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16. Abstract

A 1992 report to Congress, pursuant to Intermodal Surface Transportation Efficiency Act (ISTEA) sections 1089 and 6015, acknowledges that Texas serves a disproportionate share of the U.S-Mexico international trade, and, accordingly, recommends the development of federal-aid program options to improve transportation infrastructure related to international trade. In order to take advantage of this recommendation, border states must monitor their transborder traffic demand and develop traffic circulation plans for their border cities. This report presents a 25-year traffic circulation plan for the City of Eagle Pass, Texas. The plan includes recommendations for increasing roadway capacity, adding left turn lanes, new routes to relieve congestion, international thoroughfares, and other relevant issues. It also includes a comprehensive analysis of transborder traffic in Eagle Pass and international thoroughfares between Piedras Negras and Eagle Pass. The recommendations take into account input from TxDOT personnel, city officials, border inspectors, international bridge managers, and several Mexican officials. The recommendations and schedules discussed in this document can assist TxDOT in planning land transport infrastructure and in alleviating those problems related to additional highway capacity, pavement rehabilitation, signalization, and right-of-way needs.

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TRAFFIC CIRCULATION STUDY AND LONG-RANGE PLAN FOR EAGLE PASS

Angela Jannini Weissmann
Rashed Islam

Research Report Number 2940-1

Research Project 7-2940
Traffic Circulation Study and Long-Range Plan for Del Rio and Eagle Pass

conducted for the

Texas Department of Transportation

by the

CENTER FOR TRANSPORTATION RESEARCH
Bureau of Engineering Research
THE UNIVERSITY OF TEXAS AT AUSTIN

January 1996

IMPLEMENTATION STATEMENT

This report discusses a traffic circulation and long-range plan for the City of Eagle Pass, Texas. The plan includes recommendations for increasing roadway capacity, adding left-turn lanes, building new routes to relieve congestion, and adding international thoroughfares, all presented in chronological order of recommended implementation. The recommendations and schedules discussed in this document will assist TxDOT in planning land transport infrastructure and alleviating such problems as additional highway capacity, pavement rehabilitation, signalization, and right-of-way needs.

Implementation of a traffic circulation plan requires interagency cooperation, especially in the case of a border city. By organizing several brainstorming meetings between TxDOT personnel and key city officials in Eagle Pass during the development of this project, Ms. JoAnn Garcia, TxDOT Project Director, effectively initiated implementation of this project. These meetings sought the coordination of all agencies involved in the development of Eagle Pass' infrastructure, and helped us ensure that this traffic circulation plan would consider equally local, state and international traffic requirements.

ACKNOWLEDGMENTS

This project relied on Texas as well as Mexican data, which included numerous sources in Texas and in Coahuila, Mexico. In addition, the study required close guidance from TxDOT staff, as well as their active help in organizing meetings and brainstorming sessions with all parties involved. We are specially indebted to Ms. JoAnn Garcia, P.E., Advanced Planning Engineer of Laredo District, and Director of this project; Mr. Kelly Kirkland, P.E., Planner of Laredo District; Mr. Robert Parker, P.E., Area Engineer for Del Rio; Mr. Manuel Rodriguez, TxDOT Maintenance Office in Eagle Pass; and Mr. Thomas D. Ellis, P.E., now District Engineer in Paris. They were always ready to cooperate, assist with data collection, and provide invaluable guidance throughout the project.

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Prepared in cooperation with the Texas Department of Transportation.

DISCLAIMERS

The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Texas Department of Transportation. This report does not constitute a standard, specification, or regulation.

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SUMMARY

A 1992 report to Congress, pursuant to Intermodal Surface Transportation Efficiency Act (ISTEA) sections 1089 and 6015, acknowledges that Texas serves a disproportionate share of the U.S-Mexico international trade, and, accordingly, recommends the development of federal-aid program options to improve transportation infrastructure related to international trade. In order to take advantage of this recommendation, border states must monitor their transborder traffic demand and develop traffic circulation plans for their border cities. This report presents a 25-year traffic circulation plan for the City of Eagle Pass, Texas. The plan includes, among other things, recommendations for increasing roadway capacity, adding left turn lanes, building new routes to relieve congestion, and adding international thoroughfares. It also includes a comprehensive analysis of transborder traffic in Eagle Pass and international thoroughfares between Piedras Negras and Eagle Pass. The recommendations take into account input received from TxDOT personnel, city officials, border inspectors, international bridge managers, and several Mexican officials. The recommendations and schedules discussed in this document can assist TxDOT in planning land transport infrastructure and alleviating such problems as additional highway capacity, pavement rehabilitation, signalization, and right-of-way needs.

