City of Laredo
ITS Master Plan

Final Report

Prepared by:

Kimley-Horn and Associates, Inc.

January 31, 2005
068530000

Copyright © 2005 City of Laredo

Kimley-Horn and Associates, Inc.

TABLE OF CONTENTS

LAREDO ITS MASTER PLAN

TABLE OF CONTENTS

LAREDO ITS MASTER PLAN

TABLE OF CONTENTS

LAREDO ITS MASTER PLAN

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS

AED	Automated Enforcement Devices
AVI	Automated Vehicle Identification
AVL	Automated Vehicle Location
CAD	Computer-Aided Dispatch
CCTV	Closed-Circuit Television
CTECC	Combined Transportation, Emergency, and Communication Center
DMS	Dynamic Message Sign
DOT	Department of Transportation
DPS	Department of Public Safety
DVAPS	Digital Video Audit Playback System
EMS	Emergency Medical Services
EOC	Emergency Operations Center
FCC	Federal Communications Commission
FSK	Frequency Shift Keying
GIS	Geographic Information System
HAR	Highway Advisory Radio
HCRS	Highway Condition Reporting System
IETF	Internet Engineering Task Force
I-Net	Institutional Network
ITS	Intelligent Transportation Systems
MDT	Mobile Data Terminal
MIS	Management Information Systems
NEMA	National Electrical Manufacturer's Association
ORANGES	Orlando Regional Alliance for Next Generation Electronic payment Systems
PSAP	Public Service Answering Point
PTZ	Pan/Tilt/Zoom
STRATIS	South Texas Regional Advanced Transportation Information System
TBPC	Texas Building and Procurement Commission
TMC	Traffic Management Center

LIST OF ACRONYMS

TTI	Texas Transportation Institute
TxDOT	Texas Department of Transportation
VIVDS	Video Image Vehicle Detectors Systems
WARN	Wireless Advisory Railroad Network

1. INTRODUCTION

1.1 Background and Project Overview

The City of Laredo Traffic Department has been working to deploy and operate Intelligent Transportation Systems (ITS) components to address the growing demand on their transportation system. The Traffic Department has deployed closed-circuit television (CCTV) cameras on arterial streets, synchronized traffic signal systems, improved vehicle detection capabilities, and operates a traffic management center (TMC). Other departments in the City of Laredo also have ITS deployments. Some international bridges include electronic payment through automatic vehicle identification and all bridges have cameras installed that post images on a website. The Police Department utilizes automated vehicle location (AVL) and mobile data terminals (MDTs) for vehicle tracking and communications. El Metro has installed electronic fare payment on all buses and is working towards adding AVL and security cameras to their fleet. Environmental Services operates five monitoring stations in the City that collect flow information at streams. The Telecommunications Department maintains the institutional network (I-Net) of fiber optic communications lines.

The Texas Department of Transportation (TxDOT) also has ITS elements within the City of Laredo. These elements include CCTV cameras, dynamic message signs (DMS), lane control signals, highway advisory radio (HAR), and a TMC. The City of Laredo TMC has a connection to the TxDOT Laredo TMC that allows sharing and control of video images.

In order to coordinate the deployment of ITS, focus on the highest priority needs, and develop a plan for operating and maintaining the City of Laredo's system, the Traffic Department is developing an ITS Master Plan. The objective of the City of Laredo ITS Master Plan is to identify ITS components, technology, and project concepts that have the potential to improve traveler safety, decrease traffic congestion, and generally manage the growth that Laredo is experiencing within its transportation infrastructure. Key elements of the City of Laredo's ITS Master Plan include:

- Identify priority ITS services for Laredo's Traffic Department;
- Develop an ITS mission and vision statement and prioritize stakeholder needs;
- Document existing and planned transportation and communication projects in the City;
- Identify and prioritize projects within the City of Laredo. Project phasing will also be developed;
- Develop a concept of operations focused on operations, staffing, and maintenance of ITS elements in the City; and
- Ensure consistency with the Regional ITS Architecture.

1.2 Document Overview

Section 1 – Introduction

This section provides an overview of the City of Laredo ITS Master Plan, as well as an overview of the stakeholders involved in the planning effort.

Section 2 – Stakeholder Input

A summary of results from the ITS Services Survey given to stakeholders and interviews held with individual agencies to discuss ITS needs is provided in this section.

Section 3 – ITS Vision, Mission, and Requirements

An ITS Vision and Mission were developed for the City of Laredo and twelve requirements were outlined by stakeholders as key areas for focus when implementing ITS in the City. This section presents these system goals and desired services.

Section 4 – Existing ITS Deployments

This section contains a summary of existing ITS deployments in the City of Laredo. ITS elements that are identified in this section include:

- Centers that are involved in the operation of ITS or related transportation systems;
- Roadside ITS elements including CCTV cameras, DMS, HAR transmitters and beacon signs, lane control signals, rail advisory signs, and water quality monitoring stations;
- Traffic signals;
- School zone flashers; and
- Communications elements such as fiber nodes and fiber optic cables.

Section 5 – Recommended ITS Deployments

A system concept for ITS deployment in the City of Laredo is presented in this section. Individual project concepts are also outlined and several communications scenarios explored for potential implementation in the City of Laredo.

Section 6 – Concept of Operations

This section contains operations, maintenance, and staffing requirements evaluations.

Section 7 – Regional ITS Architecture Consistency

This section documents the consistency of projects recommended in the Laredo ITS Master Plan with the regional ITS architecture identified in the June 2003 Laredo Regional ITS Architecture and Deployment Plan report.

1.3 Project Stakeholders

A core group of City of Laredo ITS Departments were invited to participate in this planning effort. TxDOT was also identified as a key project stakeholder. Stakeholders were asked to provided guidance, review, and input to the development of the ITS Master Plan. The following is a list of project stakeholder departments and agencies:

- City of Laredo Bridge Department;
- City of Laredo Environmental Services Department;
- City of Laredo Fire Department;
- City of Laredo Management Information Systems Department;
- City of Laredo Police Department;
- City of Laredo Telecommunications Department;
- City of Laredo Traffic Department;
- El Metro; and
- Texas Department of Transportation Laredo District.

Robert Peña from the City of Laredo Traffic Department served as the City of Laredo Project Manager.

2. STAKEHOLDER INPUT

2.1 ITS Services Survey Results

On January 21, 2004, a kick-off meeting was held in Laredo for the City of Laredo ITS Master Plan project. The purpose of the meeting included:

- Introduction of the project to key stakeholder agencies;
- Presentation of the project schedule and deliverables;
- Review of the ITS regional needs developed in the 2003 Laredo Regional ITS Architecture and Deployment Plan; and
- Stakeholder input on the types of ITS services needed in the Region.

Stakeholder agencies that participated in the meeting included the City of Laredo Bridge, Environmental Services, Fire, Police, Telecommunications, and Traffic Departments. The TxDOT Laredo District also participated in the meeting.

At the meeting, a survey was distributed to the stakeholders and each was asked to indicate the usefulness of several ITS services and technologies that the City of Laredo Traffic Department is currently offering or could potentially offer in the future. A copy of the survey is included in **Appendix A**. The services were grouped into categories for Traffic Services, Traveler Information, Transit, and Emergency Services. Three additional services were requested by stakeholders at the meeting and are categorized as “Others”. The results from the stakeholders that provided information are also included in **Table 1**. A check mark indicates that the stakeholder completing the survey considered this service to be valuable to his or her agency in fulfilling its mission. Several agencies had multiple representatives at the meeting that completed the surveys. The input from each representative is included in **Table 1** and is indicated by the survey number listed.

In **Table 2**, City of Laredo ITS services and technologies are listed in order from the ITS service or technology that the largest number of stakeholders considered valuable to those ITS services or technologies that stakeholders were least interested in the City of Laredo providing.

Table 1 – Potential City of Laredo ITS Services and Technologies

	Traffic Services															Traveler Information						Transit Services		Emergency Services		Others		
Stakeholder Agencies	Peak-Hour Traffic Mgmt Ctr Operation	24-Hour Traffic Mgmt Ctr Operation	Dispatching Capabilities	Traffic Surveillance Capabilities	Vehicle Counting Capabilities	Vehicle Speed Detection Capabilities	Vehicle Classification Capabilities	Remote Traffic Signal Control	Signal Coordination	Data Storage	Weather Sensors	Flood Detection Sensors	Electronic Parking Payment	Bridge Coordination	AVL[1] for Traffic Service Vehicles	Dynamic Message Signs	Highway Advisory Radio	Kiosks	Internet Web Site	Telephone (511)	Private Sector Providers	Transit Vehicles Signal Priority	Transit Vehicles as Probes	Emergency Vehicle Traffic Signal Preemption	Automated Crash Data Collection	Regional Smart Cards (Parking, Transit and Bridge Payment)	Video Recording	AVL[1] for On-Board Vehicle Data
City of Laredo Departments																												
Bridge Survey 1					✓		✓					✓		✓		✓		✓	✓							✓	✓	✓
El Metro Survey 1	✓		✓					✓	✓				✓			✓			✓	✓		✓	✓			✓		✓
Environmental Services Survey 1		✓									✓	✓																
Environmental Services Survey 2											✓	✓																
Fire Survey 1	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓		✓	✓	✓			✓	✓	✓			✓	✓		✓	
Fire Survey 2	✓		✓					✓								✓								✓				
Fire Survey 3	✓	✓										✓				✓						✓						
Police Survey 1	✓	✓		✓	✓	✓						✓				✓	✓	✓		✓				✓	✓			
Telecom/I-Net Survey 1	✓		✓	✓			✓	✓		✓	✓	✓		✓	✓									✓	✓			
Traffic Survey 1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
Traffic Survey 2	✓	✓		✓	✓	✓	✓	✓	✓						✓	✓								✓				
Traffic Survey 3	✓			✓				✓	✓																			
State Agencies																												
Texas Department of Transportation Survey 1	✓	✓	✓	✓	✓		✓	✓	✓			✓				✓	✓		✓					✓	✓			
Texas Department of Transportation Survey 2	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓		✓									
Total	**11**	**7**	**7**	**8**	**6**	**4**	**7**	**9**	**7**	**4**	**6**	**10**	**2**	**4**	**4**	**10**	**4**	**3**	**6**	**4**	**2**	**3**	**2**	**7**	**5**	**2**	**2**	**2**

[1] Automated vehicle location

Table 2 – Stakeholder Rankings of Potential City of Laredo ITS Services and Technologies

Ranking	City of Laredo ITS Service or Technology	Number of Stakeholders Selecting
1	Peak-Hour Traffic Management Center Operations	11
2	Flood Detection Sensors	10
	Dynamic Message Signs – Traveler Information	10
4	Remote Traffic Signal Control	9
5	Traffic Surveillance Capabilities	8
6	24-Hour Traffic Management Center Operations	7
	Dispatching Capabilities	7
	Vehicle Classification Capabilities	7
	Signal Coordination	7
11	Vehicle Counting Capabilities	6
	Weather Sensors	6
	Internet Web Site – Traveler Information	6
14	Automated Crash Data Collection	5
15	Vehicle Speed Detection Capabilities	4
	Data Storage	4
	Bridge Coordination	4
	AVL for Traffic Service Vehicles	4
	Highway Advisory Radio – Traveler Information	4
	Telephone (511) – Traveler Information	4
21	Kiosks – Traveler Information	3
	Transit Vehicles Signal Priority	3
23	Electronic Parking Payment	2
	Private Sector Providers – Traveler Information	2
	Transit Vehicles as Probes	2
	Regional Smart Cards	2
	Video Recording	2
	AVL for On-Board Vehicle Data	2

Peak-Hour Traffic Management Center Operations was ranked as the highest among the potential ITS services for the City of Laredo and **24-Hour Traffic Management Center Operations** was ranked as 6th. Peak hour TMC operations are critical to maximizing the usefulness of any ITS applications deployed in the City. Deployments such as CCTV cameras provide the most benefit when cameras are monitored to detect incidents and traffic control devices modified to alleviate delay in response to incident detection. The impact of these efforts is greatest during peak hours; however, as the system develops and capabilities increase, it will also be important to expand the operational hours of the center.

Flood Detection Sensors were ranked as 2nd and **Weather Sensors** were ranked as 11th. Flooding is currently the weather event that causes the most disruption to the City of Laredo and it is important to deploy detection to facilitate identification of problem areas and notify the public and public safety as rapidly as possible. As ITS plays a larger role in the City, other weather data could be useful as well.

Dynamic Message Signs also ranked 2nd. DMS provide a very important traffic information dissemination tool to reach a target audience who might be experiencing delays or need to take action to minimize delays to their travel time by taking an alternate route. With the multiple border crossings within the City of Laredo and a very high number of commercial vehicles, this need is greater than in other cities of comparable size. The other roadside traveler information service, **Highway Advisory Radio**, ranked as 15th. HAR also provides a very useful mechanism for sharing traffic information, but is a lower priority for the Region.

Remote Traffic Signal Control ranked as 4th and **Signal Coordination** ranked as 6th. Being able to make timing plan alternations from a remote location allows the traffic signal system to be more responsive and transportation officials to easily implement alternate timing plans for special events or incidents. Signal coordination was also a high priority to improve traffic flow through congested corridors, especially in downtown Laredo. This will be increasingly effective because it can build upon the capabilities of remote traffic signal control.

Traffic Surveillance Capabilities includes such technologies as CCTV cameras and was ranked as 5th. **Video Recording** was recommended as a second service in addition to surveillance. Video recording was ranked as 23rd. Utilizing CCTV cameras for traffic surveillance will increase the benefit that can be obtained by using other ITS technologies such as remote traffic signal control and DMS because modifications can be better tailored to the situation when operators can monitor the situation. Providing CCTV camera feeds to multiple agencies can increase the effectiveness of the cameras. Video recording, while technically possible, should be considered carefully due to liability issues that video recording may present for the City.

Dispatching Capabilities was ranked as 6th. As a component of an ITS system focused on improving transportation efficiency, dispatching capability improvements increase the effectiveness by reducing response times and therefore clearing incidents more rapidly.

Vehicle Classification Capabilities, **Vehicle Counting Capabilities**, and **Vehicle Speed Detection Capabilities** are all related and were ranked 6th, 11th, and 15th respectively. Collecting this data enables transportation system officials to make more informed decisions regarding changing signal timings, implementing detour routes and many other applications. Building the database also provides the ability to determine "normal" traffic behavior and can aid in identifying incidents and other traffic abnormalities that may require action.

Emergency Vehicle Traffic Signal Preemption was ranked as 6th. The City of Laredo Fire Department has identified key corridors for the installation of emergency vehicle signal preemption. This capability would reduce response times, as well as increase the safety for emergency responders traveling to an incident.

Internet Web Site for traveler information was ranked as 11th. Internet access saturation levels are rapidly increasing. Traveler information on the internet would reach a growing number of travelers using existing infrastructure.

Automated Crash Data Collection was ranked as 14th. The City of Laredo Police Department already has MDTs in their vehicles. Automating crash data entry and collection would build upon existing capabilities and streamline crash data analysis.

Data Storage was ranked as 15th. Data collected from ITS systems can be very useful in evaluating the effectiveness of the components and planning for future improvements.

Bridge Coordination was also ranked as 15th by stakeholders. Bridge coordination is very dependent on a number of other ITS services, such as DMS signs, CCTV cameras and vehicle detection. Bridge coordination effectiveness will increase as these other services are deployed.

Automated Vehicle Location for Traffic Service Vehicles was ranked as 15th and **Automated Vehicle Location** for On-Board Vehicle Data was ranked as 23rd. AVL for traffic service vehicles would increase the effectiveness of traffic services by cutting response times through more efficient dispatch. AVL with on-board vehicle data would assist in maintenance of vehicles, especially transit buses, by providing information on engine performance, brake conditions, and other information that is necessary to maintain vehicles.

The use of a **Telephone (511)** traveler information phone number ranked 15th and the use of **Kiosks** ranked 21st. A telephone traveler information phone number would be available to a greater number of people faster once implemented and is being examined on a statewide level for implementation. Kiosks utilize the same information provided to 511, but only reach those that stop at a kiosk location to retrieve the information.

Transit Vehicle Signal Priority ranked 21st. El Metro could realize improved efficiency through the limited deployment of transit signal priority near the downtown transit center. There are several issues to consider in implementing this service because it is important to consider the balance between the benefit to transit and the implications of signal priority on traffic in the area around the station.

Electronic Parking Payment ranked as 23rd. It is desired that electronic parking payment be implemented to build upon existing transit and bridge electronic fare payment systems; however, this capability will not increase the operational efficiency of the transportation system as much as other higher priority services.

Private Sector Providers for traveler information also ranked as 23rd. This service, though important, is primarily a private sector initiative. The City of Laredo will support any private provider with any available information, but will not be the primary implementer of any related service.

Transit Vehicles as Probes also ranked as 23rd. Using transit vehicles as probes can be accomplished in one of two ways. Transponders could be placed on transit vehicles and readers installed around the City if the capability was desired to be deployed soon; however, because this appears to be a lower priority, speed related travel data can be obtained utilizing the AVL that El Metro is in the process of implementing once the majority of vehicles have been outfitted with the required equipment.

Regional Smart Cards was an additional technology suggested by stakeholders and ranked 23rd. The international bridge system already utilizes several forms of electronic toll collection and El Metro recently added electronic fare payment capabilities to their buses. Although this service ranked fairly low, in individual interviews with Bridge, El Metro, and Traffic, the importance and need for a Regional Smart card appears to be much higher.

2.2 ITS Stakeholders Interview Results

In addition to the information gathered at the kick-off meeting with stakeholders, interviews were conducted with each stakeholder agency to allow time for a more in-depth discussion on the ITS needs of each agency. The interviews were scheduled for February 3-5, 2004 and were conducted in the offices of each agency. Interviews were typically between one to two hours in length.

Interviews were conducted with eight City of Laredo Departments, as well as the TxDOT Laredo District Office. **Table 3** identifies the agencies and individuals that participated in each interview. The following section contains a brief summary of each interview with key ITS needs identified. The full interview notes from each interview are included in **Appendix B**.

Table 3 – Stakeholders Interviewed

Agency	Name/Title	Interview Date
City of Laredo Police	Pete Palacios, Lieutenant Sanjuanita Rangel, Assistant Communication Manager Sylvia Soria, 911/Communication Supervisor	February 3, 2004
City of Laredo Telecommunications	Mario Ruiz, Telecommunications Administrator Arturo Gavilanes	February 3, 2004
El Metro	Thomas Lucek, General Manager Robert Garza, Assistant General Manager Eduardo Bernal, Planning and Marketing Manager Juan Gala, Operations Superintendent	February 3, 2004
City of Laredo Environmental Services	Riazul Mia, Director John Porter, Environmental Manager Adrian Gause, GIS. Analyst	February 4, 2004
City of Laredo Bridge	Rafael Garcia, Jr., Bridge Director Berta Rivera, Superintendent of Operations Jose Escamilla, Superintendent of Operations Ruben Villarreal, Jr., Supervisor	February 4, 2004
City of Laredo Traffic	Roberto Murillo, Traffic Director Robert Peña, Engineering Associate II Manuel Benavides, Engineering Technician Oscar Canales, Engineering Technician	February 5, 2004
City of Laredo Management Information Systems	Sandra Aleman, Application Analyst/Acting Director Javier Hinojosa, Systems Analyst	February 5, 2004
City of Laredo Fire Department	David Piton, Deputy Fire Chief Roberto Reyna, Assistant Fire Chief José Gamboa, Senior Programmer Analyst	February 5, 2004
Texas Department of Transportation	Roberto Rodriguez, ITS Systems Supervisor	February 5, 2004

2.2.1 City of Laredo Police Department

The City of Laredo Police Department operates the 911 Dispatch Center. Calls for police, fire, and emergency medical services (EMS) are handled at this center. Physical space in the center is a concern as there is little room left for growth or addition of new equipment. TxDOT is adding monitors to the 911 Dispatch Center and will provide video feeds from TxDOT CCTV cameras to the fire dispatchers at the center.

The Police currently have approximately 55 vehicles that are equipped with MDTs and AVL. They plan to increase the number of vehicles with MDTs and AVL to 75 in the near future. Software that allows tracking of all vehicles with AVL is also being installed.

Key ITS needs that could potentially be provided by the Traffic Department include:

- Traffic signal preemption for police vehicles;
- Flood detection sensor data to identify which roads are flooded;
- DMS for Amber Alerts and other messages regarding incidents and closures;
- 511 traveler information phone number that citizens could call for traveler information; and
- Rail crossing system to notify police and travelers of blocked crossings due to stopped trains.

Other ITS needs include:

- Additional space at the 911 Dispatch Center or relocation of the center to a more spacious facility;
- Video cameras in police vehicles; and
- Radio system that allows all agencies to communicate.

2.2.2 City of Laredo Telecommunications

The Telecommunications Department provides telecommunications support for all City departments. They also support the I-Net fiber optic communication lines provided to the City under an agreement with Time Warner, the local cable provider. The Time Warner franchise agreement will be up for renegotiation in the next year. The Telecommunications Department would like to have additional fiber but this will depend on the new franchise agreement that is negotiated. A requirement by the City Manager that all new fiber be installed underground will increase the cost of adding additional fiber in the City of Laredo.

I-Net provides a fiber connection from the I-Net building to the Traffic Department and supports the fiber connection from two of the Traffic Department's CCTV cameras. I-Net is also supporting a connection to the TxDOT TMC.

Key ITS needs that could potentially be provided by the Traffic Department include:

- Additional fiber optic communication lines.

2.2.3 El Metro

El Metro operates fixed route buses and paratransit vehicles to serve the transportation needs of Laredo's citizens. Card readers have been installed on all El Metro buses that have the ability to read both magnetic strip cards, as well as Smart cards with embedded chips. Six buses currently have cameras with on-board recording and all new buses will include cameras. All buses will also eventually be equipped with AVL. El Metro operates a transit center which is located downtown at 1301 Farragut Street.

Key ITS needs that could potentially be provided by the Traffic Department include:

- Signal priority for transit buses at the intersection of Juarez Avenue and Farragut Street, which is where buses first leave the downtown transit center;

- Improved signal coordination in the downtown area; and
- Improved traveler information on railroad crossings that are blocked due to stopped trains.

Other ITS needs include:

- Smart card technology that can be read by transit buses, card readers at international bridges, and parking meters;
- Improved traveler information regarding bus arrival and delay information. Key locations include the downtown transit center and the Mall Del Norte; and
- AVL with on-board vehicle data to track and schedule maintenance activities.

2.2.4 City of Laredo Environmental Services

The City of Laredo Environmental Services Department operates five monitoring stations in the City of Laredo. The stations collect data on flow information, temperature, and store storm water runoff samples. Communications to the station are through dial-up phone service and only allow the Environmental Services Department to communicate with one station at a time. Information from the sensors is provided to the City of Laredo Emergency Operations Center during major storms and floods. The media also requests information from Environmental Services.

Key ITS needs that could potentially be provided by the Traffic Department include:

- Flood detection stations, particularly in the northern part of the City;
- Improved communications to the monitoring stations to allow real-time data to be sent back to Environmental Services from multiple stations at a single time;
- CCTV cameras at locations where illegal dumping is a problem; and
- Wireless communications around the City to allow Environmental Services inspectors the ability to remotely connect to databases and upload information.

2.2.5 City of Laredo Bridge

The City of Laredo Bridge Department operates and manages four international bridges within the City of Laredo. Payment for the bridge crossings can be in the form of cash, swipe cards, or automated vehicle identification (AVI) transponders depending on the bridge. Bridges are equipped with cameras that transmit images to the Bridge Department and are also displayed on the Bridge Department's website. Weigh-in-motion has been installed on Bridges II and IV which allow commercial vehicle crossings.

Key ITS needs that could potentially be provided by the Traffic Department include:

- DMS prior to Bridges III and IV;
- CCTV cameras on FM 1472, Loop 20, and I-35 for Bridge IV and cameras on Salinas Avenue and Convent Avenue for Bridge II;
- Flood detection and closure system at Las Cruces Drive east of FM 1472 for a low water crossing;
- Flood detection near Bridge I to determine water levels during severe flooding; and
- Smart cards for pedestrian use at Bridge I. The cards should also be able to be used for transit and parking.

2.2.6 City of Laredo Traffic

The City of Laredo Traffic Department operates and maintains traffic signals, video image vehicle detectors systems (VIVDS), loop detectors, CCTV cameras and a TMC which is operational during business hours. Information and video images from TxDOT CCTV cameras, DMS, and traffic signals is sent from TxDOT to the City of Laredo TMC. The City of Laredo TMC and the Traffic Department may need to physically relocate in the near future to another facility.

Key ITS needs for the Traffic Department include:

- Signal system upgrades and improved signal coordination, particularly in the downtown area;
- Additional CCTV cameras in the City;
- DMS on arterial routes for traveler information;
- Capability to determine the location, length, and speed of trains traveling through downtown Laredo;
- Installation of additional fiber optic communications in the City;
- Expansion and possible relocation of the TMC. The relocation of the TMC could be coordinated with the City of Laredo Emergency Operation Center and the 911 Dispatch Center to develop a joint facility;
- 511 traveler information phone number to provide traffic information, including wait times at the international bridges; and
- Smart card payment system for traffic meters. The Smart card system could also be used for transit and international bridge crossings.

2.2.7 City of Laredo Management Information Systems

The Management Information Systems (MIS) Department supports other City of Laredo departments for computer and network applications. MIS currently handles the payment system for parking meters and would possibly be the department to handle the payment system for a regional Smart card that might include parking, transit, and bridge. MIS does not have any existing ITS nor do they have any ITS needs; however, they could play a vital support role in the implementation of a Regional Smart card. The Smart card could provide a single payment system for multiple City of Laredo transportation services, such as El Metro transit, crossing of the international bridges, and use of parking meters. MIS could possibly handle the payment system for the card.

2.2.8 City of Laredo Fire Department

The Fire Department provides fire, emergency medical services, and hazardous material response services for the City of Laredo. They also manage the Emergency Operations Center (EOC) which is temporarily located at the Public Works Building. Fire trucks and ambulances are being equipped with MDTs and AVL. All fire stations are connected to the I-Net communications backbone.

Key ITS needs that could potentially be provided by the Traffic Department include:

- Signal preemption for fire vehicles along priority corridors;
- Flood detector information from sensors at low water crossings;

- Camera feeds available to the EOC and Fire Department from TxDOT and City of Laredo CCTV cameras;
- Information about stopped trains, including routes that are closed, length of closure, and traffic conditions; and
- Potential collocation of the EOC with the City of Laredo TMC so that traffic information and control capabilities would be readily available to EOC managers during emergencies.

2.2.9 Texas Department of Transportation

The TxDOT Laredo District operates the South Texas Regional Advanced Transportation Information System (STRATIS). STRATIS was officially opened on February 4, 2004 and serves as the TMC for TxDOT in the Laredo Region. TxDOT also operates DMS, CCTV cameras, lane control signals, highway advisory radios, speed detectors, and video image vehicle detection systems. A railroad coordination system called the Wireless Advisory Railroad Network (WARN) is in place to inform drivers of closures at railroad crossings. TxDOT has fiber optic lines located on I-35, Loop 20, and Mines Road. There is a data connection between STRATIS and the City of Laredo TMC for sharing of CCTV camera feeds and control. The connection also allows the City of Laredo TMC to view messages that have been placed on the DMS. TxDOT has provided monitors to the City of Laredo 911 Dispatch Center to provide CCTV camera images to the center.

Key ITS needs that TxDOT have include:

- Improved traveler information on Business 35 and US 83; and
- Data connection to the Department of Public Safety (DPS) to provide them with camera feeds and other relevant data.

3. ITS VISION, MISSION, AND REQUIREMENTS

The City of Laredo ITS Stakeholder group developed a vision and a mission statement for the ITS system. A vision statement identifies the image of success for an organization or system to best meet the needs of their stakeholder group. The vision developed by stakeholders in the City of Laredo is identified below.

City of Laredo ITS Vision –

> *As an international gateway city, the City of Laredo will build a world-class transportation network that uses intelligent transportation systems to improve safety and increase efficiency for all travelers in the City of Laredo.*

A mission statement addresses the purpose, business, and values of system or organization. The stakeholder group discussed the needs to be addressed by ITS in the City of Laredo, how they were going to do it, and what principles would guide the efforts. From this discussion the group constructed the mission statement identified below.

City of Laredo ITS Mission –

> *The City of Laredo will serve the transportation needs of its citizens and visitors by improving public safety, reducing congestion, and providing real-time traveler information through the deployment of intelligent transportation systems, integration of elements, and coordination of all departments involved in the transportation network.*

Based on the surveys and agency interviews conducted, as well as feedback from stakeholder meetings, a number of high priority ITS requirements to achieve the vision and mission are recommended for consideration in the City of Laredo. Each of these requirements represents services or technologies that one or more stakeholder agencies have said would be a high priority for implementation in the next several years.

In **Table 4**, the recommended high priority ITS requirements in the City of Laredo are identified. After each requirement, the agency or agencies that identified the requirement as an important need are identified. The recommended agency or agencies that should be responsible for implementing the service are also identified.

