; Interstate 20 from the Louisiana state line to approximately two miles west of SE Loop 281 outside of Longview, Texas; Interstate 369 from I-30 to US 59 in Texarkana, Texas; and US 59 from I-369 in Texarkana, Texas to approximately two miles north of US 84 in Tenaha, Texas. A total of 13 DMS units and 19 CCTV cameras are currently deployed or under construction in the TxDOT Atlanta District. **Table 3** summarizes the locations and orientations of these DMS units and CCTV cameras. The locations and orientations of these ITS devices are shown in **Figure 2**.

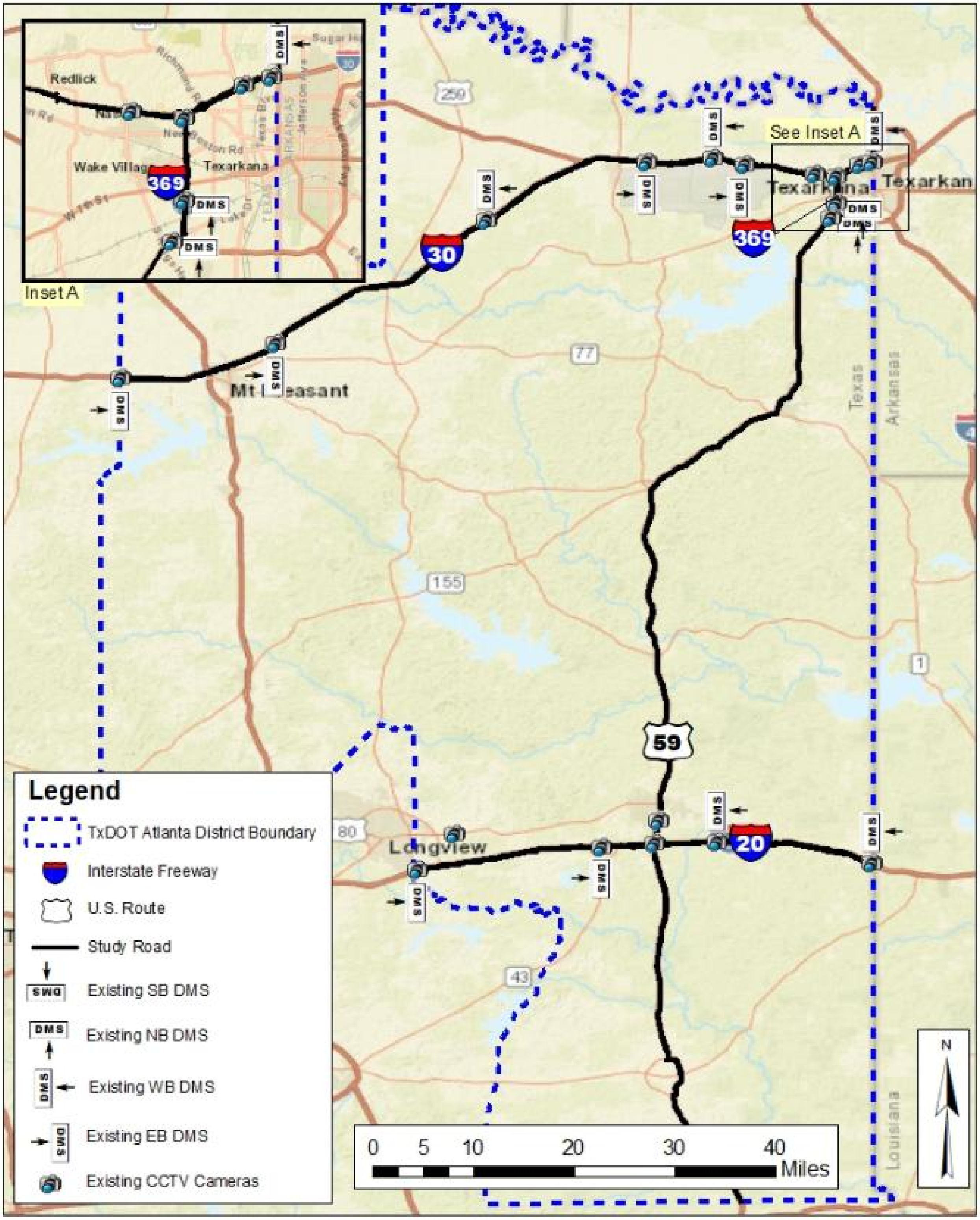
The DMS are currently used to display public service announcements, such as AMBER alerts, and to provide alerts when freeway operations change, like in preparation for a winter weather event that will require ice prevention operations. The existing CCTV cameras have pan-tilt-zoom (PTZ) capabilities, and the majority of the existing cameras are placed adjacent to DMS to provide visual confirmation of posted messages. Fiber is not currently installed in any areas of the TxDOT Atlanta District. ITS device and traffic signal communication occurs via cellular modems.

Table 3: Existing ITS Deployments

Roadway	Approximate Lat/Long	Location and Orientation	ITS Device
I-30	33.161, -95.125	EB at Franklin County Line	DMS & CCTV
	33.210, -94.903	EB at FM 1001	DMS & CCTV
	33.387, -94.599	WB at FM 561	DMS & CCTV
	33.471, -94.370	EB at CR 2003	DMS & CCTV
	33.477, -94.274	WB at Garden Road	DMS & CCTV
	33.467, -94.228	EB at FM 2253	DMS*
	33.468, -94.228	SP 74	CCTV
	33.453, -94.128	FM 989	CCTV
	33.451, -94.097	I-369	CCTV
	33.467, -94.063	FM 1397	CCTV
	33.470, -94.047	Arkansas State Line	CCTV
	33.471, -94.043	WB at US 71	DMS
I-369	33.411, -94.097	NB at US 67	DMS & CCTV
US 59	33.391, -94.105	EB at FM 989	DMS & CCTV
	32.524, -94.352	Bell Street	CCTV
I-20	32.453, -94.700	EB at US 259	DMS & CCTV
	32.487, -94.435	EB at SH 43	DMS & CCTV
	32.492, -94.359	US 59	CCTV
	32.495, -94.268	EB at FM 31	DMS & CCTV
	32.463, -94.046	EB at Louisiana State Line	DMS & CCTV
US 80	32.505, -94.645	Trinity Services	CCTV

**Under construction*

Figure 2: Existing ITS Deployments Along Study Roads



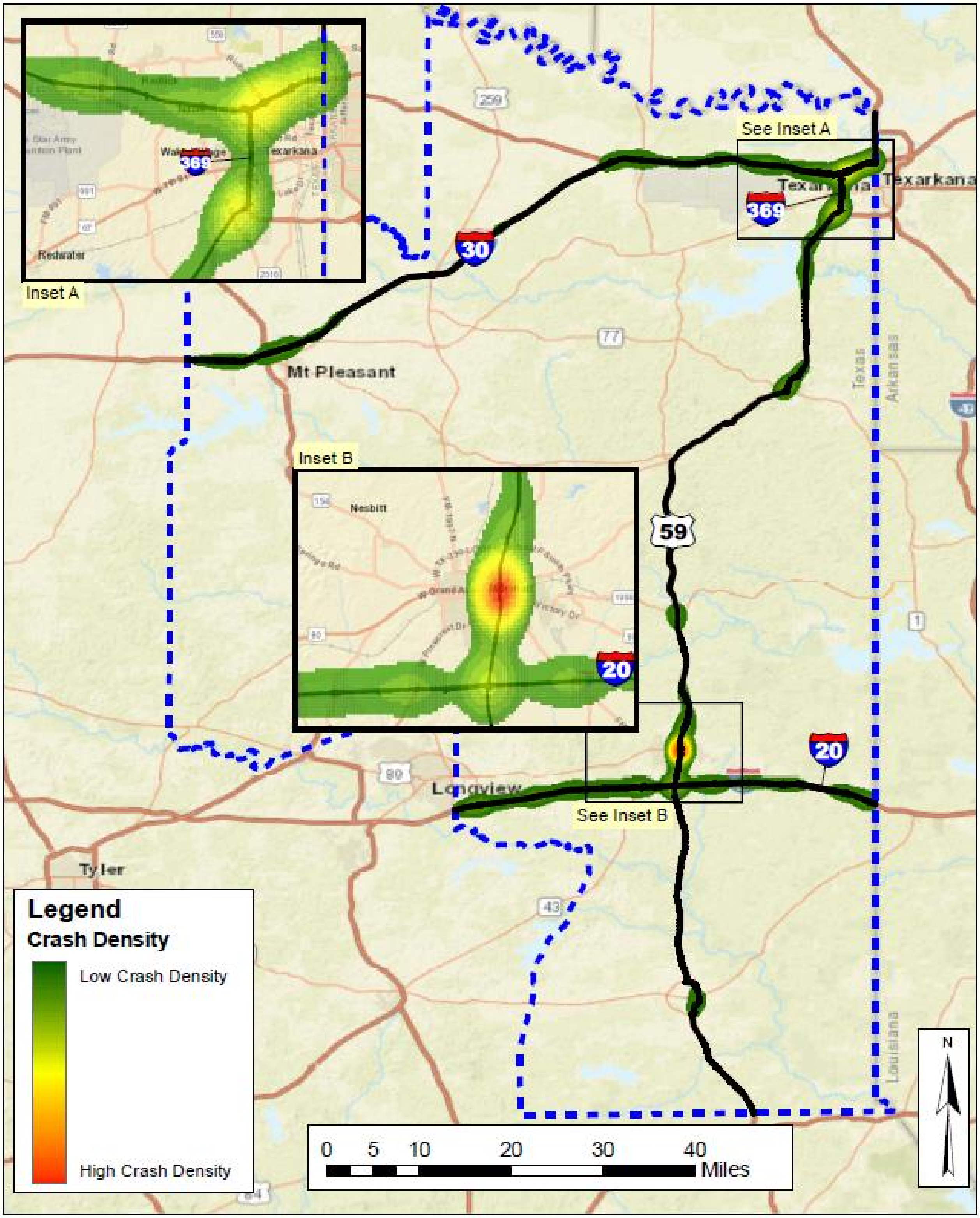
Historical Crash Data Analysis

Crash data for the District was analyzed to identify locations where potential CCTV camera deployments could be used to support traffic incident verification. The TxDOT Crash Records Information System (CRIS) has a crash data query tool that provides details of reported crashes within Texas. Crashes are filterable based on a variety of characteristics. For this study, the historical crash data was filtered to show crashes from 2015 through 2020 within the TxDOT Atlanta District. This data was analyzed along the study corridors of I-30, I-20, US 59, and I-369 to locate crash hotspots, as shown in **Figure 3**.[1]

The largest crash hotspots along the study roads were identified along I-30, I-369, and US 59 around Texarkana, as well as on US 59 through Marshall, Texas. The CRIS data for the portion of I-30 through Mount Pleasant shows low to moderate crash density.

The portion of I-20 that stretches through the Atlanta District had a consistent low to moderate crash density. As the road gets closer to urban areas, such as Longview and Marshall, the number of crashes increases. The historical crash data for I-30 outside of Texarkana, between I-369 and US 82, shows a similar trend. These rural freeway corridors include several minor crash hotspots.

Figure 3: Crash Density Heatmap Along Study Roads



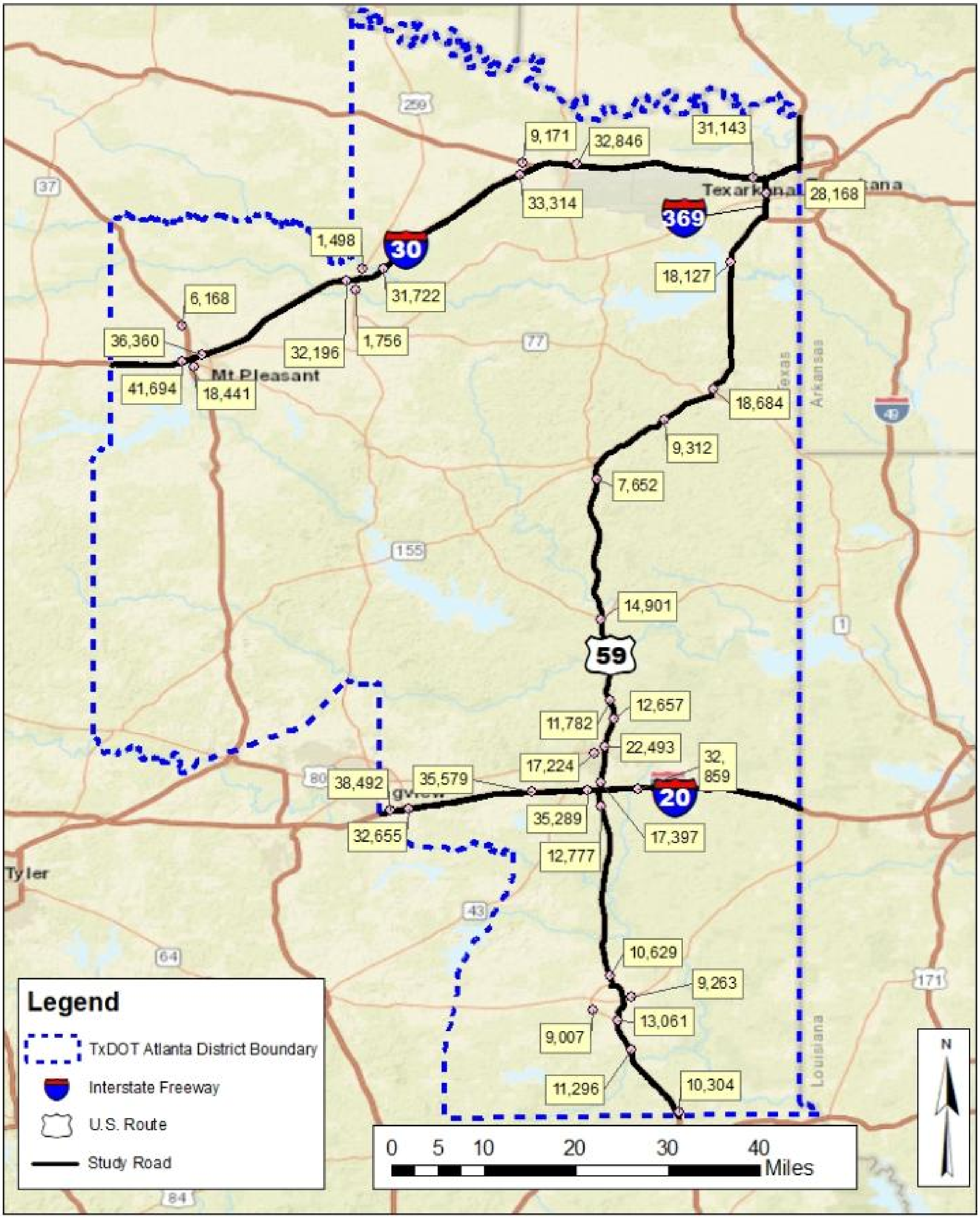
Average Annual Daily Traffic Analysis

The TxDOT Traffic Count Database System (TCDS) was utilized to determine priority locations for the proposed ITS devices based on traffic volumes. 2019 TCDS Average Annual Daily Traffic (AADT) counts were reviewed along the study corridors I-30, I-20, US 59, and I-369 in the TxDOT Atlanta District. **Figure 4** shows the data point locations and corresponding AADT volume from the TCDS stations near crash hotspots, urban areas, and junctions. Count stations along major roadways that are not the study corridors were also captured to determine the volume of motorists approaching the study corridors from other major routes in the District.

The TCDS stations along I-30 through Mount Pleasant, Texas recorded over 30,000 vehicles in 2019. Volumes along I-20 through Longview and south of Marshall also exceeded 30,000 vehicles per day. Along US 59, the AADT volumes ranged from approximately 7,500 to over 20,000 vehicles per day. The segments with greater AADT generally had a higher density of crashes. In 2019, US 59 had the greatest daily volumes around and through Marshall. The cities of Atlanta, Jefferson, and Carthage were other locations on US 59 where the number of vehicles and crashes are higher than along other more rural segments.

Several major roads had daily volumes in excess of 10,000 vehicles near interchanges with I-30. The south leg of US 271 at I-30 exceeded 15,000 vehicles per day in 2019. The north leg of US 82 almost reached an AADT of 10,000 and is a crash hotspot. These areas are important because they directly provide access to the study corridors and can impact or be impacted by those traffic conditions.

Figure 4: TCDS Average Annual Daily Traffic Data Along Study Roads



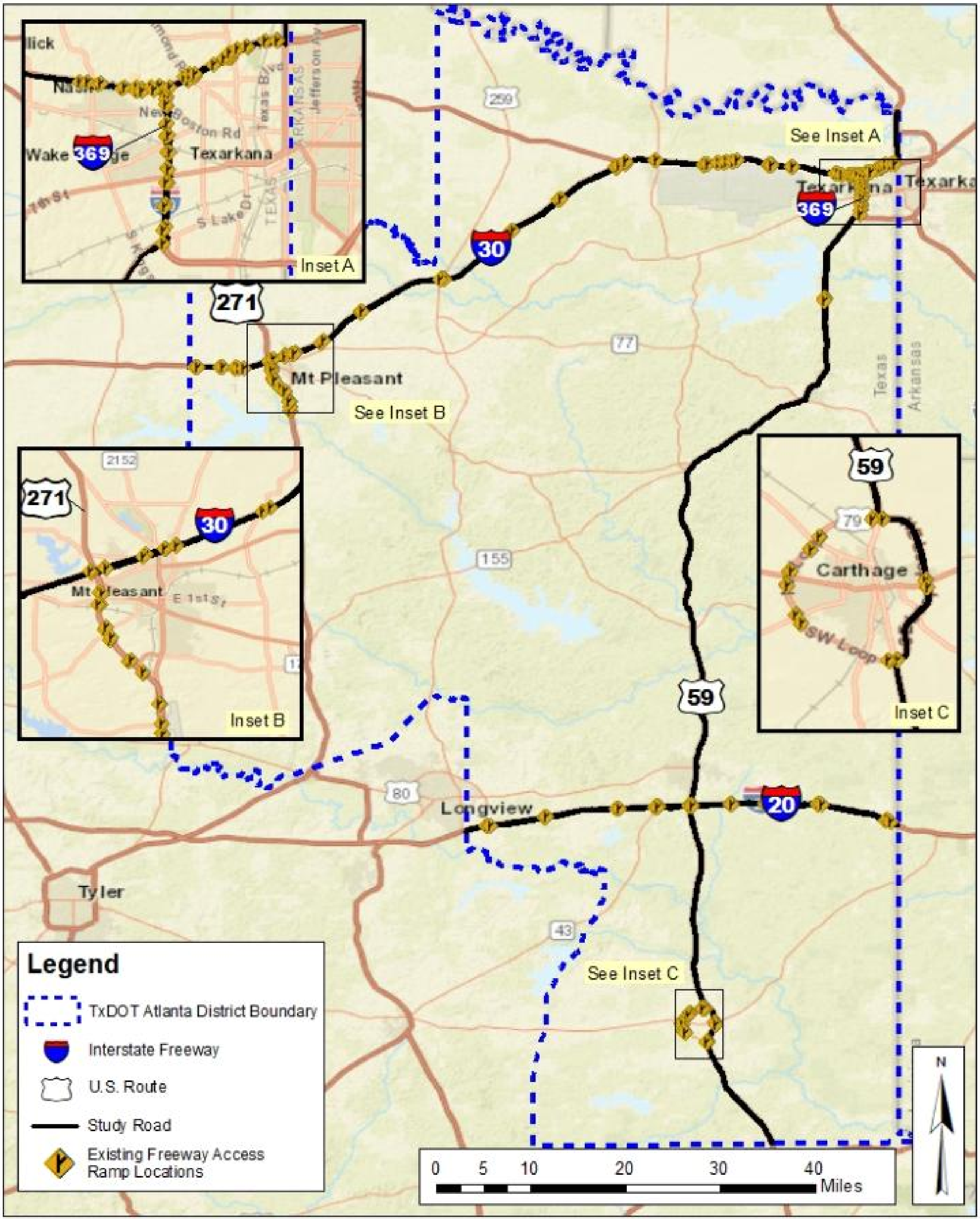
Ramp and Decision Point Analysis

Freeway access ramps and interchanges are examples of roadway infrastructure that can pose unique challenges related to access management. Hazardous weather conditions or traffic incidents can lead to closures which cause major delays, and ramps and interchanges can provide travelers the means of detouring around closed roads. Freeway access ramps located along study corridors and near key decision points are shown in **Figure 5**.

Ramps allow for this diversion of traffic to avoid an incident queue and reduce congestion. DMS units located near routing decision points can provide information to travelers that will help them detour around an incident. Freeway access ramps at key decision points in the vicinity of the study corridors, such as the full loop around Carthage, are included in **Figure 5** to highlight locations where alternate route selection may be encouraged when roads are closed or congested.

Grade separated freeway access ramps and nearby overpasses are also particularly susceptible to icy road surface conditions in freezing temperatures, since air passage beneath the road surface in these locations makes those road segments cool more quickly than surrounding road surfaces. ITS devices, such as CCTV cameras, can be used to detect dangerous road surface conditions and drivers can be warned of these conditions using DMS in the area.

Figure 5: Existing Freeway Access Ramps Along or Near Study Roads



Anecdotal Accounts from District Staff

In addition to a review of existing data and infrastructure locations, other traffic operations and safety priorities were identified through discussions with TxDOT Atlanta District staff. These anecdotal accounts of issues in the past that could have been better addressed through improved surveillance capabilities are not necessarily reflected in the reviewed data but still represent important needs that should be considered in developing the proposed system. These priorities are described below:

- Need for CCTV coverage along US-271 at decision points approaching Mount Pleasant.
- Need for better CCTV coverage along the full freeway loop and at decision points around Carthage.
- Need for coverage along I-20 at the interchange with US-80 to better detect backups near the Louisiana border.
- Need for coverage at locations with history of water-on-road issues described by maintenance staff.
- Need for coverage along US-259 at the bridge over the Red River at the Oklahoma state line.

Need for System Improvements

The existing system is limited due to its lack of ITS field devices. With only 13 DMS units and 19 CCTV cameras currently deployed districtwide, there are few locations where TxDOT can detect incidents or unusual traffic conditions, or where road users can receive information to adjust their travel behavior.

There is a need to improve TxDOT’s ability to monitor conditions and communicate to travelers along I-20, I-30, US 59 and I-369 so that the TxDOT Atlanta District can better respond to planned and unplanned atypical traffic events and can better inform road users of current conditions. To improve and enhance the operations and communication along this corridor, it is recommended that new CCTV cameras and DMS units be installed strategically at locations along these corridors and in other spot locations throughout the District.

The following statements summarize the District’s existing traffic operations needs which could be fulfilled by ITS device deployments:

- Network operators need to have full control of deployed field surveillance and traveler information equipment from the TxDOT Atlanta District Office and from any network access point with appropriate District credentials.
- Network operators need a sustained communication link with all deployed ITS field infrastructure.
- Network operators need to quickly and directly surveil key interchanges, crash hotspots, work zones, and other operationally important locations along I-20, I-30, I-369, and US 59.
- Network operators need to quickly and directly surveil key interchanges, crash hotspots, work zones, and other operationally important locations along key routes that provide access to I-20, I-30, I-369, and US-59.
- Network operators need to surveil corridors through urban parts of the District, such as Texarkana and Marshall.

- Network operators need a system deployment that is designed according to applicable state and federal standards and is cost-effective to operate and maintain.
- Network operators need the ability to communicate with travelers along I-20, I-30, I-369, and US 59 and in other spot locations throughout the District by use of DMS, especially upon entry from Louisiana and from the TxDOT Tyler, Paris, and Lufkin Districts.
- Network operators need to expand communication to travelers about travel time estimates, comparative travel times along parallel routes, weather impacts including ice and flooding warnings, roadway pretreatment ahead of expected winter weather, and anticipated construction impacts both inside and outside of the region.
- Network operators need to be able to surveil low-water crossings and bridges that see reoccurring flooding or icing.
- Network operators need the ability to verify DMS status in the field with CCTV cameras.
- Network operators need to maintain a level of safety and operations along selected TxDOT roadways in the District that is comparable to or improved over existing conditions.
- Network operators need improved communications and information sharing capabilities, including the ability to share CCTV camera feeds, with partner jurisdictions including ODOT, LADOTD, ARDOT, the City of Texarkana, the City of Marshall, and the City of Mount Pleasant.
- Network operators need the ability to transmit CCTV camera images and DMS message data online in real time for public viewing.
- Network operators need a decision tool to help the District determine when different work zone ITS technologies should be implemented as part of planned road construction.
- Network operators need the ability to share system control with the TxDOT Dallas DalTrans TMC as well as a potential future regional TMC built separate from the TxDOT Atlanta District Office.

Objectives for Proposed System

The objectives of the proposed system along I-20, I-30, I-369, and US 59 are:

- Provide full control of deployed field surveillance and traveler information equipment from the TxDOT Atlanta District Office and from any network access point with appropriate District credentials.
- Provide a reliable, sustained communication link with all deployed ITS field infrastructure.
- Provide enhanced surveillance capability of “hotspots” including key interchanges, crash hotspots, work zones, and other operationally important locations along the study routes and other key routes that provide access to the study routes.
- Provide enhanced video surveillance capability of segments of I-20, I-30, I-369, and US 59 through urban areas of the District including Texarkana and Marshall.
- Deploy ITS infrastructure in a way that satisfies other objectives while keeping maintenance requirements within the TxDOT Atlanta District’s capabilities.
- Adhere to TxDOT ITS design standards and the FHWA systems engineering process when designing, implementing, and maintaining the system.

- Enhance communication to road users along I-30, I-20, I-369, US 59, and in other spot locations throughout the District by use of DMS, especially upon entry from Louisiana and from the TxDOT Tyler, Paris, and Lufkin Districts.
- Provide communication of travel time estimates, comparative travel times along parallel routes, weather impacts including ice and flooding warnings, roadway pretreatment ahead of expected winter weather, and anticipated construction impacts along I-30, I-20, I-369, and US 59 via DMS.
- Deploy cameras at low-water crossings that see reoccurring flooding.
- Deploy cameras at bridge locations that are susceptible to relatively frequent flooding or icing conditions.
- Provide CCTV camera coverage of DMS units to remotely verify message status.
- Provide an improved level of safety along I-30, I-20, I-369, and US 59, and in other spot locations throughout the District for vehicles as compared to or improved over the existing system.
- Provide the capability to share CCTV camera feeds and message status from deployed ITS devices along I-30, I-20, I-369, and US 59 with ODOT, ARDOT, LADOTD, the City of Texarkana, the City of Marshall, and the City of Mount Pleasant.
- Allow for automated CCTV camera image and DMS message uploads to the TxDOT ITS Traveler Information website (its.txdot.gov) for viewing by the general public.
- Provide a decision tool for determining when different work zone ITS technologies should be implemented as part of planned road construction.
- Establish the ability to share system control with the TxDOT Dallas DalTrans TMC as well as a potential future regional TMC built separate from the TxDOT Atlanta District Office.

ITS Architecture Conformance

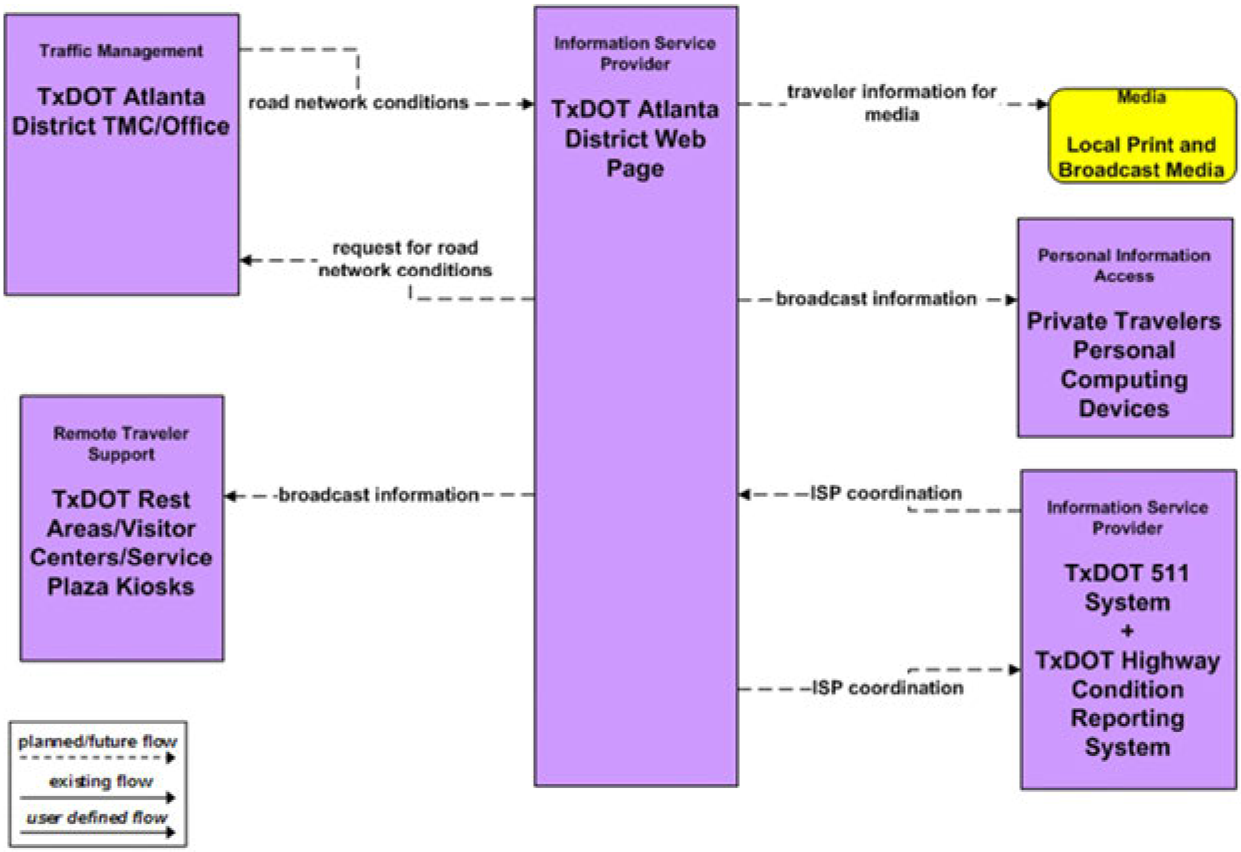
The ITS improvements proposed in this document are located within the geographic area covered by the TxDOT Atlanta District Regional ITS Architecture. The TxDOT Atlanta District Regional ITS Architecture was developed in 2003.[3] To demonstrate project conformance in compliance with FHWA requirements, it is important to review the applicable ITS service packages from the 2003 TxDOT Atlanta District Regional ITS Architecture to determine which ITS service packages describe the systems being implemented as part of this project. ITS service packages show elements, along with the data flows between them, that are required to implement an ITS service. These service packages show how different elements of technology and network users might be integrated together to exchange data to deliver an ITS service.