EXECUTIVE SUMMARY

This report presents a 25-year traffic circulation plan for the City of Eagle Pass, Texas. The plan includes recommendations for on-system roadways that need added capacity or continuous left-turn lanes; additional issues included additional truck routes, inadequate intersection configurations, intersections that may warrant signalization, international traffic routes, and right-of-way needs for future expansions.

The traffic plan was developed based on one reference scenario and two analysis scenarios. The *reference scenario* considers only the existing infrastructure throughout the analysis period; it is a theoretical scenario used only to identify potential problems and to analyze the impacts of the proposed infrastructure improvements. The two analysis scenarios were termed *low* and *high impact*, and they include the proposed infrastructure and other measures that seek to improve traffic circulation. These two scenarios refer to one major source of uncertainty in future traffic demand, namely, a proposed casino to be located on the nearby Kickapoo Indian Reservation. In the low-impact scenario, the casino traffic component is assumed to remain small, and in the high-impact scenario, it is assumed to become significant.

The traffic plan recommends an outer loop around Eagle Pass, which should be implemented in stages scheduled differently for each traffic demand scenario (high or low impact). The outer loop is outside the current city limits and links the US277–FM1589 intersection to US57, going south through Las Quintas, and meeting the proposed truck route where it concurs with Industrial Park Boulevard (if the third international bridge is implemented in the location recommended here). A specific study is necessary to determine the best loop location and to develop its design, taking into consideration the future position of the third international bridge. The study should start around 2015 (or earlier if traffic grows faster than the rates used to develop this plan).

TRAFFIC CIRCULATION PLAN

This section presents a summary of the traffic plan recommendations in chronological order of implementation, for the low- and high-impact scenarios. The report explains the methodology used to arrive at these recommendations, contains several maps and other figures, shows levels of service, and discusses implementation issues.

Immediate Implementation Recommended—All Scenarios

(1) Make US 277 Business a four-lane highway from Main St. to Loop 431. (Caveat: there is not sufficient right-of-way for standard lane widths.)

Alternative: Make US277 Business a one-way street southbound; make Avenue B and Converse a one-way route northbound. Coordinate with the City; there is sufficient right-of-way along Avenue B available for purchase.

(2) Make US277 a four-lane highway from the Loop 431 intersection up to junction with FM1589. Secure right-of-way for future extension up to junction with FM1588.

(3) Make Main Street four lanes by providing appropriate lane markings from US277B to US57. (Caveat: There is insufficient right-of-way for standard lane widths.)

Alternative: Make Main Street and Garrison (from Commercial to FM375) one-way, the former westbound, the latter eastbound.

(4) Industrial Park Boulevard: Smooth the design and rehabilitate the pavement.

(5) Secure right-of-way for future expansions along all highways, and along Brown Street and Edison Road south and east legs.

(6) Provide "NO PARKING SIGNS" where parking is prohibited.

(7) The downtown area between Monroe and Commercial should conform to the following: Main Street is one-way westbound, Rio Grande and Garrison are one-way eastbound, Commercial, and Adams are one-way southbound, Washington and Jefferson are way-one northbound, and the others are two-way.

(8) Remove the protruding curbs along Main Street in the downtown area, and consider prohibiting or restricting parking in the area.

(9) Provide left-turn lanes or bays at the intersection of FM 375 and US 57 and also along the Mall de Las Aguilas.

(10) The "Y" intersection of US 57 and Main Street: Provide pavement markings and post a sign clearly showing that when the two eastbound lanes of Main Street meet Garrison, they become three lanes, the right-most lane for right turns, the left-most for left turns, and the middle lane for both. (Note: Recommendation must be revised in case the alternative to recommendation 2 of section on "added capacity" is implemented.)