Table 4 – Recommended High Priority ITS Requirements in the City of Laredo

ITS Requirement	Requesting Agency	Implementing Agency
Consider collocating the City of Laredo Traffic Management Center, Emergency Operation Center, and 911 Dispatch Center	Fire, Police, Traffic	Fire, Police, Traffic
Upgrade the existing traffic signal system and improve traffic signal coordination	El Metro, Traffic	Traffic
Increase network surveillance through CCTV camera deployment and video sharing between the Laredo TMC and other departments	Bridge, Environmental Services, Fire, Police, Traffic, TxDOT	Traffic
Implement DMS on arterial streets	Bridge, Police, Traffic, TxDOT	Traffic
Implement flood detection on arterial streets and bridges	Bridge, Environmental Services, Fire, Police, Traffic	Traffic
Implement system to detect rail crossing closures and provide information to the public and other City of Laredo Departments	Fire, El Metro, Police, Traffic	Traffic
Implement traffic signal preemption for emergency vehicles, including fire, emergency medical services, and police	Fire, Police	Fire, Police, Traffic
Implement traffic signal priority for transit buses	El Metro	El Metro, Traffic
Implement a 511 traveler information number	Police, Traffic	Traffic, TxDOT
Implement Smart cards for transit, parking meters, and international bridge crossing payment	Bridge, El Metro, Traffic	Bridge, El Metro, MIS, Traffic
Implement additional fiber optic communications in the City of Laredo to support the transportation infrastructure	Telecommunications, Traffic, TxDOT	Telecommunications, Traffic, TxDOT
Implement automated enforcement for speed, red light running, and bridge violations	Traffic, Police, Bridge	Traffic, Police, Bridge

4. EXISTING ITS DEPLOYMENTS

4.1 Centers

A key element in the deployment of ITS is the connection of field elements to the centers, as well as connection of centers to other centers for sharing and integration of information. Key centers that are involved in the transportation system include the City of Laredo TMC, TxDOT STRATIS, El Metro Operations Center, Bridge Centers, 911 Dispatch Center, DPS, and the City of Laredo EOC. In addition, Environmental Services monitors water quality stations that provide information on potential flooding, and the Telecommunication Department's building houses the Laredo I-Net equipment.

The City of Laredo TMC and EOC may both be relocated in the near future. The TMC will be relocating if the land that it is on becomes part of the adjacent airport. The EOC may relocate due to space constraints. Additionally, the 911 Dispatch Center is also constrained by space and could possibly be relocated. There is a possibility of relocating these facilities into a joint center.

Figure 1 identifies the location of the centers included in **Table 5**.

Table 5 – Centers

Center	Operating Agency	Location
911 Dispatch Center	City of Laredo Police Department	4117 Maher Ave
Bridge 1 – Gateway to the Americas	City of Laredo Bridge Department	100 Convent Ave
Bridge 2 – Juarez – Lincoln International Bridge	City of Laredo Bridge Department	201 Santa Ursula Ave
Bridge 3 – Columbia Solidarity Bridge	City of Laredo Bridge Department	FM 3464 at FM 1472
Bridge 4 – World Trade Bridge	City of Laredo Bridge Department	11601 FM 1472
City of Laredo Emergency Operations Center	City of Laredo	5512 Thomas Ave
City of Laredo Environmental Services	City of Laredo Environmental Services Department	619 Reynolds St
City of Laredo Telecommunications Building	City of Laredo Telecommunications Department	1101 Garden St
City of Laredo Traffic Management Center	City of Laredo Traffic Department	2800 Saunders Ave
El Metro Operations Center	El Metro	1300 Farragut St
Texas Department of Public Safety	Texas Department of Public Safety	1901 Bob Bullock Loop
TxDOT STRATIS	TxDOT Laredo District	1817 Bob Bullock Loop

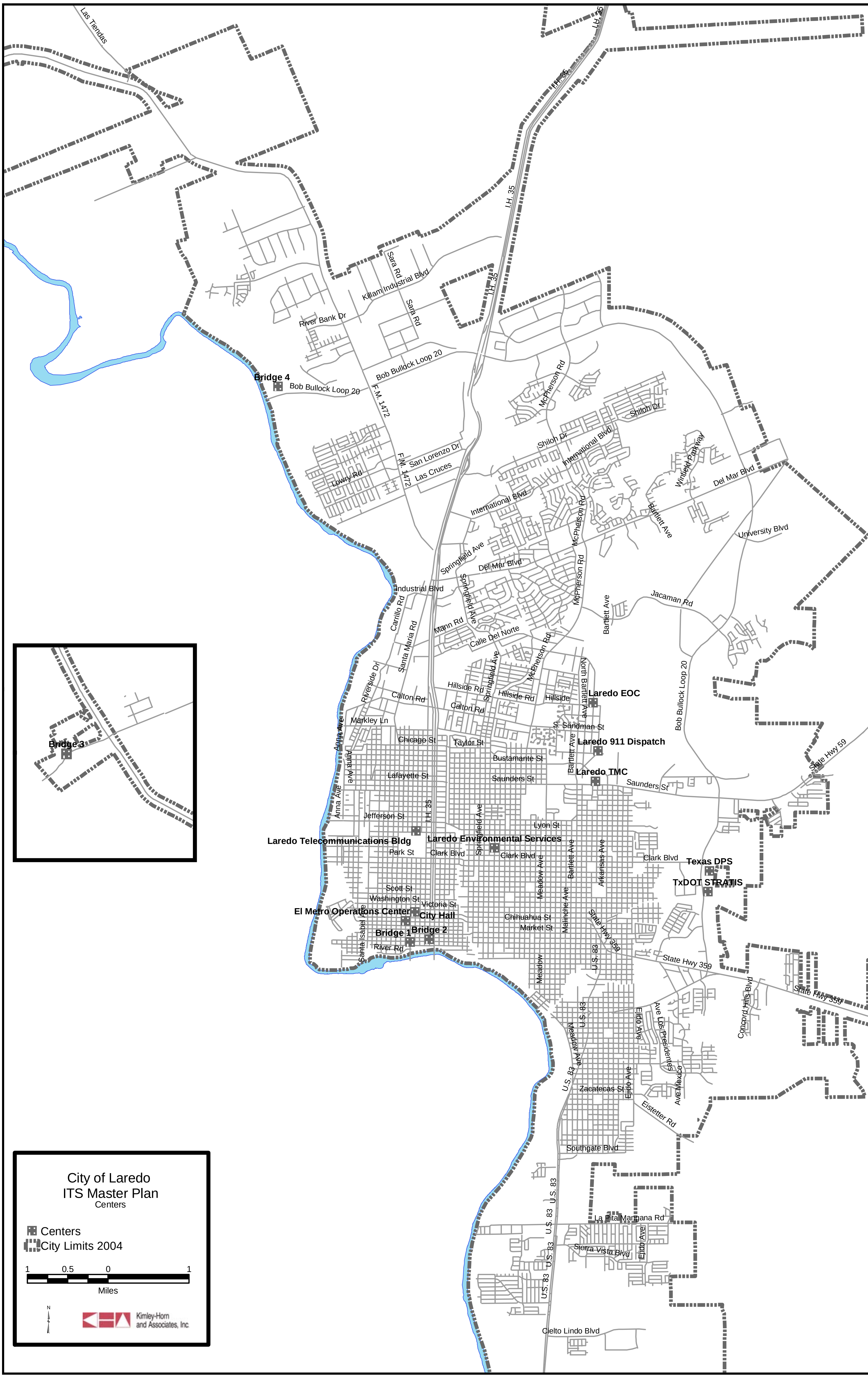

Figure 1 – Centers

4.2 City of Laredo Roadside Implementations

There are several types of roadside implementations in place in the City of Laredo, including:

- CCTV cameras on roadways;
- Still frame cameras at the international bridges;
- VIVDS; and
- Water quality monitoring stations.

In addition to equipment deployed by the City of Laredo, CCTV cameras feeds and control of TxDOT CCTV cameras are shared with the City of Laredo TMC. TxDOT DMS messages are also accessible by the City of Laredo TMC, although they are only able to view the messages but do not have control to change a message. TxDOT CCTV camera feeds are also sent to the 911 Dispatch Center for use by the fire dispatchers.

Figure 2 shows the location of the City of Laredo ITS roadside elements. These elements are also identified in **Table 6**.

Table 6 – City of Laredo Roadside ITS Elements

Element	Operating Agency	Location	Status
Wireless CCTV Camera (1)	City of Laredo Traffic Department	US 59 – Meadow Ave	Existing
Wireless CCTV Cameras (2)	City of Laredo Traffic Department	FM 1472 – Interamerica Blvd	Existing
Wireless CCTV Pan/Tilt/Zoom (PTZ) Camera (1)	City of Laredo Traffic Department	McPherson Rd – Shiloh Dr	Existing
Wireless CCTV Cameras (2)	City of Laredo Traffic Department	McPherson Rd – Jacaman Rd	Existing
Wireless CCTV Cameras (2)	City of Laredo Traffic Department	McPherson Rd – Del Mar Blvd	Existing
Wireless CCTV Cameras (3)	City of Laredo Traffic Department	FM 1472 – Santa Maria Ave	Existing
Wireless CCTV Cameras (3)	City of Laredo Traffic Department	Jacaman Rd – Sinatra Pkwy	Existing
Wireless CCTV PTZ Camera (1)	City of Laredo Traffic Department	Jacaman Rd – Loop 20	Existing
Wireless CCTV Camera (1)	City of Laredo Traffic Department	Flores Ave – Victoria St	Existing
Bridge 1 Cameras	City of Laredo Bridge Department	Bridge 1	Existing
Bridge 2 Cameras	City of Laredo Bridge Department	Bridge 2	Existing
Bridge 3 Cameras	City of Laredo Bridge Department	Bridge 3	Existing
Bridge 4 Cameras	City of Laredo Bridge Department	Bridge 4	Existing
Bustamante Water Quality Monitoring Station	City of Laredo Environmental Services Department	Bustamante St near Meadow Ave	Existing
Canal Water Quality Monitoring Station	City of Laredo Environmental Services Department	Canal St near San Francisco Ave	Existing
Enterprise Water Quality Monitoring Station	City of Laredo Environmental Services Department	Enterprise St near Interamerica Blvd	Existing
Guerrrero Water Quality Monitoring Station	City of Laredo Environmental Services Department	Guerrero St near McDonell Ave	Existing
Jefferson Water Quality Monitoring Station	City of Laredo Environmental Services Department	Jefferson St near San Francisco Ave	Existing

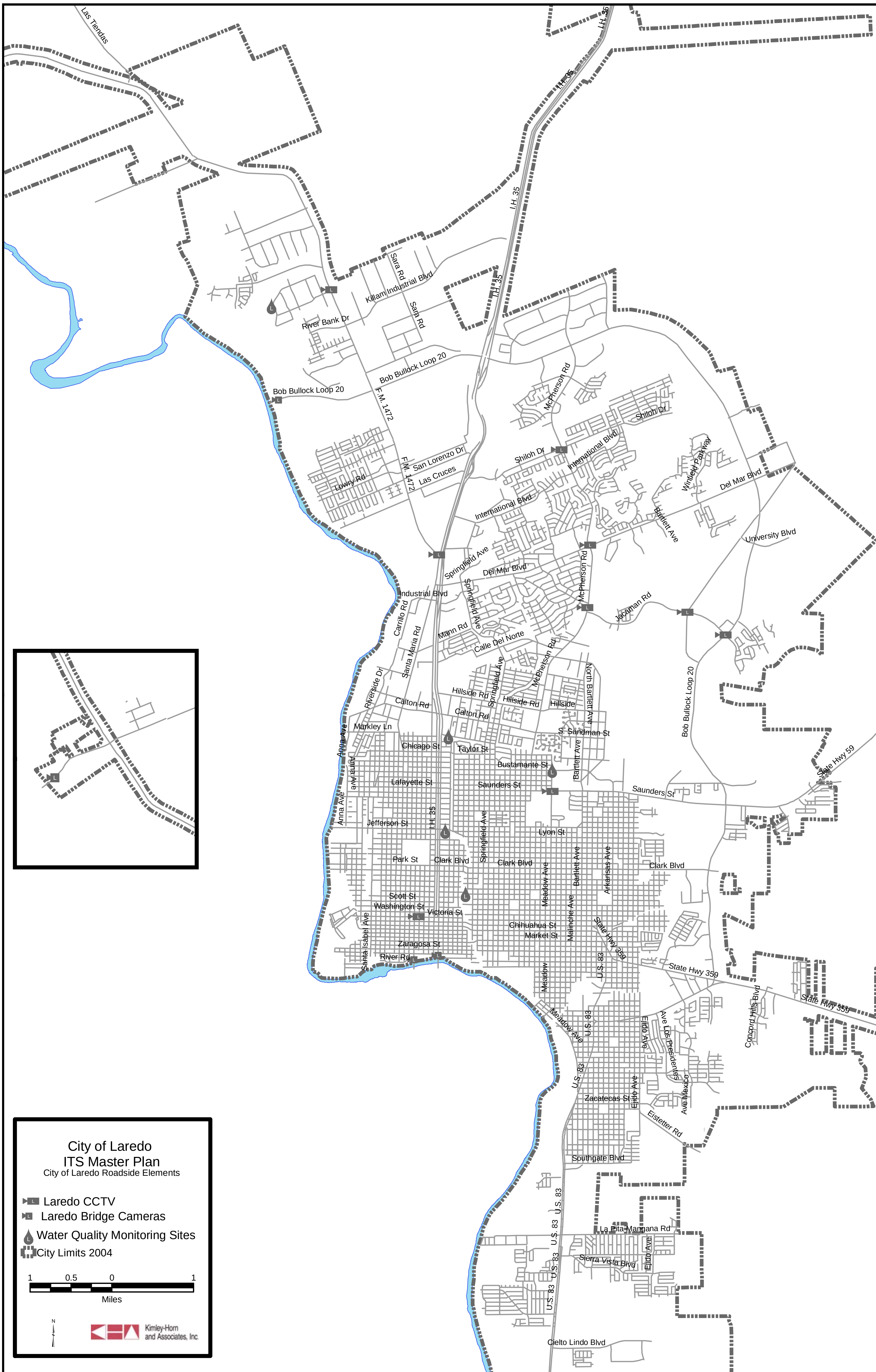

Figure 2 – City of Laredo Existing Roadside Elements

4.3 City of Laredo Traffic Signals

The City of Laredo Traffic Department operates traffic signals and school zone flashers within the limits of the City of Laredo.

The City primarily uses Naztec Series 900 National Electrical Manufacturer's Association (NEMA) TS1 controllers for their signals. Crouse-Hinds, Kentron, and Naztec 848 controllers are also used at select locations. **Table 7** identifies the signal location and type of controller. In **Figure 3**, the location of each signal and type of communication is identified. Repeater locations are also identified. Signals are identified in one of the following categories:

- Online by Radio–Radio: Radio communication is used from the TMC to the master controller and from the master controller to the slave controllers.
- Online by Modem–Radio: Phone drops are used for communication from the TMC to the master and radio is used for communication from the master to the slaves.
- Online by Modem–Hardwire: Phone drops are used for communication from the TMC to the master and hardwire is used for communication from the master to the slaves.
- Online by Fiber–Hardwire: Fiber optic communication is used from the TMC to the master and hardwire is used for communication from the master to the slaves.
- Off System: Communication from the TMC to the signal does not exist.
- TxDOT Signal: Signal is owned, operated, and maintained by TxDOT.

Figure 3 also identifies signals that are currently on a closed loop system along with the location of the master controller.

The City of Laredo Traffic Department also operates school zone flashers using either a time switch or a pager programmable time switch.

Table 7 – City of Laredo Traffic Signal Locations and Controllers

Signal Location	Controller	Signal Location	Controller	Signal Location	Controller
Alexander and Del Mar	Naztec 900	Chihuahua and Malinche	Naztec 900	Farragut and San Bernardo	Naztec 900
Arkansas and Clark	Naztec 900	Chihuahua and Meadow	Naztec 900	Farragut and San Dario	Naztec 900
Arkansas and Corpus Christi	Naztec 900	Chihuahua and Tilden	Naztec 900	Farragut and Santa Maria	Naztec 900
Calle del Norte and McPherson	Crouse-Hinds	Chihuahua and Seymore	Naztec 900	Farragut and Santa Ursula	Naztec 900
Arkansas and Hwy. 359	Naztec 900	Clark and Bob Bullock (Loop 20)	Naztec 900	Fenwick and McPherson	Naztec 900
Arkansas and Lyon	Naztec 900	Clark and Malinche	Naztec 900	Flores and Grant	Naztec 900
Arkansas and Market	Naztec 900	Clark and Martin	Crouse-Hinds	Flores and Hidalgo	Crouse-Hinds
Arkansas and Montgomery	Naztec 900	Clark and Meadow	Naztec 848	Flores and Houston	Naztec 900
Arkansas and Saunders	Naztec 900	Clark and Seymour	Naztec 848	Flores and Iturbide	Crouse-Hinds
Bartlett and Chihuahua	Naztec 900	Clark and Springfield	Naztec 900	Flores and Lincoln	Crouse-Hinds
Bartlett and Clark	Naztec 900	Clark and Texas	Crouse-Hinds	Flores and Matamoros	Naztec 900
Bartlett and Corpus Christi	Crouse-Hinds	Concord Hills and Hwy. 359	Naztec 900	Flores and Park	124 F
Bartlett and Guadalupe	Naztec 900	Convent and Farragut	Naztec 900	Flores and Washington	Naztec 900
Bartlett and Lane	Crouse-Hinds	Convent and Grant	Naztec 900	FM 1472 and Flecha Ln.	Naztec 900
Bartlett and Locust	Naztec 900	Convent and Hidalgo	Naztec 900	FM 1472 and Loop 20	Naztec 900
Bartlett and Lyon	Naztec 900	Convent and Houston	Naztec 900	FM 1472 and Rancho Viejo	Naztec 900
Bartlett and Mier	Crouse-Hinds	Convent and Iturbide	Naztec 900	FM 1472 and Killam	Naztec 900
Bartlett and Saunders	Naztec 900	Convent and Lincoln	Naztec 900	FM 1472 and San Gabriel	Naztec 900
Bartlett and Bustamante	Naztec 900	Convent and Matamoros	Naztec 900	FM 1472 and International	Naztec 900
Benington and Del Mar	Naztec 900	Convent and Park	124 F	Gale and McPherson	Naztec 900
Boomtown and Loop 20	Naztec 900	Convent and Scott	Kentron	Gale and Springfield	Naztec 900
Bristol and FM 1472	Naztec 900	Convent and Victoria	Naztec 900	Garden and Salinas	Crouse-Hinds
Bustamante and Meadow	Naztec 900	Convent and Washington	Naztec 900	Garden and Santa Maria	Naztec 900
Bustamante and McPherson	Naztec 900	Convent and Zaragoza	Naztec 900	Gonzalez and Santa Maria	Naztec 900
Calle del Norte and McPherson	Naztec 900	Corpus Christi and Hendricks	Kentron	Gateway and San Bernardo	Naztec 900
Calle del Norte and Springfield	Naztec 900	Corpus Christi and Malinche	Crouse-Hinds	Grant and Juarez	Naztec 900
Calle del Norte and St. James	Naztec 900	Corpus Christi and Marcella	Naztec 848	Grant and Salinas	Naztec 900
Calton and McPherson	Naztec 900	Corpus Christi and Meadow	Crouse-Hinds	Grant and Santa Maria	Naztec 900
Calton Rd. and I.H. 35	Naztec 900	Corpus Christi and Monterrey	Naztec 848	Green and Meadow	Naztec 900
Calton Rd. and San Bernardo	Naztec 900	Corpus Christi and Seymour	Crouse-Hinds	Guadalupe and Malinche	Naztec 900
Calton Rd. and San Francisco	Naztec 900	Corpus Christi and Springfield	Naztec 848	Guadalupe and Marcella	Naztec 900
Calton Rd. and Santa Maria	Naztec 900	Country Club and McPherson	Naztec 848	Guadalupe and Meadow	Naztec 900
Calton Rd. and Springfield	Naztec 900	Davis and Victoria	Crouse-Hinds	Guadalupe and Seymour	Naztec 900
Calton Rd. and Yeary	Naztec 900	Del Mar and Albertsons	Naztec 900	Guadalupe and Tilden	Naztec 900
Canones and U.S. 83	Naztec 900	Del Mar and I.H. 35	Naztec 900	Gustavus and Meadow	Naztec 848
Cedar and Chihuahua	Naztec 900	Del Mar and Lindenwood	Naztec 900	Gustavus and Seymour	Naztec 848
Cedar and Clark	Crouse-Hinds	Del Mar and McPherson Dr.	Naztec 900	Gustavus and Springfield	Crouse-Hinds
Cedar and Corpus Christi	Crouse-Hinds	Del Mar and McPherson Rd.	Naztec 900	Hidalgo and Juarez	Naztec 900
Cedar and Guadalupe	Naztec 900	Del Mar and Santa Maria	Naztec 900	Hidalgo and Salinas	Naztec 900
Cedar and Gustavus	Crouse-Hinds	Del Mar and Springfield	Naztec 900	Hidalgo and San Agustin	Crouse-Hinds
Chestnut and U.S. 83	Naztec 900	Del Mar Exit and Santa Maria	Naztec 900	Hidalgo and San Bernardo	Naztec 900
Chicago and San Bernardo	Naztec 900	Farragut and Flores	Crouse-Hinds	Hidalgo and San Dario	Naztec 900
Chicago and Santa Maria	Naztec 900	Farragut and Juarez	Crouse-Hinds	Hidalgo and Santa Maria	Naztec 900
Chicago and I.H. 35	Naztec 900	Farragut and Salinas	Naztec 900	Hidalgo and Santa Ursula	Naztec 900
Chihuahua and Marcella	Naztec 900	Farragut and San Agustin	Crouse-Hinds	Hillside and McPherson	Naztec 900

Table 7 – City of Laredo Traffic Signal Locations and Controllers (continued)

Signal Location	Controller	Signal Location	Controller	Signal Location	Controller
Hidalgo and San Agustin	Crouse-Hinds	Lafayette and Santa Maria	Naztec 900	Park and San Eduardo	124F
Hidalgo and San Bernardo	Naztec 900	Lincoln and Santa Maria	Naztec 900	Park and San Enrique	124F
Hidalgo and San Dario	Naztec 900	Loop 20 and Wal-Mart	Naztec NT 900	Park and San Francisco	124F
Hidalgo and Santa Maria	Naztec 900	Loop 20 and Boomtown	Naztec 900	Park and San Jorge	124F
Hidalgo and Santa Ursula	Naztec 900	Loop 20 and Los Presidentes	Naztec 900	Park and Santa Maria	124F
Hillside and McPherson	Naztec 900	Loop 20 and New York	Naztec 900	Plum and Meadow	Naztec 900
Hillside and Springfield	Naztec 900	Loop 20 and U.S. 83	Naztec 900	Salinas and Victoria	Naztec 900
Hillside and Yeary	Naztec 900	Loop 20 and Hwy. 359	Naztec 900	Salinas and Zaragoza	Naztec 900
Houston and Juarez	Crouse-Hinds	Loop 20 and U.S. 59	Naztec 900	San Agustin and Houston	Naztec 900
Houston and Salinas	Naztec 900	Loop 20 and I.H. 35	Naztec 900	San Agustin and Victoria	Naztec 900
Houston and San Agustin	Naztec 900	Loop 20 and University	Naztec 900	San Bernardo and Washington	Naztec 900
Houston and San Bernardo	Naztec 900	Lyon and Malinche	Naztec 900	Sanchez and I.H. 35	Naztec 900
Houston and San Dario	Naztec 900	Lyon and Monterrey	Naztec 900	San Bernardo and Scott	Naztec 900
Houston and San Eduardo	Naztec 900	Lyon and Springfield	Naztec 900	San Bernardo and Victoria	Naztec 900
Houston and Santa Maria	Naztec 900	Lyon and Meadow	Naztec 848	San Bernardo and Washington	Naztec 900
Houston and Washington	Naztec 900	Lyon and Tilden	Crouse-Hinds	Sanchez and San Bernardo	Naztec 900
Houston and Santa Ursula	Naztec 900	Mann and Springfield	Naztec 900	Sanchez and San Eduardo	Crouse-Hinds
Hudson and Washington (LCC)	Naztec 900	Mann and Santa Maria	Naztec 900	Sanchez and San Enrique	Naztec 900
I.H. 35 and Lafayette	Naztec 900	Main and Washington	Naztec 900	Sanchez and San Francisco	Crouse-Hinds
I.H. 35 and Mann Rd.	Naztec 900	Marcella and Taylor	Naztec 900	Sanchez and Santa Maria	Naztec 900
I.H. 35 and Park	Naztec 900	Market and Marcella	Crouse-Hinds	San Dario and Scott	Naztec 900
I.H. 35 and Shiloh	Naztec 900	Market and Meadow	Naztec 900	San Dario and Victoria	Kentron
I.H. 35 and Milo	Naztec 900	Market and Zapata	Naztec 900	San Dario and Washington	Kentron
International and McPherson	Naztec 900	Matamoros and Salinas	Naztec 900	San Eduardo and Victoria	Naztec 900
Industrial and Santa Maria	Naztec 900	Matamoros and San Agustin	Naztec 900	San Enrique and Washington	Crouse-Hinds
Iturbide and Juarez	Crouse-Hinds	Matamoros and San Bernardo	Naztec 900	San Eduardo and Washington	Crouse-Hinds
Iturbide and Salinas	Naztec 900	Matamoros and San Dario	Naztec 900	Santa Maria and Scott	Naztec 900
Iturbide and Santa Maria	Naztec 900	Matamoros and San Eduardo	Naztec 900	Santa Maria and Victoria	Naztec 900
Jacaman and Loop 20	Naztec 980-TY2	Matamoros and Santa Maria	Naztec 900	Santa Maria and Washington	Naztec 900
Jacaman and McPherson	Naztec NT900	McPherson and Taylor	Naztec 900	Santa Rita and U.S. 83	Naztec 900
Jacaman and Sinatra	Naztec 980-TY2	Matamoros and Santa Ursula	Naztec 900	Santa Ursula and Scott	Naztec 900
Jefferson and I.H. 35	Naztec 900	McPherson and Shiloh	Naztec 900	Santa Ursula and Victoria	Naztec 900
Jefferson and San Bernardo	Naztec 900	McPherson and United	Naztec 900	Santa Ursula and Washington	Naztec 900
Jefferson and Santa Maria	Crouse-Hinds	McPherson and U.S. 59	Naztec 900	Sanders and U.S. 59	Naztec 900
Juarez and Lincoln	Crouse-Hinds	Meadow and U.S. 59	Naztec 900	Saunders and Springfield	Naztec 900
Juarez and Matamoros	Crouse-Hinds	Monterrey and U.S. 59	Naztec 900	Sierra Vista and U.S. 83	Naztec 900
Juarez and Victoria	Naztec 900	Muller and FM 1472	Naztec 900	South Gate and U.S. 83	Naztec 900
Juarez and Washington	Naztec 900	Napoleon and U.S. 83	Naztec 900	Springfield and Taylor	Naztec 900
Lafayette and I.H. 35	Naztec 900	Palo Blanco and U.S. 83	Naztec 900	Saunders and Tilden	Naztec 900
Lafayette and San Bernardo	Naztec 900	Park and San Bernardo	Naztec 900	U.S. 83 and Zacatecas	Naztec 900

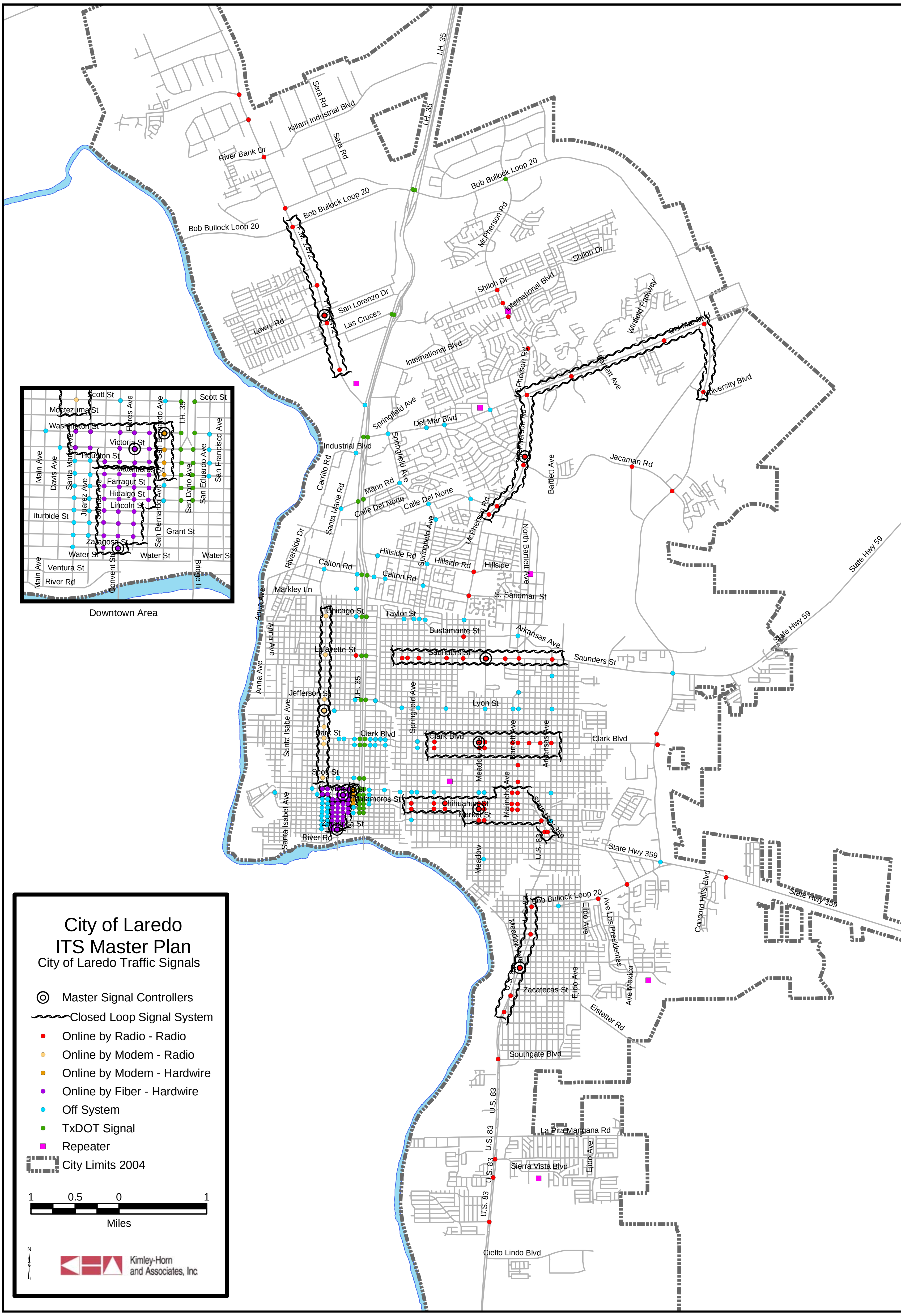

Figure 3 – City of Laredo Existing Traffic Signals

4.4 City of Laredo Communications

The City of Laredo I-Net provides fiber optic communications for City departments throughout the City limits. I-Net includes fiber optic communications that were provided to the City under an agreement with Time Warner, the local cable provider. The Time Warner franchise agreement is currently under renegotiation and growth of the I-Net system will depend largely on the new agreements that are reached.