The ITS elements to be installed as part of the future improvements along I-30, I-20, US 59, I-369, and in other spot locations throughout the District include CCTV cameras and DMS units. Eleven service packages from the architecture correspond to the proposed improvements:

- ATIS01 – Broadcast Traveler Information (Updated in RAD-IT Version 8.3 to TI01)
- ATMS01 – Network Surveillance (Updated in RAD-IT Version 8.3 to TM01 – Infrastructure-Based Traffic Surveillance)
- ATMS06 – Traffic Information Dissemination (Updated in RAD-IT Version 8.3 to TM06)
- ATMS07 – Regional Traffic Control (Updated in RAD-IT Version 8.3 to TM07 – Regional Traffic Management)
- ATMS08 – Incident Management System (Updated in RAD-IT Version 8.3 to TM08)
- EM01 – Emergency Response (Updated in RAD-IT Version 8.3 to PS01 – Emergency Call-Taking and Dispatch)
- EM04 – Roadway Service Patrols (Updated in RAD-IT Version 8.3 to PS08)
- MC03 – Road Weather Data Collection (Updated in RAD-IT Version 8.3 to WX01)
- MC04 – Weather Information Processing and Distribution (Updated in RAD-IT Version 8.3 to WX02)
- MC08 – Work Zone Management (Updated in RAD-IT Version 8.3 to MC06)
- MC10 – Maintenance and Construction Activity Coordination (Updated in RAD-IT Version 8.3 to MC08)

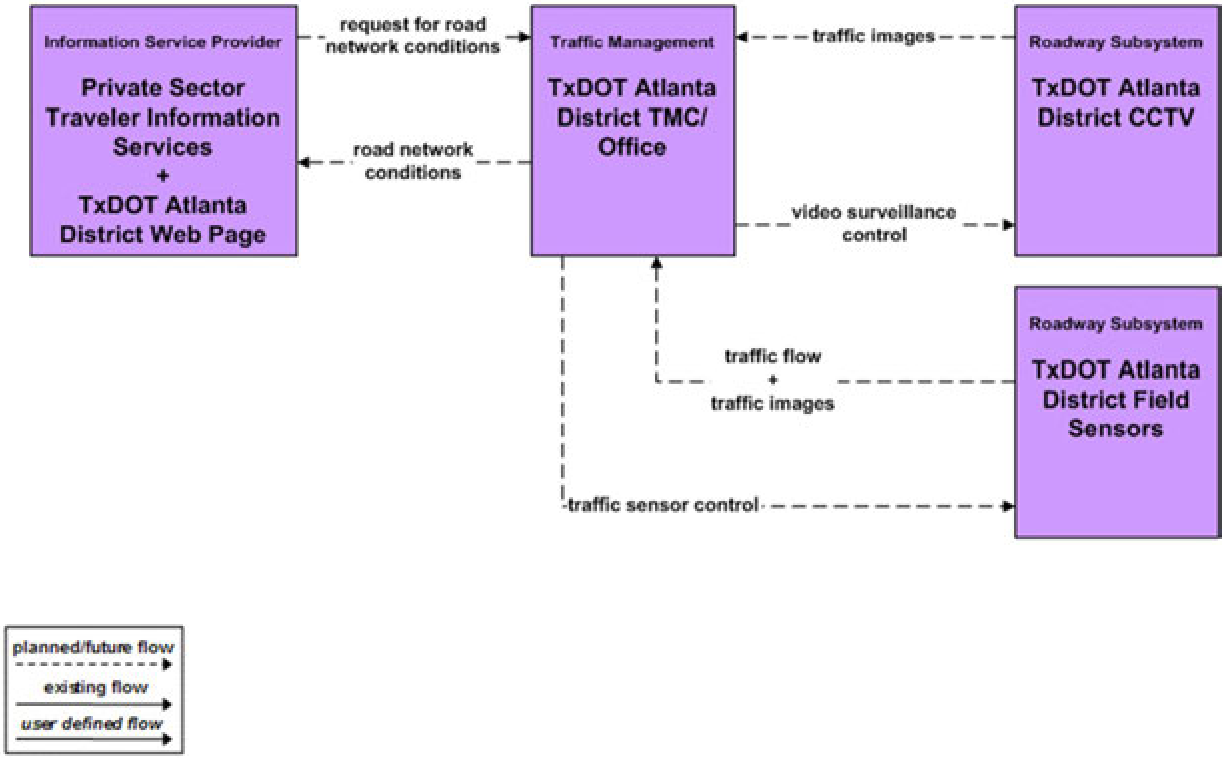
The ATIS01 – Broadcast Traveler Information service package shows ITS elements and data flows that the TxDOT Atlanta District can use to disseminate traveler information. The ATIS01 service package diagram that was included in the 2003 TxDOT Atlanta District Regional ITS Architecture is shown in **Figure 6**, and all flows are still planned as shown.

Figure 6: ATIS01 - Broadcast Traveler Information Service Package Diagram



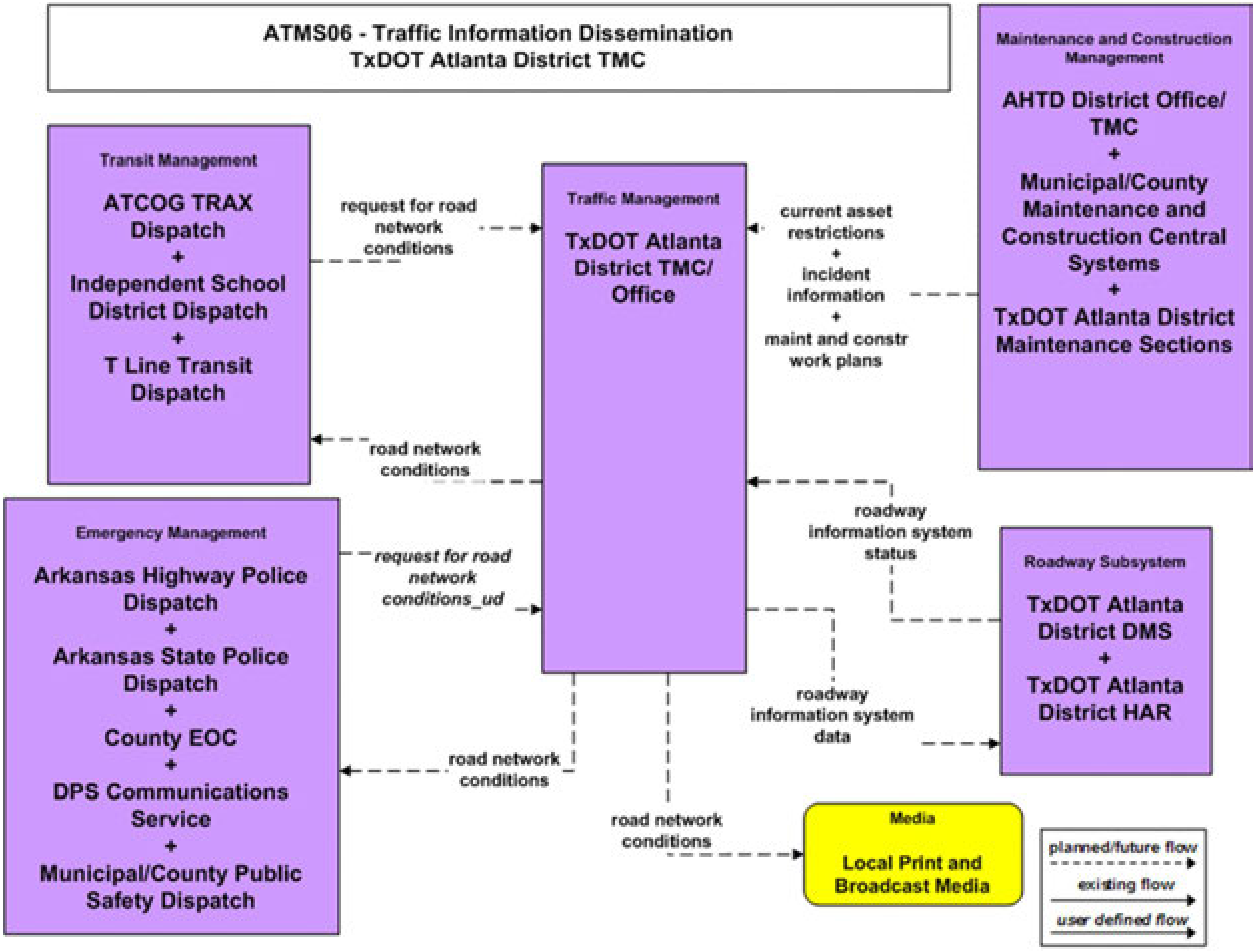
The ATMS01 – Network Surveillance service package shows ITS elements and data flows that the TxDOT Atlanta District uses to monitor its roads using field sensors and CCTV cameras. The ATMS01 service package diagram that was included in the 2003 TxDOT Atlanta District Regional ITS Architecture is shown in **Figure 7**. Since the original development of this service package diagram, TxDOT Atlanta District CCTV cameras have been implemented, sending traffic images to the District Office and allowing video surveillance control. Therefore, the flows between ‘TxDOT Atlanta District TMC/Office’ and ‘TxDOT Atlanta District CCTV’ should currently show as existing rather than planned.

Figure 7: ATMS01 - Network Surveillance Service Package Diagram



The ATMS06 – Traffic Information Dissemination service package shows ITS elements and data flows used to allow the TxDOT Atlanta District to share traffic information with the travelling public via communication methods such as DMS, area resource dispatchers, and the media. The ATMS06 service package diagram that was included in the 2003 TxDOT Atlanta District Regional ITS Architecture is shown in **Figure 8**. Since the original development of this service package diagram, TxDOT Atlanta District DMS units have been implemented, allowing District staff to send roadway information system data to DMS and receive DMS status information. Therefore, the flows between 'TxDOT Atlanta District TMC/Office' and 'TxDOT Atlanta District DMS' should currently show as existing rather than planned. Furthermore, the reference to AHTD should be revised instead to ARDOT since the department has recently rebranded.

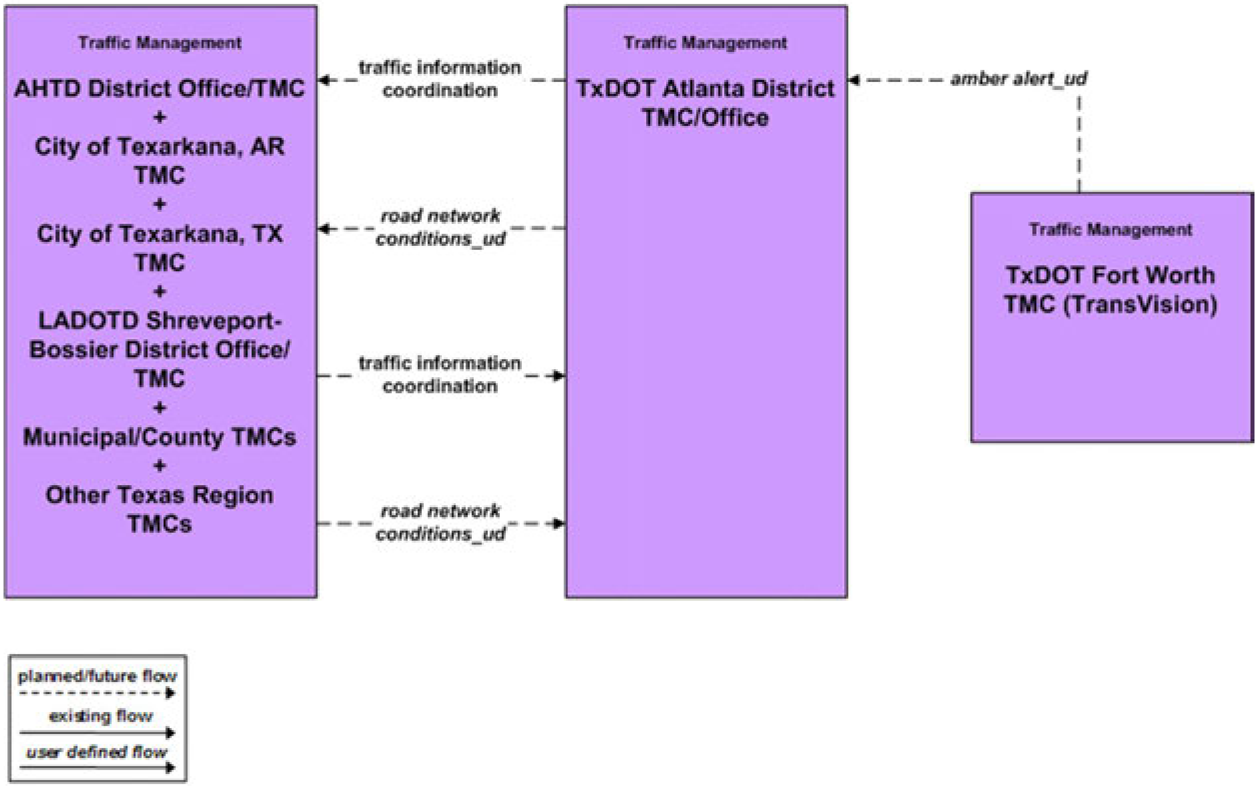
Figure 8: ATMS06 – Traffic Information Dissemination Service Package Diagram



The ATMS07 – Regional Traffic Control service package shows ITS elements and data flows used to allow the TxDOT Atlanta District to coordinate with local cities, LADOTD, ARDOT, ODOT, and other TxDOT Districts. The ATMS07 service package diagram that was included in the 2003 TxDOT Atlanta District Regional ITS Architecture is shown in **Figure 9**.

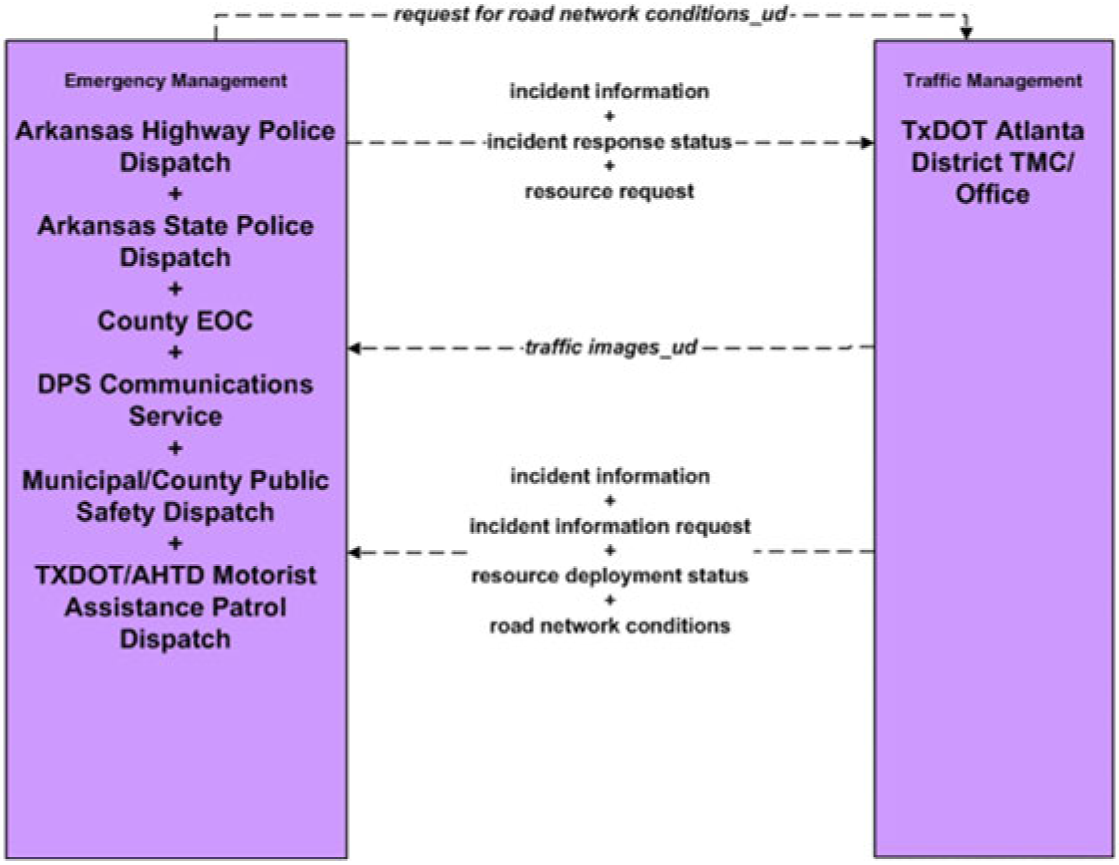
To better fit the current conditions, this service package diagram should be edited to remove 'TxDOT Fort Worth TMC (TransVision)' and instead show in its place 'TxDOT Dallas TMC (DalTrans)', and the amber alert flow between the 'TxDOT Dallas TMC (DalTrans)' and 'TxDOT Atlanta District TMC/Office' should now show as existing rather than planned. Existing flows for traffic information coordination and road network conditions should also connect these two TMCs, with these data flows showing in both directions. Furthermore, the reference to AHTD should be revised instead to ARDOT since the department has recently rebranded. All other flows from 'TxDOT Atlanta District TMC/Office' to other TMCs should remain planned, as shown.

Figure 9: ATMS07 – Regional Traffic Control Service Package Diagram



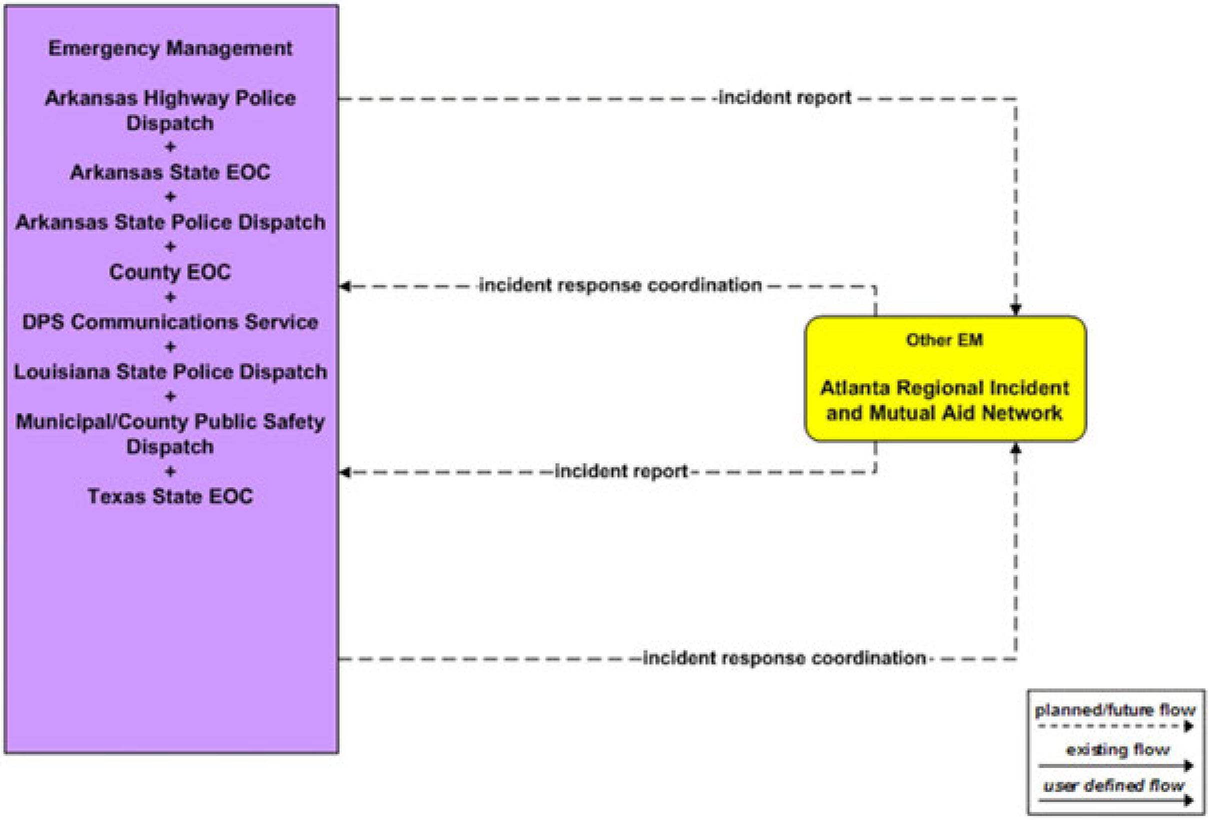
The ATMS08 – Incident Management System service package shows ITS elements and data flows used to allow the TxDOT Atlanta District to manage both unexpected incidents and planned events to maximize traveler safety and minimize effects on the transportation network. The ATMS08 service package diagram that was included in the 2003 TxDOT Atlanta District Regional ITS Architecture is shown in **Figure 10**, and all flows are still planned as shown. The reference to AHTD should be revised instead to ARDOT since the department has recently rebranded.

Figure 10: ATMS08 – Incident Management System Service Package Diagram



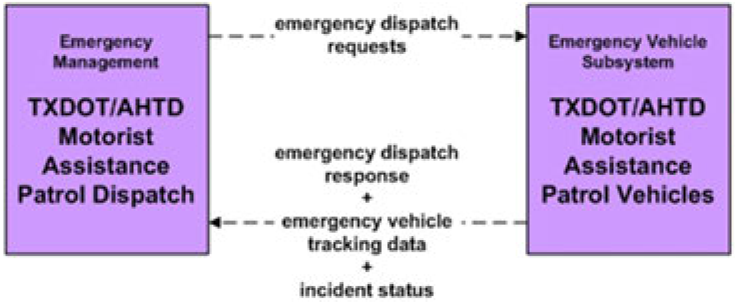
The EM01 – Emergency Response service package shows ITS elements and data flows used to allow basic public safety call-taking and dispatch services in the TxDOT Atlanta District. The EM01 service package diagram that was included in the 2003 TxDOT Atlanta District Regional ITS Architecture is shown in **Figure 11**, and all flows are still planned as shown.

Figure 11: EM01 – Emergency Response Service Package Diagram



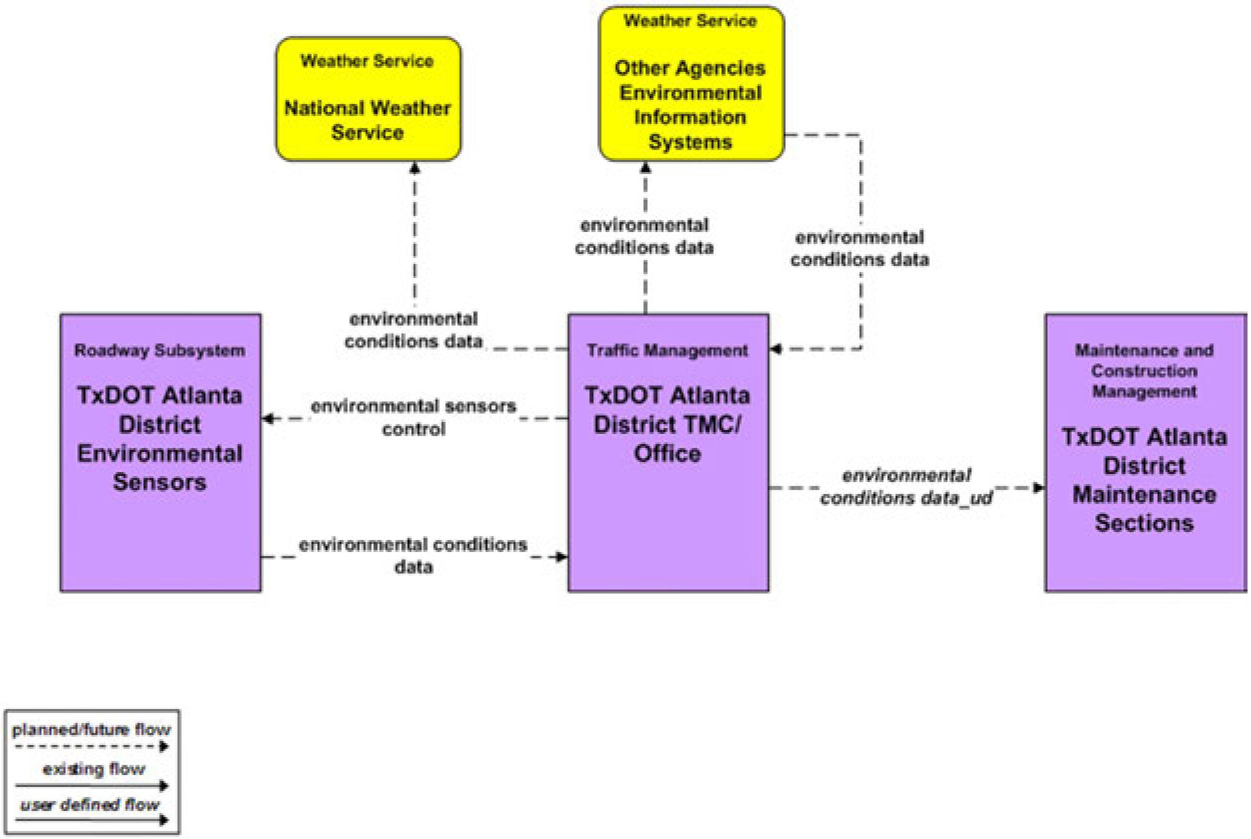
The EM04 – Roadway Service Patrols service package shows ITS elements and data flows used to allow the TxDOT Atlanta District to support a roadway service patrol that monitors roads and aids motorists to clear minor incidents or disabled vehicles from travel lanes. The EM04 service package diagram that was included in the 2003 TxDOT Atlanta District Regional ITS Architecture is shown in **Figure 12**, and all flows are still planned as shown. The references to AHTD should be revised instead to ARDOT since the department has recently rebranded.

Figure 12: EM04 – Roadway Service Patrols Service Package Diagram



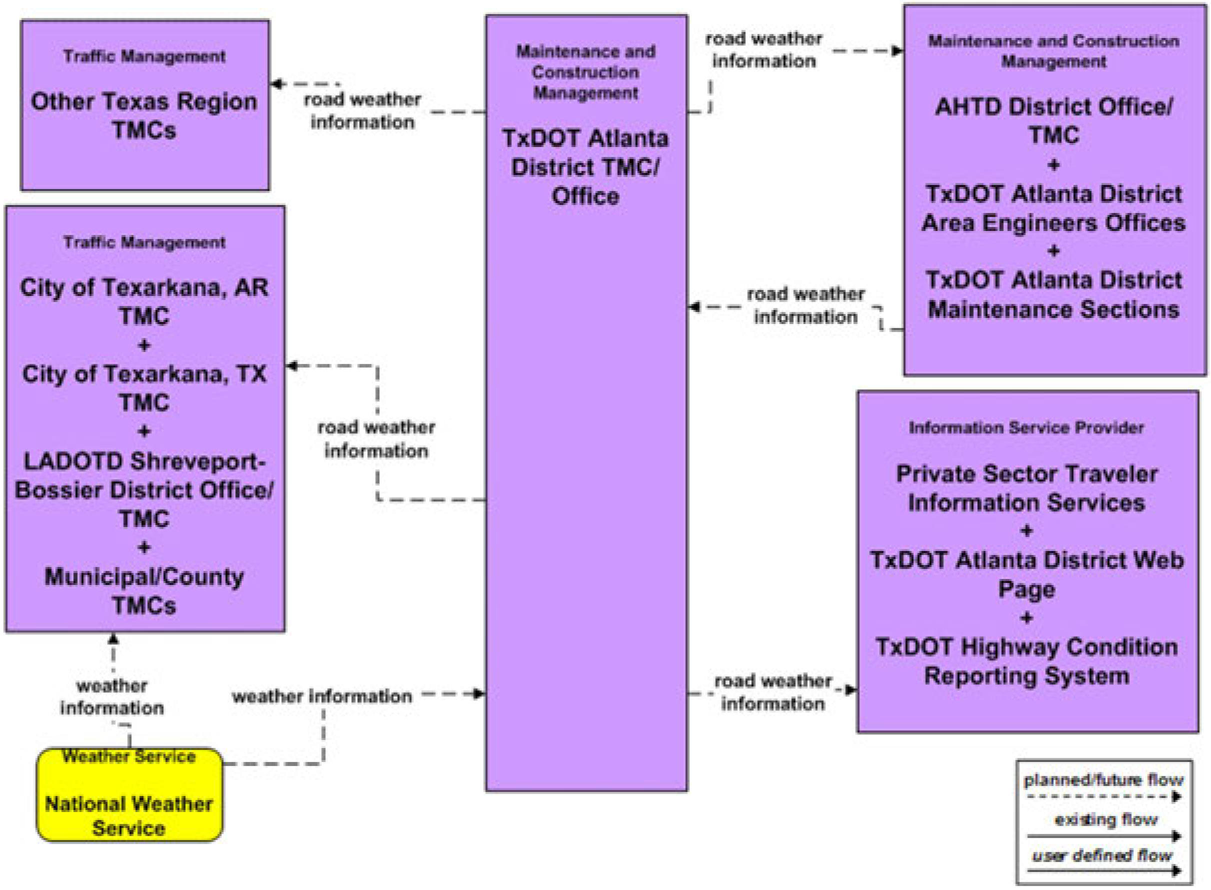
The MC03 – Road Weather Data Collection service package shows ITS elements and data flows used to collect road and weather data via environmental sensors deployed along TxDOT Atlanta District roadways. The MC03 service package diagram that was included in the 2003 TxDOT Atlanta District Regional ITS Architecture is shown in **Figure 13**. Since the original development of this service package diagram, TxDOT Atlanta District environmental sensors have been implemented at several low water crossings, allowing the District Office to receive weather related data. Therefore, the flows between 'TxDOT Atlanta District TMC/Office' and 'TxDOT Atlanta District Environmental Sensors' should currently show as existing rather than planned.

Figure 13: MC03 – Road Weather Data Collection Service Package Diagram



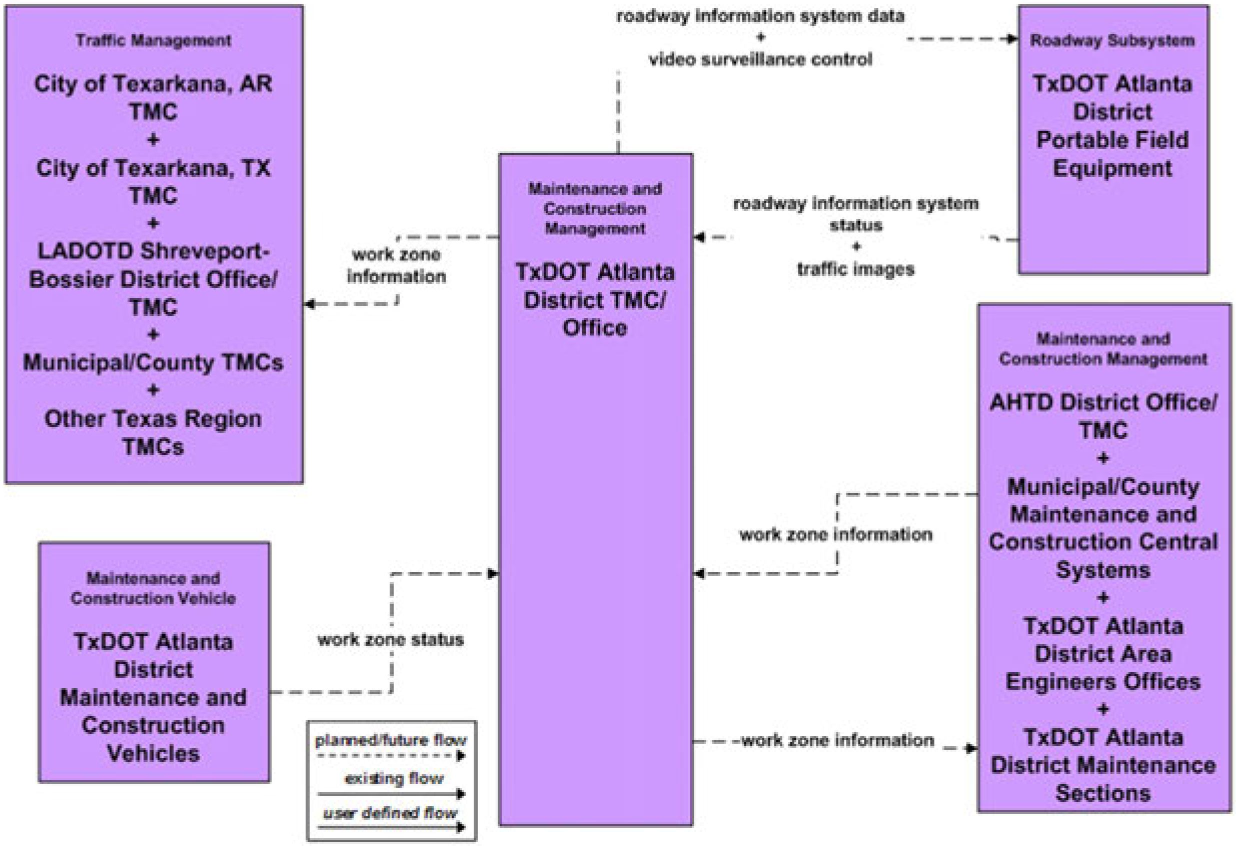
The MC04 – Weather Information Processing and Distribution service package shows ITS elements and data flows used to detect environmental hazards via environmental data collection to determine corrective actions to improve roadway operations during weather events. The MC04 service package diagram that was included in the 2003 TxDOT Atlanta District Regional ITS Architecture is shown in **Figure 14**. Since the original development of this service package diagram, the TxDOT Atlanta District has established better communication with public information sources. Therefore, a 'Local Print and Broadcast Media' terminator that shows an existing 'road weather information' flow from 'TxDOT Atlanta District TMC/Office' should be added to the service package diagram. Furthermore, the reference to AHTD should be revised instead to ARDOT since the department has recently rebranded.