(11) Intersection of US 277 B and Main Street: Prohibit parking at least half a block from intersection (along Main).

(12) Smooth right angle at the intersection of Ceylon Street and Second Street along US 277 Business.

(13) Signalize intersection of Monroe Street and FM1021.

(14) Signalize intersection of Kifuri and Highway Blvd. (FM1021).

(15) Signalize intersection of Garrison and Travis Streets.

(16) Synchronize signals of cross streets perpendicular to US57 (Garrison Street) with actuated signals at US57.

(17) Synchronize signals along Main Street and Rio Grande Street (downtown area).

Immediate Implementation Recommended—High-Impact Scenario

(1) Secure right-of-way to extend Las Quintas to US57 (North) and to expand the FM1021 segment east of FM3443.

Implementation Recommended by 2000—All Scenarios

(1) FM375: Add one lane each way, and secure right-of-way for additional lanes in 2010.

(2) FM375 and FM3443 should be connected to provide alternative for intersection of FM375 and US57.

(3) Implement a continuous left-turn lane along the US277/US57 segment east of FM375.

(4) Implement a left-turn lane along Loop 431 and secure right-of-way for future expansions.

(5) Coordinate loop extension with city. It has plans to extend Loop 431 as shown in Figure 4.3. Many landowners have already agreed to provide a 60m right-of-way for this loop.

(6) Implement new international bridge and truck route. Ensure a proper design, with turning radius and slopes appropriate for large trucks. Verify status of NAFTA truck size and weight harmonization and provide appropriate radius for Mexican and Canadian 18-wheelers, or secure additional right-of-way for future upgrade.

(7) Implement and enforce truck routes shown in Figure 4.7 of Chapter 4, which include prohibition of through trucks at downtown area once the proposed truck route is built.

(8) Loop 431 intersections with Second Street, Kilowatt, and Bibb should have left-turn bays.

(9) Ensure a properly designed intersection of FM375 and the new truck route, with turning radius and slopes appropriate for large trucks. Verify status of NAFTA truck size and weight harmonization and provide appropriate radius for Mexican and Canadian 18-wheelers, or at least secure additional right-of-way for future upgrade in case these larger trucks are authorized.

(10) Intersection of US57 and proposed Second Street extension should have left-turn bays.

(11) Both ends of proposed FM375–FM3443 link should have left-turn bays.

(12) Synchronize signals of intersections along FM375, including the new truck route and the recommended link between FM375 and FM3443.

(13) Signalize both ends of proposed FM375–FM3443 link.

(14) Signalize the intersections of the Second, Kilowatt, and Bibb extensions with Loop 431 if enough demand has developed; if so, synchronize signals along Loop 431

(15) Synchronize signals along Bibb Avenue after its extension is completed.

Implementation Recommended by 2000—High-Impact Scenario

(1) Upgrade FM3443 to for lanes (two lanes each way).

(2) Upgrade the FM1021 segment east of FM3443 to six lanes to accommodate a high casino demand.

(3) Duplicate and pave Rosita Valley Road (off FM1021), which provides access to the casino. This should be coordinated with the County.

(4) Extend Las Quintas northward up to US57.

(5) Initiate study to develop preliminary plans for outer Loop, which will link US57 to the junction of US277 and FM1589 (located north of current Eagle Pass city limits), and continue around the current southern city limits up to Industrial Park Boulevard (and/or new international truck route). Secure right-of-way for this loop.

(6) Keep the old international bridge open at least until midnight once the new bridge is in operation.

(7) Signalize intersection of FM1021 and Rosita Valley Road. Signal cycles should vary during the day according to casino demand.

Implementation Recommended by 2010—All Scenarios

(1) Extend Loop 431 along FM3443, then to the west until it intersects the new truck route at Industrial Park Blvd.

(2) Add two lanes (one each way) along Loop 431, matching its extensions along FM3443 and the proposed south extension.