There are three communication hub locations set up in the City. These are located at the Telecommunication building, Traffic Department building, and City Hall. In addition, a series of nodes are located throughout the City that provide access points to the I-Net system. The hub and node locations are identified in **Table 8**. These locations are also shown in **Figure 4**.

Table 8 – City of Laredo Communications Infrastructure

Entity	Site Name	Location	Status
Hub	Telecommunications Building	1101 Garden St	Existing
Hub	Traffic Safety	2800 Saunders Ave	Existing
Hub	City Hall	1100 Houston St	Existing
Node	City Hall	1100 Houston St	Existing
Node	Bridge #1	100 Convent Ave	Existing
Node	Bridge #2	201 Santa Ursula Ave	Existing
Node	Bridge #4	11601 FM 1472 (World Trade Bridge)	Existing
Node	Main Clinic (Health Department)	2600 Cedar Ave	Existing
Node	Laredo Community College	West end of Washington St	Existing
Node	Public Library (New)	Corner of Calton Rd and McPherson Rd	Existing
Node	Santo Niño Library	2200 Zacatecas St	Existing
Node	Leo G. Cigarroa High School (LISD)	2600 Zacatecas St	Existing
Node	Martin High School (LISD)	2000 San Bernardo Ave	Existing
Node	J.W. Nixon High School (LISD)	Elm Cir	Existing
Node	Alexander High School (UISD)	3600 Del Mar Blvd	Existing
Node	UISD Administrative Office	201 Lindenwood Dr	Existing
Node	United High School (UISD)	8800 McPherson Rd	Existing
Node	United South High School (UISD)	4001 Avenida Las Presidentes	Existing
Node	San Augustine High School	1300 Galveston St	Existing
Node	Traffic Safety	2800 Saunders Ave	Existing
Node	Traffic Controller #1	Corner of Victoria St and Flores Ave @ City Hall	Existing
Node	Traffic Controller #2	Corner of Convent Ave and Zaragoza St (@ Bridge #1)	Existing
Node	Transit Center (El Metro Administrative Offices)	1300 Farragut St	Existing
Node	Transit Center (El Metro Shop)	401 Scott St	Existing
Node	Water Plant	2200 Jefferson St	Existing
Node	Fire Station #1	1 Guadalupe St	Existing

Table 8 – City of Laredo Communications Infrastructure (continued)

Entity	Site Name	Location	Status
Node	Fire Station #2	2200 Zacatecas St	Existing
Node	Fire Station #3	2420 San Bernardo Ave	Existing
Node	Fire Station #4	1919 Houston St	Existing
Node	Fire Station #5	2601 Bartlett St	Existing
Node	Fire Station #6	4903 Maher St	Existing
Node	Fire Station #7	1120 Calton Rd	Existing
Node	Fire Station #8	510 Del Mar Blvd	Existing
Node	Fire Station #9	13301 Mines Rd	Existing
Node	Fire Training Facility and Fire # 13	18.5 Mile Marker FM1472 (26911 Pinto Valle Dr)	Existing
Node	Police Station: Azteca	20 Iturbide St	Existing
Node	Police Station: Santo Niño	2200 Zacatecas St	Existing
Node	Police Station: Colonia Guadalupe	501 Bruni St	Existing
Node	K. Tarver Recreational Center (Parks)	2902 Tilden St	Existing
Node	Empty Node (former Water HQ)	Corner of Bartlett St and Bustamante St	Existing

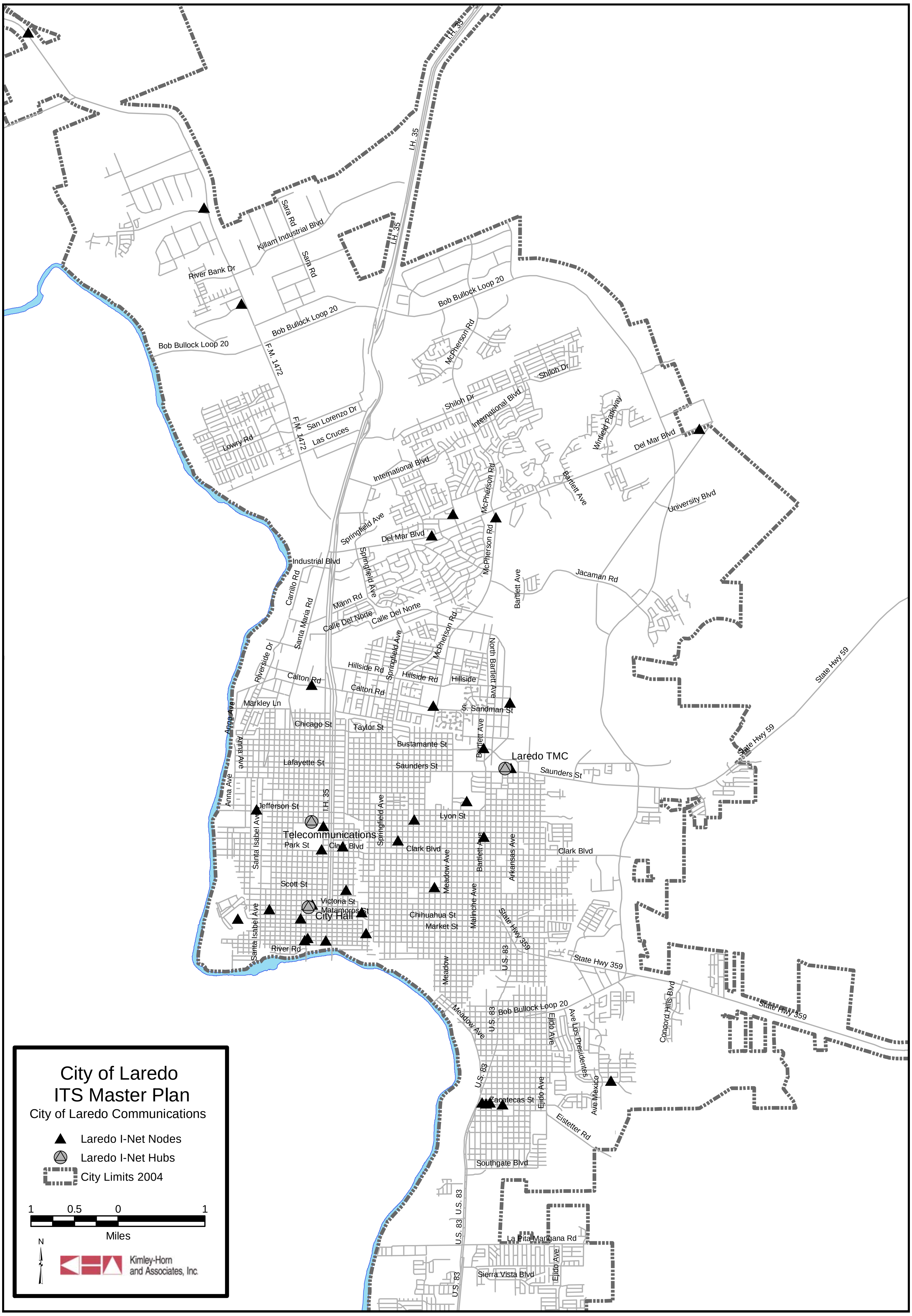

Figure 4 – City of Laredo Existing Communications

4.5 TxDOT Roadside Implementations

TxDOT operates a number of roadside ITS implementations, all of which are controlled through the TxDOT STRATIS center. A number of new implementations are also planned for the future. TxDOT currently shares control of their CCTV cameras with the City of Laredo TMC. The City also has the ability to monitor messages placed on TxDOT's DMS; however, they do not have control of the DMS to change messages.

HAR is used by TxDOT to broadcast traveler information messages to motorists. A number of WARN signs are placed throughout the City. These signs alert motorists of a railroad crossing and advise them to tune to an AM radio station which broadcasts additional information.

Lane control signals are used on freeways and major arterials to notify motorists of lane closures. VIVDS use video images at signalized intersections to actuate traffic signal control. Video from VIVDS can be brought back to the STRATIS center if desired.

TxDOT roadside implementations in place in the City of Laredo include:

- CCTV cameras;
- DMS;
- HAR and HAR beacon signs;
- Lane control signals; and
- VIVDS.

Table 9 identifies the TxDOT roadside ITS elements including the status of the implementation. All of the TxDOT ITS elements are identified in **Figure 5**.

Table 9 – TxDOT Roadside ITS Elements

Element	Operating Agency	Location	Status
CCTV Cameras I-35	TxDOT Laredo	I-35 south of Uniroyal Dr	Planned
CCTV Camera I-35	TxDOT Laredo	I-35 near Shiloh Dr	Planned
CCTV Camera I-35	TxDOT Laredo	I-35 near Del Mar Blvd	Planned
CCTV Camera I-35	TxDOT Laredo	I-35 between Mann Rd and Calle Del Norte	Existing
CCTV Camera I-35	TxDOT Laredo	I-35 near Saunders St	Existing
CCTV Camera I-35	TxDOT Laredo	I-35 near Clark Blvd	Existing
CCTV Camera FM 1472	TxDOT Laredo	FM 1472 between Killam Industrial Blvd and Interamerica Blvd	Existing
CCTV Camera FM 1472/Loop 20	TXDOT Laredo	Intersection of Loop 20 and FM 1472	Existing
CCTV Camera Loop 20	TxDOT Laredo	Loop 20 east of FM 1472	Existing
CCTV Camera Loop 20	TxDOT Laredo	Loop 20 east of I-35	Planned
CCTV Camera Loop 20	TxDOT Laredo	Loop 20 north of Del Mar Blvd	Planned
CCTV Camera Loop 20	TxDOT Laredo	Loop 20 south of Del Mar Blvd	Planned
CCTV Camera Loop 20	TxDOT Laredo	Loop 20 south of Jacaman Rd	Planned
CCTV Camera Loop 20	TxDOT Laredo	Loop 20 at Saunders St/SH 59	Planned
DMS Southbound I-35	TxDOT Laredo	Southbound I-35 north of Uniroyal Dr	Planned
DMS Southbound I-35	TxDOT Laredo	Southbound I-35 north of Killam Industrial Blvd	Existing
DMS Southbound I-35	TxDOT Laredo	Southbound I-35 south of Loop 20	Planned
DMS Southbound I-35	TxDOT Laredo	Southbound I-35 between Mann Rd and Calle Del Norte	Existing
DMS Southbound I-35	TxDOT Laredo	Southbound I-35 near Jackson St	Existing
DMS Northbound I-35	TxDOT Laredo	Northbound I-35 near Jackson St	Planned
DMS Northbound I-35	TxDOT Laredo	Northbound I-35 south of Uniroyal Dr	Planned
DMS Southbound FM 1472	TxDOT Laredo	Southbound FM 1472 between Killam Industrial Blvd and FM 3464	Existing
DMS Northbound FM 1472	TxDOT Laredo	Northbound FM 1472 south of Loop 20	Existing
DMS Eastbound Loop 20	TxDOT Laredo	Eastbound Loop 20 west of FM 1472	Existing
DMS Westbound Loop 20	TxDOT Laredo	Westbound Loop 20 east of FM 1472	Existing
HAR Beacon Sign Northbound I-35	TxDOT Laredo	Northbound I-35 south of Calton Rd	Existing
HAR Beacon Sign Northbound I-35	TxDOT Laredo	Northbound I-35 south of Loop 20	Existing
HAR Beacon Sign Northbound FM 1472	TxDOT Laredo	Northbound FM 1472 south of Loop 20	Existing
HAR Transmitter	TxDOT Laredo	I-35 south of Loop 20	Existing
Lane Control Signals Southbound FM 1472	TxDOT Laredo	Southbound FM 1472 between Killam Industrial Blvd and FM 3464	Existing
Lane Control Signals Eastbound Loop 20	TxDOT Laredo	Eastbound Loop 20 west of FM 1472	Existing
Lane Control Signals Westbound Loop 20	TxDOT Laredo	Westbound Loop 20 east of FM 1472	Existing
VIVDS	TxDOT Laredo	Traffic signals throughout the Laredo District	Existing
WARN Signs	TxDOT Laredo	Various intersections along FM 1472, as well as along I-35	Existing

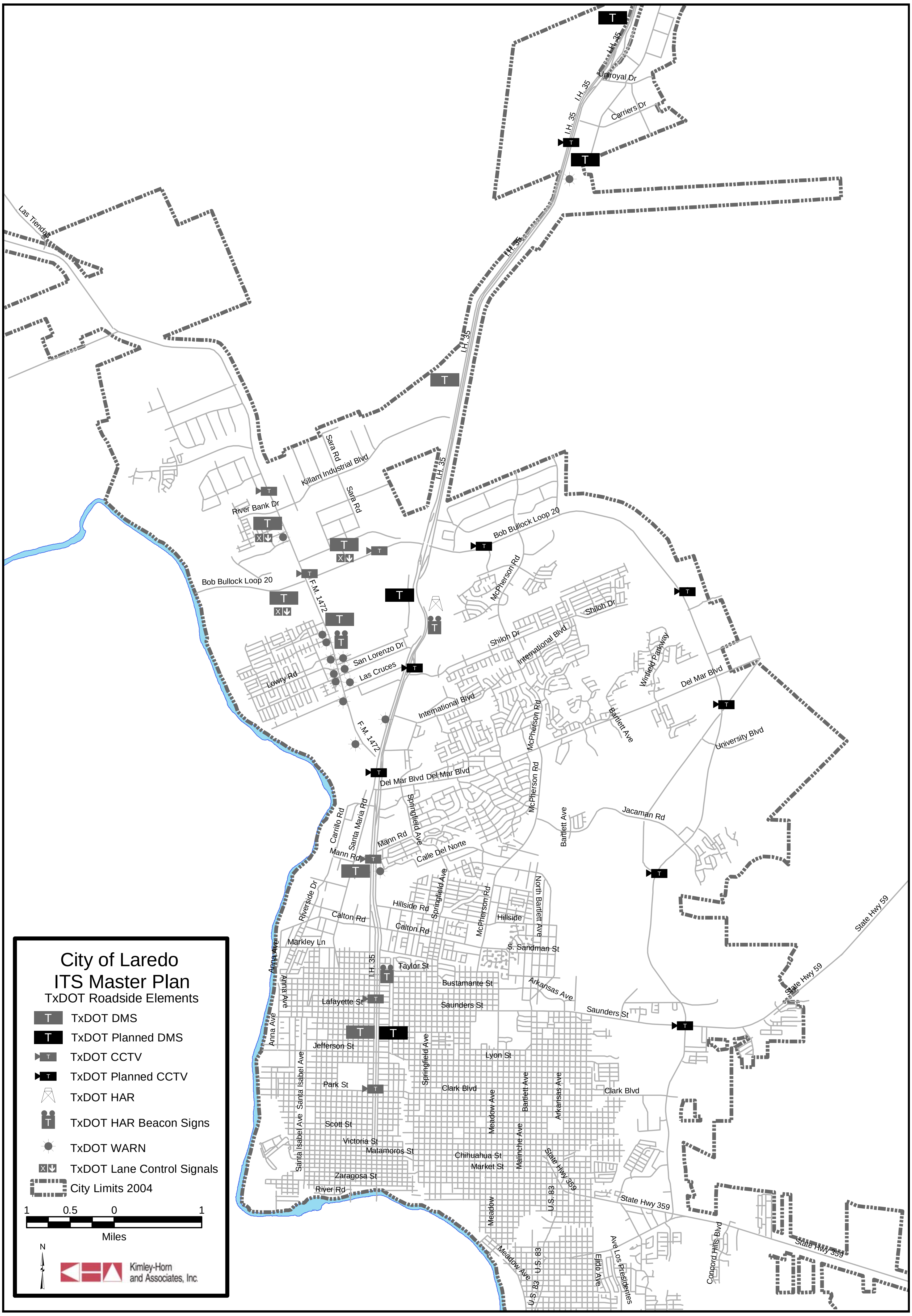

Figure 5 – TxDOT Existing and Planned Roadside Elements

4.6 TxDOT Communications

In addition to roadside ITS implementation, TxDOT has also deployed several miles of fiber optic cable around the City to provide communications to their roadside infrastructure. The total length of TxDOT fiber will more than double in the future with TxDOT's planned deployments and will include most of Loop 20 and I-35 within the City of Laredo limits.

Table 10 and **Figure 6** identify the existing and future locations of TxDOT fiber.

Table 10 – TxDOT Communication Elements

Element	Operating Agency	Location	Status
Fiber	TxDOT Laredo	Connection piece at FM 1472 and Loop 20	Existing
Fiber	TxDOT Laredo	Garden St from I-35 to Flores Ave	Existing
Fiber	TxDOT Laredo	I-35 from Hidalgo to Park St	Planned
Fiber	TxDOT Laredo	I-35 (northbound frontage road) from south of Scott St to south of Hillside Rd	Existing
Fiber	TxDOT Laredo	I-35 from Hillside Rd to north of Shiloh Dr	Planned
Fiber	TxDOT Laredo	I-35 from north of Shiloh Dr to Killam Industrial Blvd	Planned
Fiber	TxDOT Laredo	I-35 from Killam Industrial Blvd to north of Uniroyal Dr	Planned
Fiber	TxDOT Laredo	Loop 20 from west of I-35 to McPherson Rd	Planned
Fiber	TxDOT Laredo	Loop 20 from McPherson Rd to the Armory	Existing
Fiber	TxDOT Laredo	Loop 20 from the Armory to Loop 20/US 59	Planned
Fiber	TxDOT Laredo	Loop 20 (SB side) from TxDOT Laredo District Office to Saunders St	Existing
Fiber	TxDOT Laredo	Saunders St (WB side) from Loop 20 to City of Laredo Traffic Management Center	Existing

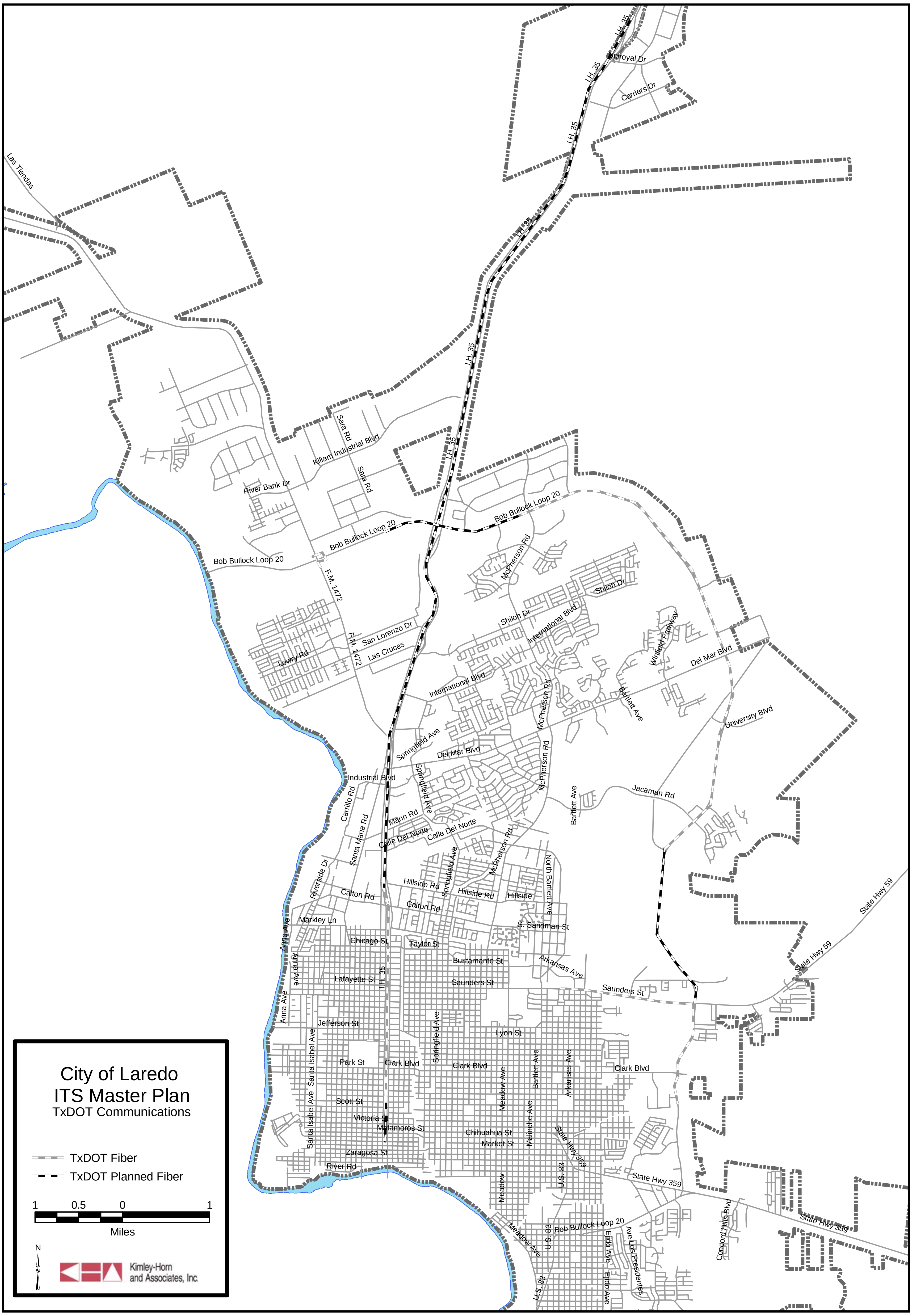

Figure 6 – TxDOT Communications

5. RECOMMENDED ITS DEPLOYMENTS

5.1 System Concept

Using the ITS vision and mission as guidelines, a system concept was developed to satisfy the identified requirements for ITS deployments in the City of Laredo. A new Traffic Department TMC with expanded capabilities will serve as the cornerstone for ITS deployments in the City. Expanded capabilities will focus on the addition of equipment to support additional planned ITS elements and could include the incorporation of the EOC and 911 Dispatch Center.

Integrating services was a high priority as representatives from different City departments sought to provide more seamless service to citizens and visitors to Laredo. The most significant of these integrations would be a joint operations center that would ideally include the TMC, EOC, and 911 Dispatch Center. Citizens would benefit from increased efficiency of dispatch services both to clear traffic related incidents more rapidly and to individual emergency calls. Another significant recommended integration was to develop a Smart card system for electronic payment. The same payment instrument would be used for bridge tolls, parking, and public transportation fares.

Deployment of additional ITS devices will support the City's ITS goals. CCTV cameras will provide improved congestion information and incident detection to allow traffic management officials to make more informed traffic management strategy decisions. In addition, this information will aid in more efficient emergency services dispatch, possibly reducing response times. If an incident is located in an area visible to a CCTV camera, dispatchers can assess the situation and dispatch the most appropriate equipment. Strategically deployed DMS will relay information to the public about the state of the transportation network. Flood detection and road closure systems will allow automated road closures due to high water on roadways.

The specific ITS requirements identified by stakeholders and an explanation of their status as it relates to this ITS Master Plan are summarized in **Table 11**. The purpose of Section 5 is to provide a detailed description of the recommendations for how each of these stakeholder requirements should be addressed. Section 5.2 describes the recommended projects in detail and Section 5.3 provides an overview of recommended telecommunications alternatives.

Table 11 – ITS Master Plan Recommendations

ITS Requirement	ITS Master Plan Recommendation
Consider collocating the City of Laredo Traffic Management Center, Emergency Operations Center and 911 Dispatch Center	Recommend joint TMC/EOC with possible 911 Dispatch Center integration
Upgrade the existing traffic signal system and improve traffic signal coordination	Recommend upgrade of existing signal controllers and communications system
Increase network surveillance through CCTV camera deployment and video sharing between the Laredo TMC and other departments	Recommend deployment of 15 CCTV cameras, 1 still frame camera, and upgrade of 2 CCTV cameras to full pan/tilt/zoom in the City and provide capability for other City departments to access video feeds
Implement DMS on arterial streets	Recommend deployment of 3 DMS in the City
Implement flood detection on arterial streets and bridges	Recommend deployment of 4 flood detectors with closure gates
Implement system to detect rail crossing closures and provide information to the public and other City of Laredo Departments	Proposed overpasses and TxDOT WARN system will address many locations of concern
Implement traffic signal preemption for emergency vehicles, including fire, emergency medical services and police	Recommend deployment of signal preemption at 50 intersections that are a priority for Fire/EMS
Implement traffic signal priority for transit buses	Recommend signal timing changes at intersection of Farragut/Juarez and signal coordination improvements throughout the system
Implement a 511 traveler information number	TxDOT to address with City of Laredo potentially providing local transportation information
Implement Smart cards for transit, parking meters, and international bridge crossing payment	Recommend implementing common system for payment of transit fares, City parking meters, international bridge crossings
Implement automated enforcement for speed, red light running, and bridge violations	Will address in plan but not make a recommendation for implementation at this time
Implement additional fiber optic communications systems in the City of Laredo to support the transportation infrastructure	Recommend several communications alternatives based on signal system requirements, ITS field requirements, and TMC location

5.2 Project Concepts

A listing of desired projects for the City of Laredo was developed in coordination with stakeholders to address the ITS requirements. The projects outline strategic deployments for implementing ITS and achieving the City of Laredo's ITS vision. **Table 12** summarizes each of these recommended projects.

The projects are shown in priority order within categories and a project name and brief description of the project is provided. The department(s) responsible for the project, including implementation, operations, and maintenance, have been identified. These are often, but not always, the same department. An opinion of probable cost for the project implementations is also included. In Section 5.2.1 through 5.2.5, a more detailed description of each of these projects is included. The Section that addresses each project in more detail is referenced in **Table 12**.

A detailed breakdown of the cost estimate, including unit cost and number of each component, is included in **Table 13**.