Figure 14: MC04 – Weather Information Processing and Distribution Service Package Diagram



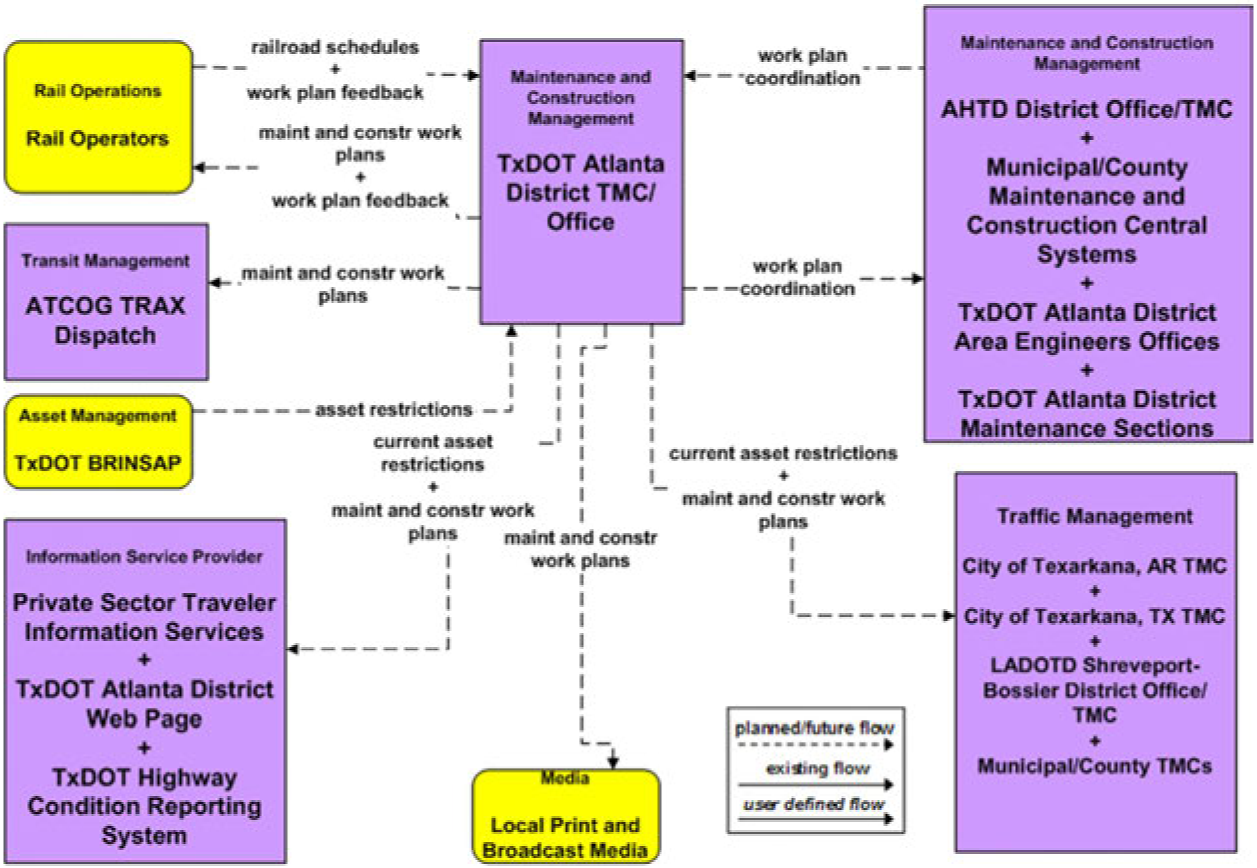
The MC08 – Work Zone Management service package shows ITS elements and data flows used to allow the TxDOT Atlanta District to direct work zone activities and inform travelers of work zone activity via DMS or other communication methods. The MC08 service package diagram that was included in the 2003 TxDOT Atlanta District Regional ITS Architecture is shown in **Figure 15**. Since the original development of this service package diagram, portable CCTV and DMS have been implemented to allow District staff to monitor work zones by sending roadway information system data to DMS, controlling video surveillance, and receiving DMS status information and traffic images. Therefore, the flows between 'TxDOT Atlanta District TMC/Office' and 'TxDOT Atlanta District Portable Field Equipment' should currently show as existing rather than planned. Furthermore, the reference to AHTD should be revised instead to ARDOT since the department has recently rebranded.

Figure 15: MC08 – Work Zone Management Service Package Diagram



The MC10 – Maintenance and Construction Activity Coordination service package shows ITS elements and data flows used to allow dissemination of information about maintenance and construction activities to relevant operations centers. The MC10 service package diagram that was included in the 2003 TxDOT Atlanta District Regional ITS Architecture is shown in **Figure 16**. Since the original development of this service package diagram, the TxDOT Atlanta District has established better communication with public information sources. Therefore, the flows between 'TxDOT Atlanta District TMC/Office' and 'TxDOT Highway Condition Reporting System', as well as 'Local Print and Broadcast Media' should currently show as existing rather than planned. Furthermore, the reference to AHTD should be revised instead to ARDOT since the department has recently rebranded.

Figure 16: MC10 – Maintenance and Construction Activity Coordination Service Package Diagram



The changes to the architecture described above will properly show that the existing District Office as well as potential future traffic management centers have the capability of monitoring and controlling the devices that are part of proposed improvements to I-30, I-20, I-369, and US 59 and other spot locations throughout the District. Since 2003, the TxDOT Atlanta District has deployed CCTV cameras, DMS units, temporary equipment for work zones, and environmental sensors. These ITS devices have established a foundation for video surveillance control, communication with the traveling public, coordination between Districts, work zone management, and weather data collection. Therefore, no further updates to the architecture would be required for the ITS deployment proposed in this document beyond the changes already listed in the discussion above.

System Conceptual Design

Summary of Recommendations

The previous sections mentioned several limitations of the existing ITS system. To address these limitations, it is recommended that additional DMS units and new CCTV cameras be installed along and adjacent to the I-30, I-20, US 59, and I-369 corridors, as well as at several other spot locations with a history of road weather impacts. The recommended full buildout ITS scheme for the District includes a total of 19 CCTV cameras and five DMS units. Device locations are split into three implementation priority groups. The quantities of recommended device deployments for each group are summarized in **Table 4**.

The high priority group emphasizes device deployments along study routes at crash hotspots and key decision points where the District staff want better coverage due to frequent backups. The medium priority group includes additional CCTV cameras and DMS along each of the study routes to enhance coverage of these key corridors, especially at documented crash hotspots and decision points with high AADT. Low priority devices are recommended to address the District's desire to expand the number of roads that have surveillance coverage in locations with documented history of water-on-road issues.

Table 4: Proposed ITS Deployments by Priority and Roadway

Priority	Roadway	CCTV	DMS
High	I-20	1	0
	US 59	3	0
	US 271	2	1
	High Priority Total	**6**	**1**
Medium	I-30	2	1
	I-20	2	0
	US 59	3	2
	I-369	1	1
	SH 149	1	0
	Medium Priority Total	**9**	**4**
Low	US 59	1	0
	US 259	1	0
	SH 8	1	0
	SH 155	1	0
	Low Priority Total	**4**	**0**

Recommended Device Locations

To accommodate the design considerations listed in the previous section, 19 CCTV cameras are planned to be installed at the locations indicated in **Table 5** and five DMS units are planned to be installed at the locations indicated in **Table 6**.

A map displaying the high priority locations for recommended ITS infrastructure is shown in **Figure 17**. A map displaying the proposed medium priority locations for recommended ITS infrastructure is shown in **Figure 18**. The low priority locations for recommended ITS infrastructure are shown on the map in **Figure 19**.

Figure 20 displays all recommended ITS infrastructure locations with CCTV identification labels, relating each camera to the device details summarized in **Table 5**. **Figure 21** displays all recommended ITS infrastructure locations with DMS identification labels, relating each message unit to the device details summarized in **Table 6**. Individual maps for all recommended ITS device locations are included in **Appendix A**.

Figure 17: Proposed ITS Locations Along Study Roads – High Priority

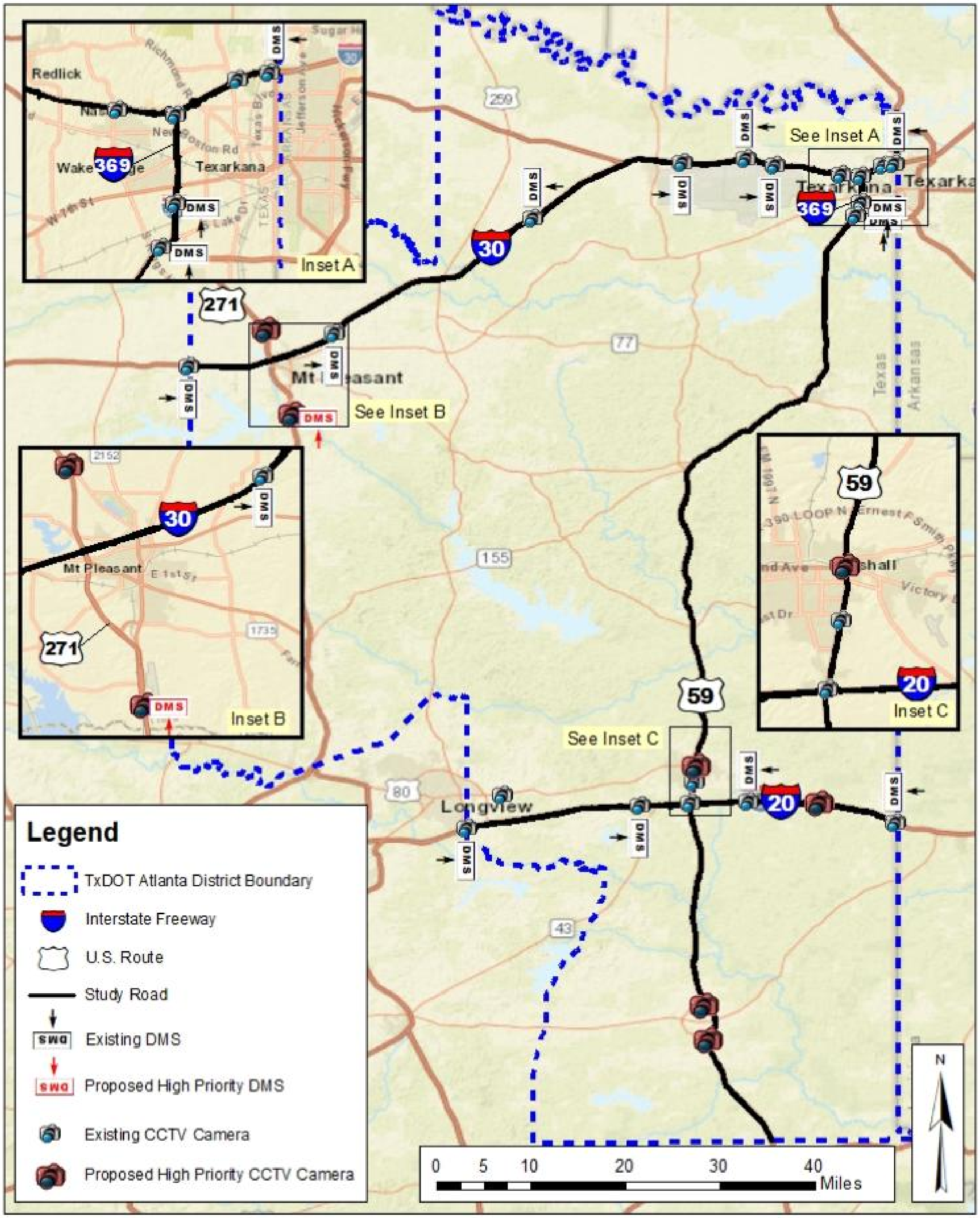


Figure 18: Proposed ITS Locations Along Study Roads – Medium Priority

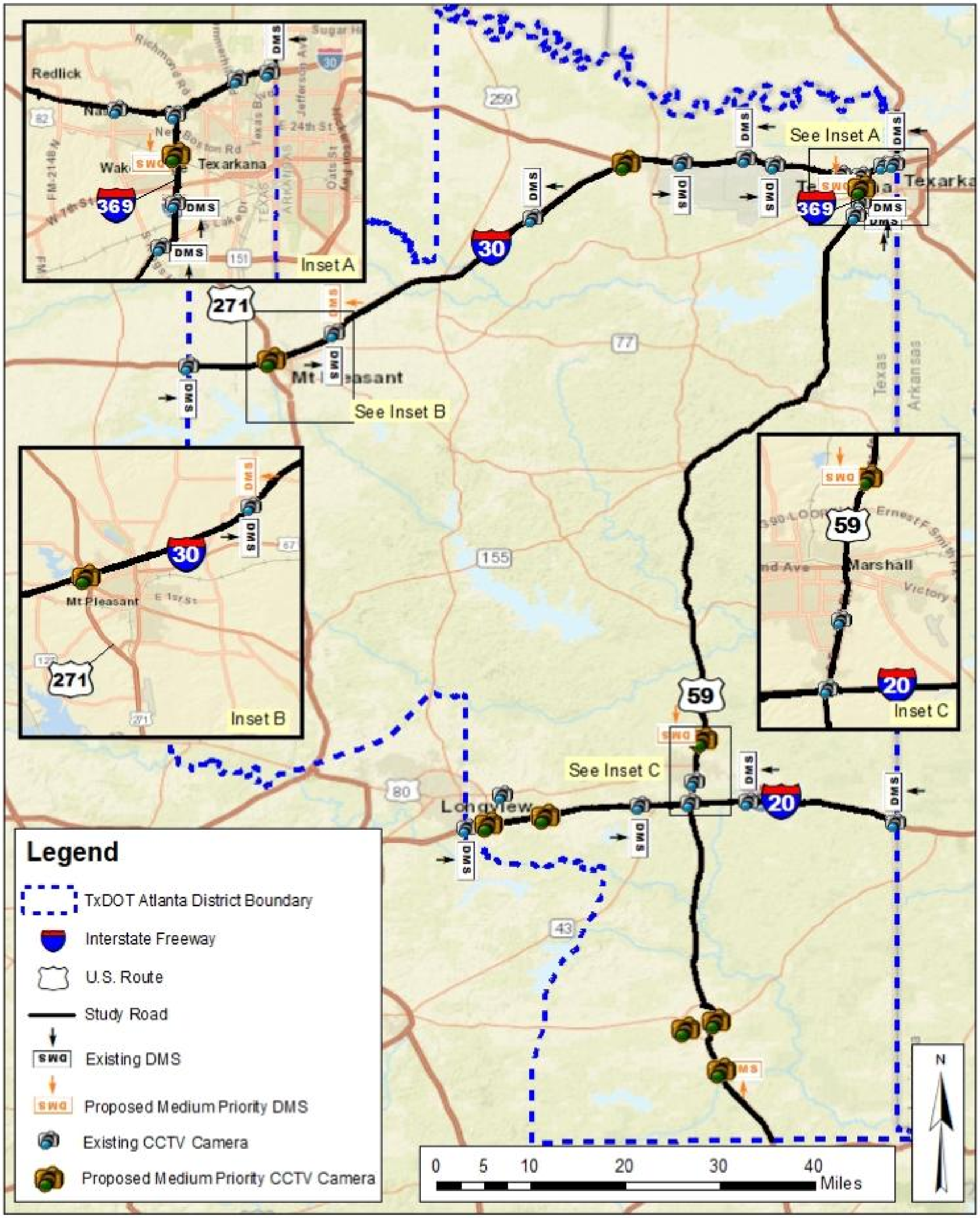


Figure 19: Proposed ITS Locations Along Study Roads – Low Priority

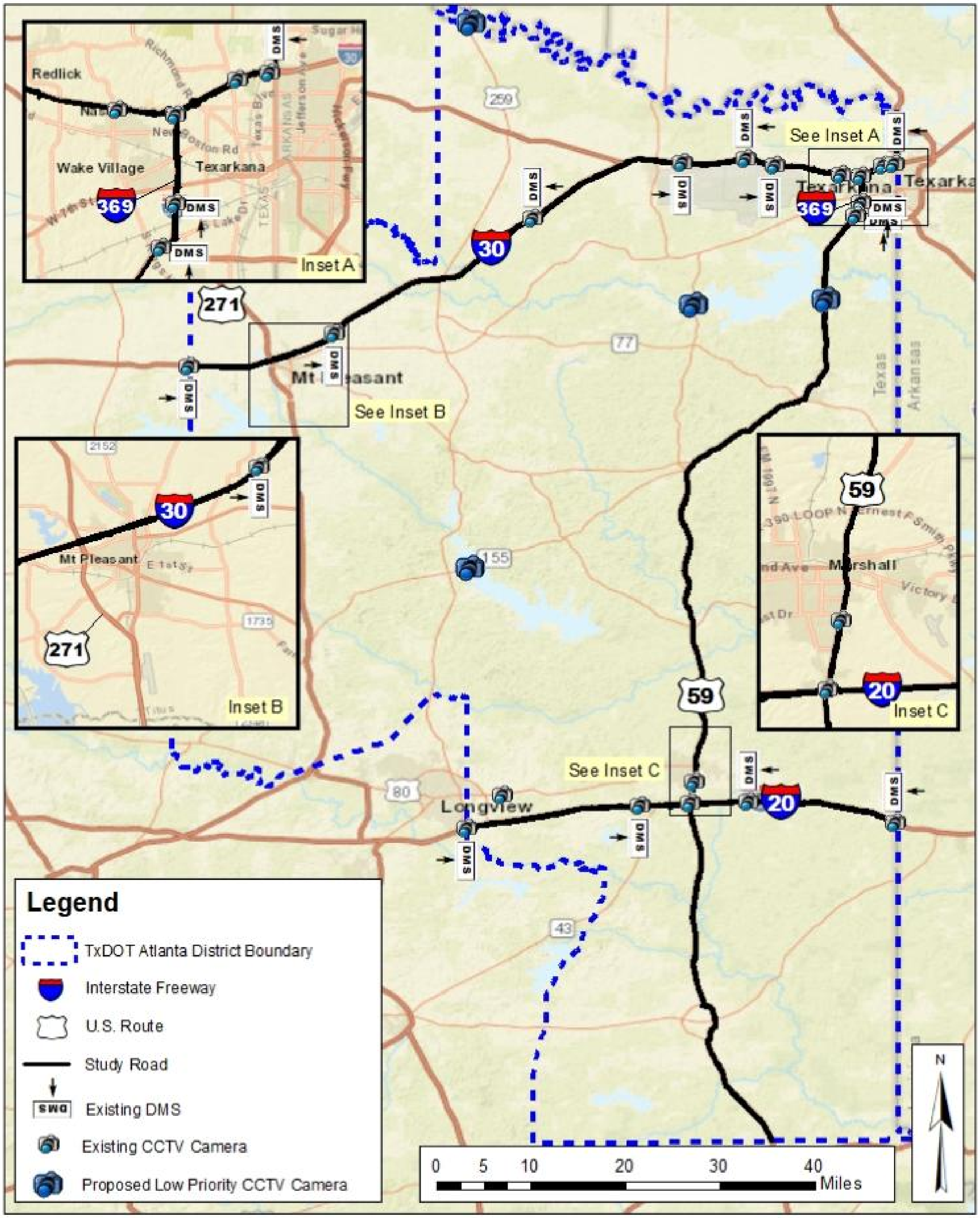


Figure 20: All Proposed ITS Locations Along Study Roads – CCTV Camera Identification

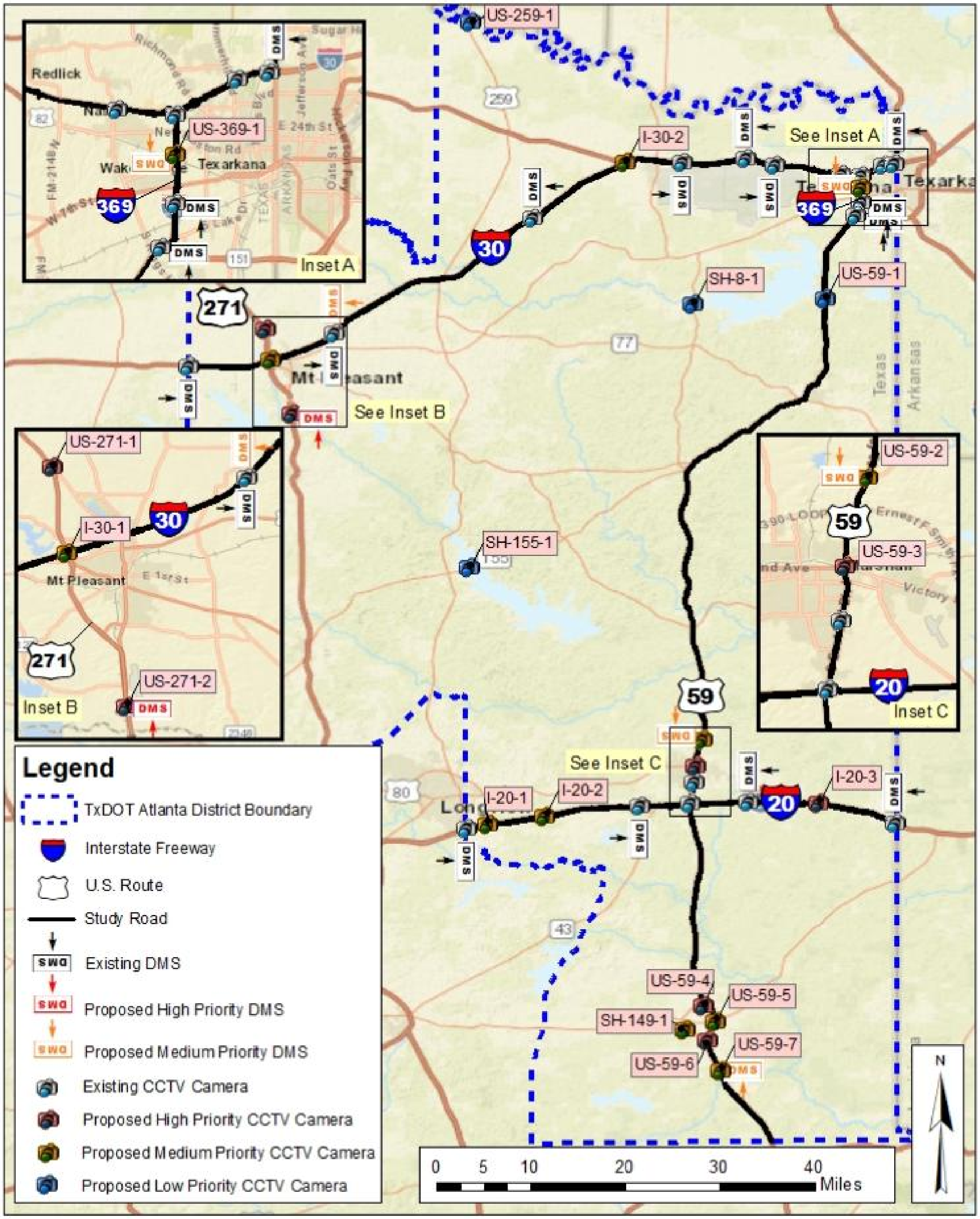


Table 5: CCTV Locations and Considerations

CCTV	Priority	Approx. Lat/Long	Key Transportation Elements in View (Approximate Lat/Long)
I-30-1	Medium	33.169, -95.000	• Tankersley Creek bridge (33.164, -95.016) • US 271/W. Ferguson Rd overpass (33.170, -95.000) • Entrance ramps (33.169, -95.002 WB & 33.171, -94.995 EB) • Exit ramps (33.169, -95.002 EB & 33.171, -94.995 WB) • Major crash hotspot • Urban coverage
I-30-2	Medium	33.471, -94.457	• CR 4008 overpass (33.470, -94.460) • US 82 overpass and ramps (33.471, -94.457) • SH 98 overpass (33.465, -94.470) • Entrance ramp (33.466, -94.467 EB & 33.463, -94.475 WB) • Exit ramps (33.463, -94.475 EB & 33.467 -94.465 WB) • Minor crash hotspot
I-369-1	Medium	33.431, -94.096	• US 82 overpass (33.443, -94.097) • Westlawn Dr and RR overpass (33.432, -94.096) • US 67 overpass (33.419, -94.096) • Waggoner Creek bridges (33.432, -94.097 & 33.431, -94.095) • Entrance ramps (33.434, -94.096 NB; 33.434, -94.097 SB; 33.428, -94.097 SB; 33.421, -94.096 NB & 33.416, -94.097 SB) • Exit ramps (33.439, -94.096 NB; 33.438, -94.097 SB; 33.428, -94.095 NB; 33.422, -94.096 SB & 33.416, -94.096 NB) • Major crash hotspot • Urban coverage • Proposed SB DMS (33.426, -94.096)
US-59-1	Low	33.263, -94.153	• Sulphur River bridge (33.305, -94.151) • FM 3129 overpass (33.263, -94.153) • Entrance ramps (33.267, -94.153 NB & 33.260, -94.153 SB) • Exit ramps (33.267, -94.153 SB & 33.258, -94.153 NB) • Minor crash hotspot • District-identified key location due to history of bridge icing
US-59-2	Medium	32.590, -94.340	• Intersection with FM 1793 (32.590, -94.340) • Proposed SB DMS (32.590, -94.341) • Minor crash hotspot • District-identified priority location

CCTV	Priority	Approx. Lat/Long	Key Transportation Elements in View (Approximate Lat/Long)
US-59-3	High	32.548, -94.350	• Intersection with US 80 (32.548, -94.350) • Major crash hotspot • Urban coverage • District-identified priority location
US-59-4	High	32.182, -94.338	• US 79/NW Loop overpass (32.182, -94.338) • Entrance ramps (32.182, -94.340 WB & 32.182, -94.336 EB) • Exit ramps (32.182, -94.340 EB & 32.182, -94.336 WB) • Urban coverage
US-59-5	Medium	32.159, -94.320	• Hoggs Bayou bridge (32.168, -94.323) • US 79 overpass (32.159, -94.321) • Entrance ramps (32.161, -94.321 NB & 32.156, -94.320 SB) • Exit ramps (32.162, -94.321 SB & 32.157, -94.320 NB) • Urban coverage • District-identified priority location
US-59-6	High	32.131, -94.332	• SH 149/SW Loop overpass (32.131, -94.332) • Entrance ramps (32.131, -94.334 WB & 32.131, -94.331 EB) • Exit ramps (32.131, -94.334 EB & 32.132, -94.331 WB) • Minor crash hotspot • Urban coverage • District-identified priority location
US-59-7	Medium	32.084, -94.311	• Elm Creek bridge (32.082, -94.310) • Proposed NB DMS (32.094, -94.317)
SH-149-1	Medium	32.146, -94.367	• SH 315 overpass (32.146, -94.367) • Entrance ramps (32.149, -94.368 NB & 32.143, -94.365 SB) • Exit ramps (32.150, -94.369 SB & 32.142, -94.365 NB) • Urban coverage • District-identified priority location
I-20-1	Medium	32.461, -94.667	• Loop 281 overpass (32.460, -94.668) • Bridge (32.458, -94.681) • Mason Creek bridge (32.463, -94.652) • Entrance ramps (32.460, -94.669 WB & 32.460, -94.664 EB) • Exit ramps (32.459, -94.672 EB & 32.461, -94.663 WB) • Crash hotspot

CCTV	Priority	Approx. Lat/Long	Key Transportation Elements in View (Approximate Lat/Long)
I-20-2	Medium	32.473, -94.580	• FM 450 overpass (32.473, -94.580) • Entrance ramps (32.474, -94.581 WB & 32.473, -94.578 EB) • Exit ramps (32.472, -94.581 EB & 32.474, -94.578 WB) • Crash hotspot
I-20-3	High	32.493, -94.162	• US 80 overpass (32.493, -94.162) • Entrance ramps (32.494, -94.167 WB & 32.492, -94.157 EB) • Exit ramps (32.493, -94.167 EB & 32.493, -94.157 WB) • District identified priority location • Minor crash hotspot
US-271-1	High	33.216, -95.008	• Decision point – US 271 (W Ferguson Rd) and BUS 271 (N Jefferson Ave) • District-identified priority location due to existing lack of coverage along US 271
US-271-2	High	33.086, -94.967	• Decision point – US 271 and BUS 271 (S Jefferson Ave) • Proposed NB DMS (33.088, -94.968) • District-identified priority location due to existing lack of coverage along US 271
US-259-1	Low	33.686, -94.694	• Red River bridge (33.687, -94.695) • District boundary • District-identified key location due to history of bridge icing
SH-8-1	Low	33.255, -94.355	• Wright Patman Lake bridges (33.260, -94.351 & 33.267, -94.348) • District-identified key location due to history of bridge icing/flooding
SH-155-1	Low	32.852, -94.697	• Lake O' the Pines bridge (32.850, -94.700) • District-identified key location due to history of bridge icing/flooding

Figure 21: All Proposed ITS Locations Along Study Roads – DMS Unit Identification

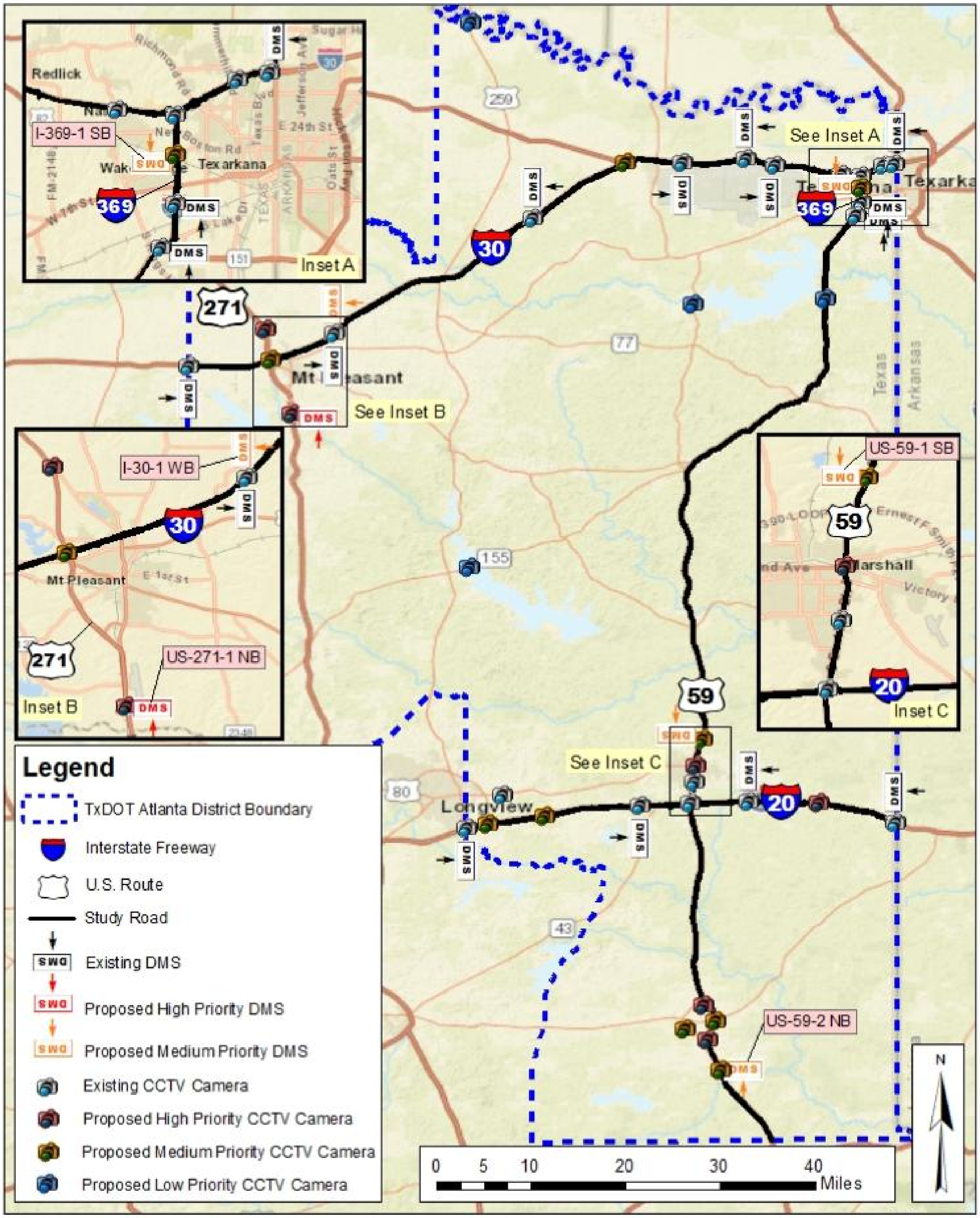


Table 6: DMS Locations and Considerations

DMS	Priority	Approx. Lat/Long	Relation to Decision Points
I-30-1 WB	Medium	33.209, -94.904	Located in advance of Exit 165, just east of Mount Pleasant. Exiting vehicles can detour westbound via US 67 into Mount Pleasant or continue toward Sulphur Springs. Elevated roadways in the vicinity tend to be the first to close due to weather. DMS is located near the Atlanta District border and provides opportunities for District message collaboration with the Paris District.
I-369-1 SB	Medium	33.426, -94.096	Located in advance of junction with US 59. Exiting vehicles can detour eastbound via US 59 or TX-151 Loop to Texarkana or Arkansas state border. DMS is located near the Atlanta District and state border and provides opportunities for District/state message collaboration.
US-59-1 SB	Medium	32.590, -94.341	Located in advance of SH 390 Loop in Marshall. Provides travel information for southbound motorists approaching Marshall. Exiting vehicles can detour around Marshall via SH 390 Loop, SH 43, and US 80. Information may also be provided regarding the intersection of US 59 and I-20.
US-59-2 NB	Medium	32.087, -94.313	Located in advance of SH 149/US 59 junction, south of Carthage and north of the Atlanta District border. Information may also be provided for motorists approaching Carthage regarding conditions further north along US 59 or I-20.
US-271-1 NB	High	33.088, -94.968	Located in advance of junction US 271/Business US 271. Provides travel information for northbound motorists approaching Mount Pleasant and I-30. Elevated roadways in the vicinity tend to be the first to close due to weather. Exiting vehicles can detour northbound via S Jefferson Ave.

System Design Considerations

CCTV camera locations were selected to maximize visibility of priority areas. Areas which were considered priority include urban areas, road segments that experience frequent backups, key decision points, and locations with a history of water-on-road issues, as noted by maintenance section staff. DMS unit locations were selected to correspond with locations that could provide drivers with time to interpret potential posted information, make a decision, and exit I-30, I-20, I-369, US 59, and US 271 in favor of an alternate route to detour around an incident or closure. DMS are a primary means of communicating with traveling motorists while they are using the road network. By providing timely messages regarding traffic conditions, the District will have a means of proactively managing traffic congestion by directing motorists to alternate transportation corridors to reduce delays and corresponding travel times.