(3) Initiate plans and design of third international bridge (see year 2020). Coordination with Piedras Negras is essential for implementing this new international route.

(4) Extend Las Quintas northward up to US57 (year 2000 for high impact).

(5) Extend Kilowatt in the north/south direction, starting at existing Loop 431 intersection up to Gates Street (north of city limits). This will provide an alternative to congested US277.

(6) Make US277 segment from intersection with FM1589 to the intersection with FM1588 a four-lane highway.

(7) Initiate study to develop preliminary plans for outer Loop, which will link US57 to the junction of US277 and FM1589 (located north of current Eagle Pass city limits), and continue around the current southern city limits up to Industrial Park Boulevard (and/or new international truck route). Secure right-of-way for this loop (year 2000 for high-impact scenario).

(8) Prohibit through trucks at FM375 and Bibb extension, and at proposed link between FM375 and FM3443.

(9) Provide grade separation for Loop 431 and US57 intersection.

(10) Provide left-turn bay for intersection of proposed Las Quintas extension and US277/US57.

(11) Signalize intersection of Las Quintas and US277/US57.

(12) Signalize intersection of proposed Loop 431 extension and FM1021, Edison Road and new truck route.

(13) Synchronize all signals along Loop 431.

Implementation Recommended by 2010—High-Impact Scenario

(1) Implement outer loop (from FM1021 to the junction of US277 and FM1589). This new road should have three lanes each way. The southern part should be implemented (or not) according to the results of a specific study recommended to be contracted no earlier than 2005. This study should update traffic projections and establish implementation dates, which could be earlier than recommended here.

(2) Secure right-of-way to grade-separate intersection of FM3443 with FM1021.

(3) Secure right-of-way to grade-separate intersection of US277B with Loop 431.

Implementation Recommended by 2020—All Scenarios

(1) Implement third international bridge, preferably at a westward extension of Loop 431. This is the most convenient location for Eagle Pass at this point, given all the assumptions regarding its future development. These assumptions may or may not materialize; moreover, Piedras Negras is growing south and west, and its urban

development plan published in 1992 predicts a third bridge about 15km south of the proposed location.

(2) Implement a link between the third bridge and the proposed outer loop, to divert international trucks out of Loop 431 and its proposed extensions and into the proposed outer loop.

(3) Extend Kilowatt in the north/south direction, from Gates Street up to FM1588.

(4) Implement northern part of outer loop (from US57 to the junction of US277 and FM1589). This new road should have three lanes each way. The southern part should be implemented (or not) according to the results of a specific study recommended to be contracted no later than 2010. This study should also update traffic projections and establish implementation dates, which could be earlier than recommended here (see year 2010 for high-impact scenario).

(5) Prohibit through trucks on the inner loop (Loop 431 and its proposed extensions) once the outer loop is built.

(6) Prohibit through trucks on the proposed Kilowatt extension in the N/S direction.

(7) Provide grade separation for new truck route and FM1021.

(8) Provide grade separation for Loop 431 and UP railroad.

(9) Signalize intersection of US277B and access to third international bridge (proposed).

(10) Signalize major intersections and synchronize all signs along proposed outer loop.

(11) Signalize intersection of Kilowatt extension (N/S) and FM1588.

(12) Signalize intersection of Kilowatt extension (N/S) and new outer loop.

Implementation Recommended by 2020—High-Impact Scenario

(1) Provide grade separation for intersection of FM3443 with FM1021.

(2) Provide grade separation for intersection of US277B with Loop 431.

DISCUSSION

The traffic circulation plan presented in this report relies heavily on assumptions made about future city development, traffic demand, international traffic behavior, and Piedras Negras' accession to Eagle Pass' preferred location for a third bridge. These assumptions may or may not materialize, and the recommendations for 2010 (and especially those for 2020) should be verified before implementation. In addition, uncertainties in traffic forecasts are considerably higher on the border than in other parts of the state, reinforcing the need for future verification of the traffic circulation plan developed in this study. Recommendations that are more likely to require adjustments before future implementation are discussed below.