Table 12 – Recommended Projects

Project	Description	Responsible Agency[1]	Opinion of Probable Cost	Reference Section
Traffic Management Center				
Laredo Traffic Management Center Upgrades	Add additional equipment to the existing Laredo TMC to increase functionality and upgrade existing equipment to replace aging and outdated technology. Additional equipment includes a video switch, uninterruptible power supplies, equipment rack, monitors, projectors, network and cabling equipment, and additional software and licenses. Upgrades include server and workstations. Benefits include increased system efficiency and reliability for TMC operators. The additional equipment and upgrades are also needed to maximize the functionality of the TMC and fully operate the components installed as part of other projects. These improvements provide critical interim enhancements and will be incorporated into the future TMC/Joint Operations Center.	Traffic	$88,000	5.2.1
Laredo Traffic Management Center/Joint Operations Center	Upgrade and expand the functionality of the Laredo TMC and consider establishing a joint operations center that would include the Laredo EOC and 911 Dispatch Center. The joint operations center would be designed so that the TMC, EOC and 911 dispatch would each have adequate space to accommodate their needs, but allow for close coordination between these functions during emergencies and disasters, roadway incidents and closures, and special events. Benefits include improved coordination between emergency and transportation agencies, improved response times, reduced traveler delay, and facility and communications cost savings.	Traffic Possible: Fire, Police	To Be Determined	5.2.1
Traffic Signal System				
Downtown Closed Loop Signal System Phase 1	Establish new downtown closed loop system to connect signals on designated approach routes to Bridge 1. Closed loop system is recommended to connect the following signals: ▪ Houston Street from I-35 to Santa Maria Avenue ▪ Santa Maria Avenue from Houston Street to Zaragosa Street ▪ Zaragosa Street from Santa Maria Avenue to Convent Avenue ▪ Juarez Avenue From Houston to Grant Street Signals on Houston Street, Santa Maria Avenue, and Zaragosa Street are each part of the designated approach to Bridge 1. Signals on Juarez Avenue are not currently part of a closed loop signal system and should be added to the Phase 1 system. Project will include upgrade of 21 secondary controllers and 1 master controller to NEMA TS-2 controllers with spread spectrum local interconnect. Benefits include improved signal coordination on designated approach routes to Bridge 1.	Traffic	$462,500	5.2.2

Table 12 – Recommended Projects (continued)

Project	Description	Responsible Agency[1]	Opinion of Probable Cost	Reference Section
Traffic Signal System (continued)				
Downtown Closed Loop Signal System Phase 2	Upgrade additional downtown signals not included in Phase 1 to NEMA TS-2 controllers with spread spectrum local interconnect. Phase 2 will upgrade approximately 40 secondary controllers and 3 master controllers. Signals included those that fall within the area bordered by Scott Street, San Bernardo Avenue, Zaragosa Street, and Main Avenue. The existing closed loop signal system in the downtown area should be reorganized during the implementation of Phase 2 to establish progression in key corridors. Benefits include improved signal coordination in downtown area.	Traffic	$904,500	5.2.2
Water Street Fiber Extension	Extend fiber optic telecommunication line approximately 0.5 miles from the existing terminus along Water Street to Santa Maria Avenue then north on Santa Maria Avenue to Zaragosa Street. Fiber extension will allow signals, as well as ITS devices installed as part of the Bridge 1 and 2 Traffic Coordination System efforts, to be connected to the Laredo TMC. Benefits include a high bandwidth communication link to the recommended CCTV camera at Santa Maria Avenue and Grant Street. The communication infrastructure will also allow communication to the signal master controller installed as part of the Downtown Closed Loop Signal System Phase 1.	Traffic	$50,000	5.2.2
Annual Signal System Upgrade Program	Implement annual program to replace approximately 15 signal controllers each year with NEMA TS-2 controllers and spread spectrum radio or other communication systems. As part of the program, stand alone signals should be brought into closed loops signal systems and where applicable, existing closed loop signal systems should be reorganized to improve coordination and progression. This is an annual program that, in conjunction with the downtown signal program, will allow a complete upgrade of the City's entire signal system in the next 10 years. Benefits include the addition of a reliable, updated signal control system with improved communication abilities that will allow the City to improve signal coordination and traffic flow.	Traffic	$315,000 Per Year	5.2.2
Traffic Signal Removal	Remove signals where warranted in the downtown area. Signals that should be considered for removal include those that are determined to be unwarranted and negatively impact coordination efforts in the following corridors: ▪ Santa Maria Avenue between Washington Street and Zaragoza Street ▪ Victoria Street ▪ Park Street ▪ Corpus Christi Street Any other signals along other corridors are not warranted and could negatively impact coordination should also be considered for removal.	Traffic	$5,000 Per Signalized Intersection	5.2.2

Table 12 – Recommended Projects (continued)

Project	Description	Responsible Agency[1]	Opinion of Probable Cost	Reference Section
Traffic Signal Preemption for Emergency Vehicles				
Emergency Vehicle Signal Preemption	Install emergency vehicle signal preemption on up to 49 priority intersections in the City of Laredo to allow EMS and fire vehicles to preempt traffic signals. The greatest need for signal preemption is for EMS vehicles because, due to their smaller size, they are more difficult for motorists to see. Emergency Vehicle Signal Preemption will require the addition of an emitter on each vehicle that requires signal preemption capability. The emitters cost approximately $1,000-$1,500 per vehicle. Benefits include improved safety for EMS drivers, patients, and motorists in the City of Laredo. By clearing an intersection of stopped traffic, signal preemption can also reduce delays experience by EMS and Fire vehicles at congested intersections.	Traffic, Fire	$294,000 Signal Equipment Only	5.2.3
ITS Roadside Implementations				
Traffic Coordination				
Bridge 1 and 2 Traffic Coordination System	Implement 2 CCTV cameras, 1 still frame fixed camera, and 2 DMS for traffic monitoring and traffic information dissemination at Bridges 1 and 2. The Traffic Coordination System will be used to monitor queues and delays at Bridges 1 and 2, provide information to motorists about delays or closures through the DMS, and provide still frame camera shots of queues on a website. The system includes the following infrastructure: ▪ DMS at end of southbound I-35 to inform motorists of closures at Bridges 1 and 2 ▪ DMS on southbound Santa Maria Avenue to inform motorists of closures at Bridge 1 ▪ CCTV camera at Houston Street to monitor approach to Bridge 1 from I-35 ▪ CCTV camera at intersection of Santa Maria Avenue and Grant Street to monitor approach to Bridge 1 ▪ Still frame fixed camera at intersection of Santa Maria Avenue and Water Street to provide images of Bridge 1 queues Benefits include improved traveler information for motorists, ability to monitor bridge approaches, and the ability to divert vehicles from approaches to bridges that are closed or are experiencing severe delays.	Traffic, Bridge	$245,000	5.2.4

Table 12 – Recommended Projects (continued)

Project	Description	Responsible Agency[1]	Opinion of Probable Cost	Reference Section
ITS Roadside Implementations (continued)				
Bridge 3 Traffic Coordination System	Implement 1 CCTV camera and 1 DMS for traffic monitoring and traffic information dissemination at Bridge 3. The Traffic Coordination System will be used to monitor queues and delays at Bridge 3 and provide information to motorists and commercial vehicles about delays or closures at the bridge. Benefits include improved traveler information for motorists and commercial vehicles and the ability to monitor the bridge approach.	Traffic, Bridge	$120,000	5.2.4
Flood Detection				
Flecha/Las Cruces Flood Detection and Closure System	Implement a flood detection and roadway closure system on Flecha Lane and Las Cruces Drive to detect high water on the roadway and allow automated activation of road closure gates. System includes the following infrastructure: ▪ Flood detection system and 2 closure gates on Flecha Lane west of FM 1472 ▪ Flood detection system and 2 closure gates on Las Cruces Drive east of FM 1472 ▪ CCTV camera on FM 1472 between Flecha Lane and Las Cruces Drive Benefits include decreased time to detect and close roadways due to flooding and improved safety for motorists.	Implementation: Traffic Operations and Maintenance: Traffic, Environmental Services	$74,000	5.2.4
Anna/Calton Flood Detection and Closure System	Implement a flood detection and roadway closure system on Anna Avenue and Calton Road to detect high water on the roadway and allow automated activation of road closure gates. System includes the following infrastructure: ▪ Flood detection system and a total of 3 closure gates with 1 on Anna Avenue, 1 on Calton Road, and 1 on Markley Lane ▪ CCTV camera at low point on Calton Road Benefits include decreased time to detect and close roadways due to flooding and improved safety for motorists.	Implementation: Traffic Operations and Maintenance: Traffic, Environmental Services	$57,000	5.2.4
Jacaman Flood Detection and Closure System	Implement a flood detection and roadway closure system on Jacaman Road to detect high water on the roadway and allow automated activation of road closure gates. A CCTV camera currently exists at the corner of Jacaman Road and McPherson Road that can be used to monitor the flood detection and closure system. System includes the following infrastructure: ▪ Flood detection system and 2 closure gates on Jacaman Road east of McPherson Road Benefits include decreased time to detect and close roadways due to flooding and improved safety for motorists.	Implementation: Traffic Operations and Maintenance: Traffic, Environmental Services	$27,000	5.2.4

Table 12 – Recommended Projects (continued)

<table>
<tr><th>Project</th><th>Description</th><th>Responsible Agency[1]</th><th>Opinion of Probable Cost</th><th>Reference Section</th></tr>
<tr><td colspan="5">ITS Roadside Implementations (continued)</td></tr>
<tr><td colspan="5">CCTV Camera Deployment</td></tr>
<tr><td>McPherson CCTV Camera Deployment</td><td>Install three CCTV cameras along McPherson Road and upgrade two existing CCTV cameras on Jacaman Road and Casa Verde Road to full pan/tilt/zoom. CCTV camera locations include:
▪ CCTV camera installations at McPherson Road and Tiarra Trail, McPherson Road and Gale Street, McPherson Road and Calton Road
▪ CCTV camera upgrade to full pan/tilt/zoom at McPherson Road and Del Mar Boulevard and also at Jacaman Road and Sinatra Parkway
Benefits include the ability to detect and monitor incidents and congestion, share video of incidents with emergency responders, and adjust signal timing based on real time roadway conditions.</td><td>Traffic</td><td>$75,000</td><td>5.2.4</td></tr>
<tr><td>East Laredo CCTV Camera Deployment</td><td>Install four CCTV cameras in East Laredo. CCTV camera locations include:
▪ CCTV camera installations at Clark Boulevard and Meadow Avenue, Clark Boulevard and Arkansas Avenue, Guadalupe Street and Malinche Avenue, and Chihuahua Street and Bartlett Avenue
Benefits include the ability to detect and monitor incidents and congestion, share video of incidents with emergency responders, and adjust signal timing based on real time roadway conditions.</td><td>Traffic</td><td>$80,000</td><td>5.2.4</td></tr>
<tr><td>San Bernardo CCTV Camera Deployment</td><td>Install three CCTV cameras along San Bernardo Avenue for congestion monitoring and incident detection. CCTV camera locations include:
▪ CCTV camera installations at San Bernardo Avenue and Calton Road, San Bernardo Avenue and Jefferson Street, and San Bernardo Avenue and Washington Street
Benefits include the ability to detect and monitor incidents and congestion, share video of incidents with emergency responders, and adjust signal timing based on real time roadway conditions.</td><td>Traffic</td><td>$60,000</td><td>5.2.4</td></tr>
<tr><td colspan="5">Other Projects</td></tr>
<tr><td>Farragut/Juarez Transit Improvements</td><td>Implement signal timing changes for buses at the corner of Farragut Street and Juarez Avenue. Signal timing will be adjusted to provide additional green time for buses leaving El Metro’s transit station and traveling north on Juarez Avenue. The intersection is located less then a block north of the exit from El Metro’s transit station.
Benefits include reduced wait time at the intersection for buses.</td><td>Traffic</td><td>None</td><td>5.2.5</td></tr>
</table>

Table 12 – Recommended Projects (continued)

Project	Description	Responsible Agency[1]	Opinion of Probable Cost	Reference Section
Other Projects (continued)				
Regional Smart Card	Recommend implementing common system for payment of transit fares, city parking meters, and international bridge crossing tolls. Smart card benefits include a reduction in handling of currency, increased security, and increased convenience for patrons.	Traffic, Bridge, El Metro	To Be Determined	5.2.5
Automated Enforcement	Automated enforcement for traffic violations is an emerging trend for municipalities, especially to combat red light running. The technology is maturing and could be something that the City wishes to explore for future implementation. Benefits include increased safety and social awareness.	Traffic, Police	To Be Determined	5.2.5
511 – Traveler Information	The establishment of 511 as a traveler information number will be led by TxDOT. As details of implementation plans become available it is likely that the City of Laredo will play a role in providing local transportation information to the system for distribution to callers. Benefits include improved information dissemination that can reach a broader group of travelers, not just those traveling on roadways with DMS implementations.	TxDOT	To Be Determined	5.2.5
Telecommunications				
Telecommunications System	Implement a communications system to support the deployment of ITS and advanced signal systems in the City of Laredo. Alternatives recommended for Laredo include: ▪ Alternative 1: Analog fiber distribution and leased line backbone ▪ Alternative 2: Analog fiber optic distribution and wireless or shared digital fiber backbone ▪ Alternative 3: Digital fiber optic distribution interconnect and wireless, DSL, and/or fiber backbone connectivity Alternative 2 is the recommended communication system. Benefits include increased capacity for data and video, added capabilities, and a reduction of reliance on the City of Laredo I-Net system.	Traffic	To Be Determined	5.3

[1] Agency is responsible for implantation, operations, and maintenance unless otherwise noted.

Table 13 – Project Cost Estimates

	Component and Unit Cost[1]										
	Signal Upgrades			**Signal Preemption Equipment**	**ITS Roadside Elements**						
Project	Signal Master Controller and Radio Interconnect[2]	Signal Controller and Radio Interconnect[2]	Fiber Installation Per Mile	Intersection	DMS	CCTV PTZ Camera/ Pole/ Cabinet (New Installation)	CCTV PTZ Camera Upgrade Only (Existing Installation)	Still Frame Camera Only	Flood Detector and Radio	Closure Gate and Radio	**Total Cost**
	$21,500	$21,000	$100,000	$6,000	$100,000	$20,000	$7,500	$5,000	$7,000	$10,000	
Traffic Signal System											
Downtown Closed Loop Signal System Phase 1	1	21									$462,500
Downtown Closed Loop Signal System Phase 2	3	40									$904,500
Water Street Fiber Extension			0.5								$50,000
Sum	**4**	**61**	**0.5**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**$1,417,000**
Traffic Signal Preemption for Emergency Veh.											
EMS and Fire Preemption				49							$294,000
Sum	**0**	**0**	**0**	**49**	**0**	**0**	**0**	**0**	**0**	**0**	**$294,000**
ITS Roadside Implementations											
Bridge 1 and 2 Traffic Coordination System					2	2		1			$245,000
Bridge 3 Traffic Coordination System					1	1					$120,000
Flecha/Las Cruces Flood Detec. and Closure Sys.						1			2	4	$74,000
Anna/Calton Flood Detection and Closure System						1			1	3	$57,000
Jacaman Flood Detection and Closure System									1	2	$27,000
McPherson CCTV Camera Deployment						3	2				$75,000
East Laredo CCTV Camera Deployment						4					$80,000
San Bernardo CCTV Camera Deployment						3					$60,000
Sum	**0**	**0**	**0**	**0**	**3**	**15**	**2**	**1**	**4**	**9**	**$738,000**
Traffic Management Center Upgrades											**$88,000**
Traffic Management Center/Joint Ops. Center											**To Be Determined**
Annual Signal System Upgrade Program											**$315,000 Per Year**
Traffic Signal Removal											**$5,000 Per Intersection**

[1]Unit cost estimate includes item, engineering, and installation. Telecommunications are addressed in Section 5.3.
[2]Cost includes controller and cabinet ($10,000-$10,500), spread spectrum radio ($3,500), engineering at 13% ($2,500), and installation ($5,000)

5.2.1 Traffic Management Center

The existing City of Laredo TMC is located in the Traffic Department building on Saunders Lane. At the time this study was prepared, the City of Laredo was considering relocation of the Traffic Department's existing facility which would require that a new TMC be developed. This TMC could be located with the Traffic Department, however this is not required. It is recommended that consideration be given to locating the TMC in a facility (existing or new) that would also permanently accommodate the EOC and possibly the 911 Dispatch Center.

Until such a time as a new TMC is built, it is recommended that interim upgrades be made to the existing TMC. These upgrades include the replacement of aging equipment such as servers and workstations as well as the purchase of additional equipment. Additional equipment includes a video switch, uninterruptible power supplies, an equipment rack, monitors, projectors, network and cabling equipment, and additional software and licenses. These improvements will increase system efficiency and reliability as well as enable TMC operators to fully utilize the new field devices installed as part of other projects, such as viewing video from VIVDS. The equipment purchased as part of the interim upgrades can be relocated to the new TMC when it is completed.

Joint Operations Center

As the City of Laredo TMC, EOC, and 911 Dispatch Center reach the capacity of their existing facilities and look toward establishing new centers, it is an opportune time to consider a joint operations center for the City.

A joint operations center is a partnership formed by the transportation and emergency management agencies in a city to collocate the facilities in one building. The relationship between the agencies is critical. Coordination already exists during manmade disasters and/or weather emergencies, but the capability to enhance that coordination and streamline operations on a day to day basis, as well as during an emergency situation, is an opportunity that should be explored.

Data from deployed ITS technologies, such as CCTV cameras and flood detection systems, can be a useful tool for emergency management, as well as transit operations, to facilitate dispatch functions both in everyday operations, as well as during an emergency situation. Improved dispatch benefits the transportation network and its users by clearing incidents more rapidly and getting lanes open to traffic again as soon as possible and the general public through reduced emergency response times.

Many cities have chosen to take this integrated approach to management of their emergency and transportation functions. In Texas, the City of Austin and the City of Houston provide excellent case studies.

City of Laredo Joint Operations Center

It is envisioned that the City of Laredo joint operations center would include the City of Laredo TMC, City of Laredo EOC, and the City of Laredo 911 Dispatch Center. The TxDOT Laredo District would be a logical additional partner for a joint operations center; however, in early 2004 they completed a TMC for the District and are not likely to consider relocation. Special consideration should be given to connecting the TxDOT TMC to the City of Laredo Joint Operations Center so that they may participate virtually in incident management and so that their traffic and roadway conditions data may be integrated into the dispatch functions of the center.

Collocation of the TMC and EOC would allow sharing of video, traveler information capabilities through DMS, flood detection, and traffic signal control during an emergency. By co-locating the two facilities, the need to send high bandwidth data such as video between a TMC and an EOC is eliminated. Resources can be pulled together to add features that are required by both types of centers, such as security, communications systems, and 24-hour operational capability. The addition of 911 dispatch would further improve incident identification and response capabilities. Sharing of video feeds and traffic data between the TMC and 911 dispatch will allow incidents to possibly be detected faster and, using real time traffic information can also allow dispatchers to route emergency vehicles to an incident using the fastest routes and provide emergency responders with information about the incident obtained from video feeds.

Stakeholders involved in the development of the City of Laredo ITS Master Plan identified several key functional requirements for the City of Laredo TMC. These functions have been identified in **Table 14**. Several functions already exist in the Laredo TMC. Others were identified as needed in the future, and those that were not as high a priority were identified as desired. Should the TMC be collocated with the EOC and the 911 Dispatch Center, additional functions for those services would need to be identified.

Table 14 – City of Laredo TMC Existing and Needed Functions

Existing	Future Needed	Future Desired
CCTV Camera Control	DMS Control	Incident Detection
Traffic Signal System Monitoring	Detector Data Monitoring	Improved Special Event Management
School Zone Flasher Activation	Flood Detector System Monitoring	Highway/Rail Crossing Monitoring
Special Event Management	Road Closure/Incident Info to Media	ESD Water Quality Station Monitoring
Traffic Signal Maintenance Dispatch	Security	Fleet Monitoring
Video Screen Display	Video Feeds for Other Departments	511 Information Provider
TxDOT CCTV Camera Monitoring		Video Feeds to Media
TxDOT DMS Monitoring		City Traffic Website
		Tour/Visitor Accommodations

Benefits of Joint Operation Center

Benefits of a joint operations center include:

- Improved response time to accidents, natural emergencies, and other incidents affecting the transportation system;
- Improved coordination between emergency and transportation personnel during incidents and disasters;
- Improved dissemination of traveler information to the public;
- Reduced facility cost through collocation of multiple agencies;
- Reduced cost for communications; and
- Cost effective utilization of vehicle fleets created by centralizing dispatch functions and by collocating appropriate agency personnel.

Case Study: Austin Combined Transportation, Emergency, and Communication Center

The Austin Combined Transportation, Emergency, and Communication Center (CTECC) is a partnership of local emergency management and transportation agencies in the Austin area. Partnering agencies include the City of Austin Police, Fire and EMS Departments, the Travis County Sheriff Department, Capitol Metro transit, and the TxDOT Austin District.

The traffic management portion of the center currently operates 6:00 AM to 10:00 PM Monday through Friday, but 911 dispatch and other emergency services operate in the facility 24 hours a day 365 days a year. Traffic management plans to become a 24 hour operation by the year 2012.

CTECC was developed to meet the needs of the partner agencies. Those needs that supported the concept of a joint operations center included:

- Replacing obsolete systems (911, GIS, CAD, etc);
- Replacing inadequate facilities;
- Providing adequate backup capabilities;
- Manage increasing emergency service demands;
- Integrating public safety and public service;
- Improving interagency coordination and communication;
- Improving efficiency of emergency services response; and
- Taking advantage of available economies of scale.

Almost every aspect of traffic and emergency management is controlled from the combined center, from traffic signal control to 911 dispatch. Each agency has their own resources on the control room floor and in general each agency dispatches their own service functions; however, because CTECC has a common computer-aided dispatch (CAD) system, one agency could dispatch another agency's resources in appropriate pre-arranged situations. The utilization of real-time data by the integrated CAD system enables agencies to make better decisions about deploying resources and routing of responders.

The 75,000 square foot CTECC facility houses over 100 workstations on the main control room floor. This is where the day to day operations occur. The facility also contains conference rooms, briefing rooms, and areas for the media.

The EOC for the Austin area is collocated in this facility and, when activated, has access to all of the system status information from regional transportation and emergency management agencies. The EOC occupies a separate room in the building that contains its own workstations. The fact that these day to day and emergency functions are combined in one center facilitates sharing of high bandwidth data, such as video, during an emergency situation. Costly communication links that would seldom be used are unnecessary in an arrangement such as this.

The combined center cost approximately $39 million dollars. The City of Austin participation level was 63.11 percent, TxDOT 21.33 percent, Travis County 14.06 percent, and Capital Metro 1.50 percent. These participation levels were directly tied to the amount of space each agency would occupy. TxDOT is the only transportation management agency located in the facility. The City of Austin traffic operations group chose to remain in their existing facilities. The TxDOT portion of expenses for the facility totaled about $8 million. Approximately $4.8 million went toward facility construction, $332,000 for the TxDOT video display wall, $460,500 for the shared display wall, and almost $800,000 for furniture, fixtures, and equipment (both TxDOT and shared). The rest was used for telephone systems, computer hardware and software, and construction management expenses.

CTECC's organizational structure includes a Governing Board that is made up of the City of Austin City Manager, Travis County Executive Manager of Justice and Public Safety, the TxDOT Austin District Engineer and the Capital Metro General Manager. Next in the CTECC structure is an Operating Board comprised of the City of Austin EOC Director, City of Austin Police Chief, Austin-Travis County EMS Director, Travis County Sheriff and Emergency Management Director, TxDOT Traffic Operations Director and Maintenance Director, and the Capital Metro Operations Director. This group makes decisions about operational issues involving the center. The General Manager is in charge of day to day operations of the center and works with the Information Technology Shared Support Group, as well as the CTECC Facility Group dealing with the technical and financial aspects of managing the joint operations center.

Collocation has provided many benefits for CTECC partner agencies. The regional approach to multi-jurisdictional issues and integration of related systems has led to coordination of response resources, expedited rescue efforts, and a reduction in costs. On a day to day basis the seamless exchange of information between agencies has enhanced emergency response coordination. This has been accomplished through earlier incident identification and improved routing recommendations for emergency responders, allowing incidents to be cleared faster and ultimately reducing congestion and delays for motorists. During major emergencies, the location of the EOC at CTECC allows decision makers and system operators the ability to work closely together and share information needed to manage the emergency as efficiently as possible.

Case Study: Houston TranStar

The partner agencies in Houston TranStar are responsible for all planning, design, operations, and maintenance of transportation and emergency management functions in the Houston metropolitan area. The center is a 54,000 square foot TMC jointly owned and operated by TxDOT, the Metropolitan Transit Authority of Harris County (METRO), the City of Houston, and Harris County. By collocating the operations and administrative functions of these agencies, personnel are able to work together to address the needs of the metropolitan area while still maintaining their own organizational structure.

Table 15 summarizes the agencies and functions that are operated from the TranStar facility.

Table 15 – TranStar Facility

Partner Agency	Function
TxDOT	Traffic Operations – Freeway Traffic Management Section Incident Response Motorist Assistance Program dispatch Heavy-duty wrecker Administration Accounting Information System Services
METRO	Bus Dispatch METRO Police Dispatch High Occupancy Vehicle Enforcement Traffic Engineering Administration
Harris County	Traffic Engineering – Signal Systems Section Office of Emergency Management Sheriff's Office – Motorist Assistance Patrol officers Flood Control District
City of Houston	Police Dispatch Traffic Engineering – Signal Systems Section Office of Emergency Management

In addition to the functions outlined above, the Texas Transportation Institute (TTI) operates a research center and MetroTraffic also operates its traffic information service from the facility.

TranStar works closely with the Coroner's Office, Houston Fire Department, Port of Houston, Federal Railroad Administration, and the local metropolitan planning organization. Several local television networks also broadcast live information from the center through remote camera and data connections.

TranStar's responsibilities are those of its constituent organizations, it has no charter or statutory authority. The center exists as a partnership between agencies established through interlocal agreements. Each partner agency maintains autonomous control of operational functions that fall within its range of responsibility and remains its own independent entity.

The foundation for the partnership is a pooling of individually owned resources that are shared. A pooled budget supported the initial development of the facility, central computer system, and central telecommunications system. The same budget supports maintenance activities, as well as a small administrative staff. Field devices, their maintenance, and operations staff are the responsibility of the individual agencies. Data from the field devices is made available to all agencies once it reaches the operations center, but it is the individual agencies responsibility to provide the communications necessary to bring the data to the facility. Operators can control field equipment belonging to other agencies, but the owning agency has ultimate control of their own equipment. For example, City of Houston Police dispatchers can control a camera to view an accident scene, but TxDOT can take control back at any time to direct the camera so that the backup created by the incident is visible.

The TranStar facility currently includes a central control operations room, communications room, telephone switch room, briefing area, emergency operations center, and office space for the partner agencies in addition to space for the media. The center was developed at a cost of $13.5 million as a joint effort from the partners. A $5.3 million expansion is planned to accommodate additional law enforcement and emergency management capabilities including an auditorium that could serve as sleeping quarters during a large scale emergency management operation such as a hurricane.

TranStar has an annual operating budget of approximately $2 million a year that funds the employee salaries of the administrative staff, facility maintenance, and the operating budget. The budget funding comes from the participating agencies and is based on a formula that takes in to account square footage occupied, computer and telecommunications equipment usage, and operating time. Federal allocations that have supported the center in the past include Congestion Mitigation and Air Quality, Surface Transportation Program, Federal Transit Authority, and Federal Highway Administration (FHWA) Priority Corridor funds.

5.2.2 Traffic Signal System

The City of Laredo Traffic Department operates traffic signals and school zone flashers within the limits of the City of Laredo. The City is looking to upgrade its current traffic signal system, replacing worn out and outdated devices with state of the art components. A detailed discussion of options available is provided in **Appendix C**.

Based on the current state of technology, the following recommendations are provided for the City of Laredo signal system upgrade:

- Begin systematic upgrade to NEMA TS-2 signal controllers and cabinets;
- Expand the downtown signals to include an additional closed loop system, with signals grouped to reflect the new traffic routing plan for Bridges 1 and 2;
- Focus on using wireless networks, where possible, for communications within closed loop signal systems;
- Develop plans for annual signal upgrade program;
- Explore the possibilities of purchasing traffic signal equipment through the Texas Building and Procurement Commission's Cooperative Program;
- Develop funding agreements with emergency service providers that are requesting preemption equipment. Identify agencies responsible for implementation, operations, and maintenance costs in the agreement (See Section 5.2.3);
- Continue to expand the fiber optic communications network where possible (See Section 5.3);
- Consider the use of Ethernet based systems for communications to field devices from the TMC (See Section 5.3); and
- Remove unwarranted signals in the downtown area that negatively impact progression.

It is possible, using a TS2 master controller, to begin replacing aging TS1 units with TS2 units in existing closed loop systems. This makes the TS2 controller an affordable option to the City of Laredo at this time. For cabinets that are less than 10 years old, a TS2 Type 2 controller can be inserted directly into the TS1 cabinet. Where the cabinet and controller are both over 10 years old, it is recommended that a TS2 Type 1 controller and TS2 cabinet be used. More detail on controllers and cabinets is included in Appendix C.

The annual signal upgrade program will upgrade existing closed loop signal systems to TS-2 controllers with spread spectrum local interconnect, as well as establish additional closed loop systems and upgrade stand alone signals. Existing closed loop signal systems will be reorganized to improve coordination. It is recommended that 15 signals be upgraded each year. At this pace it would take between 10 and 11 years to upgrade the entire system.

A City of Laredo bond program will provide $250,000 per year for the next several years for signal upgrades. Because not all of the bond money will be applied to controller upgrades, some of it will be used for mast arm and signal head upgrades, additional funding will be required.

Signal Procurement

In addition to the standard open bidding process, there are several statewide contracts available through the Texas Building and Procurement Commission (TBPC) to active TBPC Co-Op entities.

To make a purchase using these open market purchase orders, state agencies or active TBPC Co-Op entities send a purchase order directly to the vendor as if it were a typical city bid award; however, the state of Texas open market purchase order number and requisition number must be referenced on the purchase order sent to the vendor. A listing of available products, with pricing and purchase order numbers can be referenced at the following web site:

www.tbpc.state.tx.us/coop/index.html

There are several advantages to purchasing off of the TBPC Co-Op contracts. The primary benefits are lower costs through larger quantities and time saved by not having to advertise and award bids through the typical process. In addition, if the City provides these units on a construction project, they do not need special specifications, resulting in smaller bid packages for the job.

With regards to traffic signals, there may also be some disadvantages to purchasing off of the TBPC Co-Op contracts. For example, the State has two traffic signal controllers on their contract, including closed loop masters, through Naztec and Siemens ITS (Eagle); however, the controllers are all built exactly to TxDOT specifications, with no allowances for special options (i.e. Ethernet communications ports). In addition, the controller cabinets that are available through the State are standard NEMA P-sized, with 16 load switches. This is acceptable for most areas, but may not work at intersections where right-of way is limited and a smaller cabinet is desired.

For the City of Laredo, it is recommended that consideration be given to using materials off of the TBPC Co-Op contracts where possible. For special situations where the State specified materials will not work, the City will have to procure them through the usual advertised bidding process.

5.2.3 Traffic Signal Preemption for Emergency Vehicles

Traffic signal preemption for emergency vehicles has been requested by the City of Laredo Fire Department. Emergency vehicle signal preemption installations typically consist of detectors mounted on the approaches to the intersection, a discriminator located within the cabinet, and a preemption emitter mounted on the emergency vehicle. When an emergency vehicle approaches an intersection the emitter notifies the detector that an emergency vehicle is approaching. If the discriminator determines that the vehicle is authorized to preempt the signal, the signal timing will be modified to bring a green to the movement with the emergency vehicle approaching. Bringing the green to the approach will clear traffic that could be queued up at the intersection, thus reducing delay in passing through the intersection and decreasing response times. Another benefit is increased safety for emergency responders and the traveling public. Because the emergency vehicle will not be entering the intersection while another approach has a green, the potential for other drivers to fail to yield to the emergency vehicle is reduced and potential accidents avoided.

In the City of Laredo, the Fire Department requested preemption at 49 intersections primarily for EMS. Fire trucks could also be equipped with emitters in the future, but at this time the focus is on ambulances because they are smaller in size and not as noticeable when approaching an intersection. **Table 16** contains a listing of the intersections and the requesting station and **Figure 7** shows the implementations grouped by requesting station. There is some overlap in intersection requests from different stations.

Funding agreements between the City of Laredo Traffic Department and Fire Department should be developed to determine who will fund the capital and maintenance cost of preemption. Preemption readers at signals cost approximately $6,000 per intersection and preemption emitters on vehicles cost approximately $1,500-$2,000 per vehicle. These systems can be funded by either the Traffic or Fire Department, or a combination of both. However, typically it is the fire or emergency services departments in a city that fund the capital and maintenance cost of preemption since they are the beneficiary of these technologies.