As shown previously in **Figure 3**, crash densities on the corridors were highest in Texarkana and Marshall, making these areas candidates for enhanced CCTV camera coverage. Cameras in those locations are identified as high and medium priority for implementation due to the relatively high AADT volumes and crash frequency. There are no southbound DMS units currently deployed in these urban areas, resulting in the recommendation of medium priority southbound DMS along I-369 and US 59. These locations are also near elevated roadways and ramps that are occasionally at risk of icing over during the winter. Motorists could be warned by updated DMS messages of upcoming delays or closures and encouraged to take alternate routes to detour around impacted facilities.

The medium priority southbound DMS recommended on I-369 in Texarkana, prior to the 151 loop and US 59 split would enable the District to provide travel information before key decision points where congestion and incidents frequently occur. The I-369 camera is proposed to fill in gaps in surveillance coverage and monitor road weather conditions, as well as to verify the messages displayed on the recommended DMS unit there.

The cameras proposed along US 59 in Marshall are recommended to enhance the coverage already provided through existing cameras deployed at signals along the corridor. The high priority CCTV camera would allow District staff to observe traffic along the US 59 corridor at a central location within the city, which is a major crash hotspot with no existing coverage. This camera would also enable surveillance of the US 80 corridor through town, a key east/west alternate route for I-20. The medium priority camera is recommended to monitor congestion and verify status of the medium priority southbound DMS unit recommended along US 59 in Marshall, north of Texas Loop 390, US 80, and the junction with I-20. A freeway loop around Marshall is currently in the planning phase, and that freeway once designed may include the proposed southbound DMS for travel information prior to the new decision points in the area, as well as other ITS devices.

Mount Pleasant also has many key decision points that precede grade separated ramps which are typically the first to close due to hazardous weather conditions. Due to the lack of existing coverage, two CCTV cameras are recommended as high priority to monitor traffic approaching the city via US 271 from both the north and the south. A high priority DMS is recommended for the US 271 northbound approach to Mount Pleasant because there are no existing ITS devices along this corridor. A medium priority CCTV camera and DMS unit are also recommended along I-30 within Mount Pleasant. These are proposed near the intersection of I-30 and US 271 to increase coverage of the major corridors that support high AADT volumes. These devices would help District staff monitor a crash hotspot and disseminate travel information to westbound drivers entering Mount Pleasant.

There are no ITS devices currently deployed south of I-20 within the TxDOT Atlanta District, even though there are many corridors that support relatively high AADT and contain many decision points. Four CCTV cameras are proposed along the freeway loop around Carthage to address the lack of existing coverage in this region of the District. High priority cameras are recommended to the north and south of the city, where US 59 meets the loop at US 79 and SH 149 respectively. District staff identified the need for increased surveillance coverage of key decision points to the east and west of the loop as well. Therefore, medium priority CCTV cameras are recommended at the US 59 and US 79 interchange, on the east side of the loop, and at the junction of SH 149 and SH 315, to the west of Carthage.

A medium priority CCTV camera and northbound DMS unit pair is also recommended along US 59, south of Carthage. This camera would monitor traffic entering the Atlanta District from the Lufkin District and disseminate travel information to vehicles that are approaching multiple decision points and Carthage. A DMS unit used to exist near this location but was removed for a road widening project and there was not funding at the time to replace it.

The three CCTV cameras recommended on I-20 are to be placed at crash hotspots to allow for incident and congestion verification at these locations along the freeway and to fill gaps in camera coverage near decision points. District staff identified the CCTV camera proposed where I-20 and US 80 split as a high priority location due to US 80 being a key corridor to Marshall, an alternate east/west route for I-20, and a decision point for vehicles coming into the Atlanta District from Louisiana.

An additional CCTV camera recommended on I-30 is located at the junction with US 82, which is a crash hotspot, key decision point between Texarkana and Mount Pleasant, and has no existing coverage. US 82 runs east to west, parallel to I-30 between New Boston and Texarkana, making it an important alternate route if an incident occurs along I-30. West of New Boston, US 82 is the most direct route to Paris, Sherman, and Wichita Falls. A camera would enable the District to monitor operations at this interchange and make more informed travel information updates to DMS in the vicinity.

The CCTV cameras proposed as low priority are recommended primarily to fill the gaps in camera coverage along routes throughout the District other than the study corridors. The District maintenance sections identified three locations near bridges with a history of road weather issues, such as standing water or ice. A fourth CCTV camera is recommended along US 259 at the bridge over the Red River to monitor traffic coming into the District from Oklahoma.

Alternative Deployment Configurations Considered but Not Recommended

Several alternative ITS device configurations that were considered for this project include:

- **No action** – The "no action" alternative is not an acceptable option in this project because the limitations mentioned earlier currently prevent TxDOT Atlanta from responding to many types of operational challenges.
- **Enhanced corridor camera coverage along I-20 –** More cameras were originally recommended along I-20 because of minor and major crash hotspot areas throughout the corridor. The District chose to prioritize expanding camera coverage to new routes that do not currently have cameras, rather than increasing the frequency of cameras along Interstates that do have existing coverage, unless a major crash hotspot existed.
- **Full corridor coverage of US 59 through Marshall –** CCTV cameras were originally recommended to be deployed along US 59 through Marshall with a spacing of approximately two miles between cameras to establish full coverage through the city. District staff realized that existing detection and surveillance cameras deployed at signals could assist with incident verification. Therefore, recommendations were revised so that only two new cameras were recommended for this corridor.
- **Camera coverage of non-freeway junctions along US 59 –** Due to the lack of coverage in the middle of the District between I-30 and I-20, cameras were originally recommended at several state highway junctions along US 59. However, the District chose to prioritize camera deployments specifically at grade-separated interchanges and freeway segments along this route.

Other Recommended ITS Concepts to Support TSMO Efforts

In addition to the deployment of CCTV and DMS, two other ITS technologies were identified that could support the District's operations and safety-related needs described in this document. Both technologies are already available to District staff, with established TxDOT guidance in place to support implementation.

Smart Work Zone Systems

Smart Work Zone (SWZ) systems utilize ITS technology for construction projects along roadways to improve the safety of motorists, protect work zone personnel, and reduce construction impacts, such as work zone crashes, traffic delays, and driver frustration. SWZ systems are portable ITS devices that can be temporarily deployed during a construction project to warn motorists of the traffic conditions ahead, so they are prepared to react appropriately. These systems also enable data collection capabilities for tracking a work zone's performance measures and providing operators with a means of tracking work zone operations in real time.

The TxDOT Atlanta District is currently implementing SWZ systems in the ongoing I-30 widening project. This TxDOT improvement project includes the widening of approximately six miles of I-30 from four lanes to six lanes, adding wider shoulders, and constructing a concrete median barrier to separate eastbound and westbound traffic. SWZ sensors have been deployed to estimate the average travel time between points along the work zone. Portable DMS units are then used to display the real-time information to keep motorists updated as they travel through the work zone.

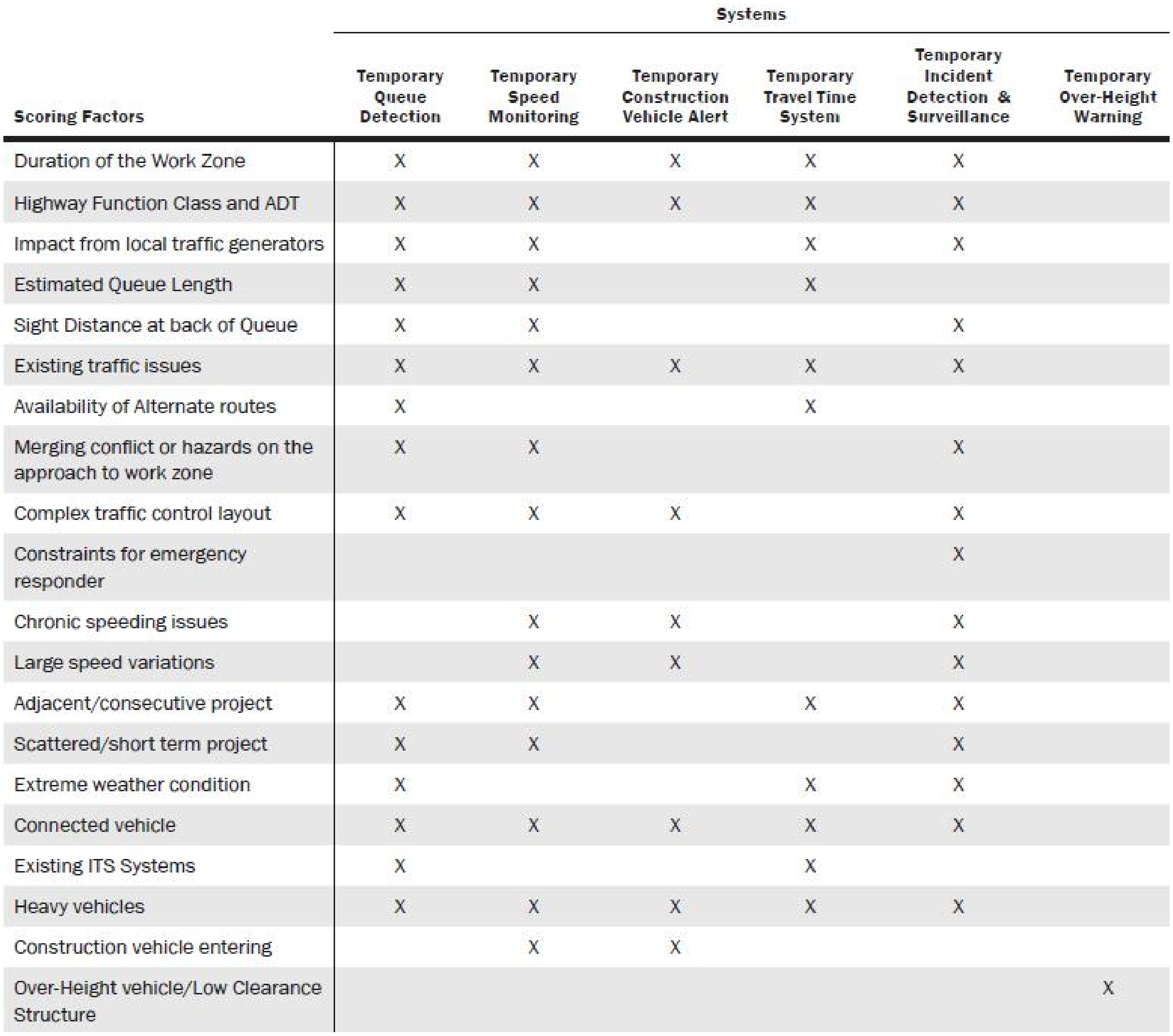
SWZ systems can address many of the District's needs and objectives related to communication, information dissemination, and safety. SWZ ITS devices can supplement or temporarily replace permanent ITS infrastructure that may lose functionality during construction, allowing operators to maintain communication and monitoring capabilities. Additional DMS enable better work zone travel information dissemination, expanding communication to travelers about travel time estimates, alternate routes, and hazards ahead. Temporary sensors and flashing warning signs can also be used to alert drivers of backed up queues, construction vehicles, and excessive speeding to improve the safety of travelers and work zone personnel.

Establishing the requirement of SWZ systems for all construction with traffic impacts, not just major projects, and standardizing SWZ ITS device deployment can improve traffic safety and operations efficiency in work zones throughout the District. TxDOT has identified six temporary SWZ systems that should be used in work zones, as well as guidelines for determining how and when to implement them. These temporary systems are:

- Temporary Queue Detection
- Temporary Speed Monitoring
- Temporary Construction Equipment Alerts
- Temporary Travel Time System
- Temporary Incident Detection and Surveillance
- Temporary Over-Height Vehicle Warning

The following discussion summarizes the *TxDOT Smart Work Zone Guidelines*, including brief descriptions of the six SWZ systems and which factors to consider for each.[4] When selecting the appropriate SWZ systems, many project factors, as well as existing conditions around the site must be taken into account. The Go/No-Go Decision Tree tool provides scoring criteria for a variety of work zone and location characteristics that would support the implementation of each of the SWZ systems.[5] A matrix of the key scoring factors used to determine the need for each SWZ system is shown in **Table 7**.

Table 7: Scoring Factors for Smart Work Zone Systems

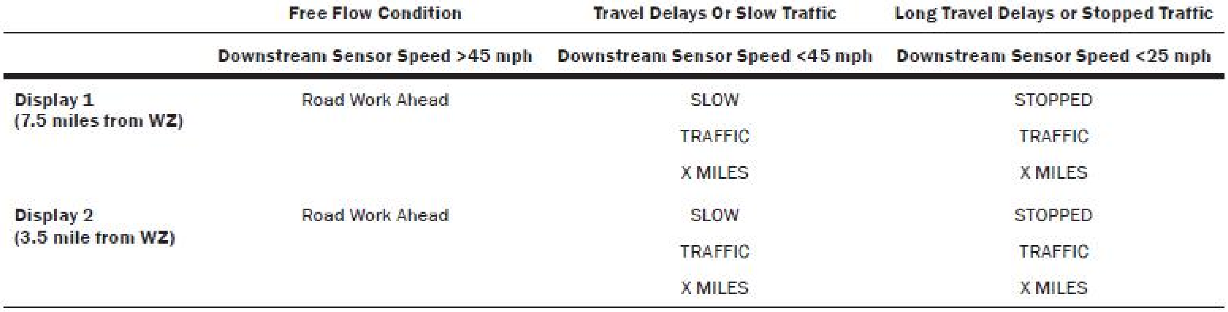


	Systems					
Scoring Factors	**Temporary Queue Detection**	**Temporary Speed Monitoring**	**Temporary Construction Vehicle Alert**	**Temporary Travel Time System**	**Temporary Incident Detection & Surveillance**	**Temporary Over-Height Warning**
Duration of the Work Zone	X	X	X	X	X	
Highway Function Class and ADT	X	X	X	X	X	
Impact from local traffic generators	X	X		X	X	
Estimated Queue Length	X	X		X		
Sight Distance at back of Queue	X	X			X	
Existing traffic issues	X	X	X	X	X	
Availability of Alternate routes	X			X		
Merging conflict or hazards on the approach to work zone	X	X			X	
Complex traffic control layout	X	X	X		X	
Constraints for emergency responder					X	
Chronic speeding issues		X	X		X	
Large speed variations		X	X		X	
Adjacent/consecutive project	X	X		X	X	
Scattered/short term project	X	X			X	
Extreme weather condition	X			X	X	
Connected vehicle	X	X	X	X	X	
Existing ITS Systems	X			X		
Heavy vehicles	X	X	X	X	X	
Construction vehicle entering		X	X			
Over-Height vehicle/Low Clearance Structure						X

Temporary Queue Detection

Temporary Queue Detection is used to address the safety issue of unexpected queueing of slowed or stopped traffic at the approaches to work zones. This system continuously monitors traffic approaching and within the work zone to detect slowed or stopped traffic. Warnings are then presented to motorists to make them aware of changing traffic conditions. The system includes a queue detector, messaging system, a network connecting the two, and a connection to a TMC for broadcasting alerts to operators. A data archiving system can be useful for scheduling lane closures, cost effective enforcement officer presence, and effective planning for future construction. **Table 8** shows typical messages to be displayed on DMS.

Table 8: Typical Queue Detection DMS Messages



	Free Flow Condition	Travel Delays Or Slow Traffic	Long Travel Delays or Stopped Traffic
	Downstream Sensor Speed >45 mph	Downstream Sensor Speed <45 mph	Downstream Sensor Speed <25 mph
Display 1 **(7.5 miles from WZ)**	Road Work Ahead	SLOW TRAFFIC X MILES	STOPPED TRAFFIC X MILES
Display 2 **(3.5 mile from WZ)**	Road Work Ahead	SLOW TRAFFIC X MILES	STOPPED TRAFFIC X MILES

The Go/No-Go Decision Tree for Temporary Queue Detection Systems puts significant weight on predicted work zone queue length. Two more priority factors are sight distance at back of queue, and existing traffic issues (for example, higher than normal crash rates, frequent gridlock, or frequent exit ramp backups). Consideration of the impact from local traffic generators, such as large event facilities versus local businesses or public facilities, is another major decision factor. The potential for merging conflicts or hazards on the approach to or within the work zone is also an important consideration.

Temporary Speed Monitoring

Temporary Speed Monitoring can be used to improve speed zone compliance and encourage more uniform travel speeds through a work zone. Sensors measure approaching vehicle speeds and display the vehicle speed to the motorist via a portable DMS or trailer-mounted sign assembly. Police presence is highly effective in reducing speed variation but is expensive. Temporary Speed Monitoring is a good alternative, particularly when the DMS or Speed Feedback Trailers are used sparingly to maintain drivers' respect for speed warnings and when they are used in combination with brief, targeted police enforcement efforts. The system is composed of one or more speed detectors, a messaging system with brief messages or two digit LED messages (shown in **Figure 22**), a network connecting the two, and a connection to a TMC/emergency agency for extreme speed violation notifications. Including a data archiving system is useful for scheduling enforcement officer presence.

Figure 22: Speed Monitoring Message Display

Highway functional classification and ADT, chronic speed issues, and large speed variations are top factors, all holding the same weight for scoring the need for Temporary Speed Monitoring. Existing traffic issues (for example, higher than normal crash rates, frequent gridlock, or frequent exit ramp backups), duration of the work zone in terms of time, estimated queue length, and impact from local traffic generators are the next most important considerations.

Temporary Construction Equipment Alerts

Temporary Construction Equipment Alerts are used to inform drivers about construction equipment leaving the work zone and entering the main travel lanes. If motorists are not aware in advance of construction vehicles entering the traffic stream, they may need to brake suddenly, increasing the risk for rear end collisions due to the rapid changes in vehicle speeds. Traffic Control Plans attempt to minimize this issue by extending construction barricades past the actual work area to provide more of an acceleration lane for construction equipment. These temporary construction equipment alerts can improve the safety of merging movements by including detectors for the equipment approaching the work area boundary and message signs or warning signs with flashers, shown in **Figure 23**. A wireless communication link can be used for individual equipment operators to trigger the messaging or warning signs.

Figure 23: Temporary Construction Equipment Alerts

The presence of construction vehicles entering/exiting the main lanes of traffic is worth significantly more points in the decision tool than all other factors for this SWZ system. The second most heavily weighted factor is the presence of existing traffic issues (for example, higher than normal crash rates, gridlock, or frequent exit ramp backups).

Temporary Travel Time System

Temporary Travel Time systems are composed of a detection system that tracks individual vehicle travel times through the work zone and a communication system connecting to at least one message board or travel time sign, shown in **Figure 24**. Providing travel times helps motorists make informed decisions about route choices and reduces aggravation caused by unrealistic travel time expectations and delays. The messaging boards can also encourage detours along alternate routes to decrease congestion in the work zone.

Figure 24: Temporary Travel Time System

*I-YY=Destination Name

The Go/No-Go Decision Tree for Temporary Travel Time systems places significant emphasis on estimated queue length, and then on highway functional class and ADT. Determining the presence of existing ITS systems, meaning whether the District has the capability to actively manage the deployed units from a central TMC or office during construction, is the next most heavily weighted factor. The estimated impacts from local traffic generators near the work zone is another important consideration.

Temporary Incident Detection and Surveillance

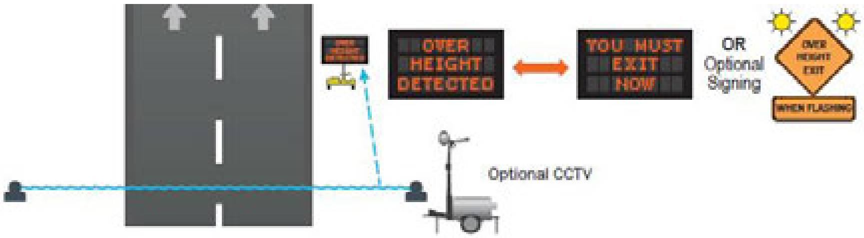
Temporary Incident Detection and Surveillance provides better awareness of traffic conditions, leading to faster detection and responses to incidents that occur in work zones. Responders need details about disabled vehicle and crash characteristics and locations so that the appropriate vehicles and equipment can be deployed for effective incident response and clearance. This system is made up of incident detection and surveillance equipment such as CCTV cameras and sensors. It is essential to have a designated party responsible for monitoring the system and acting on the data as it is collected and transmitted. An optional connection to a TMC is beneficial for alerting public safety agencies for faster incident response, as well as notifying the public. Data can be analyzed to develop countermeasures that reduce the likelihood of incidents for future projects.

Highway functional class and ADT are the scoring factors with the heaviest weight in the decision tool for identifying the need for Temporary Incident Detection and Surveillance. The heavy vehicle percentage in the area is the second most highly weighted value. Sight distance at back of queue, existing traffic issues (for example, higher than normal crash rates, gridlock, or frequent exit ramp backups), navigating constraints for emergency responders, and large speed variations are the next most important factors.

Temporary Over-Height Vehicle Warning

Temporary Over-Height Vehicle Warning systems provide advance warnings to over-height vehicles in work zone areas where low structures are present. When lanes are closed and traffic is redirected to the shoulders, the clearance under structures may be reduced. The system is composed of an electronic detection system that uses twin light beam technology to identify over-height vehicles. Dynamic or fixed messaging signs with flashing beacons are then activated to present warning to the driver, as shown in **Figure 25**.

Figure 25: Temporary Over-Height Vehicle Warning



The only project and location factor considered for the application of this system is the presence of over-height vehicles and/or low clearance structures.

Probe-Based INRIX Data

Probe-based traffic data is collected using Bluetooth-enabled devices, probe vehicle runs, toll tag and license plate readers, automatic vehicle location (AVL) systems, GPS mobile devices, and cell phone GPS-tracking services. These systems track a vehicle's position over time to determine speed and travel time between two points. This type of vehicle data can be aggregated to give insight to traffic delays caused by work zones or incidents. The data can also provide information on queue length in an area if the vehicle's position and movements are tracked over small distance increments so that the start and end of the queue may be identified. Currently, probe-based data cannot accurately estimate traffic volumes of a segment.

INRIX is a probe-based data database that consolidates commercial GPS, DOT sensor, and GPS-enabled vehicle data. The TxDOT Traffic Safety Division has a contract with INRIX that makes real-time and historical INRIX probe-based data available to all TxDOT staff, as well as to local agencies. INRIX data provides real-time travel times and can help agencies quickly detect incidents and unplanned road closures through anomalies in traffic flows, even in areas where ITS devices are not present. Historical INRIX data can be used to analyze speed and travel times on different road segments over various periods of time. This data is important for after action reviews, before and after studies, work zone impact analysis, system performance reporting, and more.

The real-time INRIX data can also be integrated into TxDOT's Lonestar Advanced Transportation Management System (ATMS) and linked to DMS units, such as the TxDOT Austin District DMS unit shown in **Figure 26**, so that real-time travel time estimates are displayed and regularly, automatically updated. Real-time travel estimates can also be applied to comparative travel time signs as well. **Figure 26** also shows a comparative travel time sign for San Marcos via I-35 and SH 45 for which TxDOT has a script set up in Lonestar to collect current travel times along both routes from INRIX every several minutes. This ensures that the most up-to-date travel times are displayed, improving the accuracy of driver expectations and assisting with route choice.

The TxDOT Traffic Safety Division is developing training for District staff to build the institutional capacity within each District to use available INRIX travel time probe data for traveler information, performance measurement, and other relevant applications. The TxDOT Atlanta District can make use of this training to incorporate INRIX data into its existing use of Lonestar ATMS to manage the messages shared on the District's DMS units.

Figure 26: Real-time Travel Time DMS Signs Displayed on the TxDOT ITS Website

Other Systems Considered but Not Recommended

There are many technologies and strategies available to address specific safety- and congestion-related traffic concerns, ranging in price, scale, application, and complexity. Many commonly deployed ITS technologies were considered to determine if their use would be appropriate for the TxDOT Atlanta District. Ultimately CCTV, DMS, and SWZ systems were identified as the priority technologies to address the District's current TSMO-related needs, with probe-based data potentially supporting the deployment of these systems. The alternative strategies that were considered as part of this project but not recommended for deployment in the District at this time are described below.

Road Weather Information System

A Road Weather Information System (RWIS) uses environmental sensors to monitor atmospheric, road surface, and water level conditions. If the sensors detect ice or water on the road, the system sends a warning message to be displayed on DMS or triggers flashing LEDs to alert approaching drivers of hazardous driving conditions. RWIS also collect data that can be used for weather forecasting and scheduling routine and seasonal maintenance.

The TxDOT Atlanta District considered installing RWIS devices at bridge and overpass locations with a history of incidents related to ice or water on the road surface, such as segments of US 59 that pass over the Sulphur River. However, the District has faced difficulties in the past with keeping RWIS and similar ITS devices operational. Therefore, District staff expressed a preference instead for expanding CCTV camera deployment to these locations due to the improved District familiarity and past reliability of CCTV when compared to RWIS.

Wrong-Way Driver Warning System

To combat wrong-way driving (WWD), sensors and warning devices may be deployed to detect vehicles traveling the wrong way and to warn the driver, TMC or public safety dispatch operators, and other motorists driving in the correct direction. WWD sensors may either be installed below the roadway surface, using inductive loop detectors (ILDs) or magnetic sensors, or mounted over the roadway surface, using video image processors (VIPs) or microwave radar detectors. When a sensor detects WWD, a signal can then be sent to an LED wrong-way sign (**Figure 27**), DMS, or in pavement warning lights. In some cases, the signal can be sent to a TMC or law enforcement to verify the detection of WWD before the warning DMS signs are triggered. Law enforcement can dispatch a vehicle to stop the at-fault driver if the warning signs are not effective.

Figure 27: Wrong-Way LED Warning Sign

Wrong-way driving is among the most dangerous traffic hazards and often leads to fatal crashes due to high speeds and the likelihood of a head-on collision with other motorists. The Harris County Toll Road Authority (HCTRA) deployed a radar system to detect drivers entering toll roads via exit ramps. The warning signs with LEDs successfully turned 74 percent of the wrong-way vehicles around.[6] However, the TxDOT Atlanta District shared that they do not have many WWD incidents, due to the lack of one-way frontage roads along many of their freeways. Therefore, TxDOT staff do not see detection and warning for WWD as a priority for now.

Wildlife Warning System

As road networks have expanded through wildlife habitats across the country, the number of animal-vehicle collisions has increased. These incidents are harmful and often deadly for the animal and can cause major vehicle damage, secondary vehicle crashes, and traffic delays. With larger animals, drivers can be seriously injured or killed, as head-on strikes can cause the animal to be flung through the windshield. Animal detection technologies including area coverage sensors or break-the-beam sensors paired with warning signs can be used to alert motorists of large wildlife in the vicinity of a roadway, as shown in **Figure 28**. This strategy to reduce animal-vehicle collisions is not recommended for the TxDOT Atlanta District because there were not many crashes that involved wildlife. Of the 328 animal-vehicle crashes within the Atlanta District in 2019, the majority were reported with no injuries.[1] These crashes were also dispersed along the study corridors evenly, with no one location containing a high concentration of animal-vehicle crashes.

Figure 28: Wildlife Warning Sign

Safety Service Patrol

Safety Service Patrols (SSP) are beneficial components to TIM programs and assist in regional TMC operations. SSP duties may include responding to and verifying incidents, providing temporary traffic control near incidents or disabled vehicles, providing assistance such as fuel or basic mechanic services to stranded motorists, and helping clear incidents. The TxDOT Atlanta District does not currently have the resources to staff or fund this relatively high-cost strategy. While the major freeways in the District each support more than 30,000 vehicles per day, the lack of an existing centralized TMC to support dispatch of SSP vehicles makes the implementation of such a program difficult.[2] The District indicated there may be interest in a SSP program on freeways in the future if funding becomes available.

Highway Advisory Radio

Highway Advisory Radio (HAR) is used to disseminate travel information to motorists along highways via broadcasting prerecorded or live messages via a radio station. This technology can be beneficial because it allows for area-wide broadcast of traveler information as opposed to sharing information from a single point such as a DMS unit. However, its effectiveness relies on drivers obeying a sign, such as the one shown in Figure 29, and setting their radio to a specific station in order for the information to be received. TxDOT no longer uses this technology since the agency determined that the challenges of successfully broadcasting information to drivers via HAR outweighed the advantages of the system. Therefore, HAR is not recommended for the Atlanta District.

Figure 29: Highway Advisory Radio Sign

Bluetooth Vehicle Detection System

Bluetooth vehicle detection systems actively search and detect in-range Bluetooth devices, tracking the device based on its unique media access control (MAC) address. This technology can be used to determine vehicle travel times and speeds by calculating the time the Bluetooth device takes to travel between two Bluetooth sensors spaced a set distance apart from one another. Because Bluetooth is a communication standard, these sensors can track the MAC of a wide range of devices. However, the device must be turned on and in "discoverable" mode so that its MAC is being broadcasted and can be received by the sensors. This strategy is not recommended for the Atlanta District because of the existing TxDOT agreement for access to INRIX probe-based data, which satisfies the need for data collection without the need to deploy sensors at preset locations.

Freight Parking Information Management System

Truck Parking Information Management Systems (TPIMS) display real-time information about parking availability at rest areas or other truck parking locations. An example of this system is pictured in **Figure 30**. An unexpected stopped truck in the shoulder or on the side of a freeway ramp represents a large stationary object in the clear zone that could potentially be struck by an errant vehicle. These signs encourage truckers to utilize provided freight parking areas instead of parking in more hazardous areas such as ramps or road shoulders.

Figure 30: Truck Parking Information Management System

In 2020, TxDOT analyzed truck parking demand and capacity shortages statewide. I-30 within the Atlanta District was identified as the corridor with the second highest average number of trucks parking in TxDOT right-of-way on weekdays. The District currently provides 365 total truck parking spaces, but the peak hour weekday demand was determined to be 593. Although there are concerns about existing facilities providing sufficient parking for trucks, two rest areas in the District have been shut down, one on I-30 at FM 4204, and one on I-20 west of FM 968. The closures were likely the result of a lack of funding and/or a lack of usage at these locations.

Reactivating these rest areas or opening new locations is not currently a stated priority for the District but may be considered again in the future if available funding increases. Because there is a more pressing need to provide more truck parking before implementing supporting ITS, TPIMS were considered but are not recommended in the TxDOT Atlanta District ITS Master Plan. If the closed rest areas or other public truck parking areas open in the future, TPIMS may become a more compelling technology to deploy along freeways in the TxDOT Atlanta District.[7]

Over-height and Oversize Vehicle Warning System

Over-height and oversize vehicle warning systems alert motorists if their vehicle is too tall or wide to travel under or through a structure so that the driver can choose an alternate route and avoid a potential collision with the structure. Hanging chains can be used to create an audible warning before the vehicle attempts to pass under a bridge or through a tunnel. Sensors can also be used to detect large vehicles and send a signal to a DMS or flashing warning sign, as with the example shown in **Figure 31**.

Figure 31: Over-height Flashing Warning Sign

The TxDOT Atlanta District does not currently have a pressing need for over-height and oversize vehicle detection and warning systems. There are some structures that have a clearance of less than 16 feet over the main lanes of the study corridors, with none being lower than 14 feet. Specifically, there is a concentration of low structures along I-30 in the vicinity of New Boston, and District staff noted that there have been a few incidents in the past 20 years where the structures have been hit, but staff indicated that these incidents were not occurring frequently enough for them to consider deploying over-height vehicle detection and warning. A review of CRIS data did not reveal any other locations of concern related to collisions involving structures.

System Operational Concept

System Operational Environment

This list describes the physical and operational environment of the ITS system such as the proposed location of the hardware equipment, hardware and software compatibility, accessibility of the hardware equipment, and the maintenance requirements. The system physical and operational environment is summarized below:

- The system will be primarily operated and monitored from the TxDOT Atlanta District Office, with after hours support from the TxDOT Dallas District DalTrans TMC. Both locations will use TxDOT's Lonestar ATMS to monitor and control the deployed DMS devices. The TxDOT Atlanta District Office will monitor and control deployed CCTVs via IP addresses entered into a web browser, and staff anticipate eventually migrating to a single platform for viewing all deployed CCTV in the region pending direction from the TxDOT Traffic Safety Division.
- The existing TxDOT Atlanta District Office TMC will monitor and control the system during weekday business hours. The TxDOT Dallas District DalTrans TMC will be responsible for monitoring the system at other times.
- The TxDOT Atlanta District will have at least one workstation with several monitors and with Lonestar installed to allow for monitoring and control of the ITS devices when needed.
- Deployed ITS devices in the TxDOT Atlanta District will communicate with the TMC via wireless cellular modems.
- The system will be operated and monitored from workstations located on the TxDOT local area network (LAN) or via a virtual private network (VPN) connection to this network.
- TxDOT staff will have the ability to log in to the system remotely via a VPN and will have full functionality consistent with their access level.
- The central server equipment for the ITS deployment will be housed in an air-conditioned environment at the TxDOT Atlanta District Office.
- The central server will be accessible via a virtual Windows server platform (maintained by the TxDOT Atlanta District IT staff) and will be able to be replaced independently from the device operating software.
- TxDOT Atlanta District operators will require training specific to the ITS devices that are deployed, with training detailed enough to allow them to set up, adjust, and fine tune all aspects of the system. The selected vendor will provide training on the installed equipment with support from the TxDOT Traffic Safety Division. This training will be included in the ITS equipment purchase price.
- Replacement or repair of defective or failed DMS equipment will be covered for five years after final acceptance by the manufacturers' warranties. The labor cost of replacement during this period will be included in the purchase price.
- The TxDOT Atlanta District expects performance monitoring and maintenance of DMS unit parts and equipment for a period of five years will be included in the purchase price.