Third Bridge and Outer Loop

Maverick County officials have recently expressed interest in constructing a third bridge north of the city limits near the intersection of Loop 431 and US277 Business. At this point, this location is recommended as the most convenient for Eagle Pass, given all the assumptions regarding its future development. But the priorities are different on the Mexican side. Preliminary

locations of the third and fourth bridges appear in Piedras Negras' development plan published in 1992 (Ref. 4.4). These locations are both outside the current Eagle Pass city limits. Piedras Negras is growing south and west, and its preferred site for a third bridge is about 10 to 15km south of the existing bridge, linking to a proposed loop around the southern part of Piedras Negras.

TxDOT should verify the status of negotiations regarding the third international bridge, especially before implementing infrastructure recommended for 2010 and afterwards. Many traffic plan recommendations discussed in this report were based on the assumption that a third bridge would be built in the northern part, as suggested. The location of the outer loop must be adjusted if the third bridge is actually located in the southern part of Eagle Pass. In this case, the outer loop must be extended further south, preferably along the westbound leg of Edison Road, until it meets the third bridge. The link to the second bridge should still exist, and its design must be carefully developed in a specific study. Figure 4.5 shows a general location, which must be adjusted and refined in a specific study even if our assumptions regarding Eagle Pass development and the third international bridge prove to be correct. For example, the specific location where the outer loop will intersect US57 will need a detailed study, one that takes into account future developments in the area.

Rail Intersections

The outer loop will have an intersection with the UP railroad, which should be left at-grade until there is sufficient demand to justify a grade separation. According to state law, this new intersection will require closing or grade separating two others. If the recommendation to grade-separate the intersection of Loop 431 and the railroad is implemented, the best candidate for closing is the intersection of Gates Street and the UP railroad (northern part of Eagle Pass, outside city limits). Designs for local links to the outer loop must take into account the fact that this loop is the only UP railroad crossing in the area.

Congestion in Densely Developed Areas

This traffic circulation plan was developed based on the assumption that current modal split patterns will remain the same throughout the analysis period. Demand diversion to transit, higher occupancy of privately owned vehicles, and/or implementation of transportation control measures (TCM) in Eagle Pass were not taken into account in this study. Consequently, the measures recommended in this study for downtown congestion will have only temporary effect, since traffic demand can be expected to grow and since the infrastructure cannot be expanded in that area. As elsewhere in the state and country, the only permanent and effective solution for congestion is higher occupancy and/or transit.

Eagle Pass, in concert with TxDOT, should develop a plan to shift demand from single- and double-occupant autos to higher occupancy and mass transit. Preliminary studies could start by 2000, and detailed studies should start no later than 2010. Issues to be investigated include, but are not restricted to, HOV lanes, park-and-ride lots, and staggered work and school hours.

According to city officials, existing downtown shopping areas are likely to grow and additional areas will open near the new bridge. We recommend that the current golf course be converted to a park-and-ride lot, one that can serve both the new and the existing international bridge. There should be bus routes from this lot to downtown, Mall de Las Aguilas, Main Street, and to any future developments. Specific bus routes would use the new truck route, FM375, Loop 431, FM1021, US277, and US57.

Other Recommendations

The intersection of FM3443 and FM1021 is predicted to reach LOS E in the low-impact scenario, and F in the high-impact scenario by the end of the analysis period. There is no recommendation to grade-separate this intersection in the low-impact scenario because, if some assumptions used in the traffic assignment do not materialize, traffic diversion to new routes such as the outer loop might be sufficient to keep this intersection at a lower LOS. On the other hand, if some assumptions used in this study are actually exceeded in the future, a grade separation is recommended for this intersection in the low-impact scenario (intersections 11 and 7 in Figure 3.4). TxDOT should monitor the traffic at this intersection and verify future demand development before deciding when (or if) to grade-separate the intersection of FM3443 and FM1021.

Implementation of state-wide transportation control measures (TCMs) appears indicated when one considers environmental problems such as pollution from mobile sources and excessive energy consumption in the transportation sector. TCMs also seem indicated when one considers the cost of infrastructure required to support low-occupancy autos as the primary transportation option in the future. The TCM potential to reduce energy consumption and improve air quality in Texas was recently investigated by CTR, and numerous other studies investigated other TCM impacts, including the cost of providing increasingly expensive infrastructure. TxDOT should update the recommendations of this traffic circulation plan in the event that a successful TCM program is implemented in the Eagle Pass area.