Table 16 – Emergency Vehicle Signal Preemption Locations

Intersection	Requesting Station (s)	Intersection	Requesting Station (s)
Meadow Ave @ Chihuahua St	9101	Lafayette St @ San Dario Ave	9103
Meadow Ave @ Market St	9101	Saunders St @ Springfield Ave	9103, 9105
Houston St @ San Eduardo Ave	9101	Saunders St @ Bartlett Ave	9105
Houston St @ Santa Ursala Ave	9101	Saunders St @ Meadow Ave	9105
Houston St @ San Dario Ave	9101	Saunders St @ Loop 20	9105, 9111
Houston St @ San Bernardo Ave	9101	Clark Blvd @ Arkansas Ave	9105
Houston St @ San Augustin Ave	9101	Clark Blvd @ Malinche Ave	9105
Houston St @ Flores Ave	9101	Clark Blvd @ Meadow Ave	9105
Houston St @ Convent Ave	9101	Clark Blvd @ Loop 20	9105, 9111
Houston St @ Salinas Ave	9101	Chihuahua St @ Malinche Ave	9105
Houston St @ Juarez Ave	9101	Calton Rd @ San Bernardo	9107
Houston St @ Santa Maria Ave	9101	Calton Rd @ Santa Ursula Ave	9107
Zapata Hwy @Loop 20	9102, 9111	Calton Rd @ San Dario Ave	9107
Zapata Hwy @ Napoleon St	9102	Calton Rd @ Springfield Ave	9107
Zapata Hwy @ Zacatecas St	9102	Calton Rd @ McPherson Ave	9107
Zapata Hwy @ Palo Blanco St	9102	San Bernardo Ave @ Chicago St	9107
Zapata Hwy @ Sierra Vista St	9102	Del Mar Blvd @ San Dario Ave	9108
Zapata Hwy @ South Gate Blvd	9102	McPherson Rd @ Del Mar Blvd	9108
Park St @ San Bernardo Ave	9103	McPherson Rd @ International Blvd	9108
Park St @ Santa Ursula Ave	9103	McPherson Rd @ Jacaman Rd	9108
Park St @ San Dario Ave	9103	McPherson Rd @ Calle Del Norte	9108
Clark St @ Springfield Ave	9103, 9105	Santa Maria Ave @ Mines Rd	9108
Jefferson St @ San Bernardo Ave	9103	Loop 20 @ Hwy 359	9111
Lafayette St @ San Bernardo Ave	9103, 9107	Loop 20 @ Avenida Los Presidentes	9111
Lafayette St @ Santa Ursula Ave	9103		

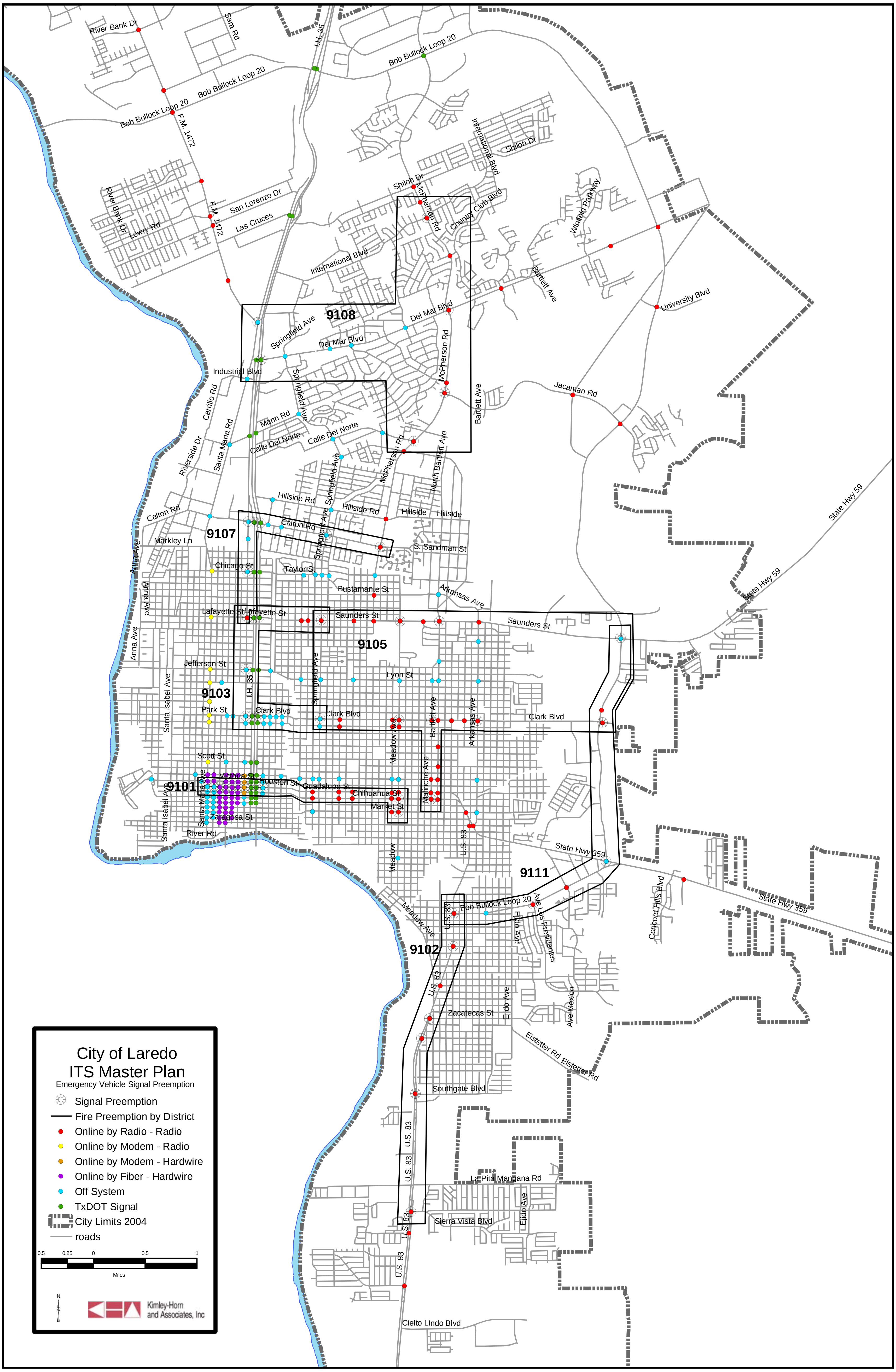

Figure 7 – Emergency Vehicle Signal Preemption Groupings

5.2.4 ITS Roadside Implementations

The roadside implementation projects address the key goals of the City of Laredo ITS System. Collectively they will provide details of transportation network status to TMC operators and distribute that information to the traveling public through automated closures and dynamic message signs. **Figure 8** shows all of the recommended roadside implementation elements and project groupings for the City of Laredo as described in **Table 11** in this section. The complete build out of the ITS roadside elements, which includes existing and recommended City of Laredo elements as well as existing and planned TxDOT elements, is shown in **Figure 9**.

The Bridge Coordination System for Bridge 1 and Bridge 2 will be utilized to monitor traffic conditions on the approaches to the bridges and share that information with travelers approaching the bridges. CCTV cameras will be used to monitor congestion and detect incidents and information about delay will be displayed on one of two DMS. One DMS is positioned to alert motorists as they exit I-35 and another is placed to alert motorists who are already in the central business district approaching Bridge 1. The placement of these signs facilitates information dissemination along the route that the City intends to establish that would make Bridge 1 the primary downtown crossing and alter traffic patterns. Also, the DMS on the approaches to the bridges make it possible to divert traffic from one bridge to another in the event of a closure or incident at one of the bridges.

The Bridge Coordination System for Bridge 3 will be utilized to monitor traffic conditions on the approaches to the bridge and share that information with travelers approaching the bridge. A CCTV camera would be used to monitor congestion and detect incidents and information about delay would be displayed on the DMS. The DMS is positioned to alert truck drivers approaching the bridge. It would primarily target drivers who are coming from warehouses in the immediate area due to its proximity to the bridge. TxDOT has two additional DMS on Loop 20 for east and westbound traffic near FM 1472 that primarily provide information about Bridge 4, but in the event of a closure or unusual delay at Bridge 3 information could be placed on these signs as well to provide warning as trucks head towards the bridge.

Three areas in the City of Laredo have been identified as high priority for flood detection and closure systems. The system is comprised of sensors that detect when there is water obstructing the roadway and automated closure gates that prevent motorists from driving into deep water. When water is detected and the gates activated, a message will be sent to the TMC notifying them of the conditions so that the information can be passed along to travelers in the area. The installations at Anna/Calton and Flecha/Las Cruces also include CCTV cameras for visual confirmation of water on the roadway and to monitor area flooding and traffic impacts.

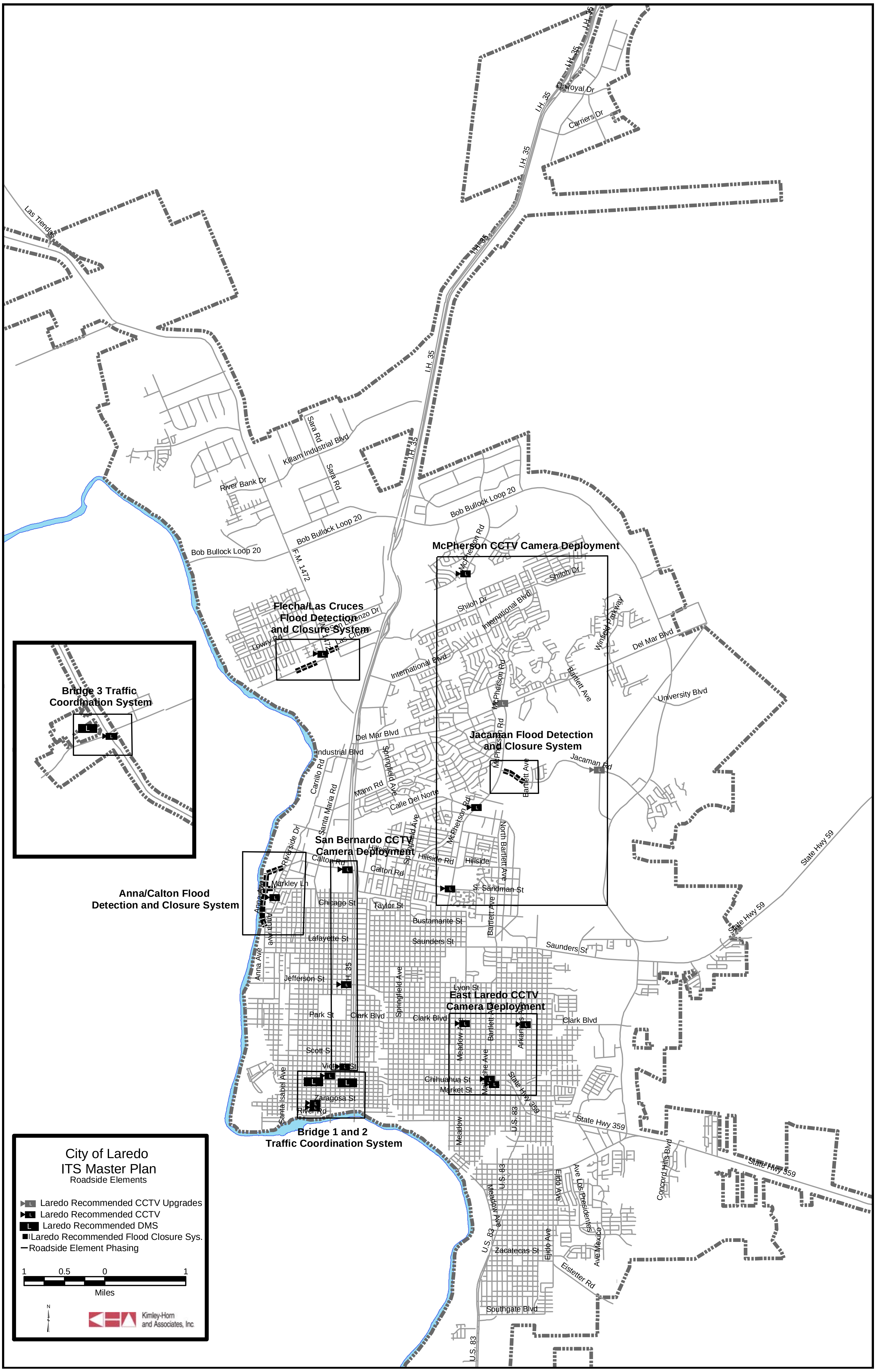

Figure 8 – Recommended City of Laredo ITS Deployments

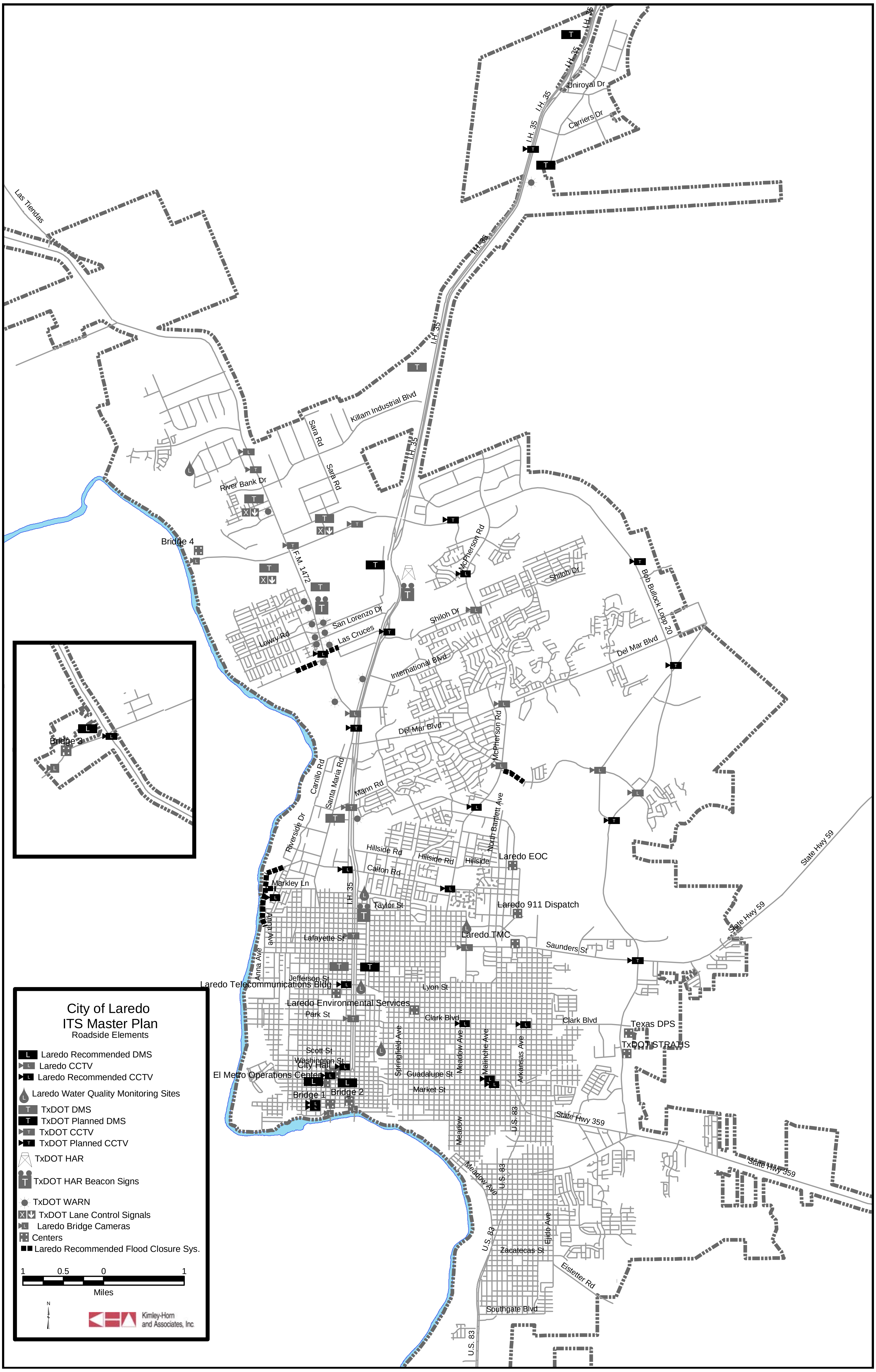

Figure 9 – Overall System Concept

5.2.5 Other Projects

This section describes other ITS services that could benefit the City of Laredo.

Farragut/Juarez Transit Improvements

El Metro currently operates a major transit station located on the south east corner of Farragut Street and Juarez Avenue. After loading or unloading passengers, buses exit the transit station onto Juarez Avenue and head north to Farragut Street. Farragut Street is located less then 1 block north of the transit station exit and is a signalized intersection. Current timing of the signal at Juarez Avenue and Farragut Street favors the east-west progression on Farragut Street and normally buses exiting the transit station are stopped at the signal as soon as they turn out of the transit station. Due to the close location of the transit station to the intersection, if more then one bus is stopped at the signal it will block the transit station exit and other buses will need to wait for a northbound green before they can pull away.

Several potential solutions were discussed with the Laredo Traffic Department. These included adding signal priority for buses at the intersection of Farragut Street and Juarez Avenue, adding a detection system at the exit of the transit station that would be coordinated with the signal at the intersection, and adjusting signal timing at the intersection to be more favorable to northbound traffic on Juarez Avenue.

Signal priority would be effective but would require that each bus be equipped with an emitter and a reader would need to be installed at the signal. A detection system at the exit of the transit station would also require additional equipment be installed at the transit station. Buses currently pull all the way up to the exit of the transit station to load and would likely activate the sensor before they are ready to exit the station. This would not help alleviate the congestion situation for the buses and would likely cause problems for east-west traffic from numerous false service calls from buses still loading and unloading at the station.

At this time it is recommended that signal system timing be used to address the issue. Modifications to timing plans to favor through movements on Juarez Avenue coupled with improved coordination throughout the downtown signal system should provide improvements in efficiency in the area and alleviate the delay for transit vehicles.

Regional Smart Cards

A Smart card is typically the size of a credit card and has a small-embedded computer chip. Unlike cards with a magnetic strip, Smart cards carry all necessary functions and information on the card and therefore do not require access to remote databases at the time of the transaction. This makes the cards particularly useful for applications such as transit fare collection and parking fee collection where it is not always desired or practical to have communications connections to support the transaction. Smart cards are more difficult to counterfeit than other card technologies and can store a much greater amount of data than cards with magnetic strips.

The two main types of Smart cards are contact and contactless cards. Contact Smart cards must be inserted into a card acceptor device where pins attached to the reader make "contact" with pads on the surface of the card to read and store information in the chip. In addition to the features and functions found in contact Smart cards, contactless Smart cards contain an embedded antenna instead of contact pads. Contactless cards do not have to be inserted into a card acceptor device, but instead need only be passed within range of a radio frequency acceptor to read and store information in the chip. The range of operation is typically from about 2.5 to 3.9 inches depending on the acceptor. Both types of Smart cards are used in many of the same applications, but contactless cards have the added convenience and speed of not having to insert the card into a reader.

In applications for groups such as transit agencies, Smart cards reduce the expense of counting and transferring currency, as well as provide an added convenience for patrons. The contactless type cards allow patrons to wave the card in front of a reader, which is faster then having to insert the card. When multiple patrons are boarding at the same time this can provide a significant time savings.

It is recommended that the City of Laredo explore the use of Smart cards for payment of bridge tolls, parking fees, and bus fares. Benefits for the City would include reduced handling of currency, equipment maintenance, and security costs. Having one fare collection system would also simplify administration and payment reconciliation. The Bridge Department, Parking Division, and El Metro could share in the implementation and administrative costs and each realize increased efficiencies. Because each Department is already considering some form of electronic payment method, it is an opportune time to consider a joint effort. El Metro would also realize an increased ability to collect valuable ridership data.

Kiosks could be added at bridges, transit transfer stations, and large parking garages/lots where patrons could purchase and recharge their cards. The option for carrying out many transactions online is also often selected when designing a Smart card system.

An example of a Regional Smart Cart is the Orlando Regional Alliance for Next Generation Electronic payment Systems (ORANGES), an initiative of the Orlando-Orange County Expressway Authority, Central Florida Regional Transportation Authority, and City of Orlando Parking Bureau. The project, which is sponsored by the Federal Transit Administration, is the first effort in the nation to combine the multiple payment applications of separate toll, transit, and parking agencies into a single payment media, other than cash. Each agency continues to manage its program independently, while allowing the settlement and funds movement of the payments to occur from a single clearing source. As of July 2004 the ORANGES card was not available to the public, but only to selected participants in the study. The trial period ended in July 2004 and the partners of ORANGES will assess the successfulness of the system and decide whether to offer the ORANGES card to the public.

Automated Enforcement

Automated enforcement refers to the use of technology to enforce traffic safety laws. Two of the most common automated enforcement techniques are red light cameras and photo radars. Red light cameras are installed at intersections and are connected to sensors. The sensors are synchronized with the traffic lights and are able to detect vehicles driving through intersections on red lights. The sensors trigger the cameras that record the day, time, and place of the violation. The photos are then used to determine the owner of the vehicle and a citation is mailed. Photo radar involves a radar device that detects speeders and then triggers a camera. Typically the camera takes two photos, one of the front of the vehicle and one of the back. The use of cameras for the enforcement of red light running violations at signalized intersections is becoming increasingly widespread in the United States.

There are also a number of alternatives available to state and local agencies for the development and operation of red light camera programs. A state or local agency may take on full responsibility for system operations and citation processing functions or elect to outsource these functions to a private contractor. When a private contractor is responsible for installation and operation of the red light camera equipment, the State or local agency establishes the necessary procedures so that the agency has complete oversight and day-to-day supervision of the program.

The cost of Automated Enforcement Devices (AEDs) varies depending on the type of camera and installation cost. The general cost range of automated enforcement devices is between $70,000 and $90,000 per intersection.

Jurisdictions that have installed automated enforcement devices for red light running have reported significant reductions in the number of violations. The City of Oxnard, California reported a 42% drop in violations and the District of Columbia has achieved a 64.8% decrease as a result of their automated enforcement program.

The initiation of a red light camera program necessitates the identification of appropriate legal requirements. Red light cameras pose a series of legal questions and concerns, the answers to which vary from state to state. One main question involves who is responsible for the citation, the registered owner or the driver. Although Texas has no specific statute, the one city in Texas that uses red light cameras holds the registered owner responsible. Of the 17 states and localities currently using red light cameras, nine hold the owner, not the driver responsible.

During the 2003 sessions, legislators in 19 states considered more than 50 bills on automated enforcement. In Texas, House Bill 901 was considered. It stated that any municipality could implement a photographic traffic signal enforcement system and the owner of the vehicle would be liable for the citation. House Bill 901 was voted out of the House Transportation Committee in March 2003.

Currently, Texas law prohibits the use of automated enforcement for criminal traffic offenses. The City of Garland has established a photo enforcement program that is allowed because of home-rule, which states that a government may exercise any power and perform any function pertaining to its government and affairs including, but not limited to the power to regulate for the protection of the public health, safety, morals, and welfare. The four red light cameras in Garland are installed on city signals and are authorized by city ordinance. The owner of the vehicle is responsible for the ticket unless they produce the drivers name and address. Per Texas law, it is not classified as a criminal conviction, does not result in points, nor is recorded on a driver’s record; however, violators are assessed a $75 penalty.

The City of Laredo has shown interest in the implementation of automated enforcement for red light running. The information in this section has been provided for informational purposes only to aid in planning and policy discussions.

511 Traveler Information

511 was designated by the Federal Communications Commission (FCC) in July of 2000 as a three-digit number for travel information. With thousands of 800 and local numbers around the country providing transportation information ranging from driving conditions to

transit information, the concept behind 511 is that it would be an easy number for callers to remember and would provide access to consolidated travel information.

The national goal is for 511 to be available to the majority of Americans by 2005, at which time deployment and usage status will be reviewed by the FCC. To date, there are 21 operational 511 services around the country, with several more 511 services in the planning stages. Most of these 511 services are statewide and are being led by the State Department of Transportation; however, there are a few regional 511 services that are being spearheaded primarily by those regions' metropolitan planning organizations.

Because the FCC order left implementation up to the individual states and regions, there are inherently some variations among 511 services. National guidelines are in place that provide for some level of consistency. Each 511 service is recommended to provide at least the following 'basic' kinds of content:

- Roadway, which includes both highways and arterials;
- Transit or public transportation, which includes bus, rail or ferry (as appropriate); and
- Weather and road surface conditions that could impact travel.

Additional content could include information about tourism and points of interest, detailed local information, special event or parking information, and multi-lingual information. This detailed additional information would require partnering with local agencies and possibly even private providers.

The existing 511 services primarily provide roadway information and weather information that could impact travel conditions, at least for the state highways. Because 511 has been primarily implemented by state departments of transportation, the content included on 511 draws on the state's databases of closures, restrictions, maintenance or construction activity and other roadway information. The majority of this information is static, and is dependent on maintenance or operations staff at the DOT manually entering closure or construction information which can then be made available by phone, web or other means. Some areas do have some real-time information, but real-time data is limited to urban area freeways that are instrumented with detectors.

Transit information is available from approximately half of the current 511 services, and it is typically provided as a call transfer to a transit agency. There are several challenges with incorporating transit information as part of a 511 service. Because most of the 511 services that are operating today are statewide, there are usually many transit agencies that would need to be linked to any one 511 service. Systems such as Arizona, Utah, and Minnesota currently only provide transfers to one or two major urban transit operators' call centers within their respective state. There is also very limited automated information available for transit, so the likely interface would need to be a direct transfer to an operator at a customer service center. Another issue with regard to transit information is that for statewide 511 systems, the exact location of the caller cannot be determined. If transit information is provided as an option, callers would need to request a specific transit provider in order to be transferred (assuming the call transfer option is in place).

At this time TxDOT operates a toll-free number that provides recorded messages of statewide road conditions. There are 29 urban transit systems within Texas, each with its own customer service center number as well as 40 rural/non-urban transit systems and nearly 300 separate providers that offer transportation services for the elderly and disabled.

TxDOT is currently studying 511 in an effort to determine the type of information that will be presented to travelers and how to structure and manage the system.

Though TxDOT is taking the lead in developing and implementing 511 for the State of Texas, local agencies, including traffic management, law enforcement and transit, can serve as a valuable information resource for a system like 511 by providing current information on local street traffic and road conditions, weather impacts on roads, incidents and transit services. The challenge is integrating that information into the larger 511 database so that it can be accessible to travelers.

As TxDOT determines what 511 will look like for the state of Texas, there will likely be opportunities for the City of Laredo to be integrated in to the system and assist in providing local information.

5.3 Telecommunications

The ITS communication infrastructure will support deployment of signal controllers and other ITS field devices, improve intra-governmental connectivity, and reduce or eliminate the need for operational leased line costs.

The first priority for the communication network is to establish a platform for supporting ITS elements within traffic operations. **Table 17** summarizes the evaluation criteria that will be used for reviewing the network alternatives compared in this section.

Table 17 – Network Evaluation Criteria

Requirement	Criteria for Network Evaluation
Network Bandwidth	Alternatives will be evaluated for the capability to support identified long-term ITS devices and the City of Laredo's intra-agency needs
Flexible Distribution Versus Trunk Uses	Alternatives will be evaluated for the ability to support devices with diverse needs (This will be based upon the ability to support multiple types of interfaces of varying bandwidths)
Network Layout/Reliability	Alternatives will be evaluated for the ability to offer path diversity and protection from single points of failure
Scalability/ Expandability	Alternatives will be evaluated for the ability to scale beyond the identified potential deployments
Maintainability/ Staffing Requirements	Alternatives will be evaluated based upon the ability to obtain replacement parts; level of staff technical expertise necessary to support the technology; and the ease of replacing equipment with newer equipment
Promotion of Interchangeability/ Interoperability	Alternatives will be evaluated based upon the ease with which network components can be acquired and deployed from different vendors
Video Distribution Options	Alternatives will be evaluated based upon the ability to handle multiple video distribution techniques
Operations Center Implications	Alternatives will be evaluated based upon the demand for physical TMC space, communication infrastructure, TMC location, and other telecommunications architecture related implications
Life-cycle Cost	Alternatives will be compared against one another over a 10 year life-cycle cost

The City of Laredo is holding discussions regarding the possible relocation of the existing TMC. A primary communication media decision has not been identified, and the ultimate communication solution will likely involve a mixture of media including fiber optics, wireless and leased lines. Options for leased lines will be evaluated as part of each telecommunications architecture because it is unlikely that the City will build a complete fiber optic interconnect to serve all of its ITS components. Similarly, wireless and copper extensions will be considered, where appropriate, in the alternatives. The alternatives that are reviewed in this section include:

- Analog fiber distribution and leased line backbone;
- An analog fiber distribution and digital backbone; and
- A digital distribution and wireless, DSL, and/or fiber backbone connectivity.

For analysis purposes, communication signals were categorized as either data or video. Data communications include CCTV control (pan, tilt, zoom), status information sent back from a device, traffic information (e.g. volume, occupancy), detectors (e.g. flood), and alarms (e.g. door open, failure). Data communications can either be one-way (simplex) or two-way (duplex) between the TMC and field devices. Video communications are primarily one-way from the field device to the TMC, with the exception of camera control. Real-time video communications require substantially greater signaling rates (bandwidth) than data communications.