System Support Environment

Table 9 describes the support environment envisioned for deployment of future ITS improvements, including facility requirements, hardware and software requirements, and personnel requirements. **Table 9** summarizes the various requirements of the envisioned ITS support environment.

Table 9: Support Environment Details

Support Environment Aspect	Detail
Facilities and Equipment Requirements	Existing TMCs at the TxDOT Atlanta District Office and the TxDOT Dallas District DalTrans building will not require additional equipment. These facilities are access-controlled through TxDOT District information technology policy and are maintained by TxDOT staff.
Utility Requirements	Utilities to TxDOT buildings and server rooms will be maintained by TxDOT maintenance staff.
ITS Deployment Architecture Constraints	Servers and workstations will be protected within TxDOT firewalls. TxDOT Atlanta District IT staff will provide resources, VPN access, equipment, and system management so that the ITS vendor may validate system operation as needed once devices have been installed. The operators will have appropriate access to the system locally, from within the TxDOT LAN and remotely via TxDOT VPN. Communications between the building and the field equipment will be via installed fiber optic cable.
Software Requirements	ITS devices will be controlled using Lonestar. TxDOT Atlanta District IT Staff administer the software on District workstations. Through Lonestar, CCTV images and DMS messages will be made available on the TxDOT ITS Website for use by the public.
Personnel Requirements	Existing TxDOT Atlanta District staff who already monitor and operate ITS devices at a TMC will incorporate monitoring and operation of the proposed ITS devices into their existing duties. No additional personnel are required to operate this system.
Maintenance Requirements	Basic maintenance of field equipment will be performed by TxDOT Atlanta District staff on an as needed basis.
Disposal Requirements	At the end of its useful life, the system’s devices will be disposed of in accordance with TxDOT practices.

Operating Agreements

To allow for cooperative monitoring or control of the proposed improvements, the TxDOT Atlanta District will pursue the following operating agreements with other TxDOT Districts and partner agencies:

- The TxDOT Atlanta District will maintain its existing agreement with the TxDOT Dallas District DalTrans TMC to allow DalTrans TMC staff to monitor and control new ITS devices in the TxDOT Atlanta District outside of weekday business hours.
- The TxDOT Atlanta District will pursue an agreement with ODOT, ARDOT, and LADOTD to allow staff from these agencies to view camera images and DMS messages being deployed along I-30, I-20, US 59, and I-369.
- The TxDOT Atlanta District will pursue agreements with the City of Texarkana, the City of Marshall, and the City of Mount Pleasant to allow staff from public safety and transportation agencies in these jurisdictions to view camera images and DMS messages being deployed along I-30, I-20, I-369, and US 59 and other spot locations in the TxDOT Atlanta District.

Applicable ITS Standards

Standards are an important tool that allow efficient implementation of the ITS elements in each project. Standards facilitate deployment of interoperable systems at local, regional, and national levels without impeding innovation as technology advances, vendors change, and as new approaches evolve. Establishing and implementing ITS standards can allow interchangeability and upgrades without being tied to a single vendor and can ultimately reduce costs by facilitating greater competition. ITS standards are developed by many different organizations, such as the American National Standards Institute (ANSI), National Transportation Communications for ITS Protocol (NTCIP), American Society for Testing and Materials (ASTM), Institute of Electrical and Electronics Engineers (IEEE), and Society of Automotive Engineers (SAE).

The proposed ITS improvements and all other incidental ITS equipment and traffic control components that are necessary for system operation should conform to the relevant ITS standards referenced in the Atlanta District Regional ITS Architecture. **Table 10** outlines the applicable standards that relate to the proposed ITS improvements.

Table 10: Applicable ITS Standards for the Proposed Project

Group/Document ID	Title
NTCIP 1203	Object Definitions for Dynamic Message Signs
NTCIP 1205	Object Definitions for Closed Circuit Television (CCTV) Camera Control
NTCIP 1208	Object Definitions for Closed Circuit Television (CCTV) Switching
ITE TMDD	Traffic Management Data Dictionary (TMDD) and Message Sets for External Traffic Management Center Communications (MS/ETMCC)

Detailed System Needs and Requirements

FHWA publishes sample detailed system needs and requirements for the implementation of CCTV and DMS systems. Compliance with system requirements should be shown as part of the system and subsystem verification process and should be conducted after system installation and individual device testing.

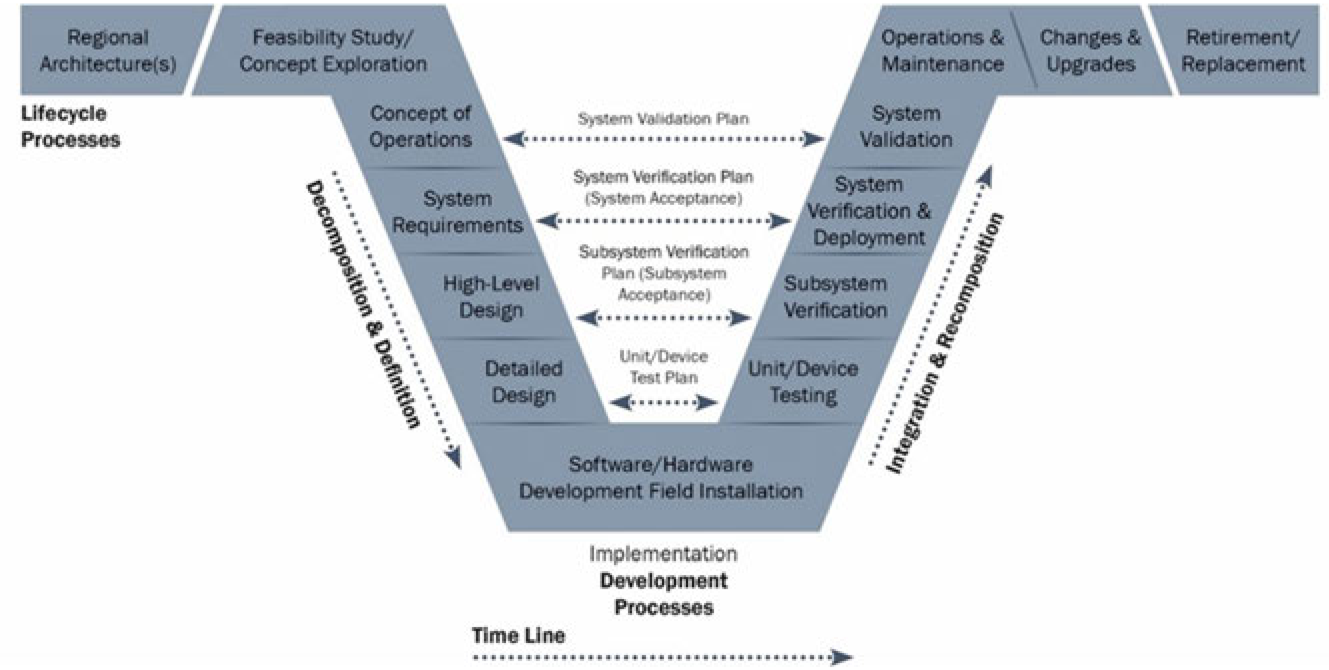
A list of model system requirements for CCTV deployments can be found at: https://ops.fhwa.dot.gov/publications/fhwahop18060/appb.htm.

A list of model system requirements for DMS deployments can be found at: https://ops.fhwa.dot.gov/publications/fhwahop18080/appb.htm.

Systems Engineering Analysis Process

The Federal Highway Administration (FHWA) utilizes a "V" method of systems engineering analysis and requires that any ITS projects funded by the Highway Trust Fund utilize this analysis method for system implementation. The "V" method, shown below in **Figure 32**, involves a before-and-after checklist for system validation, verification, testing, and integration. The analysis contained in this Concept of Operations document represents an initial step of defining the proposed system, establishing system needs and objectives, and developing planning-level recommendations and cost estimates. This document also incorporates some preliminary system requirements and high-level design, which are the next steps in the systems engineering analysis "V" method.

Figure 32: Systems Engineering "V" Diagram



As the proposed ITS improvements are designed and installed, the TxDOT Atlanta District should consider how staff will test individual devices, verify that the system elements are functioning as planned, and finally validate that the installed system fulfills each of the system goals and objectives listed in this document. All these steps should be completed as part of the systems engineering process to confirm that the system is installed as planned.

Unit and device testing refers to the need to test individual components of the proposed system prior to comprehensively testing the system. A test plan should be developed for each deployed ITS device to confirm that each device individually is functioning as designed. These test plans should be used to verify acceptable performance of individual CCTV cameras and DMS units.

The system verification plan should describe the required functions of each part of the ITS system that will allow for full system compliance. Each of the ITS system requirements should be verified by the vendor during the procurement process. If a requirement is not attainable or applicable to the ITS vendor, then the TxDOT Atlanta District can determine whether the needs that correspond to the unattainable requirements should be revisited. The verification plan should be submitted to the TxDOT Atlanta District for approval prior to implementing the ITS infrastructure. After implementation, these functions can be checked in the field to confirm they are working as designed. All verification procedures should require the presence of the vendor and District staff to be on site at the TxDOT Atlanta District Office and in the field, as necessary, during the verification of the ITS infrastructure. Each system requirement should be verified by the vendor in the presence of TxDOT Atlanta District staff or their designated representative.

System validation refers to both short and long-term performance monitoring of the proposed ITS improvements. The validation plan is meant to check the compliance of the system with the system goals and objectives established in this document. After the system has been installed, it should be checked to confirm its operations comply with system goals. The ITS system operator (assigned by TxDOT Atlanta) should conduct the validation tests, record the results, and prepare summary reports of the results for presentation to the rest of the District. The validation tests should be conducted after the system deployment and verification tests are complete. The system operator should configure system software to set up the required performance measures to collect and process data for validation tests. The system operator may need to observe operation in the field or via CCTV cameras to measure outcomes of some of the validation tests.

Once operational, it is imperative that ongoing performance measurements of the system be collected over time to promote continual use of the ITS system, or to improve upon the ITS operation by adjusting variables as deemed necessary. Those monitoring and collection intervals should be selected by the TxDOT Atlanta District to best fit their needs and schedule. It should be noted that variables within the ITS system will periodically require adjustment. TxDOT Atlanta District staff should be able to make minor adjustments to the ITS system themselves so that it continues to operate well.

Operational Scenarios for the Proposed System

Operational scenarios demonstrate how the proposed ITS improvements will assist the TxDOT Atlanta District in responding to typical incidents that might impact traffic operations. Scenarios include:

1. Standard system operations
2. A major crash near Marshall resulting in a full closure along I-20 westbound
3. A severe weather event in northeast Texas causing significant ice accumulation
4. Major planned road work that constricts I-30 through Texarkana to one lane in each direction on a weekday night

The operational scenarios show how the TxDOT Atlanta District will use proposed ITS infrastructure improvements to respond to each situation and coordinate with other agencies in Texas, Louisiana, Arkansas, and Oklahoma.

Scenario 1: Standard Operations

Scenario 1 describes standard operation of the TxDOT Atlanta District Office signal shop on a weekday, when no atypical conditions are affecting roadway capacity or operations. All freeway main lanes, frontage roads, and other key routes are fully open.

Figure 33: Scenario 1 - Standard Operations

TxDOT Atlanta District Office staff arrive at the office by 8:00 AM. The TxDOT Atlanta District Office signal shop begins to monitor traffic operations along I-30, I-20, I-369, and US 59 via the CCTV camera units deployed throughout the region. Display monitors at the District Office pull up camera feeds from locations within the District by individual camera IP addresses as needed and uses Lonestar ATMS to update DMS. A display screen shows a real-time Google map that displays green-orange-red link speeds. The TxDOT Atlanta District Office also has a workstation installed that can display CCTV feeds across several monitors on a video wall.

CCTV cameras can be used to confirm that the DMS messages displayed to the public match the DMS messages shown in Lonestar. Wall-mounted screens have been installed to display feeds from the CCTV cameras installed as a part of this operational scenario so that office staff working in the room can passively view road conditions.

DMS messages display either public service announcements (PSAs) or current travel times from INRIX. Travel times are typically shown to major destinations: within the TxDOT Atlanta District, destinations include the City of Texarkana, Mount Pleasant, Marshall, Atlanta, I-30, I-20, or US 59; beyond the TxDOT Atlanta District, destinations include the Arkansas state line, Louisiana state line, Longview, Tyler, Dallas, and Fort Worth. When applicable, these messages may be changed to display other local information, like Amber Alerts, Silver Alerts, or weather alerts. DMS messages, as well as CCTV still images, are also automatically posted online at the TxDOT ITS website for public view.

While no dedicated TxDOT Atlanta District staff actively monitor the CCTV and DMS on a full-time basis, TxDOT Atlanta District Office staff are available to respond if any atypical incidents are reported, like a major crash, a major forecasted weather event, or a new planned construction-related closure. Several sources can provide information about atypical incidents, including local police, local emergency response, DPS staff, the NWS, other TxDOT staff from TxDOT Atlanta or neighboring TxDOT districts, LADOTD, or ARDOT.

TxDOT Atlanta District Office staff end the workday at 5:00 PM. After standard business hours, the TxDOT Atlanta District Office hands off overnight and weekend operations to the TxDOT Dallas District DalTrans TMC. If major events are planned, The TxDOT Atlanta District Office calls the DalTrans TMC to relay any pertinent information, including status updates and items to monitor. After 5:00 PM, the DalTrans TMC incorporates surveillance of TxDOT Atlanta District ITS into its normal monitoring responsibilities.

Scenario 2: Major Crash

Scenario 2 involves a multi-vehicle crash on westbound I-20, one mile east of the State Highway 43 Interchange. The crash occurs at 8:40 AM on a weekday morning and involves a commercial vehicle whose saddle tanks have ruptured and are spilling diesel fuel, as well as several disabled passenger vehicles in the freeway median. Initial communication with first responders indicates that all westbound lanes and the inside eastbound lane will be closed for six to eight hours to allow for scene cleanup.

Figure 34: Scenario 2 – Major Crash and Full Westbound Freeway Closure

Shortly after the crash, the Atlanta District Office is notified of the crash by Texas DPS and the local fire department, who were notified of the crash through 911 calls. The Atlanta District Office staff can verify the exact location of the crash using CCTV cameras installed as a part of this operational scenario. With video confirmation, the Atlanta District Office staff tells Texas DPS that a commercial vehicle appears to be involved in the crash and that the vehicle appears to be leaking fuel from a ruptured saddle tank.

The Marshall Area Office staff also alert the TxDOT Atlanta District Office signal shop of the incident as it appears it will require a full closure of westbound I-20 for several hours. The TxDOT Atlanta District Office places messages on the DMS units in the vicinity of the crash along I-20 and US-59 to warn drivers of the crash ahead and provide information about the full westbound closure and single lane eastbound closure. The Marshall Area Office is in communication with the incident commander and dispatches staff to assist with temporary traffic control.

The first responders have reported multiple injuries. The diesel spill requires a special cleanup crew which can handle the hazardous material. The responding agency dispatches a crew from Dallas or Shreveport since no suitable hazardous material cleanup companies are based in Harrison County. The incident commander communicates to the Atlanta District Office an estimated incident clearance time of six to eight hours.

The Atlanta District Office notifies the District Public Information Officer of the incident, and they begin providing updates on the DriveTexas.org website and the TxDOT Atlanta District Twitter account regarding the incident and expected length of closure. The Public Information Officer also alerts members of the media so they can relay the closure information to their viewers. Although the Atlanta District Office staff initially used the CCTV cameras to monitor the incident, now that emergency response units are on-scene, CCTV cameras in the area are focused on traffic back-ups and end-of-queue monitoring.

The TxDOT Atlanta District Office posts two DMS messages on US 59, one north of Marshall to provide detour information via US 80 for southbound traffic, and one south of Carthage to provide detour information via SH 149 through Tatum for northbound traffic. A third message is posted to the westbound I-20 DMS at the Louisiana state line to provide detour information via US 80 through Marshall. The Atlanta District Office also coordinates with LADOTD to request that DMS messages be posted in Louisiana to alert westbound travelers of the closure. A message is posted on the eastbound DMS on I-20 near Longview to provide detour information via FM 450. Many travelers have begun exiting I-20 and are using SH 43, causing major delay on the alternate routes and local roads. The Atlanta District Office staff adjust signal timings along the detour routes during the closure to allow for better traffic flow through Marshall while incident cleanup continues. The Area Office staff communicate signal timing changes with City of Marshall staff so they are aware of impacts to cross streets.

The TxDOT Atlanta District Office continues to monitor the incident throughout the morning and early afternoon. The District Public Information Office representative continues to update the TxDOT Atlanta Twitter account, the DriveTexas.org website, and the media.

At approximately 3:30 PM the scene is cleared but traffic remains backed up. The Atlanta District Office operator changes the messages on the DMS to warn of congestion in the area of I-20 where the closure had been in effect. At approximately 4:00 PM the congestion has dissipated and all information from the DMS and DriveTexas.org website regarding the closure is removed. The District Public Information Office representative updates the TxDOT Atlanta Twitter account to let drivers know the incident is cleared, and the media is also alerted so they will no longer broadcast information about the closure.

After the incident has been resolved, an after-action review meeting is scheduled with Texas DPS sometime in the following several weeks to review this incident and any other significant incidents from the same time period. The after-action review meeting identifies internal improvements which could benefit the region’s response to similar incidents in the future.

Scenario 3: Severe Weather Event

Scenario 3 involves an early February major winter storm that has been predicted for most of northeast Texas, including the TxDOT Atlanta District. Forecasts have been projecting these conditions for the three days leading to the beginning of the storm. When it arrives, the storm brings more ice then was anticipated and travel conditions quickly deteriorate. The storm moves into the area around 8:00 PM on a weekday evening, and although the Atlanta District Office is only operational during business hours, many District staff members remain on duty to assist with monitoring and responding to the storm. An Arctic cold front that is accompanying the storm means there will be little snow melt for several days.

Figure 35: Scenario 3 – Severe Weather Event

With the winter storm predicted for several days in advance, the TxDOT Atlanta District staff have been working to make sure that CCTV cameras and DMS are all functioning. Maintenance section staff are assigned to regions that blanket the areas expected to be affected by the storm, with an additional unit on call in each region for backup. District operations staff have made arrangements to be in the District Office on the evening when the storm is predicted to arrive and have also arranged for other select staff to be available in shifts 24-hours per day for the next two days while the storm moves across the area. Two days before the storm, DMS messages are put up informing drivers that ice prevention operations are occurring along I-30, I-20, I-369, and US 59.

The Atlanta District Office coordinates with Texas DPS and emergency response personnel from the Cities of Texarkana, Marshall, and Mount Pleasant. Before the storm begins, staff from these agencies and the National Weather Service all participate in a preparatory conference call. Participants on this call discuss the forecasted storm, identify points of contact at each agency, and share response plans. While the winter storm is ongoing and during the response effort, information is shared between the TxDOT Atlanta District Office, Texas DPS, and the cities regarding any crashes and crash response, traffic delays, and road closures.

The Atlanta District Office is in communication with the National Weather Service to receive accurate and up-to-date information about the status of weather events. The District Office continues to receive forecast updates to make decisions in response to expected temperature and precipitation changes.

District Maintenance staff have pre-treated the roads, but visual confirmation of key corridors using CCTV cameras shows that more ice has arrived than was expected. Due to the additional ice, the region's network is severely impacted during the initial stages of the storm and Texas DPS determines that portions of I-30 and I-369 in the Texarkana vicinity should be closed. CCTV cameras also provide visual confirmation that ice has accumulated on the US 59 bridges over the Sulphur River and on SH 8 over Wright Patman Lake. District Maintenance Sections are directed by the District Office staff to quickly respond to these locations and close the roadway.

The TxDOT Atlanta District Office places messages regarding the closures on DMS across the region. The Cities of Texarkana, Marshall, and Mount Pleasant are also alerted so City staff can activate detour routes. Once a detour route has been determined, if it is in effect for an extended period, the City of Texarkana, Marshall, or Mount Pleasant staff deploys detour signage when safe to do so. If the Public Information Office is not immediately available, the Atlanta District Operations office updates the DriveTexas.org website and the TxDOT Atlanta District Twitter account. If a representative from the Public Information Office is available, they are responsible for the updates to DriveTexas.org website and the Twitter account. The Atlanta District Public Information Officer also coordinates with the media throughout the winter storm, fielding media information requests.

Due to the closure of I-30, I-369, and the Sulphur River bridge on US 59 near the Arkansas border, the Atlanta District Office coordinates with the ARDOT statewide TMC to let their staff know that these roads are closed and provide them the opportunity to warn motorists on westbound I-30 of the closures. The TxDOT Atlanta District Office also coordinates with the TxDOT Dallas District DalTrans TMC, as well as the TxDOT Paris District.

The TxDOT Atlanta District Office and local agencies remain in close contact during the winter storm until travel conditions return to normal. Part of the constant communication between the transportation agencies occurs during the reopening of major corridors in the region. The District Public Information Officer continues to update the media, DriveTexas.org website, and the TxDOT Atlanta District Twitter account. Once conditions are back to normal, all DMS messages and detour signage are removed and the Public Information Officer updates the media, DriveTexas.org website, and the TxDOT Atlanta District Twitter account.

Scenario 4: Major Planned Road Work

Scenario 4 involves planned road work that will constrict I-30 through Texarkana to one eastbound lane and one westbound lane between 10:00 PM and 6:00 AM on a weekday night. This road work has been planned for several weeks, and the road work contract includes provisions for the deployment of several SWZ units in the eastbound and westbound directions at the approach to and within the work zone area. The TxDOT Atlanta Office is not actively staffed during this road work, but the Atlanta District Operations Director is on call.

Figure 36: Scenario 4 – Major Planned Road Work

Planned road work closures are initially relayed to the TxDOT project manager by the project contractor, and the project manager relays the closure information to the District Public Information Office and the Atlanta District Office. With the road work planned for weeks in advance, the Atlanta District Engineer and TxDOT Atlanta District Office staff have been working to confirm that CCTV cameras, DMS, and SWZ units around the planned closure are all functioning. TxDOT Atlanta District Office staff check with partners and project contractors for any concurrent or nearby closures and find none, as this coordination typically also occurs when closures are initially scheduled.

The Atlanta District Operations staff has reviewed the TxDOT SWZ Guidelines and used TxDOT's Go/No-Go Decision Tool to select the appropriate SWZ systems for contractors to deploy throughout this construction project. This phase of the project is expected to last for several weeks, resulting in long-term traffic impacts and the need for a variety of SWZ systems to enhance work zone management. Existing ITS infrastructure in the region, such as CCTV cameras and DMS units, enable the TxDOT Atlanta District Office to easily connect to these additional temporary ITS devices to expand monitoring capabilities. The segment of I-30 that passes through Texarkana services an AADT greater than 30,000, so the closures will likely lead to bottlenecking and long queues. Therefore, temporary queue detection and speed monitoring systems were implemented during the project to provide warning for drivers approaching congestion. Temporary travel time systems were chosen to be implemented in coordination with the speed monitoring systems to allow the District to disseminate travel information to the public and encourage drivers to take alternate routes, such as I-369 to SH 151.

In the weeks leading up to the closure, the District Public Information Officer prepares and distributes messages to the public regarding the time, duration, and location of the closure both through an opt-in email newsletter and through a project-specific website designed to share information about I-30 corridor reconstruction efforts. The messages are posted on eastbound and westbound DMS units along I-30 throughout the Atlanta District for at least three days in advance of the closure. The Atlanta District Office also coordinates with the City of Texarkana as well as the ARDOT Statewide TMC to inform their staff of the upcoming I-30 construction and provide them the opportunity to warn motorists on I-30 and adjacent roads of the closure. The information is also available on the TxDOT Atlanta District Twitter account, the DriveTexas.org website, and the TxDOT ITS website. The District Public Information Officer notifies the media as well.

Prior to the closure, mobile SWZ units are prepared for deployment and the District Office shares their status and location with the TxDOT Dallas District DalTrans TMC and ARDOT statewide TMC. The TxDOT Atlanta District currently does not participate in the Waze Connected Citizen Program, but if they begin participating in the future, District Office staff could inform Waze of the closure with at least 24 hours of notice as a part of the program. Coordinating with Waze allows the District to share real-time closure data with road users and allows TxDOT Atlanta District Office staff to receive Waze traffic data that can be used to monitor performance of road closures.

The TxDOT Dallas DalTrans TMC monitors the closure, but the Atlanta District Operations Director is on call and ready to assist where necessary. As the closure begins, the subcontractor sets up traffic control devices to close two main lanes, constricting I-30 to one lane in each direction. DMS messages are updated to state that the closure is currently in place. The DalTrans TMC monitors the closure remotely using CCTV cameras, updating construction messaging on permanent DMS along the corridor as necessary. The DalTrans TMC also monitors the closure for any atypical events, such as a crash or excessive queueing. Temporary queue detection systems and speed monitoring sensors are set up to communicate alerts back to the DalTrans TMC and the TxDOT Atlanta District Office signal shop. Most atypical events require only continued surveillance from the DalTrans TMC, but severe events like a major crash may require the TxDOT Atlanta District Office to be notified.

As the closure concludes around 6:00 AM, the subcontractor takes down the traffic control devices and DMS messages are removed. The DalTrans TMC communicates any unusual observations or other notes to the Atlanta District Office for review on the following business day.

System Costs

Cost Assumptions

Cost estimates in this section were developed from several February 2021 TxDOT Average Low Bid unit prices, including TxDOT Atlanta District 12-month averages, State 3-month averages, State 12-month averages, and State all data averages. Where possible, District average low bidding was used. When District average low bid pricing was not available, statewide pricing was used. If 3-month and 12-month significantly differed, their values were averaged.

CCTV pole sizes selected reflect typical installations. CCTV cameras were assumed to be mounted on 50-foot poles when located along a freeway or elevated highway segment and were assumed to be mounted on 40-foot poles in all other deployment locations. Foundation design for the CCTV cameras was based on TxDOT standard *ITS(4)* sheets. Typical ITS cabinet equipment is included with each CCTV, and power delivery for the CCTV cameras assumes minimal load and distance from electrical service.

DMS pole sizes also reflect typical installations. All DMS cabinets were assumed to be pole-mounted for a more conservative cost estimate. Foundation design for the DMS units was based on TxDOT standard *COSS* sheets. Typical ITS cabinet equipment is included with each DMS, and power delivery for the DMS cameras assumes minimal load and distance from electrical service.

The individual unit cost source for each item included in CCTV installation is shown in **Table 11** for installation on a 40-foot pole, and in **Table 12** for installation on a 50-foot pole. The individual unit cost source for each item included in DMS installation is shown in **Table 13**. **Table 14** shows the cost per unit of ITS infrastructure that is used in projecting cost estimates for ITS installations along the remainder of the corridors and spot locations throughout the District.

Table 11: Cost Line Items for 40-foot CCTV Installation

Infrastructure Item	Item Code	Amount per Unit	Unit	Cost per Unit	Unit Cost Source	Total Cost per Unit
DRILL SHAFT (42 IN)	0416 6005	17	LF	$330	District 12 mo.	$5,610
RIPRAP (CONC) (CL B)	0432 6006	1.25	CY	$600	District (avg.)	$750
CONDT (PVC) (SCH 80) (2")	0618 6046	200	LF	$10	State (avg.)	$2,000
CONDT (PVC) (SCH 80) (2") (BORE)	0618 6047	100	LF	$33	District 12 mo.	$3,300
ELEC CONDR (NO.8) INSULATED	0620 6008	900	LF	$1.53	District 12 mo.	$1,377
GROUND BOX TY C (162911) W/APRON	0624 6008	3	EA	$1,235	State (avg.)	$3,705
ELC SRV TY A 120/240 060(NS)SS(E)SP(O)	0628 6009	1	EA	$6,000	State (avg.)	$6,000
CCTV FIELD EQUIPMENT (ANALOG)	6010 6001	1	EA	$6,300	State 12 mo.	$6,300
CCTV FIELD CONTROLLER	6010 6003	1	EA	$4,200	State 12 mo.	$4,200
CCTV MOUNT (POLE)	6010 6004	1	EA	$1,000	State (avg.)	$1,000
ITS POLE (40 FT) (90 MPH)	6064 6019	1	EA	$7,500	State 12 mo.	$7,500
ITS POLE MNT CAB (TY 2) (CONF 2)	6064 6084	1	EA	$6,200	State 12 mo.	$6,200
ETHERNET SWITCH (INSTALL ONLY)	6123 6001	1	EA	$800	State 3 mo.	$800
MPEG 4 VIDEO ENCODER (INSTALL ONLY)	6124 6001	1	EA	$400	State 12 mo.	$400
MPEG 4 VIDEO ENCODER (FORCE ACCOUNT)	N/A	1	EA	$1,500	N/A	$1,500
ETHERNET SWITCH (FORCE ACCOUNT)	N/A	1	EA	$1,500	N/A	$1,500
CELLULAR MODEM (FORCE ACCOUNT)	N/A	1	EA	$1,800	N/A	$1,800
					Total Unit Cost	$53,942

Table 12: Cost Line Items for 50-foot CCTV Installation

Infrastructure Item	Item Code	Amount per Unit	Unit	Cost per Unit	Unit Cost Source	Total Cost per Unit
DRILL SHAFT (42 IN)	0416 6005	17	LF	$330	District 12 mo.	$6,930
RIPRAP (CONC) (CL B)	0432 6006	1.25	CY	$600	District (avg.)	$750
CONDT (PVC) (SCH 80) (2")	0618 6046	200	LF	$10	State (avg.)	$2,000
CONDT (PVC) (SCH 80) (2") (BORE)	0618 6047	100	LF	$33	District 12 mo.	$3,300
ELEC CONDR (NO.8) INSULATED	0620 6008	900	LF	$1.53	District 12 mo.	$1,377
GROUND BOX TY C (162911) W/APRON	0624 6008	3	EA	$1,235	State (avg.)	$3,705
ELC SRV TY A 120/240 060(NS)SS(E)SP(O)	0628 6009	1	EA	$6,000	State (avg.)	$6,000
CCTV FIELD EQUIPMENT (ANALOG)	6010 6001	1	EA	$6,300	State 12 mo.	$6,300
CCTV FIELD CONTROLLER	6010 6003	1	EA	$4,200	State 12 mo.	$4,200
CCTV MOUNT (POLE)	6010 6004	1	EA	$1,000	State (avg.)	$1,000
ITS POLE (50 FT) (90 MPH)	6064 6037	1	EA	$10,000	State 12 mo.	$10,000
ITS POLE MNT CAB (TY 2) (CONF 2)	6064 6084	1	EA	$6,200	State 12 mo.	$6,200
ETHERNET SWITCH (INSTALL ONLY)	6123 6001	1	EA	$800	State 3 mo.	$800
MPEG 4 VIDEO ENCODER (INSTALL ONLY)	6124 6001	1	EA	$400	State 12 mo.	$400
MPEG 4 VIDEO ENCODER (FORCE ACCOUNT)	N/A	1	EA	$1,500	N/A	$1,500
ETHERNET SWITCH (FORCE ACCOUNT)	N/A	1	EA	$1,500	N/A	$1,500
CELLULAR MODEM (FORCE ACCOUNT)	N/A	1	EA	$1,800	N/A	$1,800
					Total Unit Cost	$57,762

Table 13: Cost Line Items for DMS Installation

Infrastructure Item	Item Code	Amount per Unit	Unit	Cost per Unit	Unit Cost Source	Total Cost per Unit
DRILL SHAFT (48 IN)	0416 6006	25	LF	$510	State (avg.)	$12,750
CONDT (PVC) (SCH 80) (2")	0618 6046	200	LF	$10	State (avg.)	$2,000
CONDT (PVC) (SCH 80) (2") (BORE)	0618 6047	100	LF	$33	District 12 mo.	$3,300
ELEC CONDR (NO.6) INSULATED	0620 6010	900	LF	$1.45	District 12 mo.	$1,305
GROUND BOX TY C (162911) W/APRON	0624 6008	3	EA	$1,235	State (avg.)	$3,705
ELC SRV TY A 120/240 060(NS)SS(E)SP(O)	0628 6009	1	EA	$6,000	State (avg.)	$6,000
INS OH SN SUP (30 FT BAL TEE)	0650 6028	1	EA	$30,000	District 12 mo.	$30,000
SIGN WALKWAY (36 IN) WITH HNDRL	0654 6004	61	LF	$270	District 12 mo.	$16,470
INSTALL DMS (POLE MTD CABINET)	6028 6001	1	EA	$26,000	State 12 mo.	$26,000
ETHERNET SWITCH (INSTALL ONLY)	6123 6001	1	EA	$800	State 3 mo.	$800
DMS UNIT (FORCE ACCOUNT)	N/A	1	EA	$115,000		$115,000
ETHERNET SWITCH (FORCE ACCOUNT)	N/A	1	EA	$1,500		$1,500
CELLULAR MODEM (FORCE ACCOUNT)	N/A	1	EA	$1,800		$1,800
					Total Unit Cost	$220,630

Table 14: Total Rounded Costs for Each Installation

Infrastructure Item	Rounded Cost per Unit
40’ CCTV	$53,940 EA
50’ CCTV	$57,760 EA
DMS	$220,600 EA

Procurement and Installation Costs

Up-front costs for the ITS system installation include the procurement and installation costs for the CCTV cameras, DMS units, and related infrastructure. **Table 15** shows the estimated costs for these ITS items. The total cost is estimated to be $2,170,000 for the CCTV and DMS units.