CHAPTER 1. INTRODUCTION

BACKGROUND AND SIGNIFICANCE OF THE PROJECT

The enormous increase in U.S.-Mexico trade, spurred by earlier Mexican trade initiatives and, more recently, by the North American Free Trade Agreement (NAFTA), has prompted new concerns regarding the Texas-Mexico border transportation infrastructure. Given that about 80 percent of this burgeoning trade is currently routed by surface through Texas, there are fears that, without adequate infrastructure in place, the economic blessings promised by NAFTA may not offset the problems caused by such massive traffic demand.

This is especially true for the border cities, already overwhelmed by a traffic demand comprising trade-related trucks and millions of autos, bicycles, and pedestrians crossing the border at an average frequency of twice a week (Ref. 1.1). In many border cities, traffic congestion starts with back-ups at border inspection procedures; with NAFTA now being implemented, border congestion is expected to increase, chiefly as a result of the additional customs inspections required to verify the origin of product components for taxation purposes. A recent survey by the Center for Transportation Research (CTR) indicated that the staffing capabilities of both U.S. and Mexican inspection agencies are limited, and that this is expected to cause additional traffic problems for border cities (Ref. 1.1).

In 1994, Del Rio and Eagle Pass served 10 percent of this traffic, which included over 8 million autos and almost 175,000 trucks, as well as nearly 34,000 international rail cars. International traffic forecasts for Eagle Pass, developed for CTR by Wilbur Smith and Associates prior to NAFTA's implementation, estimated the average yearly growth rates for the next 20 years to be between 0 and 1 percent, depending on the assumed post-NAFTA outlook (Ref. 1.2). However, actual 1994 traffic growth rates were considerably higher for Eagle Pass. Auto traffic grew around 2 percent, while truck traffic grew almost 10 percent in the southbound direction, and 23 percent northbound.

In addition to the international demand, there is another source of traffic near Eagle Pass that has potential to become significant in the future. Recently, the Kickapoo Indian Reservation (located only about 15km southeast of Eagle Pass) requested and obtained a permit to operate the only casino available in a 200-by-200km binational area containing a population of almost 350,000. According to the tribal administrator, the reservation will start operations in 1996.

STUDY OBJECTIVES

Study 7-2940 is one of many initiatives undertaken to survey NAFTA impacts on international traffic, and to develop guidelines to ensure safe and efficient transportation along the Texas-Mexico border. Its specific objective is to develop guidelines for traffic circulation in Del Rio and Eagle Pass, taking into consideration the international traffic to and from the Mexican sister cities, Ciudad Acuña and Piedras Negras, respectively. This study has the following objectives for both cities:

(1) determine the major international thoroughfares through Del Rio/Ciudad Acuña and Eagle Pass/Piedras Negras, for private and commercial traffic;
(2) identify adequate routes for international and local traffic;
(3) identify on-system roadways that need added capacity (widening) or continuous left turn lanes;
(4) identify inadequate intersection configurations;
(5) identify alternative routes that relieve congestion;
(6) identify intersections that may warrant signalization;
(7) identify truck routes that minimize congestion;
(8) develop recommendations for prioritization of future projects;
(9) develop a long-range plan for international thoroughfares; and
(10) analyze potential future international bridge locations.

Providing input for the study recommendations were city officials from Del Rio, Ciudad Acuña, Eagle Pass, and Piedras Negras; also assisting were representatives from the Texas Department of Transportation, U.S. and Mexican inspection agencies, the General Services Administration, the Coahuila Transportation Department (Secretaría de Comunicaciones y Obras Públicas de Coahuila), and various Mexican federal agencies, including the Secretaría de Desarrollo Social (SEDESOL), which is responsible for urban development. In addition, we visited the Kickapoo Indian Reservation located about 15km southeast of Eagle Pass, and interviewed relevant officials regarding their planned casino. This information was used to estimate casino-generated traffic from nearby cities, including Del Rio, Eagle Pass, Piedras Negras, Ciudad Acuña, and other cities within a two-hour drive.