5.3.1 Alternative 1: Analog Fiber Optic Distribution and Leased Line Backbone

The first alternative uses fiber optic transceivers to connect traffic signal system master controllers, DMS, CCTV cameras, and other detection systems to a hub location where telephone leased lines are then employed to connect with the TMC central system. Data channels are run through dial-up or leased 56k telephone lines in the field and polled by the TMC central system using a T-1 channel bank multiplexing device. Data distribution rings use fiber optics from the hub to each of the traffic signal master controllers and DMS cabinets. Data rings are assigned to one of the 24 modem channels on the T-1 channel bank. Based on the quantity of DMS and signal systems, a single T-1 channel bank can accommodate the City's ITS data requirements using dial-up communications to the hubs; however, dedicated leased lines would warrant a second T-1 and channel bank. At the TMC the channel bank de-multiplexes the respective field data channels (EIA-232) from each hub location.

Similarly, CCTVs in this alternative communicate over fiber optics with the closest hub where they are digitally encoded and compressed for transmission over a T-1 leased line to the TMC.

Figure 10 is a schematic of this approach. Spare distribution fibers can be used to connect water quality monitoring stations in addition to the flood detection and closure management systems without adversely impacting the operation of the signal system.

The analog fiber optic distribution alternative requires more fibers overall, while still relying heavily on annual leased line operational costs. The costs for this alternative are summarized in Section 5.3.4 of this report.

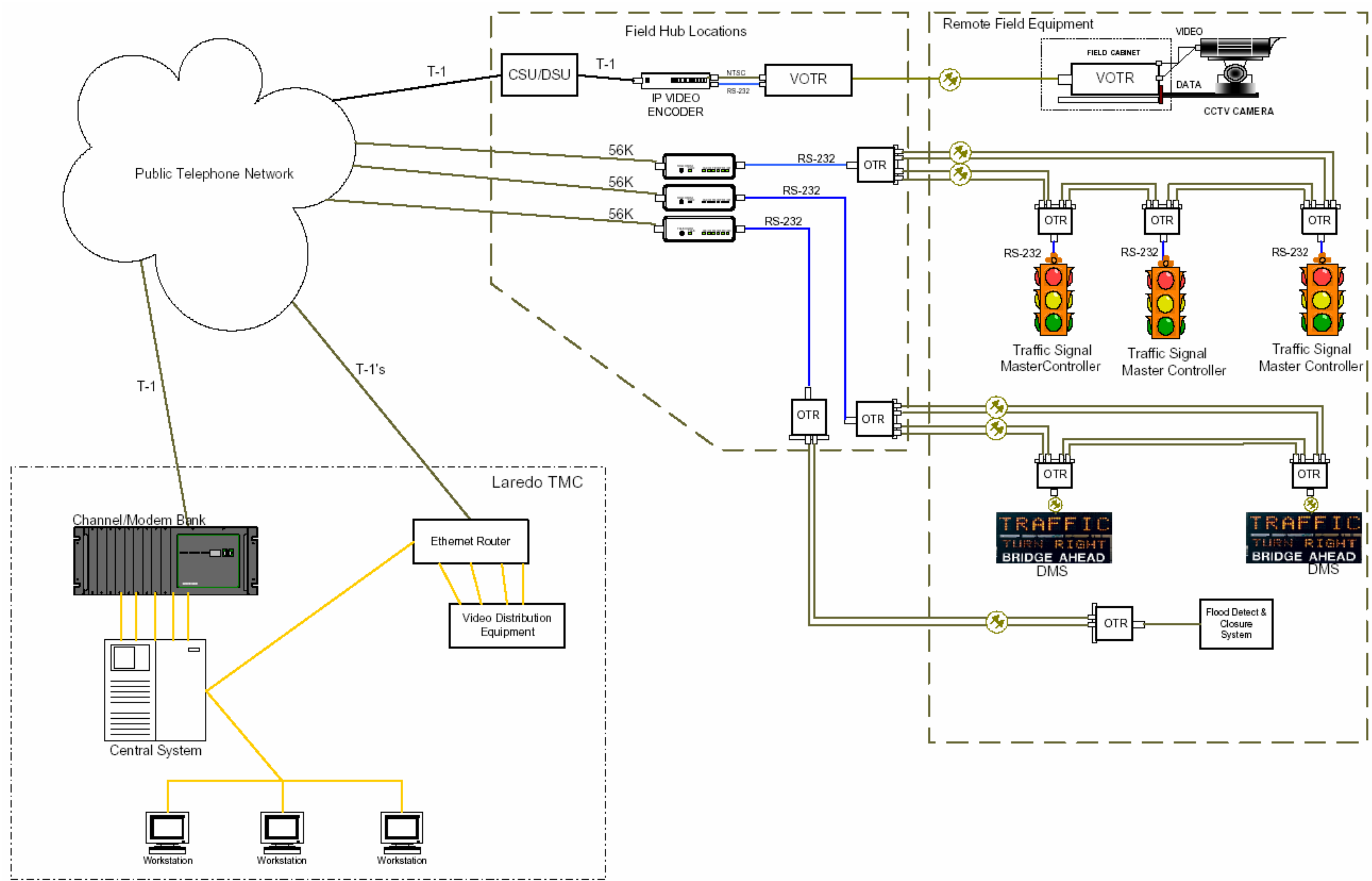

Figure 10 – Alternative 1: Analog Fiber Optic Distribution and Leased Line Backbone

Advantages for Alternative 1:

- Scalability/Expandability: Provides scalability through addition of T-1 capacity as needed for new cameras and data rings. New hubs can be added as needed and flexibly located in coordination with leased line availability.
- Flexible Distribution versus Trunk Uses: This alternative blends the simplicity of a direct connection to the TMC with the gradual build-out of a scalable fiber optic network. Fiber optics can be used for both trunk and distribution purposes.
- Maintainability/Staffing Requirements: Relatively simple to troubleshoot circuits because they can be isolated to dedicated channels on channel bank multiplexers or video decoder T-1s. Maintenance can be performed by signal technicians with minimal training.
- Life-cycle Cost: The recurring annual operations and maintenance costs are more than the other telecommunications architectural alternatives; however the initial capital cost is low making the 10 year life cycle cost of Alternative 1 the lowest of the three alternatives.

Disadvantages for Alternative 1:

- Network Bandwidth: Initially, this architecture provides limited bandwidth. There is one T-1 for data and a T-1 for each video; however, additional channel banks can be added to the TMC to expand bandwidth for data devices and higher bandwidth channelized T-3s and above can be used in the future to increase network bandwidth. This alternative does not afford the opportunity to share spare bandwidth with other agencies.
- Network Layout/Reliability: Reliability at the backbone level is limited by the telephone service provider’s network. Field distribution is reliable using fiber optic cables and in some cases, folded ring topologies.
- Promotion of Interchangeability/Interoperability: Proprietary paired electro-optics end-to-end requires limiting each daisy-chain or folded ring to a single manufacturer.
- Video Distribution Options: Limited in this alternative because all video must be sent to the TMC before distributing to others or even to backup centers.
- Operations Center Implications: Because the TMC is the direct termination of data and video communications, this alternative has a large central equipment requirement. Using leased lines in this circumstance does afford some flexibility in moving the TMC to an alternate location at a later date.

5.3.2 Alternative 2: Analog Fiber Optic Distribution and Wireless or Shared Digital Fiber Backbone

The second alternative uses Ethernet switches at communication field hubs. Field distribution to traffic signal master controllers, DMS, and CCTV is the same as Alternative 1; however, in contrast to Alternative 1 the data distribution rings are converted to Ethernet packets at the field hub by a device called a terminal server. Each hub is equipped with an Ethernet switch/router, which provides sufficient capacity to add more controllers and cameras beyond those the City has already identified. Even with four cameras streaming video at 3Mbps each along with roughly 40 signals attached to any given hub location, this would only account for less than 15 percent of the capacity of the link to the TMC. Based on the initial quantity of cameras, DMS, and signal system groupings, four primary Ethernet fiber sub-networks can accommodate the City's ITS video and data requirements for years to come. This can be done by configuring the field Ethernet switches in fiber rings, or a mesh topology to improve redundancy at the same time. At the TMC the Gigabit Ethernet Switch distributes controller data via Ethernet to the central system servers, while video is decoded by IP-based video decoders or software decoders on servers and workstations for the video display system. Backbone connections between hubs and the TMC can be made through the City's I-Net, Traffic Department's proposed fiber cables, TxDOT shared fiber resources, or even through wireless. **Figure 11** is a schematic of this approach.

Spare distribution fibers can be used to connect water quality monitoring stations in addition to the flood detection and closure management systems without adversely impacting the operation of the signal system.

The analog fiber optic distribution alternative requires as many fibers as Alternative 1, but without the annual leased line operational costs. The costs for this alternative are summarized in Section 5.3.4 of this report.

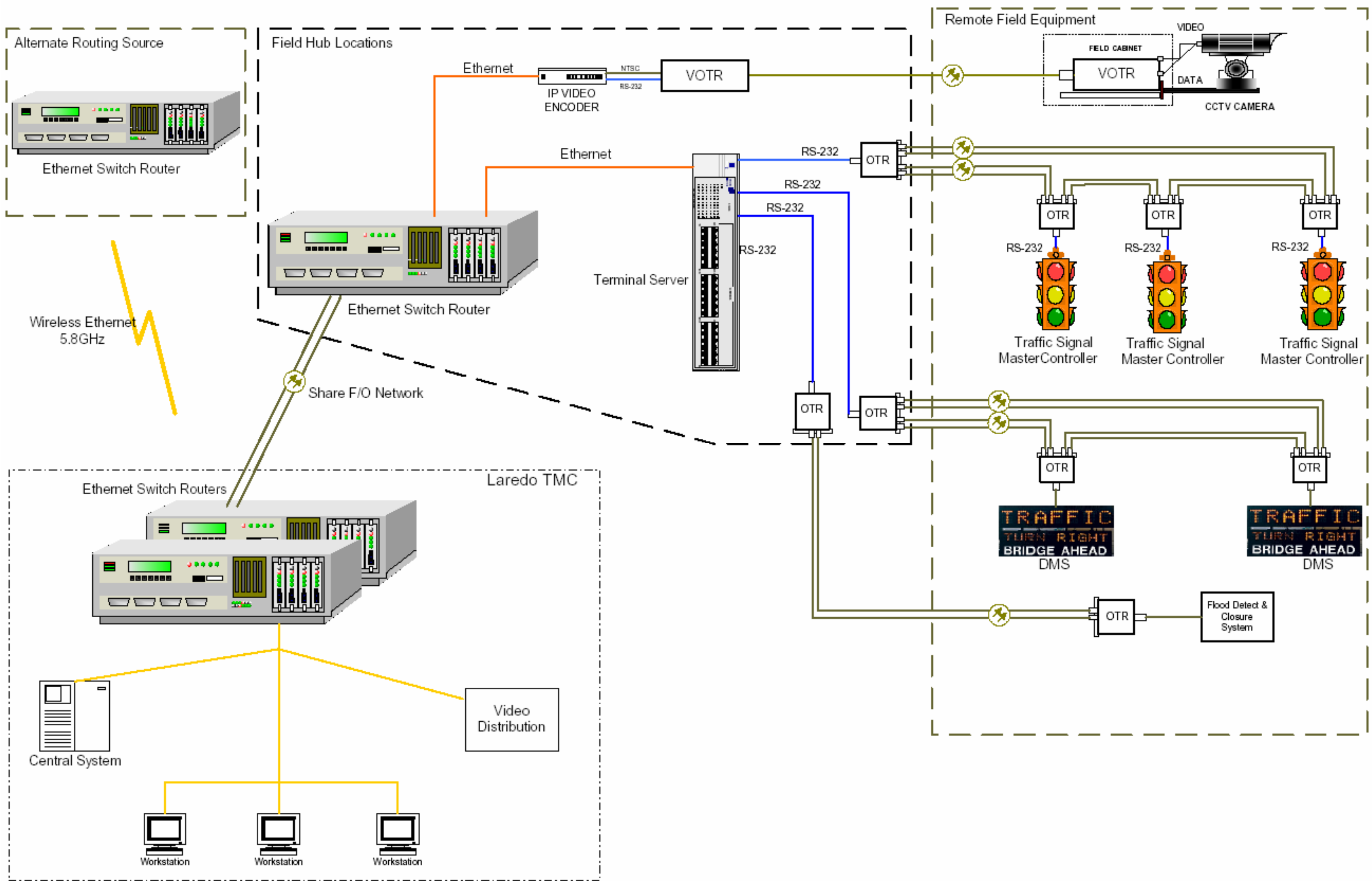

Figure 11 – Alternative 2: Analog Fiber Optic Distribution and Wireless or Shared Digital Fiber Backbone

Advantages for Alternative 2:

- Network Bandwidth: This architecture provides a high degree of bandwidth (100Mbps+) to each hub.
- Flexible Distribution versus Trunk Uses: Blends the simplicity of a direct connection approach while making better use of trunk fibers to afford future scalability.
- Scalability/Expandability: Requires fewer fibers at the TMC and from other partners (e.g. TxDOT, I-Net), and provides scalability by adding new hubs and subdividing networks without adversely effecting the TMC.
- Promotion of Interchangeability/Interoperability: With adopted standards from the Internet Engineering Task Force (IETF) along with the IEEE, many Ethernet vendors have been tested for interoperability with one another, which provides long-term protection against sole-sourcing and/or obsolescence. At the field distribution end, proprietary paired electro-optics are still a disadvantage, but this is managed by limiting the size of distribution rings as mentioned in Alternative 1.
- Video Distribution Options: Provides ability to distribute video digitally to workstations anywhere on the network, to video decoders for analog monitors and switches, and also to web servers.
- Operations Center Implications: TMC central equipment requirements are significantly lower than Alternative 1. Additionally, this network architecture is more distributed than Alternative 1 and provides flexibility to relocate the TMC more easily.
- Life-cycle Cost: The capital cost is in the mid-range of the alternatives, while the recurring annual operations and maintenance costs are less than Alternative 1 making these two alternatives nearly equal after 10 years. After such time, the operations cost benefits of this alternative will exceed those of Alternatives 1 and 3.

Disadvantages for Alternative 2:

- Maintainability/Staffing Requirements: While Ethernet is a widely accepted Information Technology standard, it is not as easy to troubleshoot as a fixed correlation between a modem channel and the end device, as with an analog multiplexed or direct connect architecture. Therefore, troubleshooting can be more complex and may require training and assistance from the Information Technology staff.
- Network Layout/Reliability: Improved reliability at the backbone level is afforded by providing diverse logical routes to the TMC; however, terminal servers and switch/routers at hubs present potential single points of failure for multiple field devices.

5.3.3 Alternative 3: Digital Fiber Optic Distribution and Interconnect

The third alternative uses Ethernet switches at each proposed traffic signal master controller cabinet to be brought onto the system. In contrast to the previous alternatives, optical transceivers in field distribution to signal controllers, DMS, and CCTV are replaced by Ethernet switches configured in a folded optical ring. Data elements are still converted to Ethernet packets like Alternative 2, but terminal servers are located at each traffic signal master controller cabinet instead of simply at the hub. The hub's Ethernet switch/router connects to the TMC in one of several methods, including City backbone fibers, TxDOT shared fibers, wireless Ethernet, or even through one or more leased telephone lines. Cameras are encoded right at the device location, which reduces the space demands at the hub. Similar to Alternative 2, it is anticipated that four primary Ethernet fiber sub-networks can accommodate the City's ITS video and data requirements for years to come. This can be done by configuring the field Ethernet switches in fiber rings or a mesh topology to improve redundancy at the same time. At the TMC the Gigabit Ethernet Switch distributes controller data via Ethernet to the central system servers, while video is decoded by IP-based video decoders or software decoders on servers and workstations for the video display system. Backbone connections between hubs and the TMC can be made through the City's I-Net nodes, Traffic Department's proposed fiber cables, TxDOT shared fiber resources, or even through wireless. Unlike Alternative 2, Ethernet presence can be accessed at each signal controller cabinet. Field devices such as cameras, dynamic message signs, and other future ITS elements only need to be connected to the nearest controller cabinet to gain access to the network, thereby reducing the need for optical distribution modems. **Figure 12** is a schematic of this approach.

Spare distribution fibers can be used to connect water quality monitoring stations in addition to flood detection and closure management systems without adversely impacting the operation of the signal system. They can also be connected to a terminal server in the nearest traffic signal master controller cabinet.

The digital fiber optic distribution alternative requires less fibers than the other alternatives because the need for multiple distribution rings is eliminated or at least dramatically reduced. The costs for this alternative are summarized in Section 5.3.4 of this report.

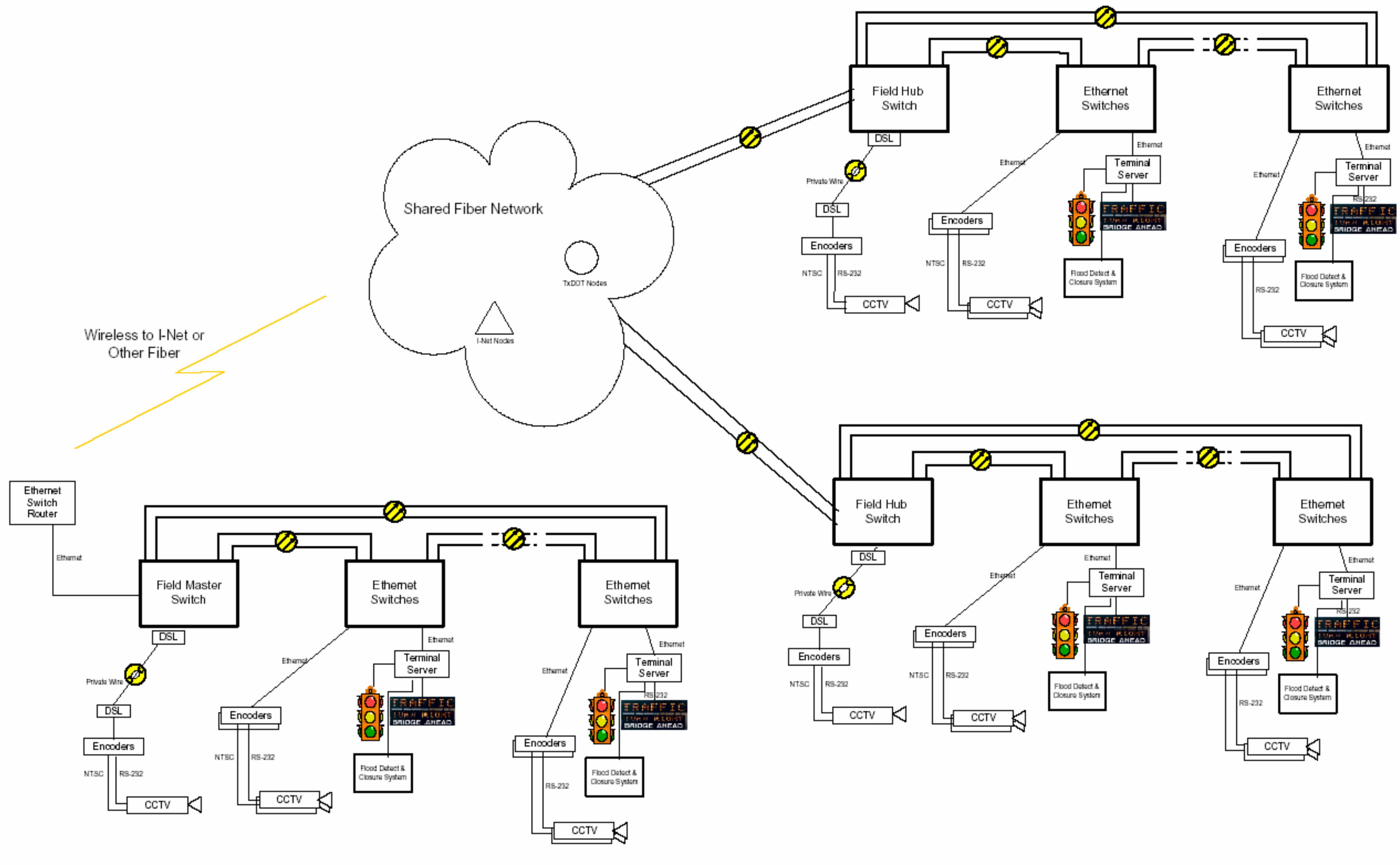

Figure 12 – Alternative 3: Digital Fiber Optic Distribution and Interconnect

Advantages for Alternative 3:

- Network Bandwidth: This architecture provides a high degree of bandwidth (100Mbps+) to each fiber sub-nodes.
- Flexible Distribution versus Trunk Uses: This alternative allows for flexible access to varying ITS device types as well as offering a high degree of opportunity for sharing fibers or network access with partnering agencies.
- Network Layout/Reliability: Improved reliability at the backbone level is afforded by providing diverse logical routes to the TMC, as well as placing switches and terminal servers in each traffic signal master controller cabinet to greatly reduce the effects of single points of failure.
- Scalability/Expandability: Requires the fewest fibers at the TMC and from other partners (e.g. TxDOT, I-Net), and provides scalability by adding new hubs and subdividing networks without adversely effecting the TMC. The alternative can readily be scaled up to Gigabit Ethernet and beyond without wholesale equipment changeout.
- Promotion of Interchangeability/Interoperability: With adopted standards from the Internet Engineering Task Force (IETF) along with IEEE, many Ethernet vendors have been tested for interoperability with one another, which provides long-term protection against sole-sourcing and/or obsolescence.
- Video Distribution Options: This alternative has the ability to distribute video digitally to workstations anywhere on the network, to video decoders for analog monitors and switches, and to web servers.
- Operations Center Implications: TMC central equipment requirements are among the lowest of the alternatives along with Alternative 2. Additionally, this network architecture is more distributed than Alternatives 1 and 2 and provides flexibility to relocate the TMC more easily than either other alternative.

Disadvantages for Alternative 3:

- Maintainability/Staffing Requirements: While Ethernet is a widely accepted Information Technology standard, it is not as easy to troubleshoot as a fixed correlation between a modem channel and the end device as with an analog multiplexed or direct connect architecture. Therefore, troubleshooting can be more complex and may require training and assistance from the Information Technology staff.
- Life-cycle Cost: The capital cost and life-cycle costs are the highest of the alternatives.

5.3.4 Comparison of Alternatives and Recommendations

Table 18 provides a summary comparison of the life-cycle costs for the three communication architecture alternatives. Cost estimates are based on the communications requirements to bring data or video from the controller cabinet for the ITS device or traffic signal master controller back to the TMC. Communication between the local controllers and master controllers are included in the signal system upgrade estimates. Exact system configurations are unknown at this time, but each alternative was evaluated using an approximate number of devices the City of Laredo may connect.

Table 18 – Comparison of Probable Costs for Network Alternatives

Item/Description	Unit Price	Unit	Alternative 1		Alternative 2		Alternative 3	
			Quantity	Subtotal	Quantity	Subtotal	Quantity	Subtotal
Video Optical Transceivers	$3,600	Pair	20	$72,000	20	$72,000		$0
Optical Transceiver	$1,600	Each	118	$188,800	118	$188,800		
DS-1 Channel Bank with SU/DSUs	$14,000	Each	1	$14,000		$0		$0
56K Modem	$300	Each	18	$5,400		$0		
DSL Modem	$400	Each		$0	8	$3,200	8	$3,200
5.8 GHz Wireless Modem	$3,000	Each		$0	4	$12,000	4	$12,000
Video Encoders	$5,000	Each	20	$100,000	20	$100,000	20	$100,000
Gigabit Ethernet Switch	$50,000	Each	1	$50,000	1	$50,000	1	$50,000
Field-hardened 100Mb Ethernet switch	$4,000	Each		$0	14	$56,000	110	$440,000
Field-hardened Ethernet EIA-232 Terminal Server	$3,000	Each		$0	14	$42,000	110	$330,000
Video Decoders for Operations Center	$4,000	Each	20	$80,000	20	$80,000	20	$80,000
48 Fiber Optic Cable	$12,000	Mile		$0		$0	8	$96,000
60 Fiber Optic Cable	$15,000	Mile	4	$60,000	8	$120,000		$0
Underground conduit	$120,000	Mile	4	$480,000	8	$960,000	8	$960,000
Splice Enclosure Plus Splicing	$1,500	Each	8	$12,000	16	$24,000	16	$24,000
POTS	$30	Month	18	$540		$0		
T-1	$500	Month	20	$10,000		$0		
Construction subtotals				$1,062,200		$1,708,000		$2,095,200
Engineering Design (as a percentage of construction)	10%			$106,220		$170,800		$209,520
Construction Inspection (as a percentage of construction)	15%			$159,330		$256,200		$314,280
Option Totals				$1,327,750		$2,135,000		$2,619,000
Annual Operations and Maintenance (as a percentage of construction)	10%			$106,220		$170,800		$209,520
Leased Line Annual Operations and Maintenance				$126,480				
10 Year Lifecycle Cost (10 years O&M + option totals)				$3,654,750		$3,843,000		$4,714,200

All three alternatives have strengths and weaknesses as design options for the City of Laredo ITS communication system. While Alternative 1 is the least expensive capital solution and limits the maintenance and operations requirements, it requires a high degree of central equipment at the TMC, which can potentially pose a problem if the TMC location is changed in the near future. The analog distribution with a digital backbone provides a good balance of network flexibility and life cycle cost. **Table 19** compares the three alternatives toward meeting the system requirements.

Table 19 – Comparison of System Attributes

Attributes	Alternative 1	Alternative 2	Alternative 3
Network Bandwidth	Moderate	High	High
Flexible Distribution vs. Trunk Uses	Limited	Yes	Yes
Network Layout/Reliability	Yes	Limited	Yes
Scalability/Expandability	Yes	Yes	Yes
Maintainability/Staffing Requirements	Basic	Complex	Complex
Promotion of Interchangeability/Interoperability	No	Limited	Yes
Video Distribution Options	Limited	Multiple	Multiple
Operations Center Implications	More TOC Space	Less TOC Space	Less TOC Space
Capital Cost	$1.3M	$2.1M	$2.6M
Annual Operations & Maintenance Costs	$233k	$171k	$210k
Lifecycle Cost (10 years)	$3.7M	$3.9M	$4.7M

Recommended Communication Alternative

Based on the results of the system analysis and the communications alternatives analysis, the recommended telecommunication architecture for the City of Laredo is Alternative 2, using analog distribution between field devices and a hub location with access to a digital backbone network. The cost savings attributed to the optical/electronics equipment outweigh the slightly higher cost for higher fiber count cables when compared with the all digital alternative. This is due to the fact that an increase in fiber count is only a fraction of the cost of the actual installation required to install the cable. This approach also provides the City with the greatest amount of flexibility as they can migrate towards more advanced telecommunications architectures as future ITS technologies dictate. An added benefit to this approach is that it provides flexibility in sharing video and data with TxDOT and other City agencies with or without tapping into the Ethernet signal network because the fibers available can be used to support many modes of communication devices. This alternative also allows the City to use many different methods of communicating with field devices besides fiber optics. Wireless data modems, for example, can be used to connect a closed loop signal system to a nearby fiber hub, or shared I-Net or TxDOT node for conversion to Ethernet. Likewise, DSL or frequency shift keying (FSK) to fiber converters can also be used to extend the range and life of the City's usable twisted pair infrastructure for connecting the "last mile" to some devices.

6. CONCEPT OF OPERATIONS

6.1 Operations

Stakeholders in the City of Laredo identified operational goals for their traffic management system. These operational requirements will drive specific staffing needs for the system. The specific set of functions desired by the City of Laredo includes:

- Traffic signals and traffic control;
- Traffic and system monitoring;
- Bridge management;
- Incident management;
- Special event management;
- Coordination and collaboration with other agencies; and
- Information gathering and dissemination.

A key operational characteristic that affects each of these functions is the hours of operation of the system. While many large urban freeway operations centers and regional TMCs are staffed 24 hours per day seven days per week, it is not envisioned that continuous operations are needed in Laredo at this time. If the center becomes a combined operations center, 911 dispatch will operate 24 hours per day and it may be reasonable at that time to have a traffic representative present at all times or for extended hours in the morning and evening. This person could respond to incidents by modifying traffic control schemes and disseminating information to the public and media.

Through a series of signal projects that will upgrade the controller units, restructure closed loop systems, and establish new closed loop systems, the City of Laredo will improve signal coordination and traffic progression.

The bridge coordination projects will enable the City of Laredo to better control and direct traffic headed for the international bridges in downtown Laredo. The bridge coordination system will support plans to restructure use of the downtown bridges and increase parking and access to Bridge 1. A new traffic approach to Bridge 1 will be implemented at the completion of the bridge project. As motorists exit I-35, DMS will advise them of delay conditions approaching Bridge 1. For those already in the downtown area another DMS will provide additional information. CCTV cameras installed in the area will allow TMC operators to monitor congestion conditions and provide improved traveler information. A fixed camera will also provide images of queues at Bridge 1 that cold be placed on a website. The downtown signal system upgrades and closed loop system configurations will facilitate the movement of vehicles to the bridge.

CCTV and DMS positioned around the City will facilitate incident management, as well as special event management. With improved incident detection and monitoring capabilities more accurate information can be provided to travelers. Improved signal system communications will provide the opportunity to adjust signal timing plans remotely for a severe incident and especially for special event management because advance notice can ensure a structured implementation of alternate timing plans.

The existing TMC already shares video feeds with TxDOT and it is anticipated that even if the 911 Dispatch Center is not collocated with the TMC, video from City of Laredo CCTV cameras will be shared with emergency services so that dispatchers can make more informed decisions about the most appropriate equipment to route to the scene of an incident if video is available.

6.2 Maintenance

A critical aspect of ITS deployment is ITS maintenance. ITS devices are either functioning or not functioning. Non-functional devices do not provide any data or contribute in any way to the system; therefore, it is important to maintain and repair equipment to minimize the down time of components and maximize system usefulness. FHWA has compiled data from system managers around the country about typical annual maintenance costs. These are shown in **Table 20**.