Table 15: Estimated ITS Infrastructure Costs

Priority	Infrastructure Item	Units Needed	Units	Cost per Unit	Total Cost
High Priority	40 FT CCTV	2	Each	$53,940	$107,880
	50 FT CCTV	4	Each	$57,760	$231,040
	DMS	1	Each	$220,600	$220,600
Medium Priority	40 FT CCTV	2	Each	$53,940	$107,880
	50 FT CCTV	7	Each	$57,760	$404,320
	DMS	4	Each	$220,600	$882,400
Low Priority	40 FT CCTV	4	Each	$53,940	$215,760
	50 FT CCTV	0	Each	$57,760	$0
	DMS	0	Each	$220,600	$0
OVERALL TOTAL FOR ALL ITEMS					$2,170,000

Recurring Costs

Over the life cycle of the proposed system, there will be recurring maintenance and power costs to allow the system to function properly. These costs are shown below in **Table 16.** Cost estimates are adapted from a study completed for the Wisconsin Department of Transportation in 2017.[8]

Table 16: Estimated Annual System Maintenance Cost

Infrastructure Item	Annual Unit Maintenance and Power Costs	Full Build-Out Units	Full Build-Out System Annual Cost
CCTV	$1,300	19	$24,700
DMS	$1,700	5	$8,500
Total System Annual Maintenance and Power Costs			$33,200

System Life Cycle

A typical design life for ITS projects is 20 years. It is anticipated that the proposed ITS improvements will have a 20-year design life. At the end of the useful life of each piece of infrastructure, the unit will be disposed of in accordance with Atlanta District procedures.

Key Takeaways

Key recommendations and takeaways from this report include:

- This report serves as an initial ITS concept of operations document for the TxDOT Atlanta District, prepared in part to demonstrate project conformance with the systems engineering analysis process required for all ITS projects funded through the Highway Trust Fund.
- As of April 2021, the TxDOT Atlanta District has deployed 19 CCTV cameras and 13 DMS units Districtwide.
- This report includes recommendations for the installation of 19 additional CCTV cameras and five additional DMS units to supplement the ITS devices that the District has previously deployed. Recommended deployments are classified as high, medium, or low priority.
- Installation of all recommended CCTV and DMS devices would cost an estimated $2.17 million, with ongoing upkeep costs for the new devices estimated at $33,200 per year.
- Recommendations are based on a review of recent crash data, volume data, identification of decision points and freeway ramp locations, and anecdotal accounts of surveillance needs shared by District staff.
- The TxDOT Atlanta District is the lead project stakeholder. Other potential stakeholders include the TxDOT Dallas District DalTrans TMC, neighboring state DOTs, and municipalities along freeways within the District.
- The TxDOT Atlanta District Regional ITS Architecture, last updated in 2003, would require minor updates for the project proposed in this report to show conformance.
- Beyond CCTV and DMS, the report includes recommendations for the TxDOT Atlanta District to expand its use of smart work zone systems and probe-based traffic data. The TxDOT Traffic Safety Division provides resources that can assist the District with implementation.
- Several other ITS concepts including road weather information systems, truck parking information management systems, and safety service patrol program were considered but not recommended for implementation at this time in the TxDOT Atlanta District.
- The report includes an operational concept to provide guidance on how the overall ITS deployment would operate as a single system to aid the District with traffic management.
- Four operational scenarios are included in the report. These scenarios describe how the proposed system could be used in everyday District operations, as well as in response to events that impact traffic flow such as a major crash, a severe winter weather event, or planned road work.

References

1. Texas Department of Transportation. (2019). *C.R.I.S. Query – Crash Records Information System*. C.R.I.S. Query. Retrieved from https://cris.dot.state.tx.us/public/Query/app/welcome

2. Texas Department of Transportation. (2019). *Traffic Count Database System (TCDS).* Retrieved from https://txdot.public.ms2soft.com/tcds/tsearch.asp?loc=Txdot&mod=TCDS

3. Texas Department of Transportation. (2003). *State of Texas Regional ITS Architectures and Deployment Plans – Atlanta Region.* Retrieved from http://www.consystec.com/texas/web/atlanta/files/atlantaregionalITSarchitecture.pdf

4. Texas Department of Transportation. (2018). *Smart Work Zone Guidelines*. Retrieved from https://ftp.txdot.gov/pub/txdot-info/trf/smart-work-zone-guidelines.pdf

5. Texas Department of Transportation. (2018). *Smart Work Zone System Go/No-Go Decision Tool*. Retrieved from https://www.txdot.gov/inside-txdot/division/traffic/smart-work-zones.html

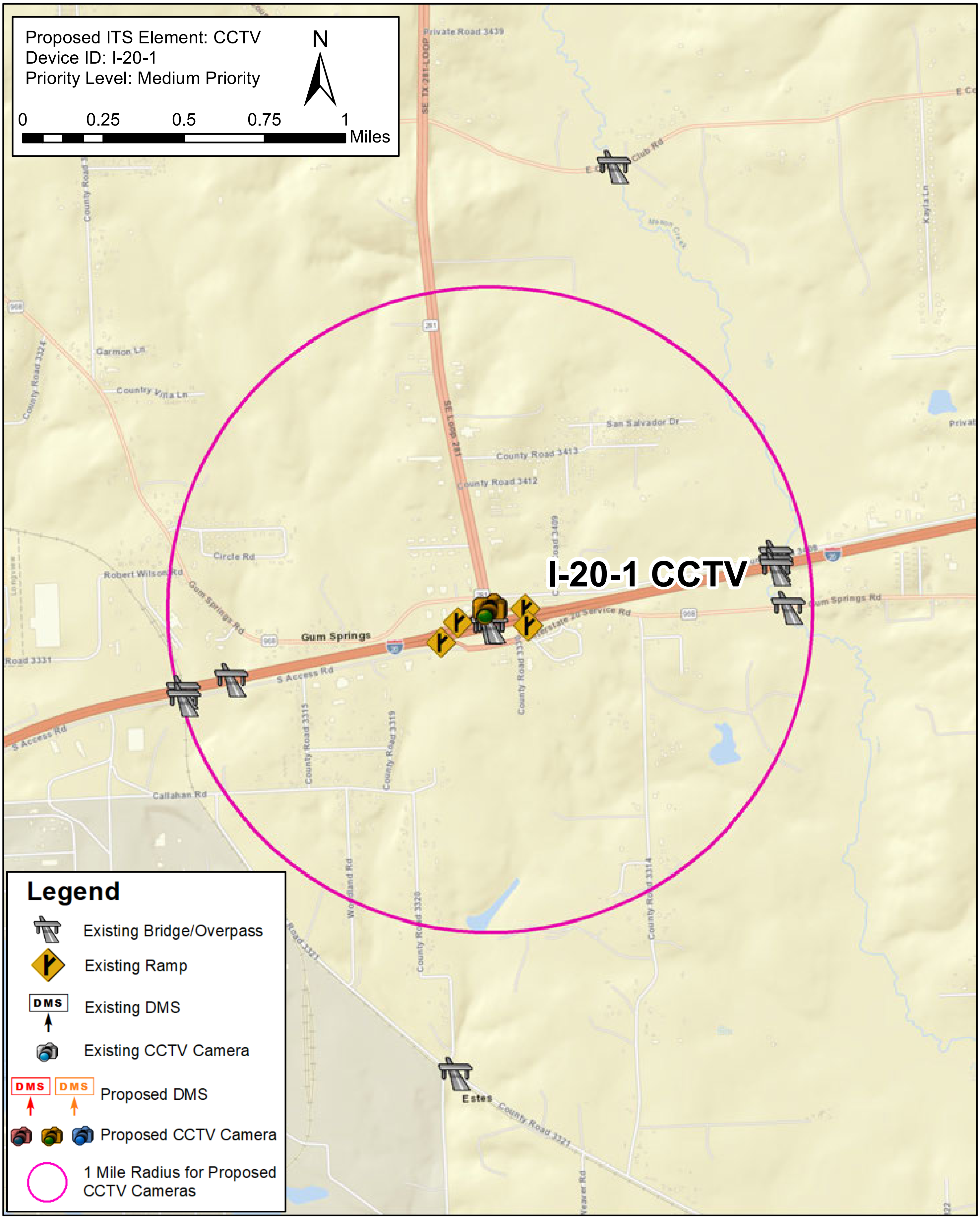
6. Texas A&M Transportation Institute. (2014). *Wrong Way Driving Countermeasures (Report No. FHWA-TX-15/0-6769-1)*, 92*.* Retrieved from https://static.tti.tamu.edu/tti.tamu.edu/documents/0-6769-1.pdf

7. Texas Department of Transportation. (2020). *Truck Parking Demand in Dedicated and Unauthorized Locations Memo*, 82. Retrieved from ftp://ftp.txdot.gov/pub/var/ftp/pub/txdot/move-texas-freight/studies/truck-parking/technical-memos/3.pdf

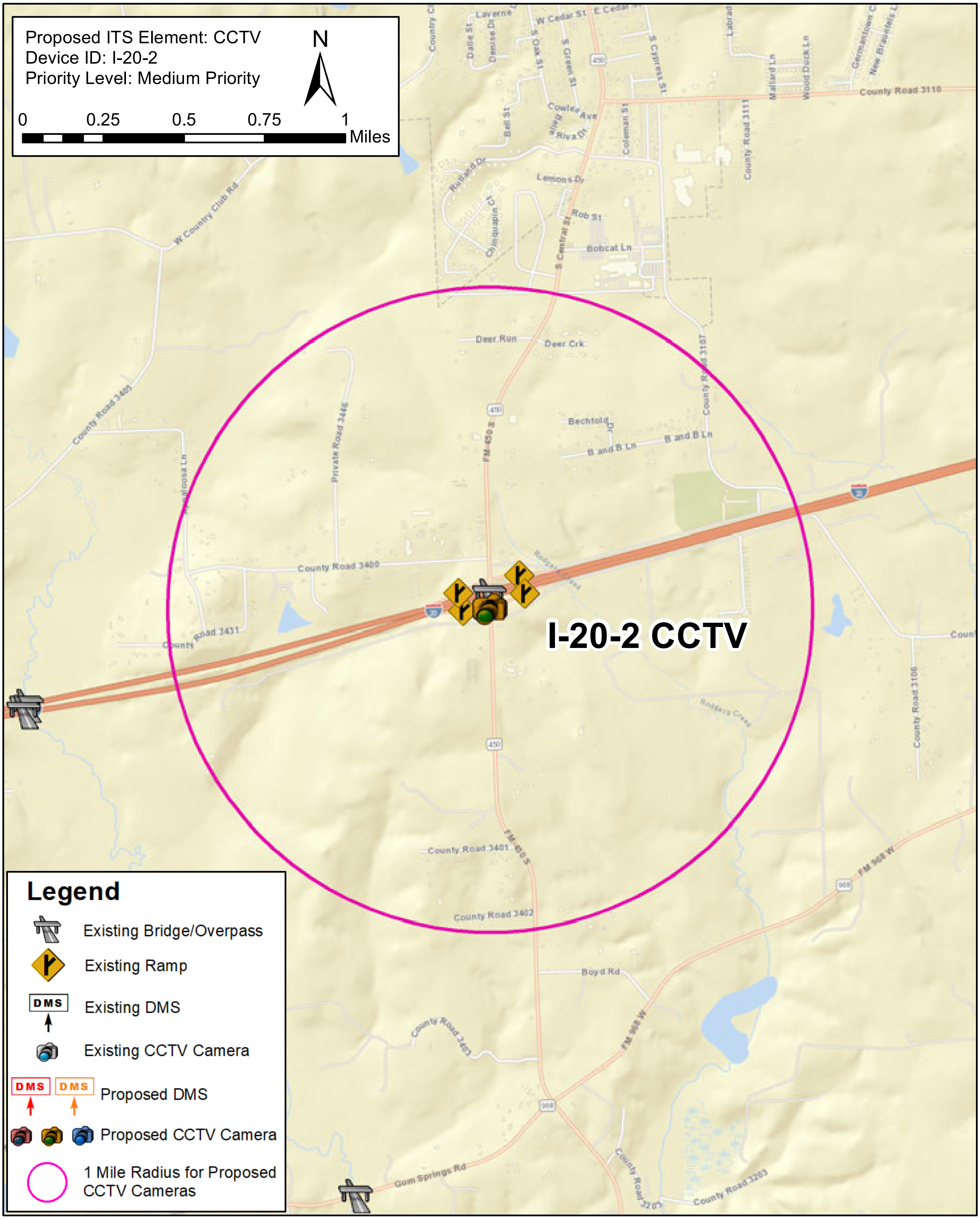
8. USDOT Intelligent Transportation Systems Joint Program Office. (2017). *Statewide annual O&M for 410 CCTV cameras and 139 DMS units.* Retrieved from https://www.itskrs.its.dot.gov/its/benecost.nsf/ID/4e0497ba4da4411a852581590062e301

Appendix A – Location Detail Maps for Recommended ITS Devices

Proposed CCTV Camera and DMS Sign Locations

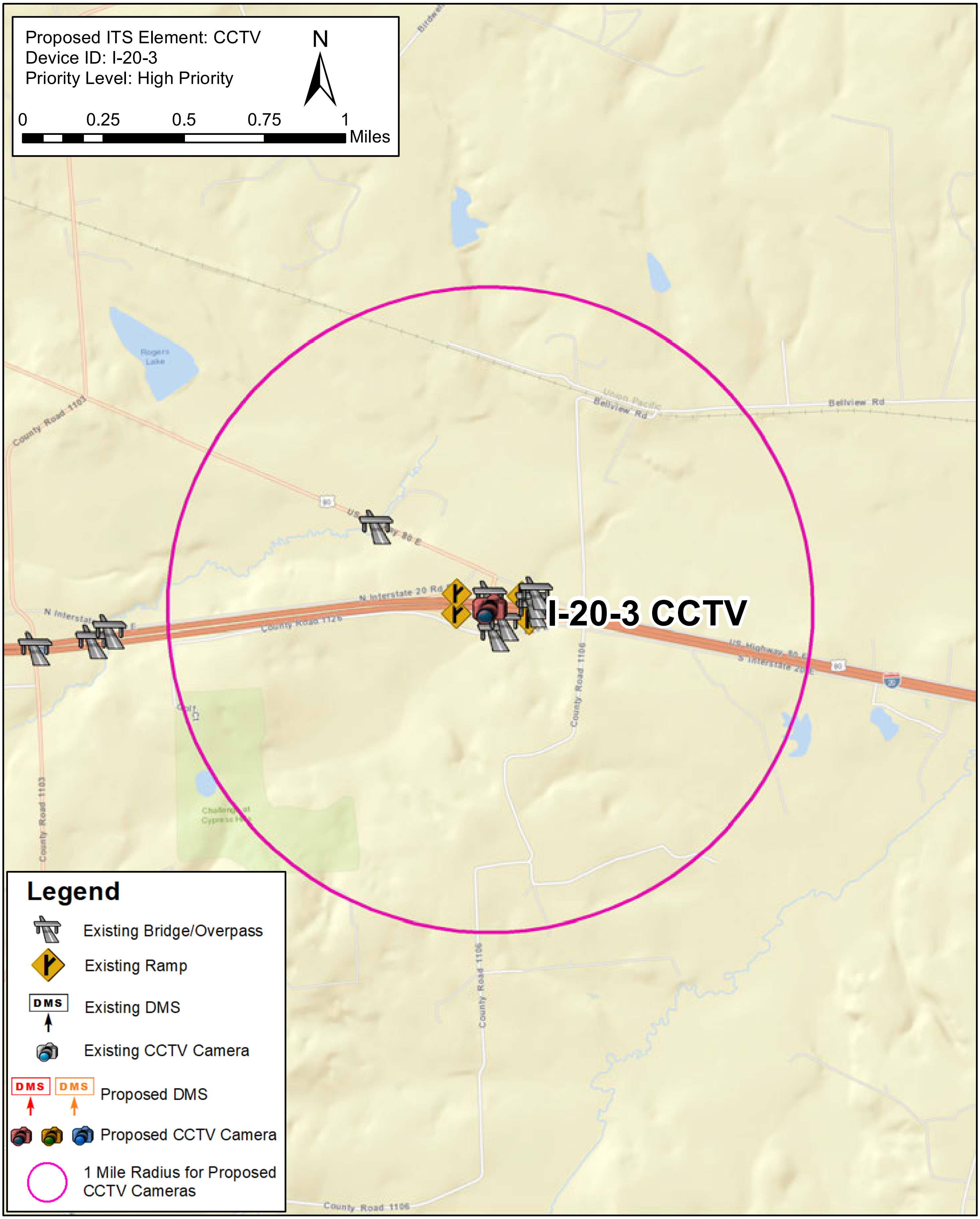


Proposed CCTV Camera and DMS Sign Locations



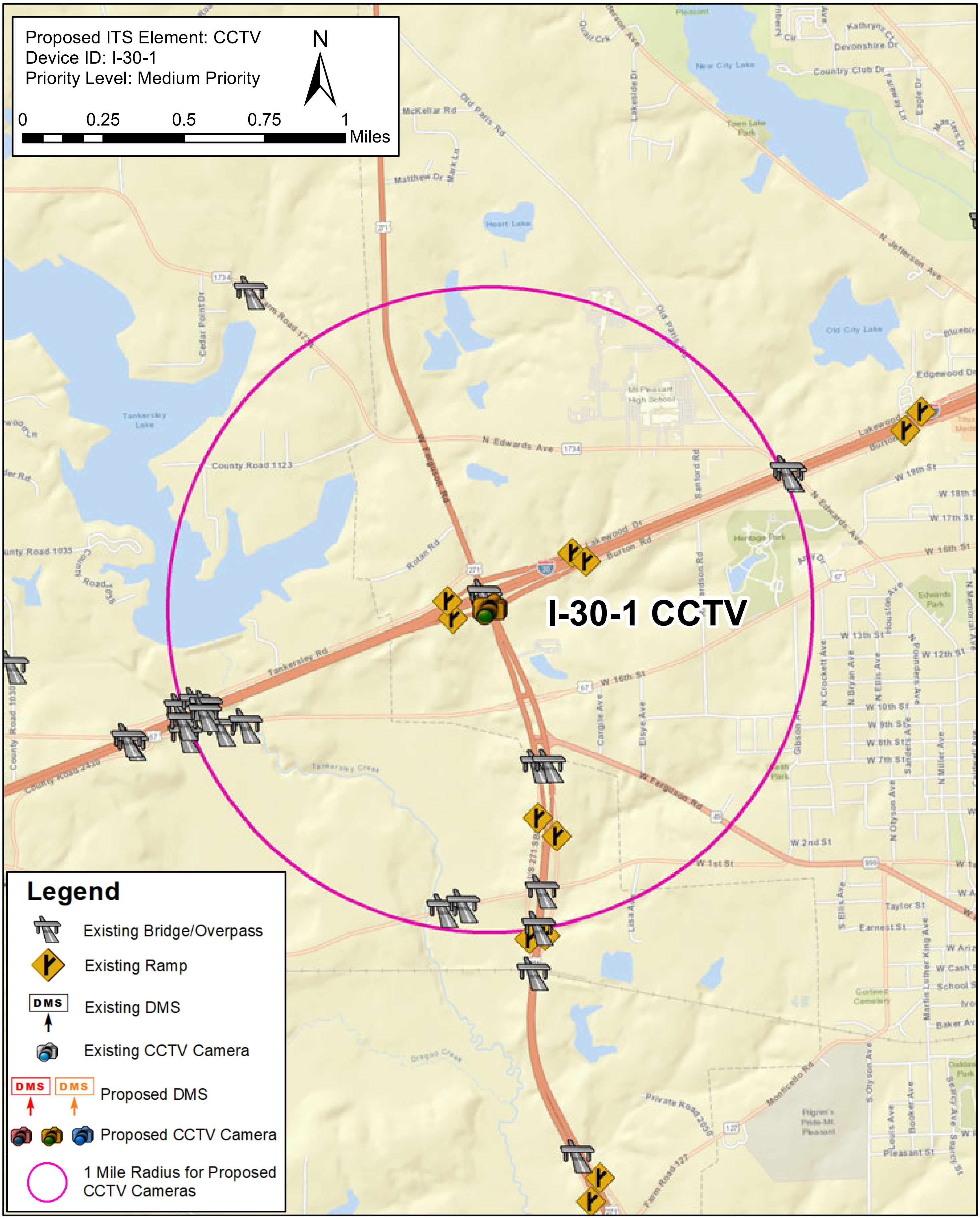
Proposed ITS Element: CCTV
Device ID: I-20-2
Priority Level: Medium Priority

Proposed CCTV Camera and DMS Sign Locations

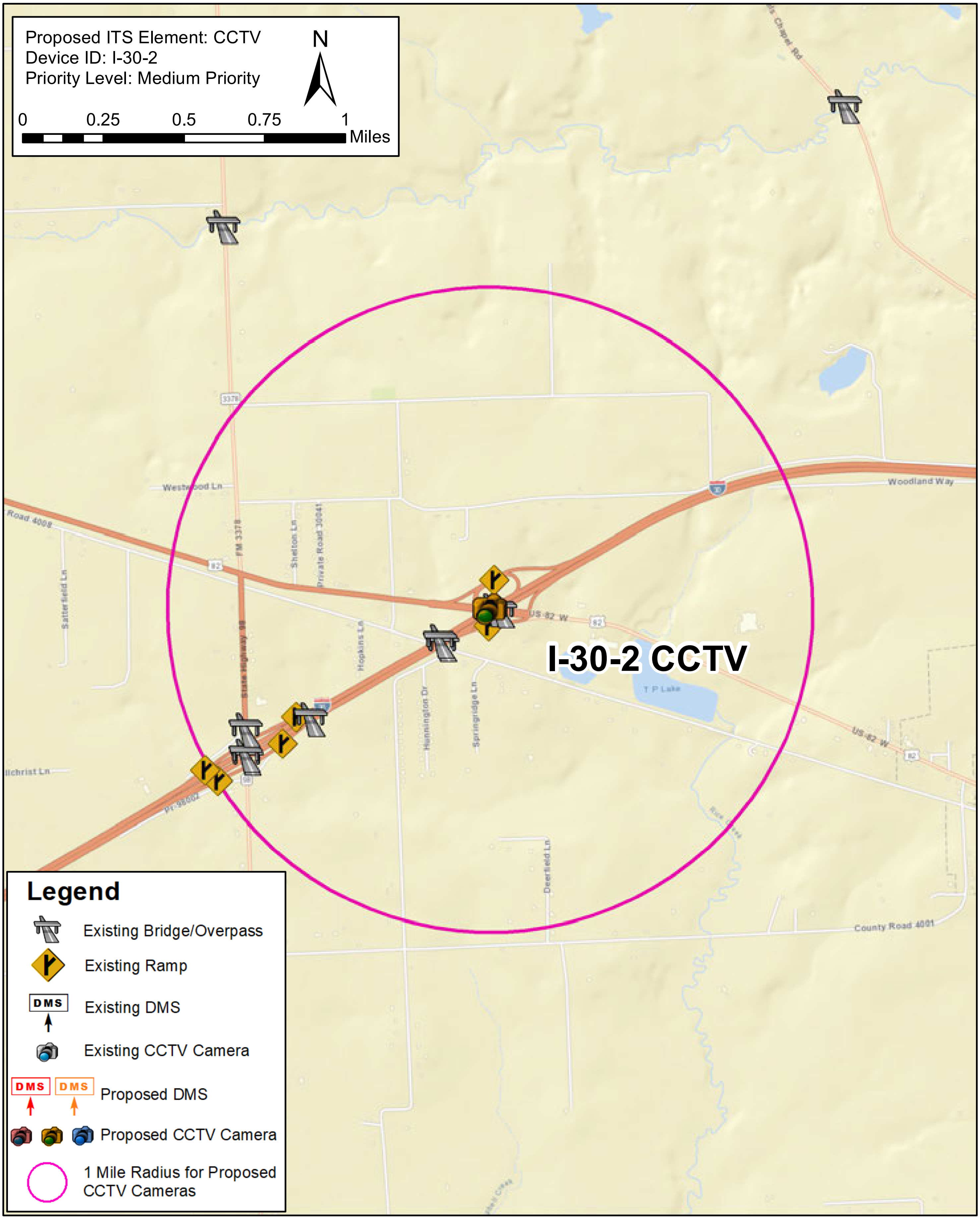


Proposed ITS Element: CCTV
Device ID: I-20-3
Priority Level: High Priority

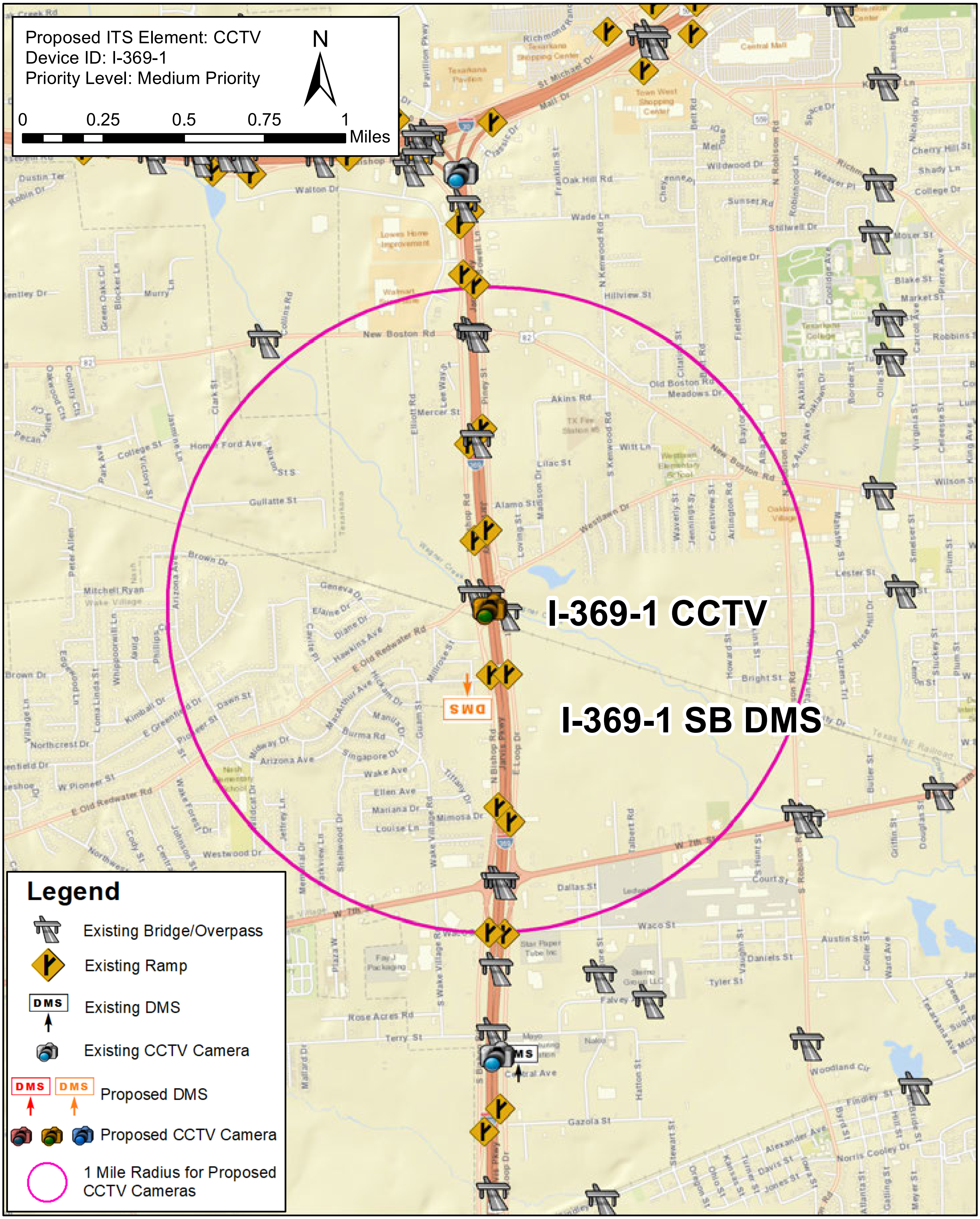
Proposed CCTV Camera and DMS Sign Locations



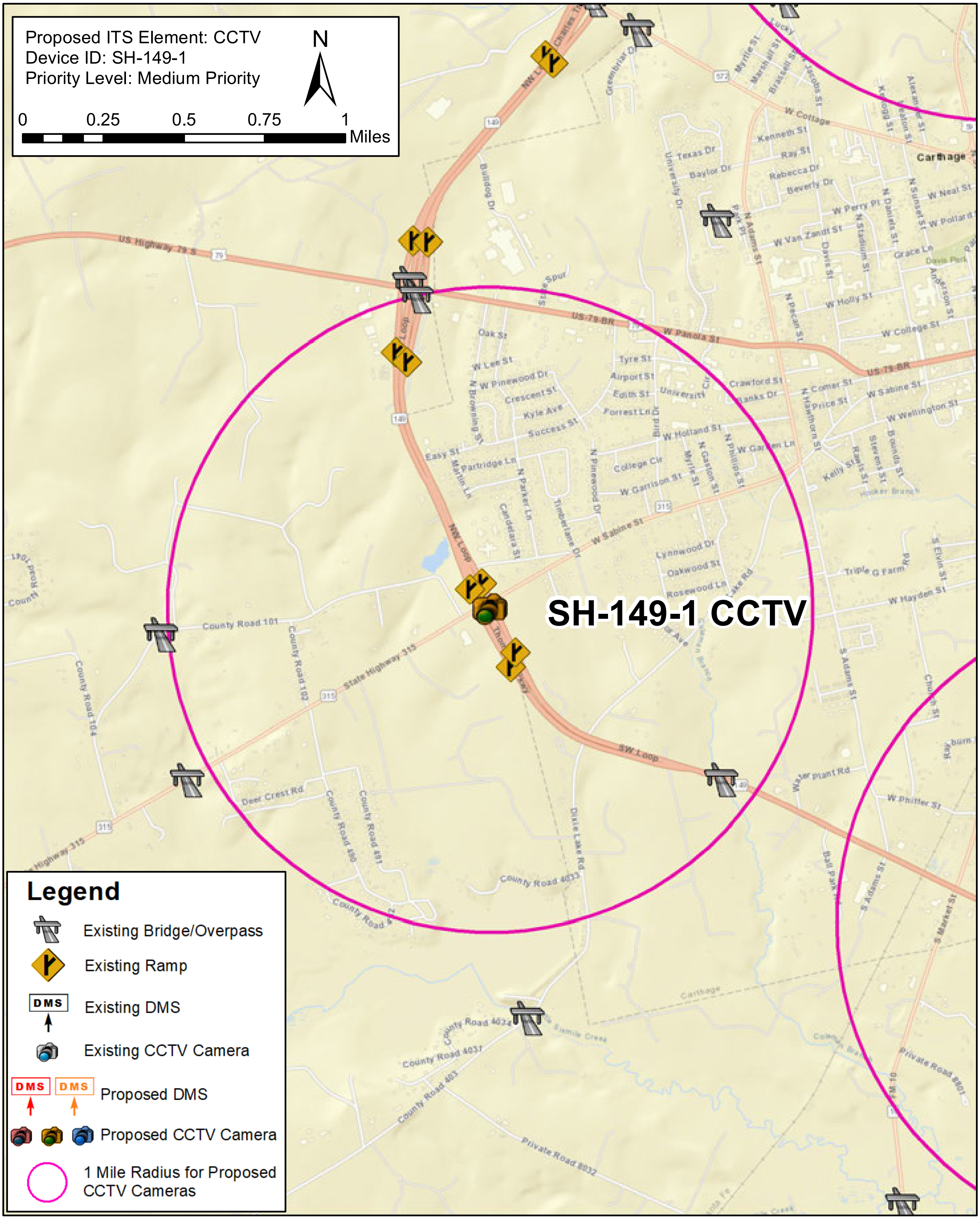
Proposed CCTV Camera and DMS Sign Locations