REPORT OBJECTIVE AND SCOPE

This report presents long-range plans and traffic circulation guidelines for the City of Eagle Pass, located at the international border between Texas and the state of Coahuila, Mexico. This report is organized into an executive summary, four chapters, and two appendices. The *Executive Summary* presents a chronological list of traffic circulation recommendations for each future scenario analyzed for Eagle Pass. It was written for a reader already familiar with Eagle Pass and Piedras Negras.

Chapter 1, *Introduction*, discusses the background, significance, objectives, and deliverables of this study. Next, it explains the report objectives and scope and organization. Finally, it presents an overview of the research approach used in this study, including the three future scenarios used to develop the network traffic assignments.

Chapter 2, *International Thoroughfares Between Eagle Pass and Piedras Negras*, discusses border traffic before and after NAFTA, comparing past and recent growth rates and presenting the international traffic projections used in this study. Next, it explains the existing and proposed international thoroughfares, and closes with a critical discussion of relevant international traffic issues.

Chapter 3, *Network Analysis*, discusses the approach and assumptions used to: (a) define the study network, (b) estimate the capacity of its main nodes and links, (c) obtain current and future hourly volumes for each study scenario, and (d) assign levels of service to each intersection and roadway segment. The chapter also discusses the traffic assignment results projected to the existing network (reference scenario), which were used in the development of the traffic circulation plan for the other scenarios.

Chapter 4, *Traffic Circulation Plan for Eagle Pass*, starts by discussing the approach used for analyzing the two traffic demand scenarios, and by presenting the traffic assignment results. It then discusses the proposed solutions to on-system roadways that need added capacity or continuous left-turn lanes, current truck routes, inadequate intersection configurations, intersections that warrant signalization, and congestion in international traffic routes.

Appendix 1 is a *Photo Album of Eagle Pass* containing pictures of relevant intersections, international routes, and highway segments. Appendix 2 is a summary of Mexican data obtained in this project.

ORGANIZATION OF STUDY REPORTS

This study deliverables are organized into three reports. Research Report 2940-1 (this report) documents the Eagle Pass traffic circulation recommendations and long-range plan. Research Report 2940-2 provides analogous documentation for Del Rio. These two reports document the study objectives and organization, the study methodology and approach, data collection, and results. Research Report 2940-3F is a bilingual executive summary discussing international traffic issues. In this case, a bilingual executive summary is paramount for effective dissemination of project results to relevant Mexican authorities and officials. Table 1.1 summarizes the project deliverables.

Table 1.1 Study 2940 Reports

Report Number	Report Title
Report 2940-1	Traffic Circulation Study and Long-Range Plan for Eagle Pass
Report 2940-2	Traffic Circulation Study and Long-Range Plan for Del Rio
Report 2940-3F	Executive Summary

RESEARCH APPROACH OVERVIEW

Eagle Pass traffic demand can be classified as either local or international. If the casino planned for the nearby Indian reservation is successful, a third category — tourism —should be added. Our study approach was specifically envisioned to address the following major concerns:

(1) Binational study perspective
(2) Flexibility of the traffic assignment methods
(3) Compatibility between available data and traffic assignment method

(4) Reliability of results
(5) Permanence of study guidelines

These issues are intertwined. A traffic circulation plan for a border city cannot be reliable, flexible, or permanent without a binational, multi-agency perspective. This binational perspective must be considered at three levels — through study conceptualization, data collection, and input from decision-makers and agencies on both sides of the border. The latter two concerns were addressed by subcontracting a Mexican consultant[1] located near the study area and knowledgeable about international traffic issues. Input from relevant agencies and other interested parties on both sides of the border were used in different study scenarios. The choice of a traffic assignment method compatible with available data contributes towards flexibility and reliability of results, the former by taking advantage of all available data, and the latter by avoiding substituting ad-hoc values of dubious accuracy for unavailable data required to use a pre-selected traffic assignment method.