Table 20 – FHWA Annual Maintenance Costs

Technology	Lifespan (years)	Annual Maintenance Cost	
		Low	High
CCTV Video Camera	10	$1,500	$2,400
DMS	20	$2,400	$6,000
Weather Station	25	$1,900	$4,100
Roadway Closure Gates	20	$3,000	$4,000
Signal Controller	20	$200	$900

Types of Maintenance

Response Maintenance – Almost every public agency provides maintenance in response to alarms, customer requests, or identified problems. Response maintenance is defined as the repair of failed equipment and its restoration to safe, normal operation. It requires action based on the priority of the subsystem that has failed and takes precedent over preventative maintenance activities for the duration of the issue.

Preventative Maintenance – While most public agencies provide response maintenance, few provide preventative maintenance on a regular, routine basis. Preventative maintenance is defined as a set of checks and procedures to be performed at regularly scheduled intervals to ensure that equipment properly functions. It includes checking, testing, inspecting, record keeping, cleaning, and replacement based on the function and rated service life of the device and its components. Preventative maintenance is intended to ensure reliable mechanical, electrical, and electronic operation of equipment, thereby reducing equipment failures, response maintenance, road user costs, and liability exposure. The emphasis in preventative maintenance is checking for proper operation and taking proactive steps to repair or replace defective equipment, thus ensuring that problems are not left until the equipment fails.

Lack of staff and limited funding are often cited as reasons that preventative maintenance is not carried out. It should be noted that most ITS field devices are comprised of solid state components that have become much more reliable in recent years and do not require the same frequency of preventative maintenance that they once did.

ITS Device Maintenance Requirements

There are no established or accepted guidelines that agencies can utilize to determine maintenance staffing levels by classification for the number and type of ITS devices that it owns and operates. There are several agencies that maintain ITS devices that have staffing levels and/or practices that can be found in literature or have been interviewed as part of other projects. These examples include:

- The Maryland State Highway Administration employs eight technicians to conduct both response and limited preventative maintenance for 35 permanent and close to 100 portable variable message signs. Another eleven technicians are responsible for 250 field devices including CCTV cameras, road weather information systems, detectors, and traveler advisory radios.
- The Virginia Department of Transportation employs seven technicians and one engineer to conduct response maintenance for its Northern Virginia ATMS system for over 1500 devices, including CCTV cameras, DMS, and detectors. The District seldom conducts preventative maintenance.
- The Northwest Region of the Washington State DOT has a maintenance staff of twelve people that conduct both response and preventative maintenance for 1150 ITS devices from CCTV cameras to call boxes and ramp meter systems. They also maintain over 100 miles of fiber optic.

The national examples indicate that one maintenance staff person can maintain anywhere from 100 to 200 ITS devices.

Choice of technology can affect the size of the required maintenance staff. For example, over time some agencies have received portable DMS at the completion of construction projects. As projects might have different specifications for the signs and contractors have made the final product selection, agencies end up with a variety of difference technologies that comprise their portable DMS fleet, thus complicating maintenance activities. Developing a city-wide specification can mitigate this type of problem. Technology choices themselves can also reduce the overall need for maintenance activities. Some technologies have built in diagnostic functions that can aid in troubleshooting.

Recommended staffing guidelines for the City of Laredo are to have one technician per 100 ITS devices. Though the range of examples from around the country was 100-200 devices per technician, the City of Laredo is early in its deployment of ITS devices and the lower ratio initially will allow room for it to increase as the system grows and technicians gain experience and comfort with the devices.

The City of Laredo Traffic Department currently maintains 9 ITS devices. An additional 32 devices are recommended for implementation (2 camera upgrades included in the plan are not included as part of the 32 devices as they are already existing). According to the 100 devices per technician ratio, this would require 0.32 additional technicians or the equivalent of 521 hours of additional maintenance per year. An additional 49 signal preemption devices have also been recommended which will require an additional 0.49 technicians or the equivalent of 797 hours of additional maintenance per year. Estimates were based on ITE estimated maintenance staff productivity levels that take in to account vacation, holidays, sick leave, training and breaks for a total of 1,627 productive hours per year.

Maintenance of the communications system will depend on the alternative chosen and is discussed as part of the evaluation of alternatives included in Section 5.3.

6.3 Staffing Requirements

Staffing for operations and maintenance is a function of the type and number of ITS devices, the hours of operation, and services supported by the system. In addition to existing devices, the City of Laredo may add additional ITS field devices, signal preemption, closed loop systems, and an expanded communication system. As identified in Section 6.2, the addition of the ITS roadside elements will require an additional 0.32 technician and the signal preemption devices could require an additional 0.49 technician. The telecommunications system will also require maintenance depending on the type of system the City chooses to implement. The City of Laredo should review existing staff and workload to determine if existing staff is adequate or if additional staff is required to handle the increase in workload for maintenance.

It is anticipated that the TMC will continue to operate during normal business hours Monday through Friday. At this time there is not a significant congestion problem that would necessitate that the TMC operate outside of peak travel times. For special events or incidents TMC operations hours would need to be extended. As the TMC functionality increases and operating hours are possibly extended in the future, it is recommended that additional staff be added to support expanded TMC operations.

7. REGIONAL ITS ARCHITECTURE CONSISTENCY

7.1 Laredo Regional ITS Architecture and Deployment Plan

The Laredo Regional ITS Architecture and Deployment Plan was completed in June 2003. Representatives from the City of Laredo, El Metro, Webb County, TxDOT, FHWA, US Border Patrol, and US Customs participated in the development of the plan. The goal of the Regional ITS Architecture and Deployment Plan included the following:

- Identification of a long range vision for deployment of ITS in the Region;
- Identification of ITS services and needs in the Region;
- Description of how these services will be provided, including which agencies will be involved and what data will be shared; and
- Identification of projects for deployment in a 5-year, 10-year, and 20-year time frame.

Development of the plan was also necessary to ensure ITS projects in the Region are eligible for federal funding in the future. The FHWA final rule to implement Section 5206(e) of the Transportation Equity Act for the 21st Century (TEA-21) requires that ITS projects funded through the Highway Trust Fund conform to the National ITS Architecture and applicable standards. A similar rule from the Federal Transit Agency for transit projects is also in effect. Because the Laredo Regional ITS Architecture conforms to the National ITS Architecture, in order for ITS projects in Laredo to be eligible for federal funding they only have to show that they are consistent with the Laredo Regional ITS Architecture. If a project is recommended for the Region that is not consistent with the regional architecture, the regional architecture can be modified to reflect the new project provided that all stakeholders involved agree to the change.

7.2 Applicable Market Packages

In order to ensure the recommended projects in the Laredo ITS Master Plan were consistent with the Laredo Regional ITS Architecture, each project recommendation in Section 5 of this report was matched to the market packages that are applicable. Market packages represent the ITS services that are recommended for the Region. They graphically depict how a service will be deployed, which agencies are involved, and the data that will be shared. A summary of the market packages from the Laredo Regional ITS Architecture that are applicable to recommended projects in this report is included in **Table 21**. The major components of each project have been identified and the market packages that correspond to those components are listed. A single asterisk next to a market package indicates that the current market package in the Laredo Regional ITS Architecture needs to be modified in order to accommodate the project. Two asterisks indicated that the market package does not currently exist and it should be added the to the Laredo Regional ITS Architecture. These changes are recommended for incorporation into the Laredo Regional ITS Architecture and Deployment Plan at the time of the next update.

Table 21 – Market Package Summary

Project	Major Project Components	Applicable Market Packages
Laredo Traffic Management Center Upgrades	TMC	ATMS01 – Network Surveillance ATMS03 – Surface Street Control ATMS06 – Traffic Information Dissemination
Laredo Traffic Management Center/Joint Operations Center	TMC	ATMS01 – Network Surveillance ATMS03 – Surface Street Control ATMS06 – Traffic Information Dissemination
	EOC	ATMS08 – Traffic Incident Management System EM1 – Emergency Response
	JOC	ATMS08 – Traffic Incident Management System EM1 – Emergency Response EM2 – Emergency Routing
Downtown Closed Loop Signal System Phase 1	Signals	ATMS03 – Surface Street Control
Downtown Closed Loop Signal System Phase 2	Signals	ATMS03 – Surface Street Control
Water Street Fiber Extension	Communications for signals and field elements	ATMS01 – Network Surveillance ATMS03 – Surface Street Control ATMS06 – Traffic Information Dissemination
Annual Signal System Upgrade Program	Signals	ATMS03 – Surface Street Control
Traffic Signal Removal	Signals	Not applicable to market package matching
Emergency Vehicle Signal Preemption	Signal Preemption	EM2 – Emergency Routing
Bridge 1 and Bridge 2 Traffic Coordination System	CCTV Cameras	ATMS01 – Network Surveillance
	DMS	ATMS06 – Traffic Information Dissemination
	Still Frame Cameras	ATMS01 – Network Surveillance *ATMS06 – Traffic Information Dissemination
Bridge 3 Traffic Coordination System	CCTV Camera	ATMS01 – Network Surveillance
	DMS	ATMS06 – Traffic Information Dissemination
	Still Frame Cameras	ATMS01 – Network Surveillance *ATMS06 – Traffic Information Dissemination
Flecha/Las Cruces Flood Detection and Closure System	Flood Detection and Closure Gates	**ATMS21 – Roadway Closure Management **MC03 – Road Weather Data Collection
	CCTV Camera	ATMS01 – Network Surveillance
Anna/Calton Flood Detection and Closure System	Flood Detection and Closure Gates	**ATMS21 – Roadway Closure Management **MC03 – Road Weather Data Collection
	CCTV Camera	ATMS01 – Network Surveillance
Jacaman Flood Detection and Closure System	Flood Detection and Closure Gates	**ATMS21 – Roadway Closure Management **MC03 – Road Weather Data Collection
McPherson CCTV Camera Deployment	CCTV Camera	ATMS01 – Network Surveillance

Table 21 – Market Package Summary (continued)

Project	Major Project Components	Applicable Market Packages
East Laredo CCTV Camera Deployment	CCTV Camera	ATMS01 – Network Surveillance
San Bernardo CCTV Camera Deployment	CCTV	ATMS01 – Network Surveillance
Farragut/Juarez Transit Improvements	Signal timing improvements	ATMS03 – Surface Street Control
Regional Smart Card	Fare payment card for transit, parking, and bridge tolls	ATMS10 – Electronic Toll Collection ATMS16/17 – Parking Facility Management/Regional Parking Management APTS4 – Transit Passenger and Fare Management
Automated Enforcement	Red light running enforcement cameras	Not covered by any market packages in the National ITS Architecture Version 5.0
511 – Traveler Information	Traveler Information Phone System	ATIS2 – Interactive Traveler Information
Telecommunications System	Communications to support ITS elements	ATMS01 – Network Surveillance ATMS03 – Surface Street Control ATMS06 – Traffic Information Dissemination

* Market package needs to be modified

** Market package needs to be added to the architecture

7.3 Market Package Modifications and Additions

It was agreed by the stakeholders that developed the Laredo Regional ITS Architecture and Deployment Plan that the plan should be periodically reviewed and updated in order to reflect current project deployment status and to re-evaluate priorities. A two-year time frame was selected to correspond with the Laredo MPO's Transportation Improvement Plan (TIP) updates. TxDOT was identified as the agency to take the lead in bringing together the stakeholder group and updating the Laredo Regional ITS Architecture and Deployment Plan.

As a result of the review performed on the Laredo ITS Master Plan projects, several market package modifications are recommended for updates or inclusion in the next revision of the Laredo Regional ITS Architecture. These changes include the modification of the Traffic Information Dissemination market package and addition of market packages for Roadway Closure Management and Road Weather Data Collection. **Figures 13-15** provide a detailed description of the recommended market package changes and additions.

Traffic Information Dissemination

The market package shown in **Figure 13** is the Traffic Information Dissemination (ATMS06) market package for the City of Laredo TMC. This market package was modified from the market package in the Laredo Regional ITS Architecture to include images from the still frame camera that is a component of the Bridge 1 and 2 Traffic Coordination System project identified in Section 5. The flow "traffic images" from the City of Laredo TMC to the City of Laredo Webpage, and potentially the TxDOT Laredo District Webpage, is an addition to this diagram. Additionally, this market package was previously shown as two separate figures. These figures were consolidated to simplify the market package for the City of Laredo TMC and allow it to be presented in one figure.

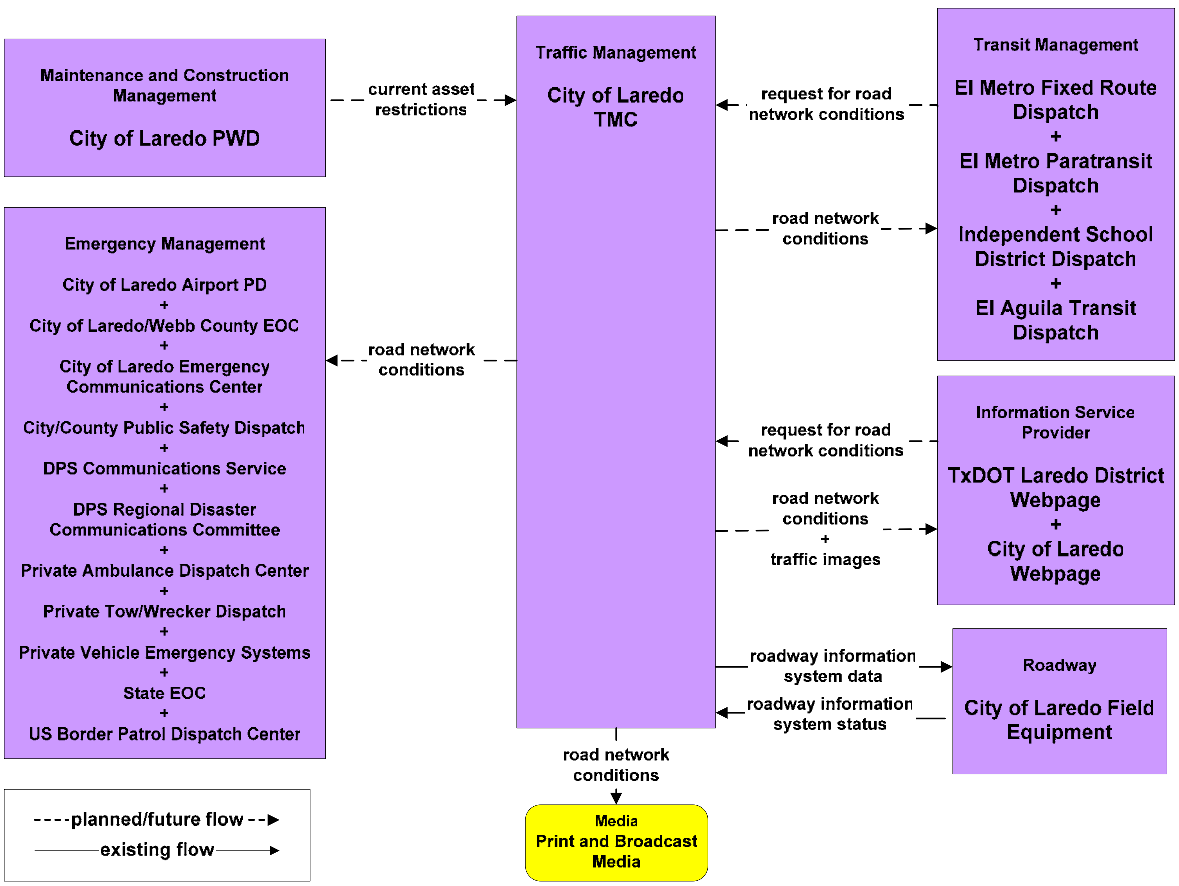

Figure 13 – ATMS06 Traffic Information Dissemination: City of Laredo TMC

Roadway Closure Management

The Roadway Closure Management (ATMS21) market package shown in **Figure 14** is recommended for addition to the Laredo Regional ITS Architecture. This Roadway Closure Management market package was added to the National Architecture as part of Version 5.0, which was released after the Laredo Regional ITS Architecture was complete. The Roadway Closure Management market package is recommended for inclusion in the Laredo Regional ITS Architecture to represent the following projects identified in Section 5:

- Flecha/Las Cruces Flood Detection and Closure System;
- Anna/Calton Flood Detection and Closure System; and
- Jacaman Flood Detection and Closure System (does not include CCTV).

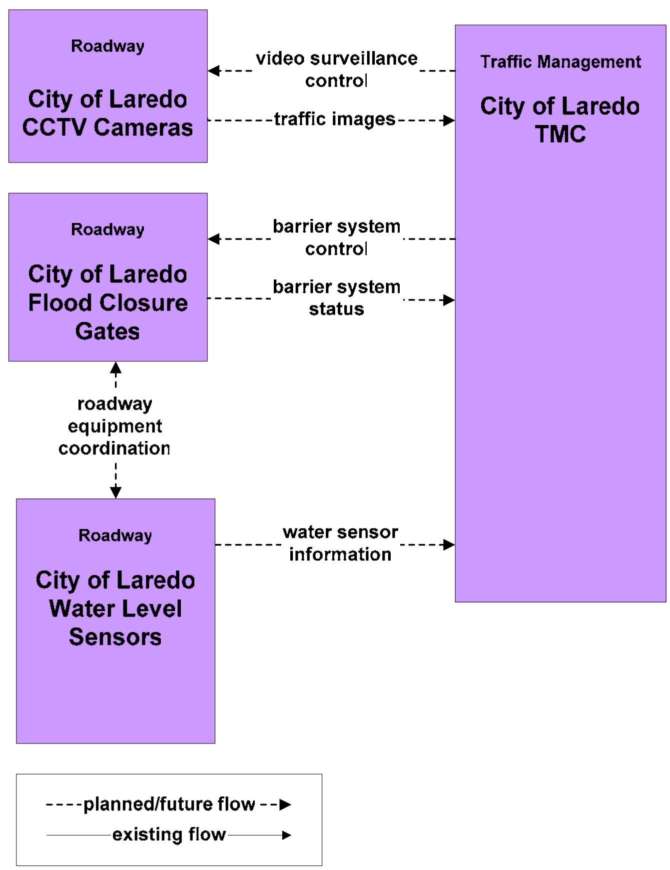

Figure 14 – ATMS21 Roadway Closure Management: City of Laredo Flood Closure System

Road Weather Data Collection

The Road Weather Data Collection (MC03) market package was not selected for the Laredo Region when the Architecture was originally developed. At that time there were no plans by the stakeholders involved in the development of the Regional ITS Architecture to implement flood detection devices. **Figure 15** is a Road Weather Data Collection market package that has been customized for the City of Laredo to represent additional information sharing that could be implemented as part of the flood detection and closure system projects described in **Figure 14**. The market package indicates that information about water levels could be sent not only to the City of Laredo TMC but also to the City of Laredo Environmental Services Division.

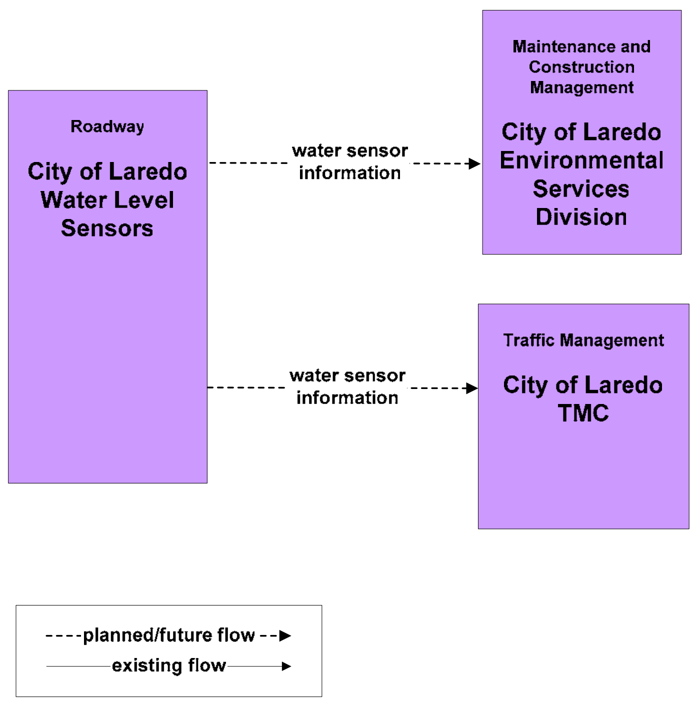

Figure 15 – MC03 Road Weather Data Collection: City of Laredo Flood Detection

APPENDIX A – SURVEY

City of Laredo ITS Survey

This is a list of potential City of Laredo ITS services. We'd like to review these with you and have you indicate those services which you believe could add value to your work assignments, either in the work area for which you are responsible or to your agency at large.

First we will go through each service, as we do this please check whether or not your agency views this as an important service. After that we will provide some time for you to rank those services selected in order of importance to your agency. Thank you for your help in identifying priorities for the City of Laredo.

Agency:____

Name:_____________________________________ Title:___________________________________

Is this service important to your agency?	**ITS Service**	**Rank of Importance**
Traffic Services		
	Peak hour traffic management center operation	
	24-hour traffic management center operation	
	Dispatching capabilities	
	Traffic surveillance capabilities	
	Vehicle counting capabilities	
	Vehicle speed detection capabilities	
	Vehicle classification capabilities	
	Remote traffic signal control	
	Signal coordination	
	Data storage	
	Weather sensors	
	Flood detection sensors	
	Electronic parking payment	
	Bridge coordination	
	Automated vehicle location for traffic service vehicles	
Traveler Information		
	Dynamic message signs	
	Highway advisory radio	
	Kiosks	
	Internet	
	Telephone (511)	
	Private sector providers	
Transit Services		
	Transit vehicle signal priority	
	Transit vehicles as probes	
Emergency Services		
	Emergency vehicle traffic signal preemption	
	Automated crash data collection	
Others		

APPENDIX B – INTERVIEW SUMMARIES

Pete Palacios
Lieutenant

Sanjuanita Rangel
Assistant Communication Manager

Sylvia Soria
911/Communication Supervisor

Department Overview	▪ The 911 Dispatch Center is located in the City of Laredo Police Department and handles calls for police and fire. ▪ Physical space is a key concern. The center is becoming filled with equipment and has little room to expand.
Existing ITS Uses and Plans	▪ Police currently have 55 vehicles equipped with mobile data terminals (MDTs) and automatic vehicle location (AVL). They plan to increase the number of vehicles with MDTs and AVL to 75 in the next few months. ▪ Software (Looking Glass Dispatch) that allows tracking of all vehicles with MDTs and AVL is currently being installed. Police want to include fire vehicles on the software but fire does not have the funds to install MDTs and AVL on vehicles. ▪ TxDOT is adding several monitors for viewing TxDOT CCTV cameras into the 911 Dispatch Center. The cameras will primarily be used by the fire dispatchers. There are concerns among the operators about lack of time to monitor the cameras and lack of space for the monitors.
ITS Needs	▪ Traffic signal preemption for police vehicles. ▪ Cameras mounted in police vehicles. ▪ Automatic enforcement for speeding and red light running. ▪ Additional space at the 911 Dispatch Center or a new facility to relocate 911 into. ▪ Police have software that can track tickets, accident, and other information but they do not have the man power to add the data to the software. They would like to be able to have officers automatically add information to the system from their vehicles. City of Laredo Traffic is the primary requestor of this data. ▪ The radio system needs to be City wide to allow all agencies to be able to communicate, including police, fire and other departments. All departments could install an 800 MHz system if funding were available. Currently, police can communicate with fire but fire can't communicate with police because the police are not on an open channel. ▪ Vehicle speed detection capabilities would be useful for officers when rerouting traffic due to incidents. ▪ Data from flood detection sensors would be useful. The Police post officers at high risk intersections to keep motorists from driving into low water crossings when flooded and better information on where flooding has occurred would assist the Police. ▪ DMS and highway advisory radio would be useful for posting Amber Alerts and other messages regarding incidents and closures. ▪ A 511 traveler information number would be useful in reducing the number of calls to police during a traffic incident. At the present time, many people call police for traffic information during an incident. ▪ Blocked roads due to stopped trains at rail crossings continue to be a major issue in Laredo. Train tracks divide the City into two parts. Two major hospitals are located in the north eastern part of the City. Stopped trains cut off ambulance access to the hospitals when the ambulances are in the downtown portion of the City. ▪ The Police do not see a need for video recording. They are concerned that video can be subpoenaed after an incident and also see little value to their Department in recording video.

Mario Ruiz
Telecommunications Administrator

Arturo Gavilanes

Department Overview	▪ Telecommunications provides telecommunications support for all City departments. They also support the institutional network (I-Net) of fiber optic communication lines provided to the City under an agreement with Time Warner, the local cable provider. ▪ The Time Warner franchise agreement will be up for renegotiation in the next year. Telecommunications would like to have additional fiber from the local cable television provider but this will depend on the new franchise agreement that is negotiated. ▪ The City Manager has required that all future utilities be placed underground. Currently, aerial fiber is used for I-Net. This has been harmed by bullets in the past. The underground utility requirement will cause the cost of adding fiber to substantially increase.
Existing ITS Uses and Plans	▪ City Departments connected on the I-Net system include: Traffic, El Metro, Police, Fire, Bridge, Utility, and Library. ▪ I-Net provides a fiber connection from the I-Net building to Traffic. Two Traffic Department CCTV cameras (located at Bridge 1 and City Hall) also have a fiber connection. ▪ I-Net plans to connect with the TxDOT STRATIS TMC using 2 to 4 strands of fiber. ▪ In order to plan for the Traffic Department's future communication needs, a site for the future TMC will need to be determined. ▪ Telecom has communications hubs at the following locations: I-Net Building, City Hall, and the Traffic Department. ▪ Mario Ruiz will provide a list of all fiber access points for I-Net.
ITS Needs	▪ Additional fiber and connections to I-Net are required; however, the expansion of I-Net will depend largely on the new cable television franchise agreement that will be negotiated in the next year. ▪ Any fiber system that the Traffic Department implements that could be designed with additional capacity for I-Net would be extremely useful.

Thomas Lucek
General Manager

Eduardo Bernal
Planning and Marketing Manager

Robert Garza
Assistant General Manager
Operations and Maintenance

Juan Gala
Operations Superintendent

Department Overview	▪ El Metro operates fixed route buses and paratransit vehicles to serve the transportation needs of Laredo's citizens. There is a transit center located downtown at 1301 Farragut Street.
Existing ITS Uses and Plans	▪ A new card reader system has been installed on all El Metro buses. The readers currently work on magnetic strip cards, but have the ability to read Smart cards with embedded chips. ▪ 6 buses currently have cameras with on-board video recording. New buses that are ordered will also include cameras. 49 buses and 25 paratransit vehicles will eventually be equipped with cameras and on-board video recording. ▪ Automated vehicle location (AVL) is installed on some but not all buses. All buses will eventually be equipped with AVL. Transit dispatchers will be able to track and reroute buses using the AVL and data connections to the buses. ▪ Trapeze software handles all reporting of ridership and other relevant transit data. Trapeze will be integrated with the AVL on the buses.
ITS Needs	▪ Smart card technology that can be read by transit buses, card readers at the international bridges, and parking meters. ▪ Improved traveler information at bus stops. Key locations for bus arrival information include the downtown transit center and the Mall Del Norte. The information could be displayed in these locations via a small dynamic message sign. ▪ Signal priority for transit at Juarez and Farragut. This intersection is located next to the transit center and buses are often delayed here as they pull out of the center. ▪ Improved traffic signal coordination in the downtown area. ▪ Radio system that allows all agencies to be on the same frequency. The Police Department is currently putting together a plan for the radio system. ▪ Train delays severely impact bus route schedules. All but one route for El Metro comes through downtown and can be impacted by a stopped train. Better information on where the trains are and how long they will be stopped is needed.