Proposed CCTV Camera and DMS Sign Locations

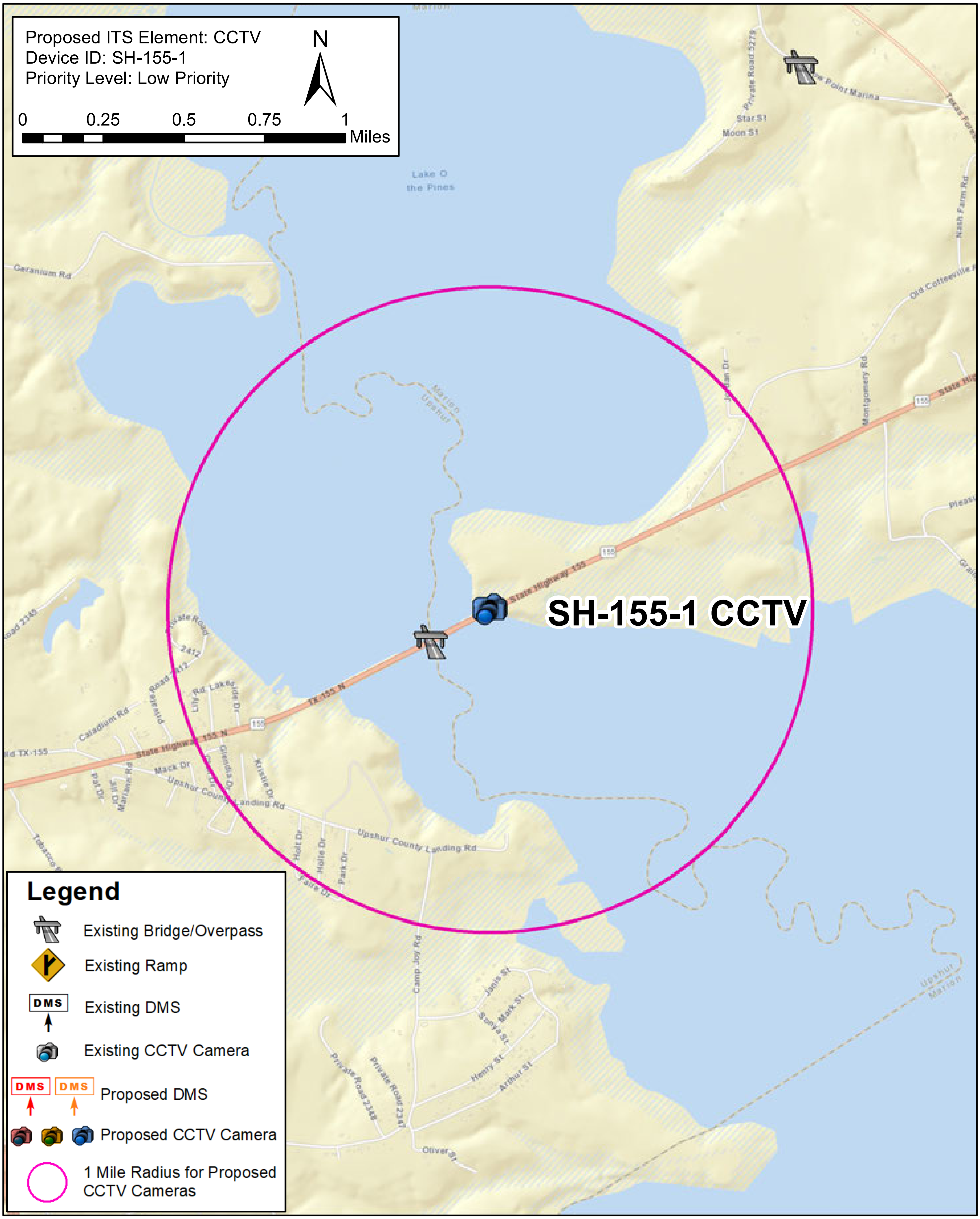


Proposed CCTV Camera and DMS Sign Locations

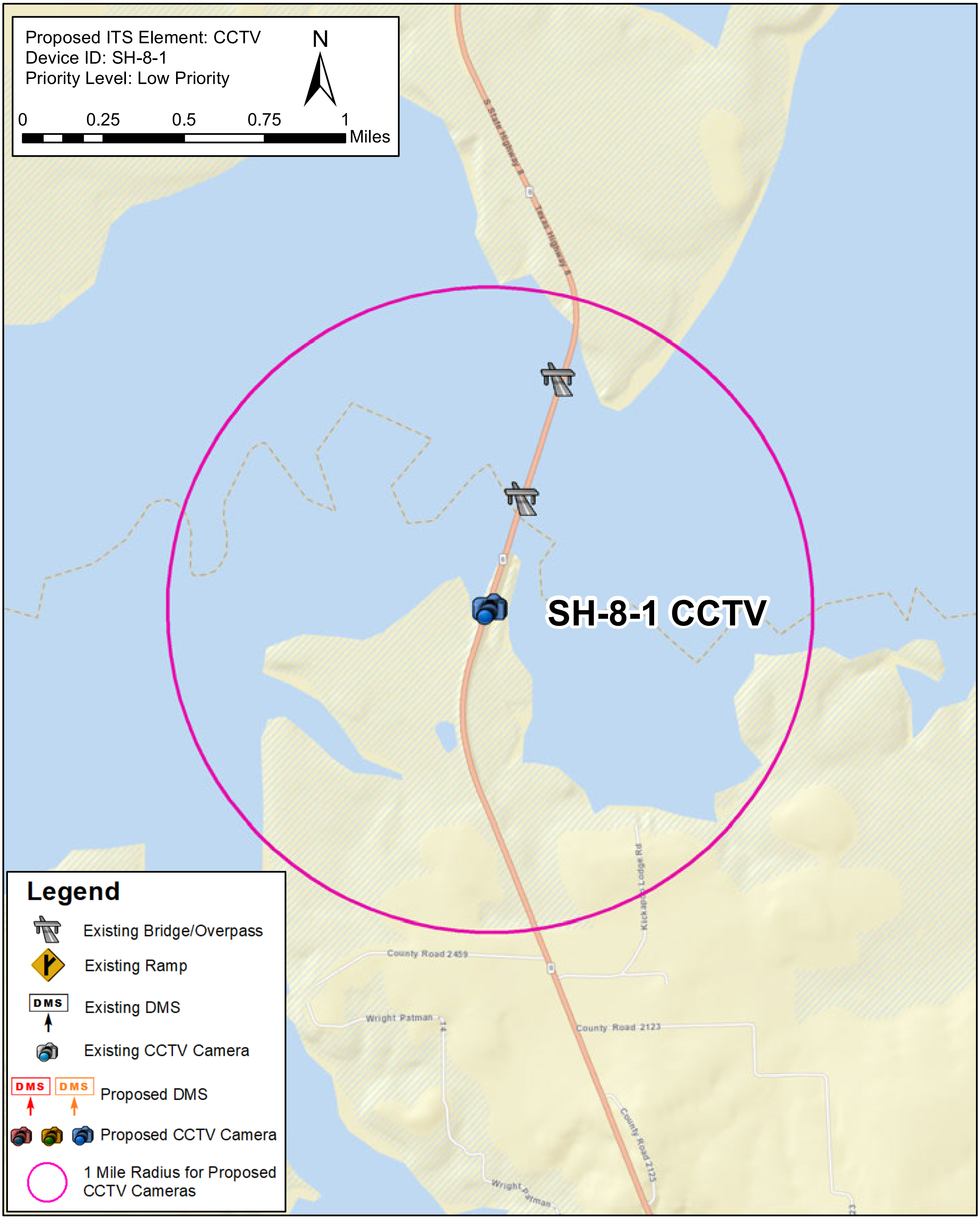


Proposed ITS Element: CCTV
Device ID: SH-149-1
Priority Level: Medium Priority

Proposed CCTV Camera and DMS Sign Locations

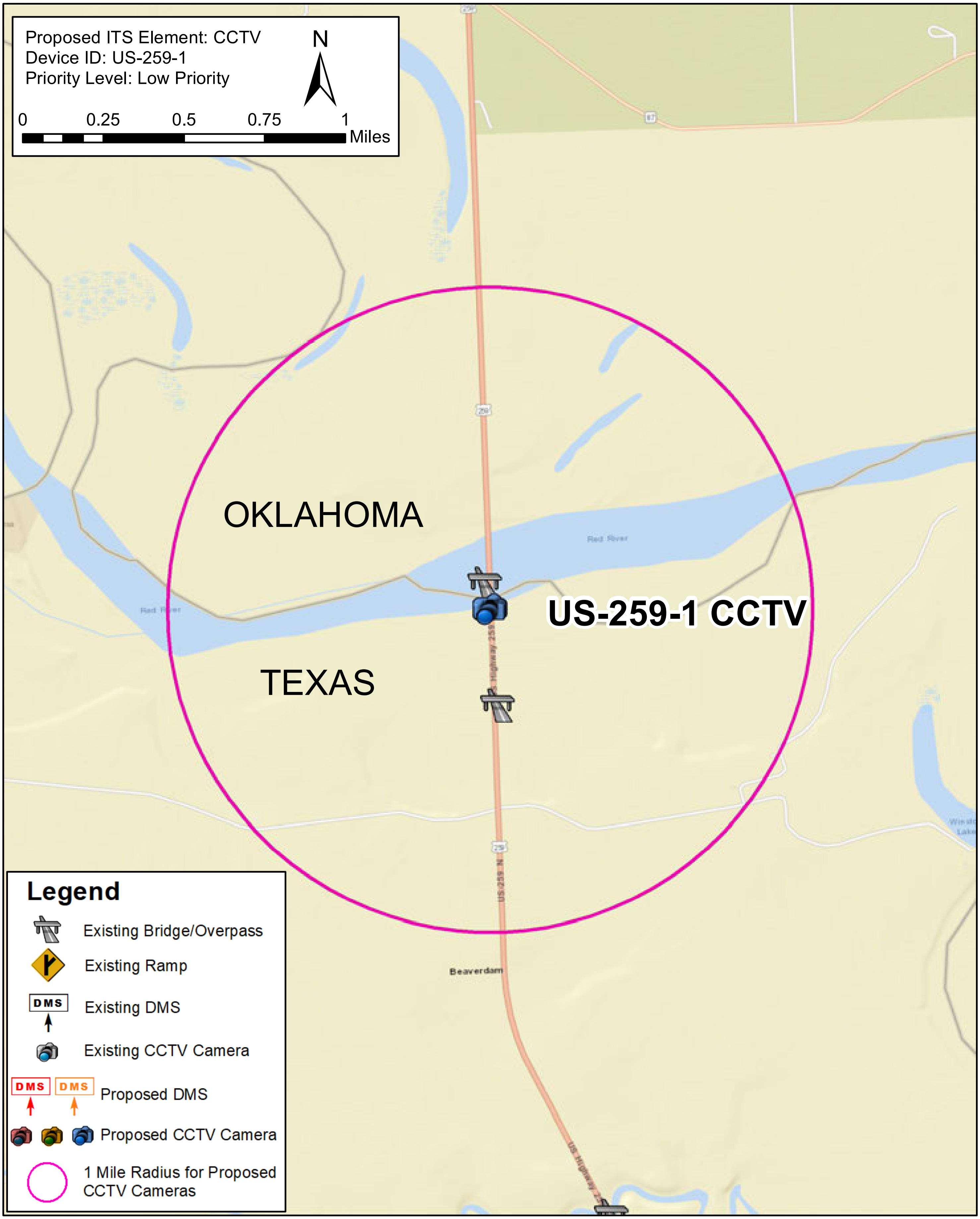


Proposed CCTV Camera and DMS Sign Locations

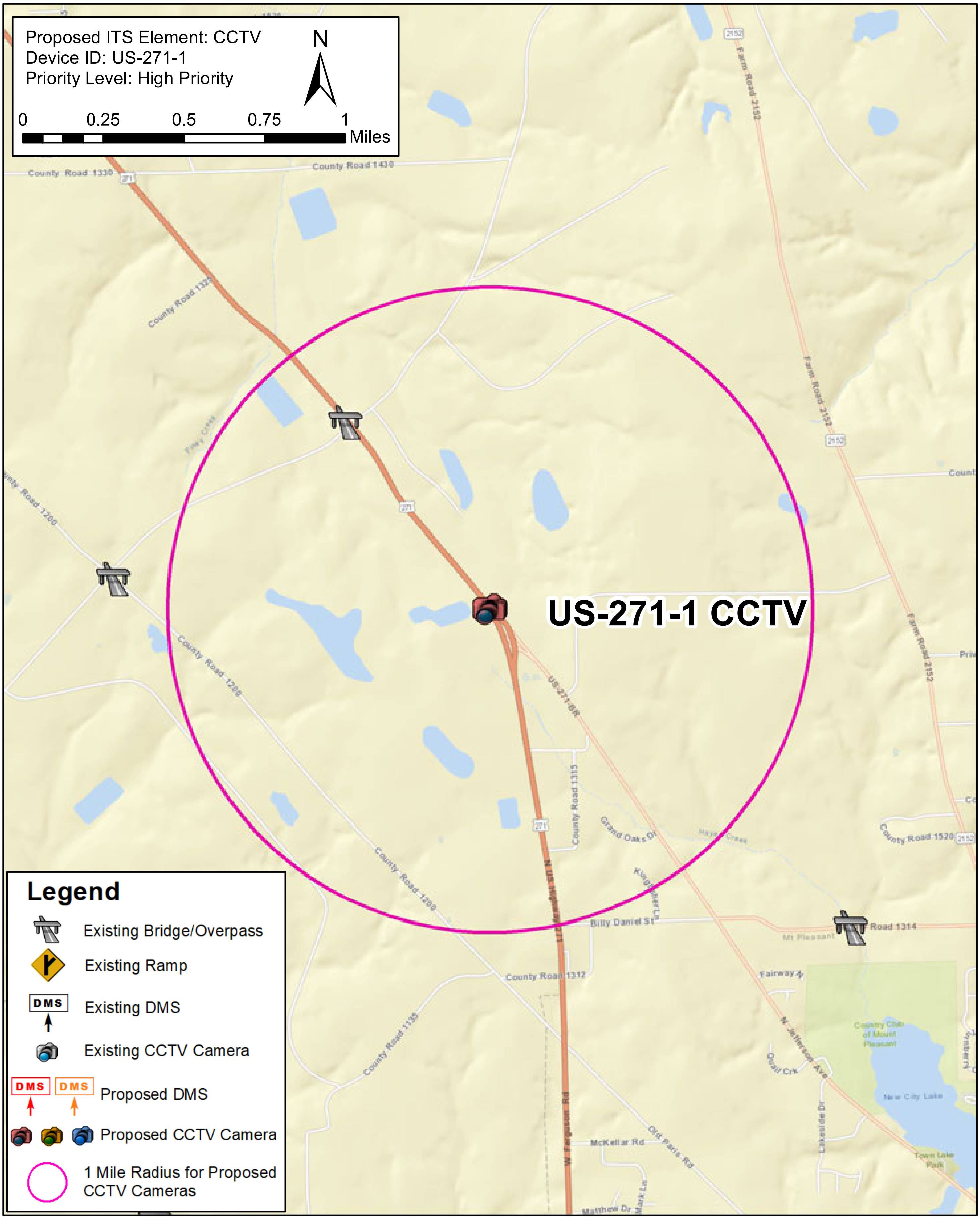


Proposed ITS Element: CCTV
Device ID: SH-8-1
Priority Level: Low Priority

Proposed CCTV Camera and DMS Sign Locations

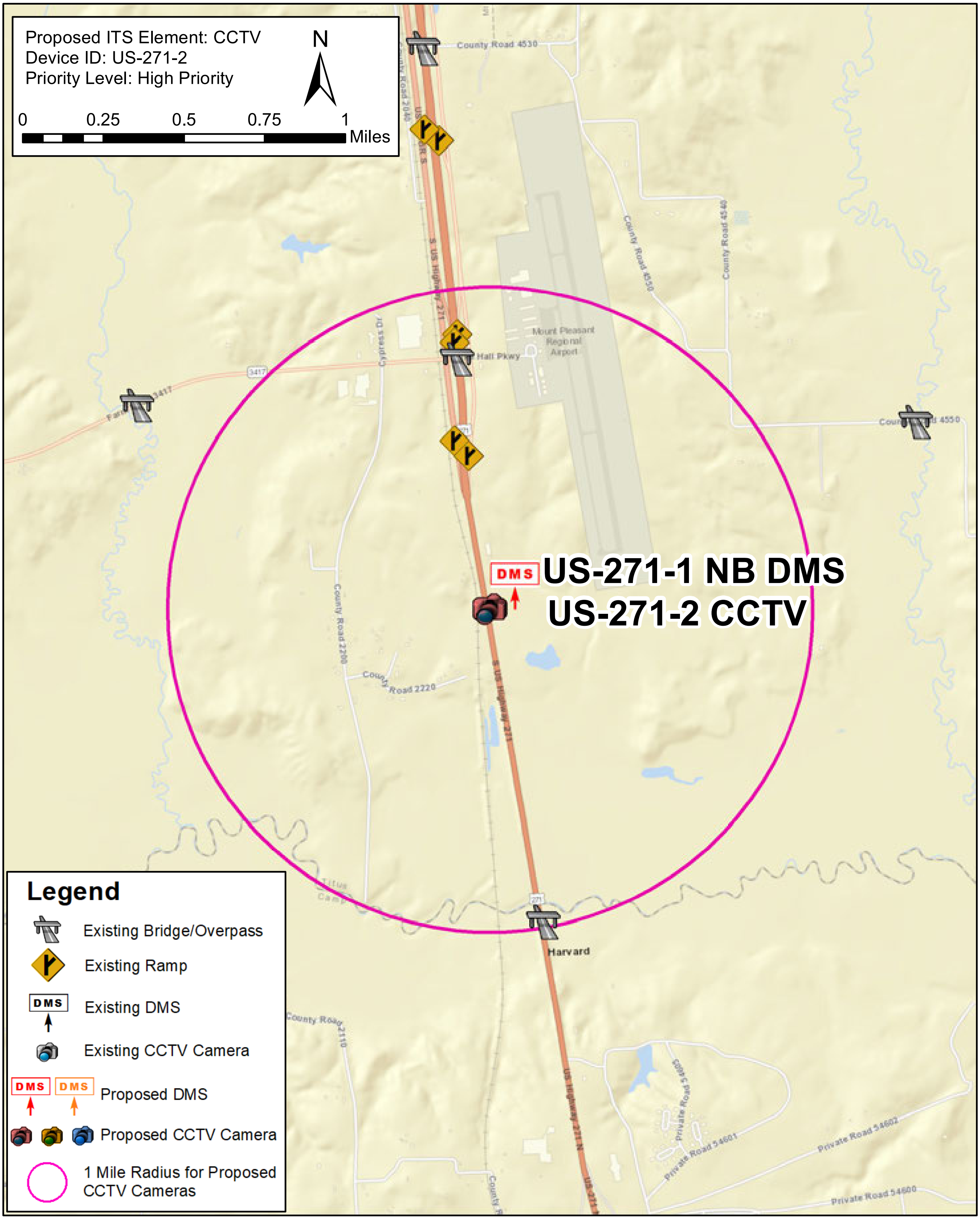


Proposed CCTV Camera and DMS Sign Locations

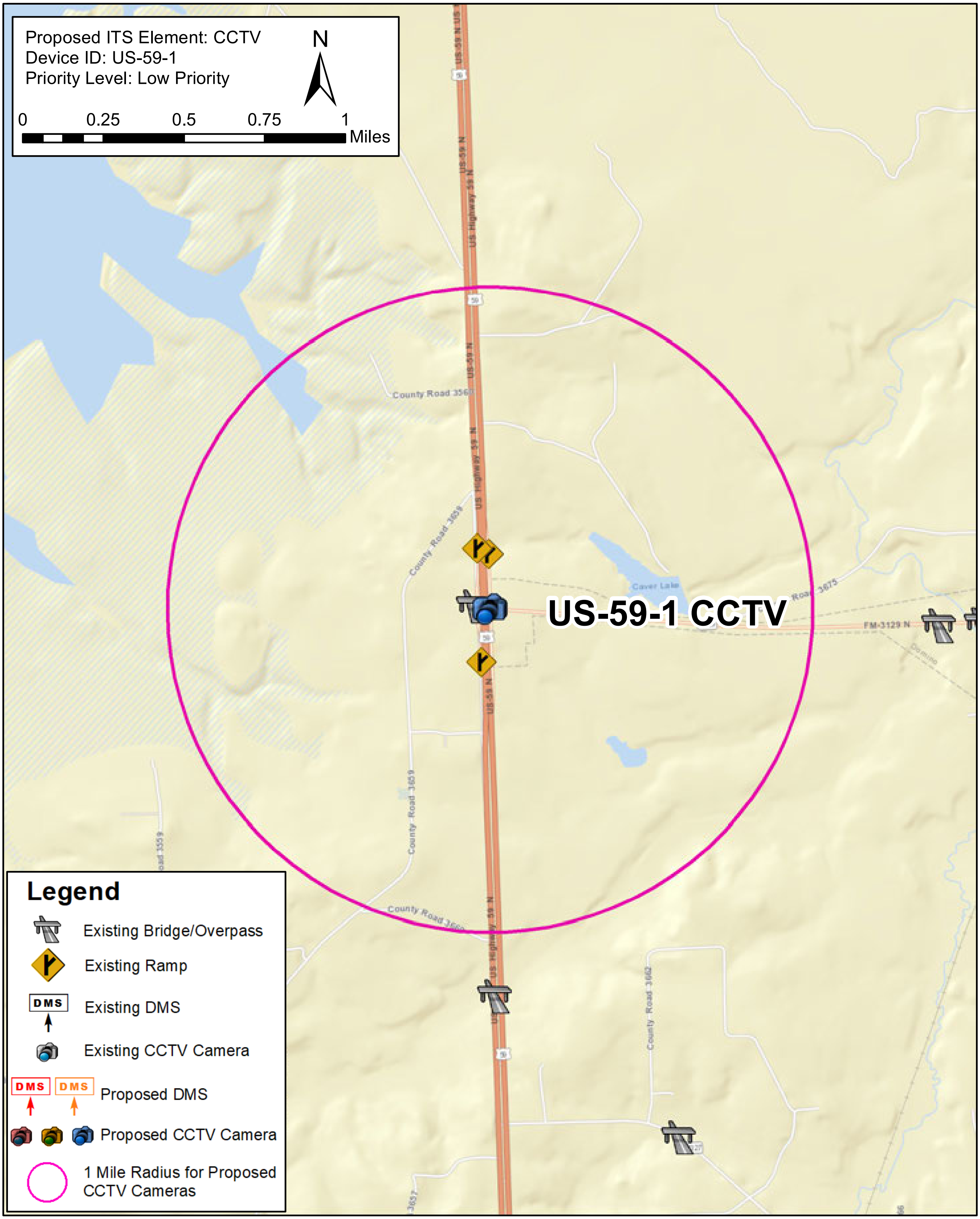


Proposed ITS Element: CCTV
Device ID: US-271-1
Priority Level: High Priority

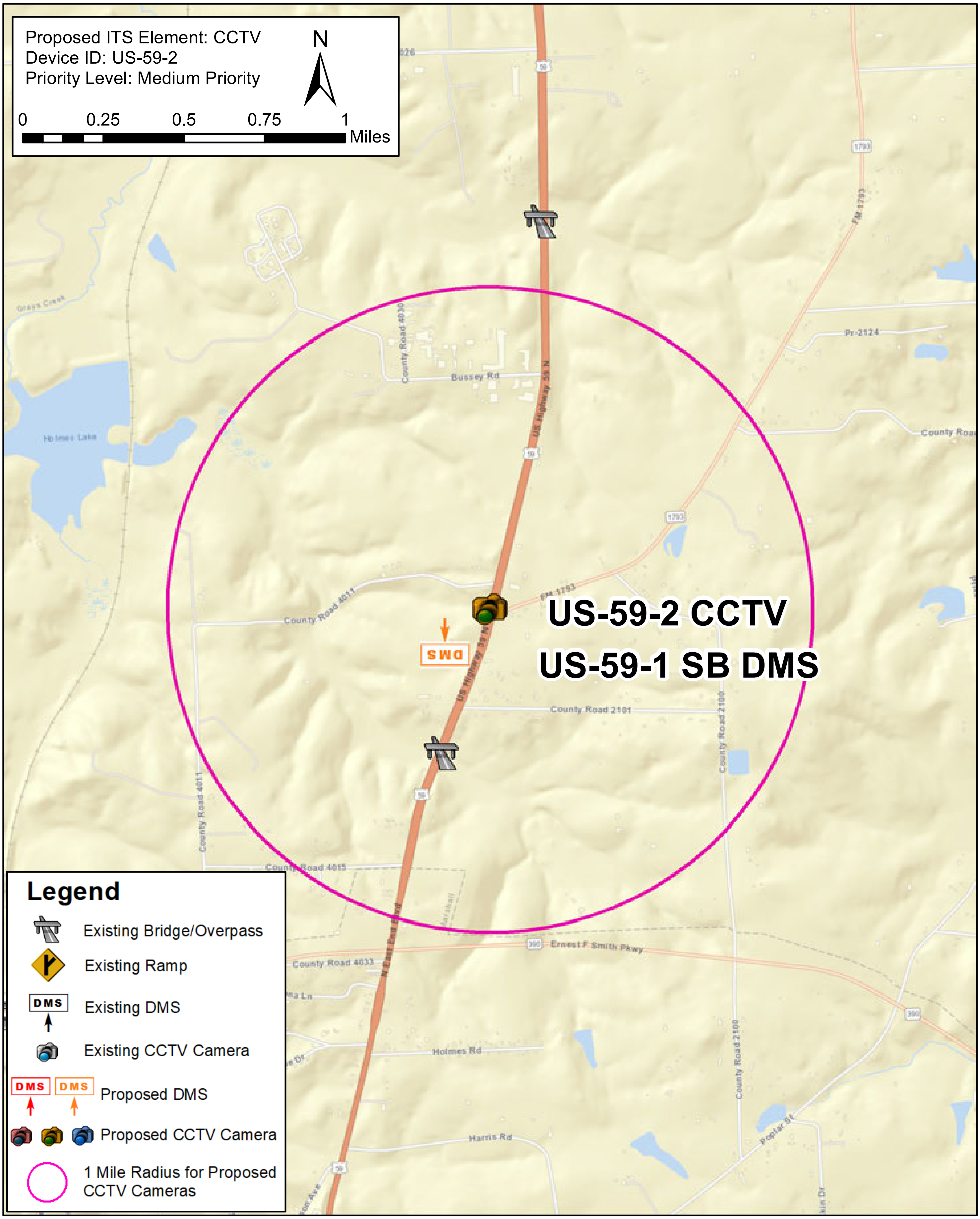
Proposed CCTV Camera and DMS Sign Locations



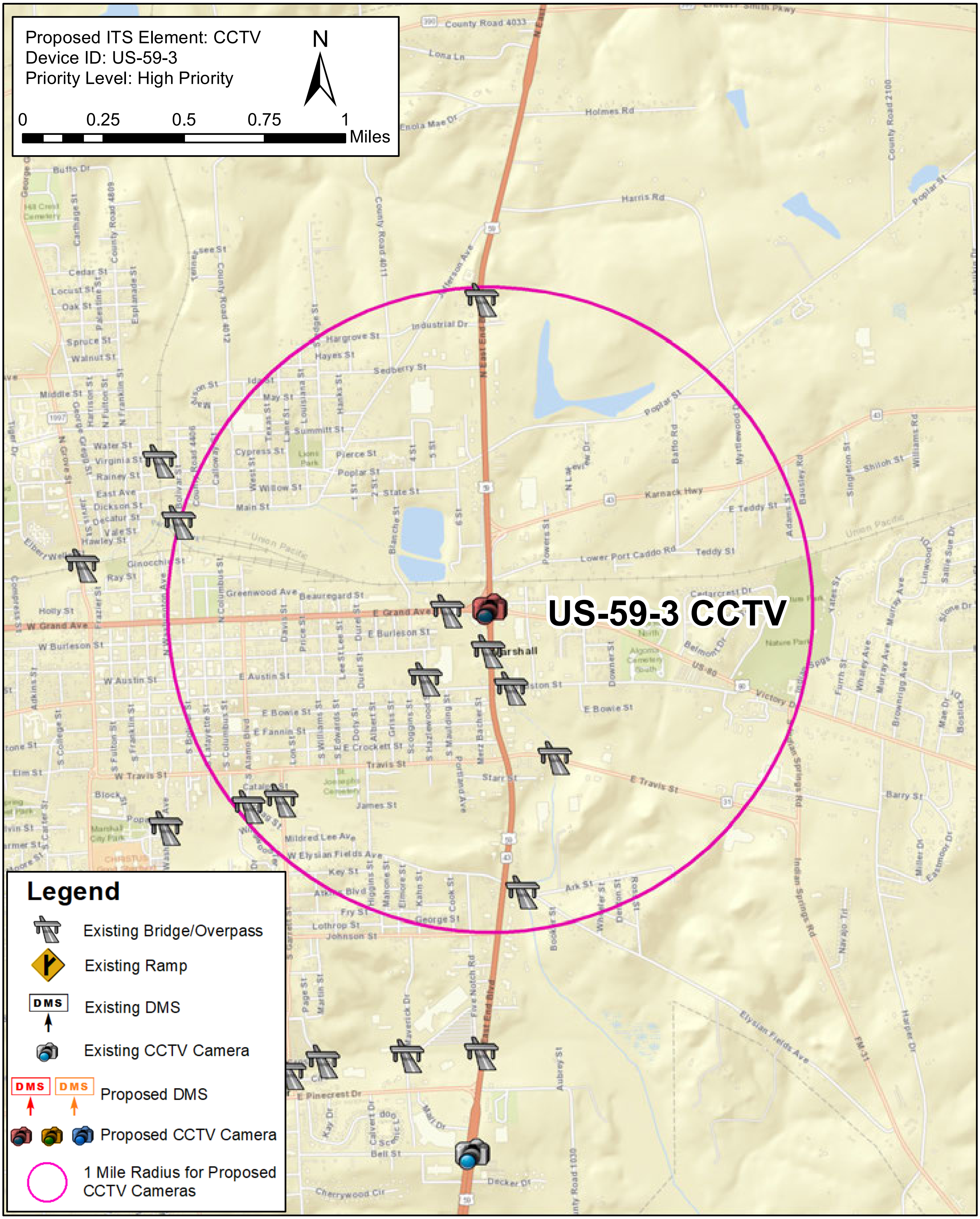
Proposed CCTV Camera and DMS Sign Locations



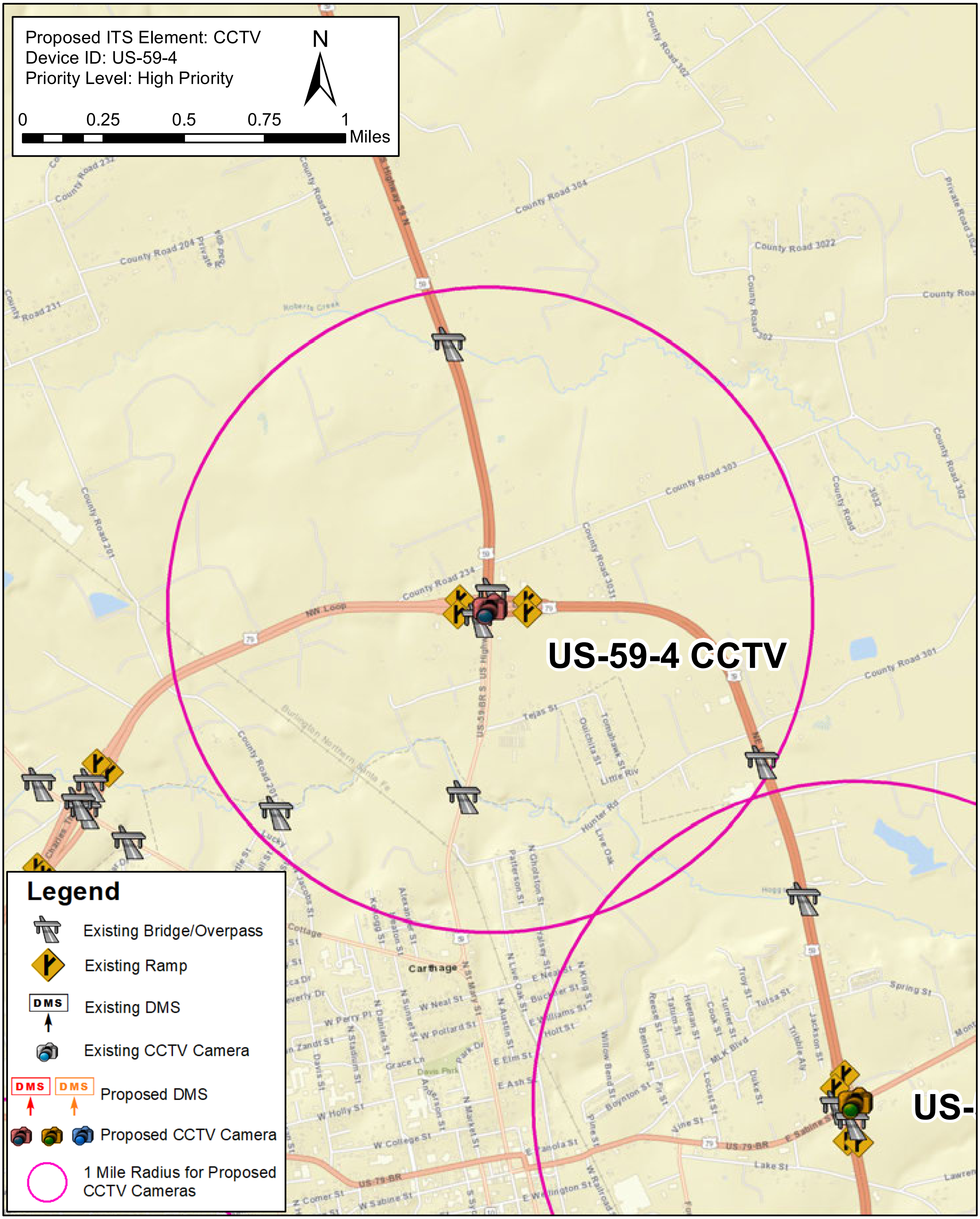
Proposed CCTV Camera and DMS Sign Locations



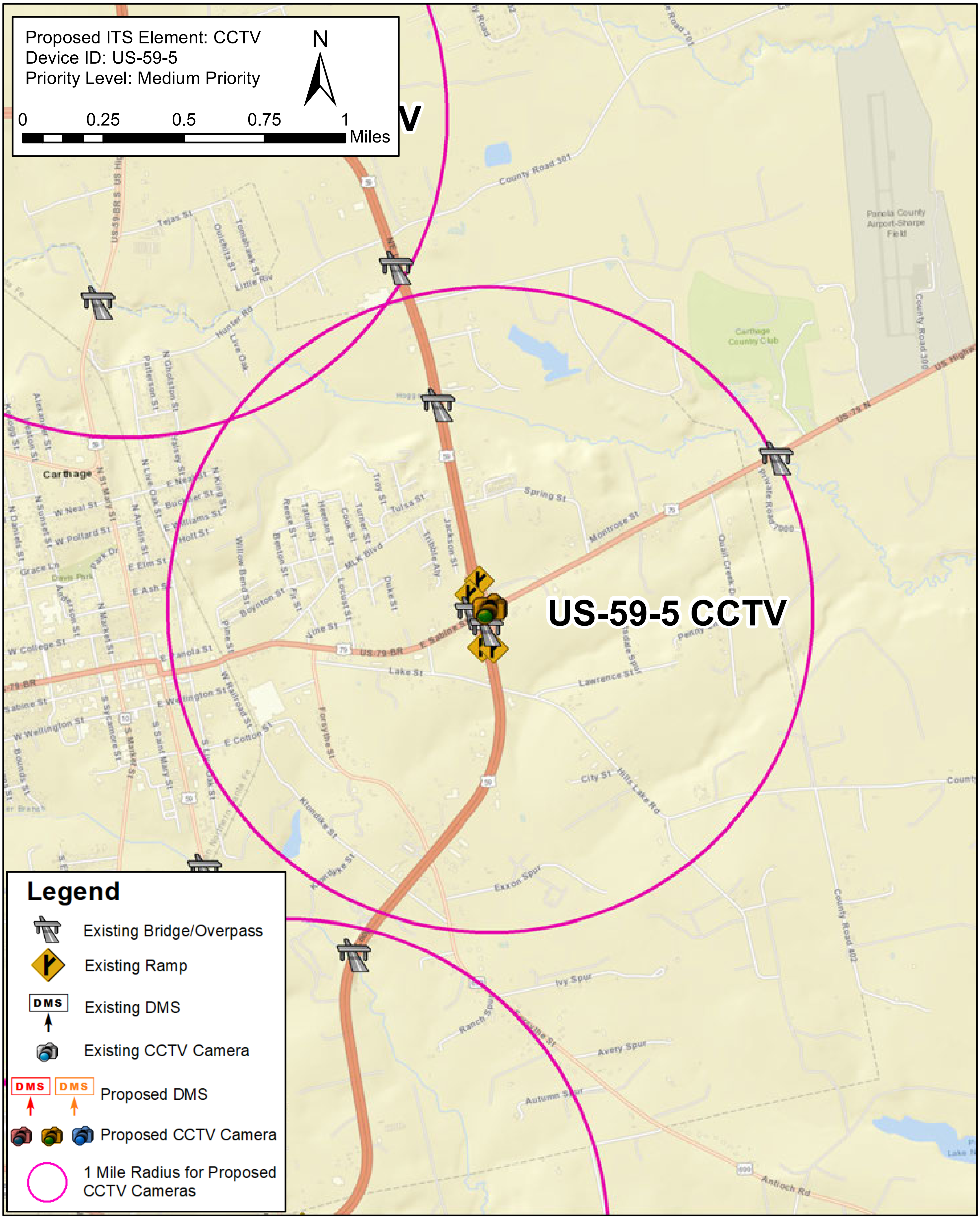
Proposed CCTV Camera and DMS Sign Locations



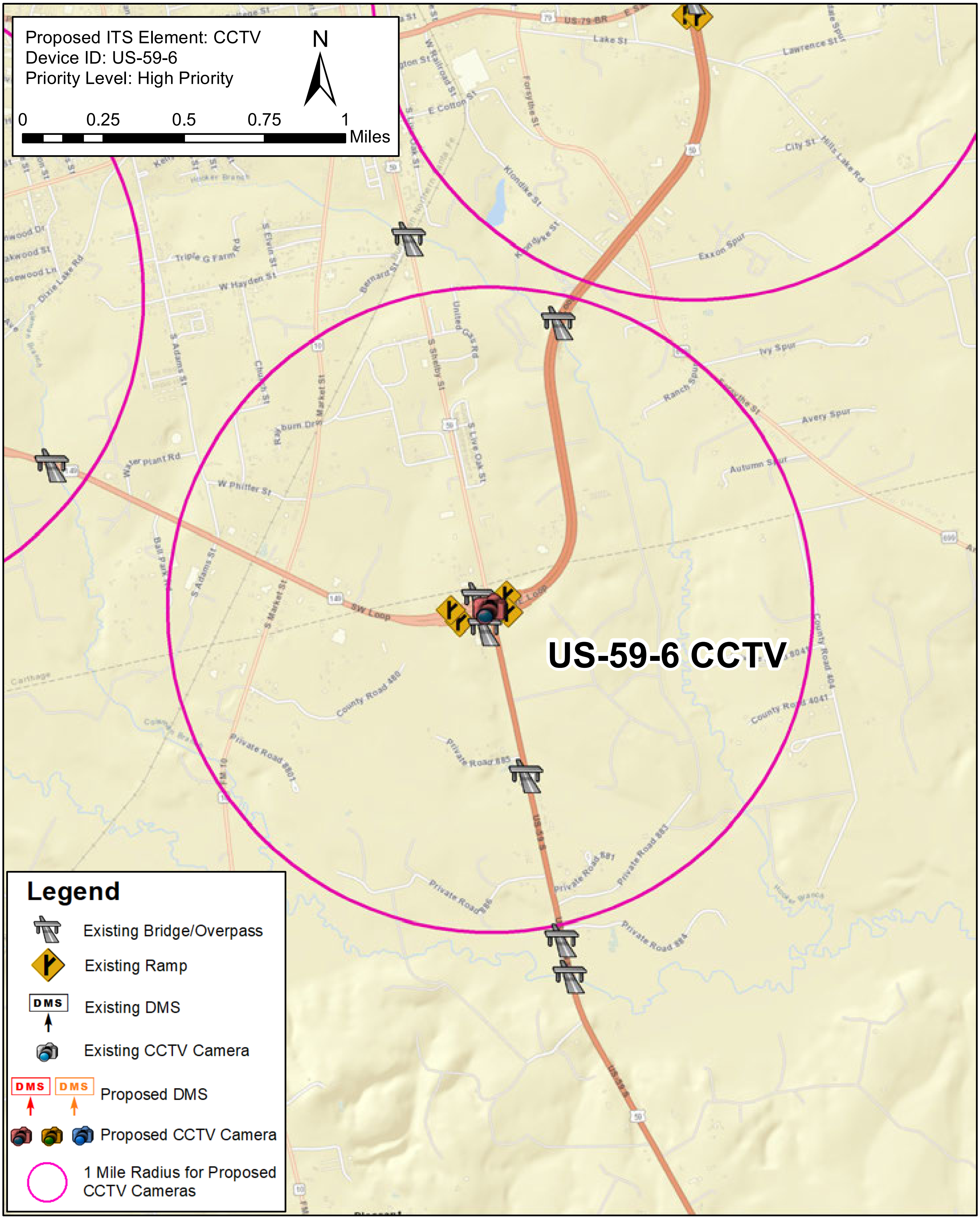
Proposed CCTV Camera and DMS Sign Locations



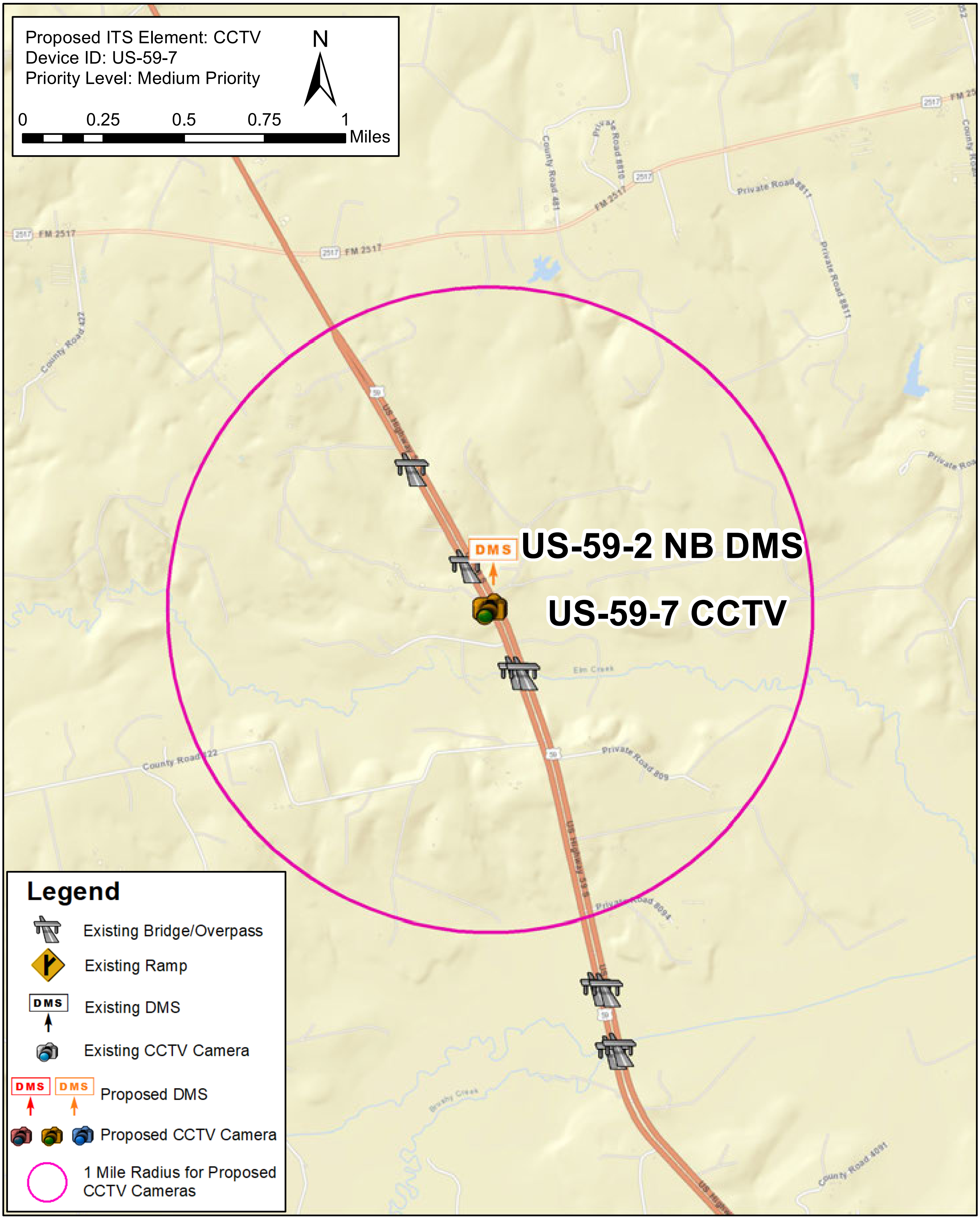
Proposed CCTV Camera and DMS Sign Locations



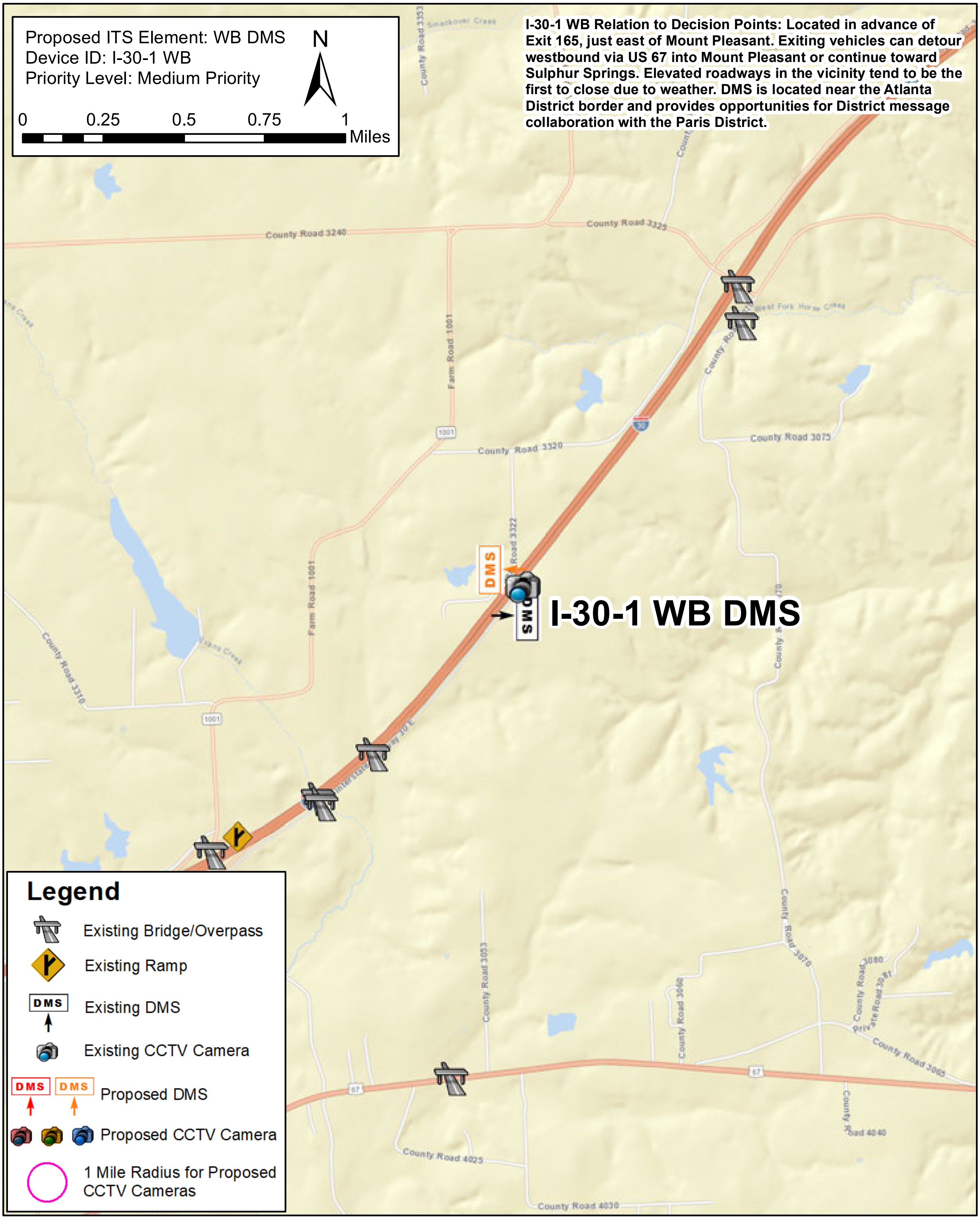
Proposed CCTV Camera and DMS Sign Locations



Proposed CCTV Camera and DMS Sign Locations



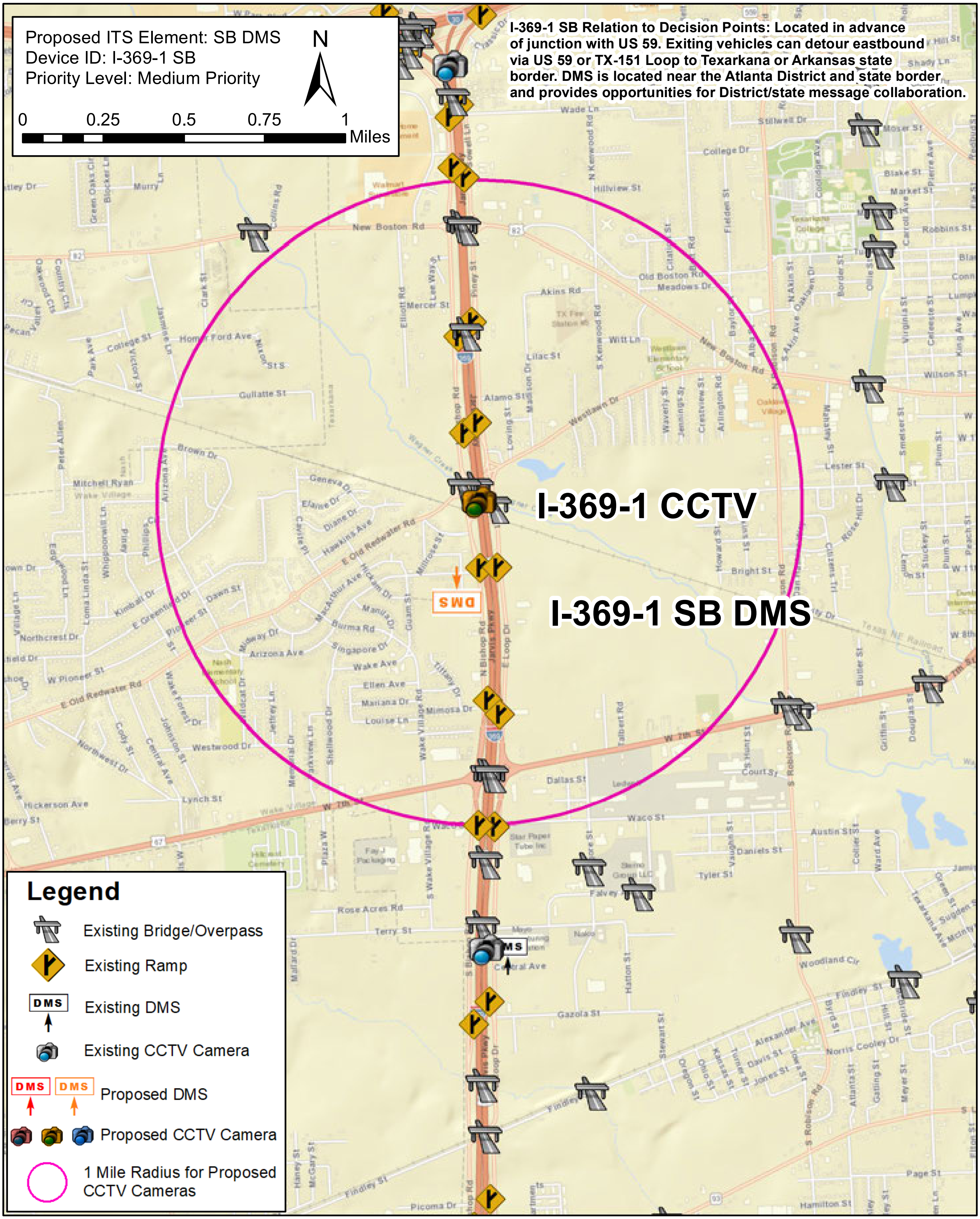
Proposed CCTV Camera and DMS Sign Locations



Proposed ITS Element: WB DMS
Device ID: I-30-1 WB
Priority Level: Medium Priority

I-30-1 WB Relation to Decision Points: Located in advance of Exit 165, just east of Mount Pleasant. Exiting vehicles can detour westbound via US 67 into Mount Pleasant or continue toward Sulphur Springs. Elevated roadways in the vicinity tend to be the first to close due to weather. DMS is located near the Atlanta District border and provides opportunities for District message collaboration with the Paris District.

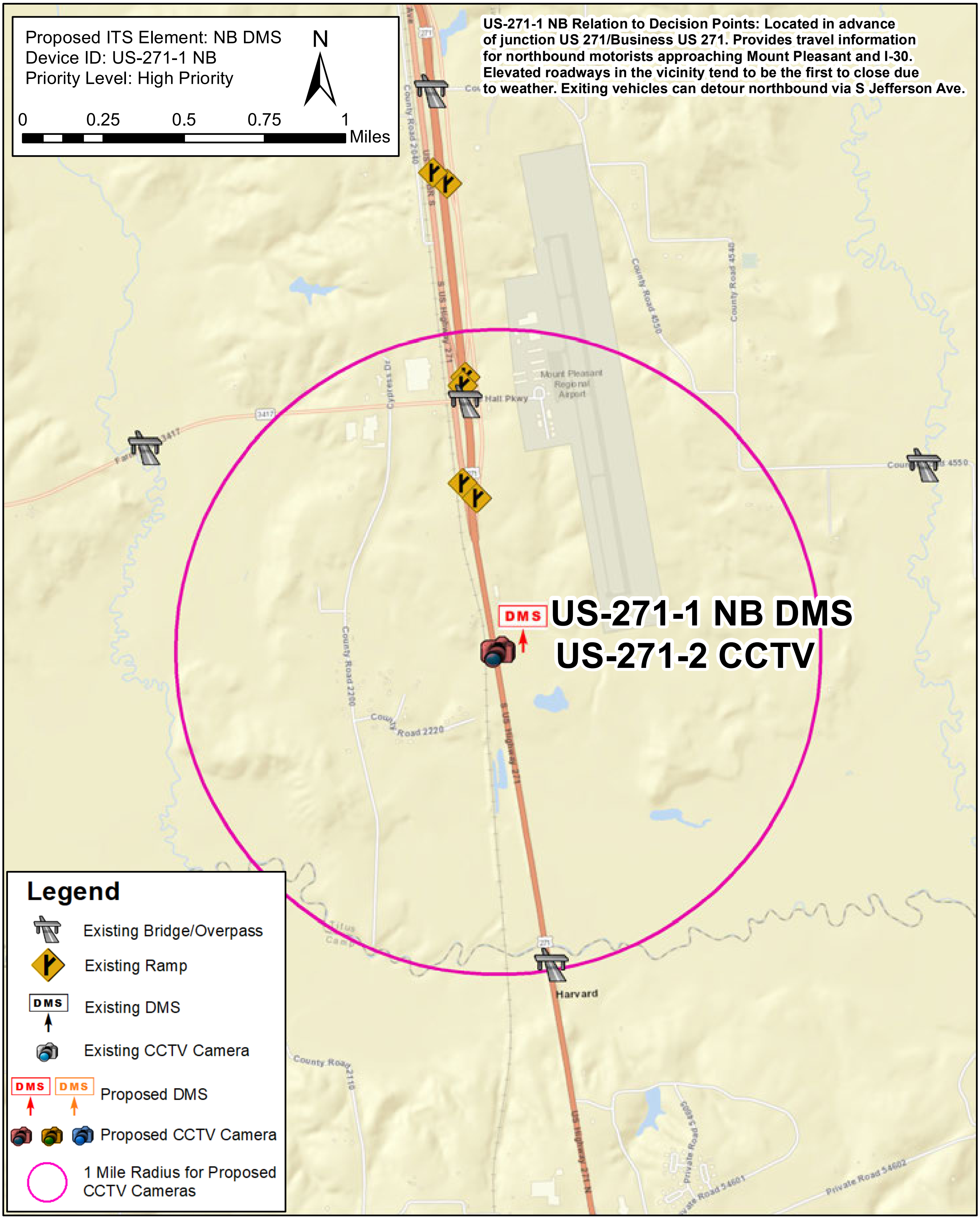
Proposed CCTV Camera and DMS Sign Locations



Proposed ITS Element: SB DMS
Device ID: I-369-1 SB
Priority Level: Medium Priority

I-369-1 SB Relation to Decision Points: Located in advance of junction with US 59. Exiting vehicles can detour eastbound via US 59 or TX-151 Loop to Texarkana or Arkansas state border. DMS is located near the Atlanta District and state border and provides opportunities for District/state message collaboration.

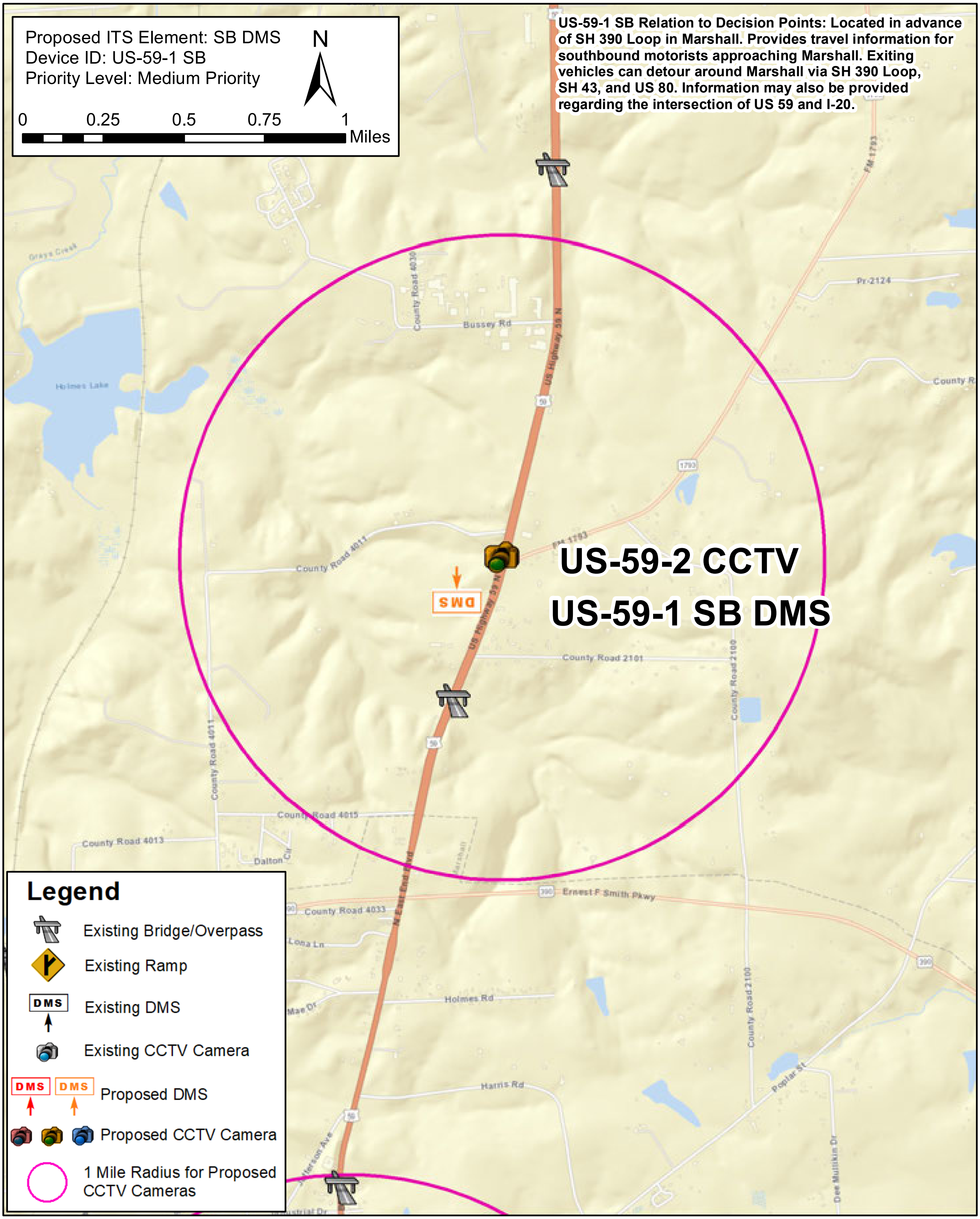
Proposed CCTV Camera and DMS Sign Locations



Proposed ITS Element: NB DMS
Device ID: US-271-1 NB
Priority Level: High Priority

US-271-1 NB Relation to Decision Points: Located in advance of junction US 271/Business US 271. Provides travel information for northbound motorists approaching Mount Pleasant and I-30. Elevated roadways in the vicinity tend to be the first to close due to weather. Exiting vehicles can detour northbound via S Jefferson Ave.

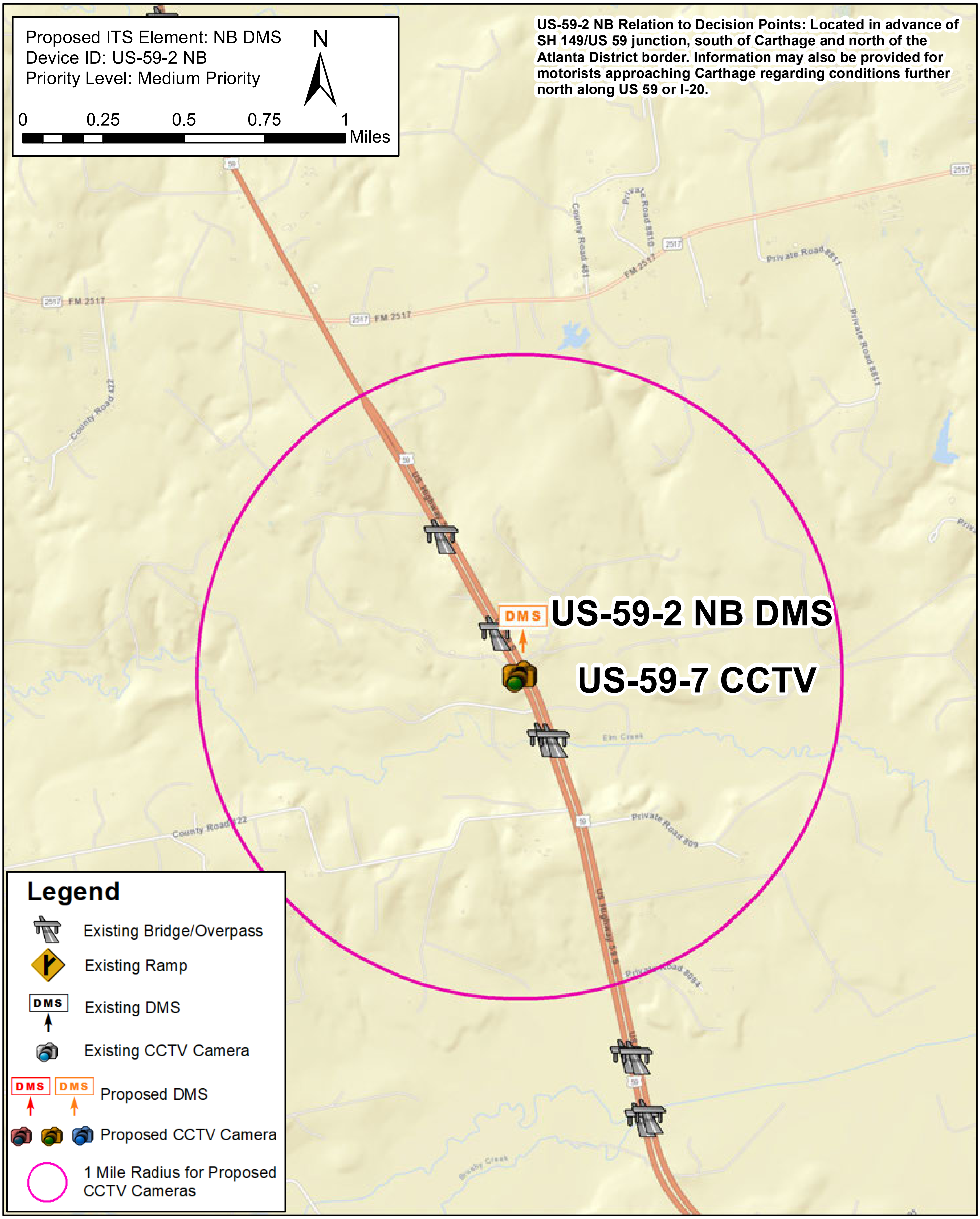
Proposed CCTV Camera and DMS Sign Locations



Proposed ITS Element: SB DMS
Device ID: US-59-1 SB
Priority Level: Medium Priority

US-59-1 SB Relation to Decision Points: Located in advance of SH 390 Loop in Marshall. Provides travel information for southbound motorists approaching Marshall. Exiting vehicles can detour around Marshall via SH 390 Loop, SH 43, and US 80. Information may also be provided regarding the intersection of US 59 and I-20.

Proposed CCTV Camera and DMS Sign Locations



Proposed ITS Element: NB DMS
Device ID: US-59-2 NB
Priority Level: Medium Priority

US-59-2 NB Relation to Decision Points: Located in advance of SH 149/US 59 junction, south of Carthage and north of the Atlanta District border. Information may also be provided for motorists approaching Carthage regarding conditions further north along US 59 or I-20.

Kimley»Horn
Expect More. Experience Better.

In association with

OTHON
ENGINEERING

Final Version

Texas
Department
of Transportation®