<table>
<tr><td colspan="2" align="center">Riazul Mia
Director

John Porter
Environmental Manager

Adrian Gause
G.I.S. Analyst</td></tr>
<tr><td>Department Overview</td><td>Environmental Services operates 5 monitoring stations in the City of Laredo.</td></tr>
<tr><td>Existing ITS Uses and Plans</td><td>Five monitoring stations collect data on flow information and temperature, as well as store storm water runoff samples. The water samples are manually collected. Data from the stations can be collected real time through a dial up system. Environmental Services can only dial one station at a time. Monitoring stations cost approximately $50,000-$60,000. Rain gauges cost approximately $5,000-$10,000. Cost for the telephone connection is $20-$30 per month per site.
When the City of Laredo Emergency Operations Center (EOC) is activated due to floods, the EOC will call Environmental Services to get flood data. Environmental Services needs to call up each monitoring station to get the data.
Media will call Environmental Services for rain fall and flooding information.
Data from monitoring stations is also shared with the media and EPA during storms.
Adrian Gause will provide coordinates of all of the monitoring station locations.</td></tr>
<tr><td>ITS Needs</td><td>Five additional rain gauges in the City. Full monitoring stations are not needed because EPA requires that runoff is collected only at five locations in the City.
Improved communication to the monitoring stations. The current system requires each station by dialed up individually and monitoring of multiple stations at the same time is not possible. A communication system that would provide real time information from all monitoring stations would be ideal.
Improved power system for existing and future monitoring stations and rain gauges. Monitoring stations will sometimes lose power in flood conditions.
Tracking of Environmental Service Department vehicles using GPS would be useful.
Cameras at locations where dumping is an issue would be helpful to the Environmental Services Department for monitoring activity at these locations.
Wireless communication around the City would be useful to allow inspectors the ability to remotely connect to databases and upload information.</td></tr>
</table>

Rafael Garcia, Jr. Bridge Director	**Jose Escamilla** Superintendent of Operations
Berta Rivera Superintendent of Operations	**Ruben Villarreal, Jr.** Supervisor

Department Overview	▪ The City of Laredo Bridge Department operates and manages 4 international bridges within the City of Laredo (Bridges I, II, III, and IV). ▪ Bridge I – Gateway to the Americas Bridge is for non-commercial vehicles and pedestrian and accepts cash and swipe cards. ▪ Bridge II – Juarez-Lincoln international Bridge is for non-commercial vehicles only and accepts cash, swipe cards, and automated vehicles identification (AVI) transponders. ▪ Bridge III – Columbia Solidarity Bridge is for non-commercial and commercial vehicles and accepts cash, swipe cards, and AVI transponders. ▪ Bridge IV – World Trade Bridge is for commercial vehicles only and accepts swipe cards and AVI transponders. ▪ AVI transponders and swipe cards can be purchased at Bridges II, III, and IV. Bridge I sells only swipe cards. ▪ The Bridge Department maintains counts of pedestrians and vehicles at all bridges. ▪ The approach and configuration for Bridge I is being reconstructed. When completed Bridge I will have booths with staff available, as well as vending machines for swipe cards and transponder purchase and payment.
Existing ITS Uses and Plans	▪ AVI systems on Bridges II, III, and IV. The system is compatible with toll systems used in Dallas. ▪ Digital Video Audit Playback System (DVAPS) – SAIC Transcore system that provides digital recording of images at all toll booths. Images are archived for 30 days (may be archived longer for incidents). The DVAPS system is not a CCTV camera, instead the images are a series of digital photos that are connected together to simulate video. ▪ Camera images are available on the Bridge Department's website and are used by commercial vehicle operators. Drivers will also radio closure and queue information back to dispatchers. ▪ Bridges III and IV have weigh-in-motion.
ITS Needs	▪ Dynamic message signs (DMS) prior to Bridges III and IV to communicate information on closures or long queues. ▪ Ability to update Bridge website with real time queue and closure information. ▪ CCTV cameras on FM 1472, Loop 20, and I-35 for Bridge IV. ▪ CCTV cameras on Salinas Avenue and Convent Avenue for Bridge II. ▪ Flood detection and closure systems at Las Cruces Drive just east of FM 1472 for low water crossing. Currently, there is only a sign to indicate the depth and due to a number of warehouses on Las Cruces there are a large number of commercial vehicles that use this crossing. ▪ Bridge I is the lowest bridge and does get flooded on occasion. Bridge II also is susceptible to floods. There may be some need for flood detection near Bridge I. ▪ The Bridge Department wants to add Smart cards for pedestrians at Bridge I. Ideally, the cards will also be able to be used for transit and parking payment.

Roberto Murillo Traffic Director **Robert Peña** Engineering Associate II	**Manuel Benavides** Engineering Technician **Oscar Canales** Engineering Technician

Department Overview	▪ The City of Laredo Traffic Department is responsible for the Traffic Safety, Oversize Permits, Taxi, Parking, and Fleet Management Divisions.
Existing ITS Uses and Plans	▪ Signals – Laredo operates 245 signals, 135 of which are currently online and all timing plans to be implemented from a remote location. All signals are using TS1 controllers except three signals which are using TS2. Laredo plans to continue upgrading signals to TS2 in the future. ▪ Video Image Vehicle Detector Systems (VIVDS) – Laredo uses loops and VIVDS, however they prefer loops. VIVDS are negatively affected by fog, rain, and dirt and have not proven to be reliable for detecting vehicles. ▪ CCTV Cameras – Laredo operates cameras using both fiber optic and wireless communications. ▪ TMC – Laredo's TMC operates during business hours and provides pan, tilt, and zoom control for cameras, signal timing plan control, alarms for signals in red flash, and system detectors. Security for the TMC is not currently provided but this may be needed if the TMC were to be collocated with the City of Laredo Emergency Operations Center (EOC). The TMC will operate extended hours during emergencies. ▪ TxDOT CCTV Cameras, Dynamic Message Signs (DMS) and Traffic Signals – Laredo can view and control TxDOT CCTV cameras. They can also view messages on TxDOT DMS but do not have control nor is there a need for control of the DMS. Laredo can not change timing plans for TxDOT signals but they would like this capability.
ITS Needs	▪ Smart card payment system for parking meters. This same type of Smart card could be used for El Metro transit and crossing of the international bridges. ▪ Collocation of the City of Laredo TMC with the EOC. The Traffic Department, including the TMC, may be moving out of their existing building. The City of Laredo EOC is temporarily located in the Public Works Building and may also need to be moved. If both facilities were moved, collocation of the TMC and EOC should be considered for increased integration and data sharing between the TOC and EOC during an incident that causes activation of the EOC. Security at the TMC may be needed if it is located with the EOC. ▪ Capability to share CCTV camera feeds and other data with the media. ▪ Capability to determine the location, length, and speed of trains traveling through downtown Laredo. ▪ Capability to monitor taxi cabs and know when meters are turned on and off. Taxi cabs are under the Traffic Department's jurisdiction and this capability would help Traffic to monitor overcharging. ▪ 511 traveler information number to provide traffic information, including wait times at the international bridges. ▪ Capability to bring video back from VIVDS. This capability is not currently implemented. ▪ Installation of additional fiber communications. Laredo will get spare fiber from TxDOT on Loop 20 and I-35, but additional fiber is still needed on the west side of Laredo. ▪ Upgrade of traffic signal communications systems and synchronization of signals in the downtown area. ▪ Access to signal data from mobile units operated by the City. Some type of mesh network that provides communication back to the TMC, as well as mobile units, would be ideal. ▪ Ability to track maintenance vehicles using global positioning systems.

Sandra Aleman
Application Analyst/Acting Director

Javier Hinojosa
Systems Analyst

Department Overview	▪ The Management Information Systems (MIS) Department supports other City of Laredo Departments for computer and network applications. MIS currently handles the payment system for parking meters and would possibly be the Department to handle the payment system for a regional Smart card that might include parking, transit and bridge.
Existing ITS Uses and Plans	▪ Currently MIS does not have any ITS uses or plans; however, they do support the Traffic Department in the implementation of their systems as needed.
ITS Needs	▪ MIS does not have any current ITS needs. ▪ MIS could play a vital support role in the implementation of a Regional Smart card. The Smart card could provide a single payment system for multiple City of Laredo transportation services, such as El Metro transit, crossing of the international bridges, and use of parking meters. MIS would most likely handle the payment system for these types of systems.

David Piton
Deputy Fire Chief

Roberto Reyna
Assistant Fire Chief

José Gamboa
Senior Programmer Analyst

Department Overview	▪ The Fire Department provides fire, emergency medical services, and hazardous material response services for the City of Laredo. Response time is 4 minutes inside of the City of Laredo and 20 minutes outside of the City.
Existing ITS Uses and Plans	▪ The Fire Department manages the Emergency Operations Center (EOC) which is located at the Public Works Building. ▪ Mobile data terminals (MDTs) and global positioning systems (GPS) will be added to all fire trucks and ambulances. The Fire Department is currently planning to add this equipment to all fire trucks and ambulances but it will take time to implement. ▪ Each Fire Station is connected to the I-Net communications backbone.
ITS Needs	▪ Signal preemption for fire vehicles. The Fire Department will provide a list of priority corridors. ▪ The EOC is currently located at the Public Works Building but Fire is planning to relocate this facility. Fire was interested in co-locating the EOC with the City of Laredo TMC so that traffic information and control capabilities would be readily available to EOC managers during emergencies. ▪ The Fire Department and EOC would like to have camera feeds from TxDOT and City of Laredo CCTV cameras. These camera feeds could be used to monitor railroad crossings, flooding situations, and incidents. Fire would also like to have 24 hour recording of these cameras. ▪ Trains that stop on the tracks while in the City continue to present a serious problem. The trains can be stopped for long periods of time and create severe traffic problems. The stopped trains can increase the response time of fire trucks and ambulances. The tracks must be crossed in order to reach the two major hospitals from downtown Laredo. Ambulances traveling to the hospitals from downtown are sometimes delayed by the trains. More information about the location of the trains and the roads impacted by the closures is needed. ▪ Flood detector information would be useful for Fire so they can be notified of hazardous situations at low water crossings. ▪ The Fire Department would like to have a system in place to notify them if any part of the communications system goes down. ▪ A communication system to allow video to be streamed from an incident into fire trucks en-route or at the incident would be helpful. This would most likely need to be some type of City wide communication system. ▪ One concern of the Fire Department is that funding be available for maintaining any of the systems that are deployed.

Roberto Rodriguez ITS Systems Supervisor	
Department Overview	▪ The TxDOT Laredo District operates the South Texas Regional Advanced Transportation Information System (STRATIS). STRATIS was officially opened on February 4, 2004 and serves as the traffic management center (TMC) for TxDOT in the Laredo Region.
Existing ITS Uses and Plans	▪ TxDOT has the following roadway ITS elements in place: 7 dynamic message signs (DMS), 6 CCTV cameras, 13 lane control signals, highway advisory radios including 6 signs, speed detectors, and video image vehicle detection systems (VIVDS). ▪ Fiber optic lines are located on I-35, Loop 20, and Mines Road. ▪ A railroad coordination system called the Wireless Advisory Railroad Network (WARN) is in place to inform drivers of closures at railroad crossings. The system has been installed on Mines Road and on the northbound I-35 frontage road north of Laredo at Uniroyal Drive. ▪ A fiber connection with 24 strands has been established between STRATIS and the City of Laredo TMC. The City can access up to 4 video feeds at a time and can control pan, tilt, and zoom of the TxDOT CCTV cameras. The City can also view messages that are placed on the DMS. ▪ Monitors for viewing CCTV cameras have been added to the City of Laredo 911 Dispatch Center. These were not operational at the time of the interview but are planned to come on-line shortly. ▪ Two Border Safety Inspection Facilities (BSIFs) will be constructed in Laredo to allow for inspection of commercial vehicles. The BSIFs will include CCTV cameras and loop detectors.
ITS Needs	▪ TxDOT needs better traveler information on Business 35 and US 83. ▪ A connection including camera feed needs to be established with the Department of Public Safety (DPS) in Laredo. DPS is in a complex located next to the TxDOT Laredo District Office.

APPENDIX C – TRAFFIC SIGNAL OPTIONS

C1. OVERVIEW

The City of Laredo Traffic Department operates traffic signals and school zone flashers within the limits of the City of Laredo. A number of TxDOT signals on state routes are also operated and maintained by the City through a municipal maintenance agreement with TxDOT. The Traffic Department has deployed CCTV cameras on arterial streets and operates a TMC.

The City primarily uses Naztec Series 900 NEMA TS1 controllers for their signals. Crouse-Hinds, Kentron, and Naztec 848 controllers are also used at select locations. Current communications to field devices include fiber optic cable, hardwire interconnect, spread spectrum radio and direct dial up phone lines.

The City is looking to upgrade its current traffic signal system, replacing worn out and outdated devices with state of the art components. There are several options available to the City, which are discussed in the following sections.

C2. CONTROLLER AND CABINET OPTIONS

C2.1 Electromechanical

Until the 1980's, most agencies used electromechanical traffic signal controllers. These controllers could be coordinated, but the phase sequence could not be changed and they provided no means of changing phase length based on vehicle actuations. These types of controllers are very old and it is not recommended that any new electromechanical devices be placed in the field.

C2.2 NEMA TS 1

In the late 1980's, solid-state actuated traffic signal controllers became available. These controllers followed the NEMA (National Electrical Manufacturer's Association) TS 1 standard. This standard defined the pin settings for every input and output of the controller and some programming features. NEMA TS 1 controllers have programmable ring structures and phase sequences and can extend phases based on vehicle actuations. **Figure C1** shows common TS controllers.

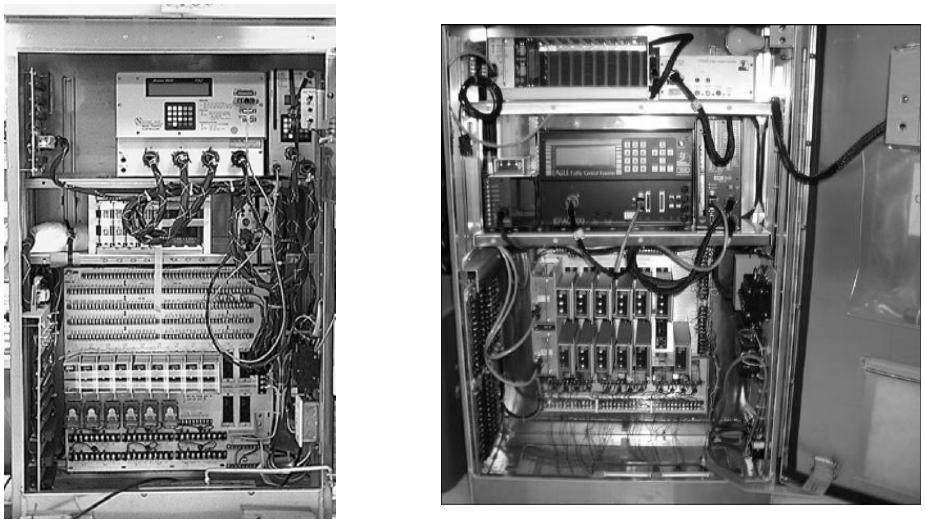

Figure C1 - TS1 Controllers

One of the biggest limitations of a TS1 controller was that every function required a direct wire connection between the controller and the cabinet. Every connection was a potential failure point. Also, the progress of technology would be limited because it would be difficult to add a new input or output function because a new wire would be needed and therefore a new pin (and there might not be a connector available).

The same limitations that discrete inputs and outputs would have on the computer industry apply to the traffic signal industry. In the NEMA TS 1 standard, all traffic signal controllers had one pin designated for each input and output function and these pins were defined by NEMA. Not only were each of these connections a potential failure point, but expanding the functionality of the controller was very difficult. Some agencies, like TxDOT, defined their own extra connector on the controller (D-connector) to accomplish this functionality, but this connector was not standard and was still subject to the same problems as previously defined connectors.

Although NEMA TS 1 defined the communications within the cabinet, it did not define communications from controller to controller; therefore, each manufacturer used their own proprietary protocol for communications within closed loop systems. This meant that one brand of controller could not be placed in another manufacturer's system and be expected to communicate. It is difficult in a low-bid process to get specific manufacturer's controllers needed to keep a system communicating.

NEMA TS 1 controllers represent technology that is over 10 years old and it is becoming increasingly difficult to obtain support from manufacturers. It is not recommended that any new TS1 controllers be placed in the field, unless it is necessary to maintain compatibility within a fairly new and existing closed loop system.

C2.3 NEMA TS 2

While NEMA TS 1 controllers provided for much better traffic signal control than what was available in the past, they still had limitations, and NEMA began working on development of a new TS2 Standard.

In 1992, representatives from several NEMA manufacturers came together and designed a new traffic signal controller and cabinet standard. This standard, known as NEMA TS 2-1992, uses a cabinet with a common serial bus instead of point-to-point wiring and incorporates many features that had previously been supplied in addition to TS 1. NEMA TS 2 is a mature standard and is currently used by many agencies and municipalities throughout the country including

C2.4 Discussion on "Serial" Cabinets

It is obvious how point-to-point wiring is not the most practical or efficient way to accomplish communications in the computer industry, neither is it in the traffic signal cabinet. The NEMA traffic signal manufacturers borrowed the idea of serial communications from other industries and incorporated it into their cabinets. Having a limited number of discrete inputs and outputs limits the abilities and functionality of today's traffic signal controllers. A cabinet that uses serial communications can take advantage of greater processing capabilities of today's traffic signal controllers and expand their functionality.

Changing from TS 1 cabinets to TS 2 cabinets is not as drastic a change as one might envision, though. The whole cabinet hasn't changed. The detector panel is still there, the detector card rack is still there, the conflict monitor is still there, and the field wiring is all still there. The point-to-point wiring from the A, B, C connectors on the controller to the backpanel of the cabinet is really the only thing different (they're not there). Instead of 3 or 4 connectors with a pin for each input and output, all communications are handled through a 15-pin SDLC connector on the controller. The controller, conflict monitor, detectors, and load switches all have the same SDLC connector and communicate through a common serial bus. **Figures C2** and **C3** highlight the differences between the TS1 and TS2 cabinets.

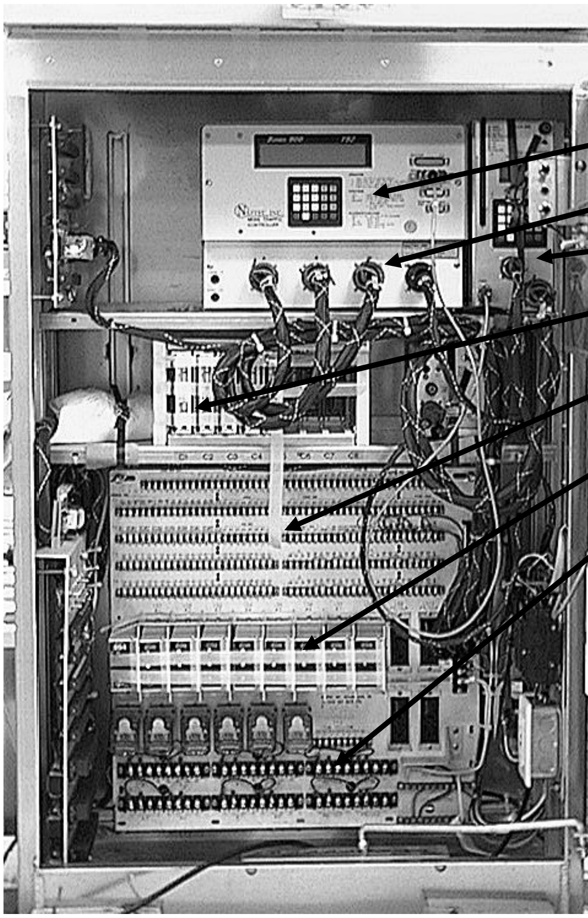

Figure C2 – TS 1 Cabinet

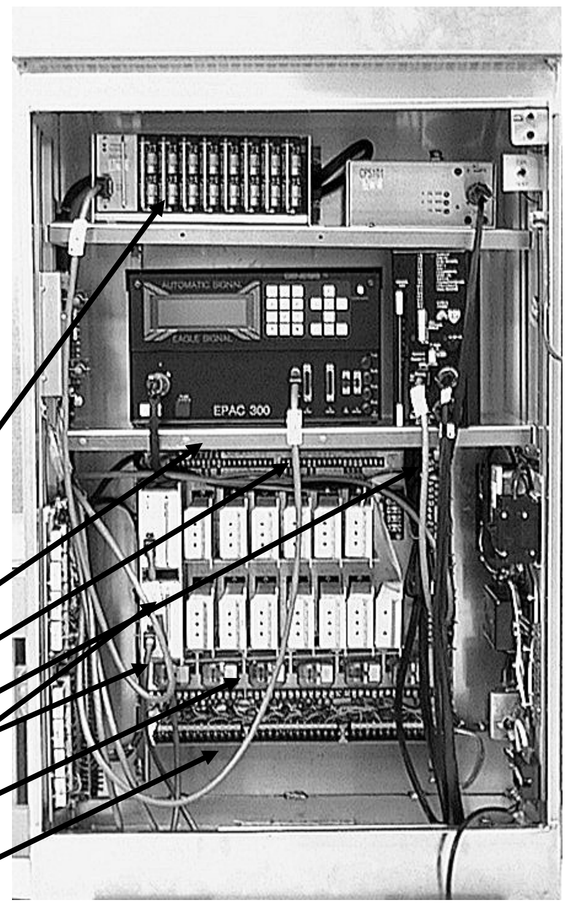

Figure C3 – TS 2 Cabinet

All the components are hooked into this common serial bus through a Bus Interface Unit (BIU). Each component that talks on the bus has a BIU. The BIUs are exactly the same and are interchangeable from component to component, manufacturer to manufacturer.

Going to serial communications in the cabinet not only provides more input and output capabilities of the controller, it also brings another advantage to the cabinet. Having a common serial bus that all the components communicate through allows the controller to talk to and listen to each of the other components in the cabinet. A failure anywhere in the cabinet can be seen and reported by the controller. If the controller loses communications with the conflict monitor or load switches, it can put the intersection on flash. If the controller loses any of the communications links, it will report where the problem is in the cabinet and can display it on the front panel of the controller. The controller stores all the reports of the conflict monitor and communications failures and these can be brought back through a closed loop system or an isolated intersection with communications to the district or field office.

TS 2 provides new flexibility and functionality in the traffic signal controller that was not there before. All inputs and outputs are "mappable". Any detector input can be used to call any phase. The TxDOT specification requires that 32 detector inputs be available but some manufacturers provide up to 64.

TS 2 also provides new flexibility with phase outputs. The current TxDOT traffic signal controller specification requires that 16 phases and 8 overlaps be available. It also requires a flexible ring structure with at least 4 rings available. The ability to map phase and overlap outputs to a specific load switch is important because a cabinet would rarely have 24 load switches to accommodate all 24 outputs required. In most cases when more than 8 phases are used, two or more of these phases actually control the same vehicle movement using an overlap output. This overlap can be assigned in the controller (without any backpanel wiring), to be output through any load switch. These means that a movement that is traditionally phase 2 but is actually being controlled by phase 2 and 10 through overlap E, can be output through load switch 2. This is important because, in this case, phase 2 does not need a load switch output so instead of leaving load switch 2 unused, it can be used by the overlap to output to the signal heads and still be recognizable to the signal tech which movement it should be.

The NEMA TS2 controller represents an affordable option to the City of Laredo at this time. It is possible, using a TS2 master controller, to begin replacing aging TS1 units with TS2 units in existing closed loop systems. For cabinets that are less than 10 years old, a TS2 Type 2 controller can be inserted directly into the TS1 cabinet. Where the cabinet and controller are both over 10 years old, it is recommended that a TS2 Type 1 controller and TS2 cabinet be used.

C2.5 Type 170

The NEMA TS 1 and TS 2 specifications are functional specifications. They describe what the controller should do and how it should communicate to the cabinet. They do not dictate the hardware required to perform this functionality. Because of this, NEMA manufacturers have been successful at building cheaper, smaller, and more powerful controllers as the electronics industry develops cheaper, smaller, and more powerful components.

In the 1970's, the California Department of Transportation (Caltrans) developed the 170 specification for their traffic signal controllers. This specification was entirely hardware based and defined the controller to the screw size. Although this was convenient that all intersections contained the same piece of hardware, intersections installed in 1998 are installed with 1970's technology. With such hardware limitations, it is obvious that the software that could be developed for the 170 platform was limited at best. **Figure C4** shows a 170 controller.

Figure C4 – 170 Controller

The Type 170 controller is an expensive option and is generally only being purchased in legacy systems where there is an abundance of other 170 units. The Type 170 controller is not recommended for the City of Laredo.

C2.6 Type 2070

Realizing the limitations of the Type 170 Controller, in 1994 Caltrans designed a controller to replace the 170. To take advantage of today's technology, this controller was to be multi-functional and multi-tasking. The new controller standard was designated as the 2070. The 2070 is shown in **Figure C5**.

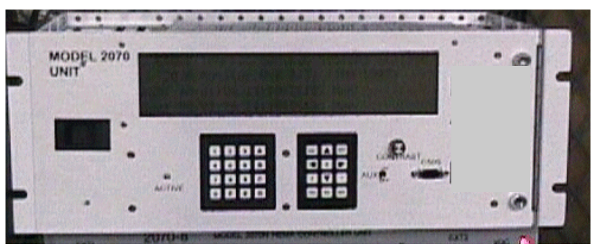

Figure C5 – 2070 Controller

The 2070 is designed around a VME backplane that allows additional VME cards to be installed to add additional functionality. The traffic controller software would either have to be developed in-house or purchased from another vendor. The idea of an expandable, open-architecture controller has promise.

The same limitations that plagued the 170, though, are destined to plague the 2070 because Caltrans took the same approach and designed the 2070 down to the screw size. The most obvious limitation is that just within the time span of the development of the specification, processor speed has increased dramatically. The 2070 specification was started in 1994 and upon delivery of the first few controllers now in 1998, the processor in it is in the decline of its product life cycle. With 333 MHz Pentium processors now becoming the standard, the 2070 specification requires the equivalent of a 25 MHz 386 processor. It is difficult to justify paying top-dollar for a 25 MHz 386 today.

It should be noted that VME technology is very expensive. Although this is a widely used standard in several industries, the hardware remains costly. The 2070 controllers currently cost between $4,000 and $5,000. Contrary to the belief that this was a new controller and therefore a new technology, and the price would go down as more are bought, VME technology is not new and the price has not gone down with quantity. A 2070-lite version of the controller has been proposed that will eliminate the VME backplane, but this takes the expandability out of the controller.

The $4,000 to $5,000 price does not include traffic signal software. That is an additional cost, up to $1,000 per intersection. Caltrans has hired software programmers and electrical engineers to write their own controller software. To a municipality or state agency that does not have an in-house staff to write and maintain controller software, it is an extra burden.

Because NEMA controllers include traffic signal software, NEMA manufacturers have always had to compete with each other to add features and have the most functionality. Because of this competition and the advances in electronic component technology, NEMA manufacturers have always been able to supply state-of-the-art traffic signal control software to their users. In the 170 arena, competition for software is not as great. In the past, there have been two main software developers for 170's. Once a 170 user buys a software package from a vendor, they are generally tied to this package and to this vendor for a long time. Although the user can buy additional features from the software vendor, the software vendors are not as likely to develop as many features as quickly due to lack of competition and lack of hardware capable of supporting advanced features.

With the creation of the 2070, NEMA-like software has now been developed for the "Type 170" platform. Traditional 170 users are now able to get software functionality in the 2070 that is common among NEMA. Currently, most manufacturers of 2070 controllers (i.e. Naztec and Siemens ITS – Eagle) include software packages for their controllers.

There are some alternative 2070 software packages available. One is the Caltrans consortium software package that is only available to those entities participating in the consortium. It is similar in style to NEMA software, using a menu-structure front panel display and similar phasing structure. This software, though, is only as advanced as early 1980's NEMA software, allowing only 8 phases and no flexible ring structure. The other 2070 software package that is available was developed by Gardner Siemens ITS and can be purchased by any entity for up to $1,000 per intersection. This software is comparable to today's NEMA standards and would even come close to meeting the current TxDOT traffic signal functional specification. However, the Gardner software does not include the diamond interchange sequences and coordination functions that are defined by the TxDOT TS 2 specification, though.

Procuring additional software packages to run Type 2070 controllers is an important cost consideration when selecting traffic control systems. Because of the cost of these units and the additional software, they are not recommended for the City of Laredo.

C2.7 ITS Cabinet

The 2070 was originally designed with 170 connectors for input and outputs. There are 155 pins on two connectors, but still with discrete inputs and outputs. Later, a module was added to the 2070 that had NEMA A, B, C, D connectors so that the 2070 could be used in a TS 1 cabinet. This new controller was at this point still limited to the same number of inputs and outputs as any previous controller.

Realizing these limitations, a 2070 or "ITS" Cabinet committee was formed. This committee decided to adopt the same SDLC communications within the cabinet as NEMA TS 2. Instead of BIUs connecting the devices to the common serial bus, the committee designed SIUs (Serial Interface Units) to connect the devices to the bus. The major difference between an SIU and a BIU is that the SIU has a faster baud rate. This faster baud rate, though, is not necessary for traffic signal applications. This cabinet was designed so that a TS 2 controller could be used with BIUs in place of a 2070 and SIUs. The estimated cost of the ITS cabinet without controller is about $10,000. A TS 2 cabinet without the controller is about $4500. Given this, the TS2 cabinet is the recommended option for the City of Laredo.

C2.8 Advanced Traffic Controller (ATC)

In order to try and reduce the costs of traffic signal controllers, it was determined that a uniform national specification was required for the Advanced Traffic Controller (ATC).

These specifications define specific, interchangeable modules that are combined to form an ITS cabinet that is capable of running control software that might be provided from a variety of providers. These specifications, in many cases, define several module options that can be arranged in a variety of composition configurations to meet the needs of the user.

By standardizing the types of controllers and cabinets that agencies purchased, it has been argued that the quantity of scale will result in much lower costs for users.

In July 1999, a formal agreement was reached among NEMA, ITE, and AASHTO to jointly develop, approve and maintain the ATC standards. Under the guidance of a Joint AASHTO/ITE/NEMA Committee on the ATC, a Working Group was created in order to develop a standard for the Advanced Transportation Controller. The first official meeting of this working group was in September 1999. Three separate standards are to be developed by this working group, including:

- ATC Controller
- ATC Cabinet
- Application Programming Interface (API)

Currently, the ATC Cabinet specifications have been completed and adopted. The ATC Controller specification is in draft form and is currently being reviewed for adoption. The API standard is still under development. This is a critical component of the standards, because it provides the interface by which all vendor specific programs will communicate with the controllers.

Until the national ATC specifications are completed and the cost savings are proven over time, it is not recommended for the City of Laredo; however, this may be a consideration in later years, as it is being designed for compatibility with legacy systems.

C3. CENTRALIZED SIGNAL CONTROL SYSTEMS

A centralized signal control system communicates directly with each local signal controller individually using a digital computer. The computer is used to control, operate, and/or supervise the traffic signal control system from a centralized location. These systems can be arranged in a variety of ways depending on the specific needs. Generally, this type of system consists of the following basic components:

- Central Computer Facility, which can consist of one large or small computer, one master computer and several satellite computers, or several independent computers.
- Communications, which can be via cable, fiber optics, telephone, radio, microwave, or a combination of these.
- Field Equipment, including local signal controllers, system detectors, variable message signs, preemption equipment, lane control signals, and CCTV cameras.

Like the closed loop system, there are generally limitations on the number of local intersections that can be tied into each input channel of the central computer. Furthermore, the centralized signal control system requires a separate communications line to each individual intersection. With the uncertainty of the location of the City of Laredo TMC, it is not recommended that a centralized computer system be considered at this time.