Study Scenarios

Eagle Pass traffic circulation was analyzed under three different scenarios: reference, low impact, and high-impact. The reference scenario is a theoretical case in which no additional infrastructure improvements are made throughout the analysis period. Its purpose is twofold:

(1) diagnose current and potential traffic circulation problems, and
(2) serve as a basis for evaluating the impacts of added capacity, better traffic signalization, and other improvements.

Both the high- and low-impact scenarios include the proposed international bridge, assumed to be opened to traffic in 2000. In the low-impact scenario, the casino traffic demand is assumed to be small, having little impact on the Eagle Pass infrastructure. In the high-impact scenario, the casino demand will be more significant and, accordingly, must be considered in the long-range plan.

International Thoroughfares

International traffic demand is a function of such socioeconomic variables as trade, which flows through hubs or thoroughfares. It can be classified as either local or long-haul. According to origin and destination studies conducted by CTR, 81 percent of all international trips have origins and destinations in Piedras and Negras Eagle Pass, respectively (Ref. 1.1). Although these results indicate the prevalence of local thoroughfares, the long-haul demand consists basically of trade-related traffic, which is important to the national interests of both the U.S. and Mexico. In addition, the number and weight of the heavy trucks that must utilize the local infrastructure exceed the ranges usually found in other urban areas of similar size.

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[1]Ingeniería Gario, from Saltillo, Coahuila.

The international traffic demand was projected into the future using data already available at CTR, updated by additional data specifically collected for this study. The latter consists primarily of a traffic demand study for a proposed international bridge in Eagle Pass (Ref. 1.5). At this point, international traffic projections must rely on assumptions about the outcome of the peso devaluation in Mexico. Early data indicate that the peso devaluation caused a decrease in auto and (especially) pedestrian traffic, but did not affect truck traffic growth in Eagle Pass. Pedestrian traffic is a concern in this study only in terms of safety.

Modeling Approach

The complete transportation planning process consists of three basic phases: data collection, analysis and forecasting, and trip generation, distribution, and assignment. These phases are summarized in Figure 1.1, which depicts their interrelationships and their chronological order in a traffic study (Ref. 1.4).

The top row in Figure 1.1 represents the data collection phase. In the case of this study, international traffic is an important component of the overall demand for Del Rio and Eagle Pass networks; yet two recent events — the peso devaluation and NAFTA — caused disturbances in the traffic time-series that cannot be statistically explained as a function of socioeconomic variables at this point. Therefore, because the value of the traditional traffic forecast methodology is questionable for this study, we used an alternative approach.

Of paramount importance to this study is the allocation of trips to each major network link. Initially, the study team considered using TRANPLAN, an automated traffic assignment algorithm to assign trips to the path of minimum impedance between every pair of zones. This approach is represented schematically in Figure 1.2. In this figure, the circles indicate traffic generation nodes obtained from a detailed origin and destination matrix. "US" represents Eagle Pass nodes (such as a shopping area) and "MEX" represents Piedras Negras nodes (such as maquiladoras for truck traffic). As shown in Figure 1.2, two important inputs are required for successful and accurate development of a TRANPLAN simulation of Eagle Pass: (1) detailed origin and destination data disaggregated by city zones for both Eagle Pass and Piedras Negras, and (2) detailed traffic data at each network leg (or arterial segment) linking two nodes.

Available data actually are considerably limited in scope: the only origin and destination data available for Eagle Pass were collected for state-wide planning purposes, and origins and destinations are U.S. and Mexican cities, not zones within Eagle Pass or Piedras Negras. In addition, availability of traffic counts in Eagle Pass is limited to arterials under TxDOT jurisdiction. Practical use of any automated traffic assignment algorithm requires each unavailable data to be substituted for ad-hoc estimates, which may result in significant error propagation that cannot be controlled during an automated process. This problem was circumvented by developing spreadsheets containing all major intersections and network links, and then assigning traffic manually, in a stepwise process where the influence of each assumption on the traffic assignment outcome was adequately controlled. Current international traffic hubs were defined based on qualitative origin and destination information collected during several interviews, and on the results

of an origin and destination survey aggregated by city that also provides trip purpose information (Ref. 1.1).

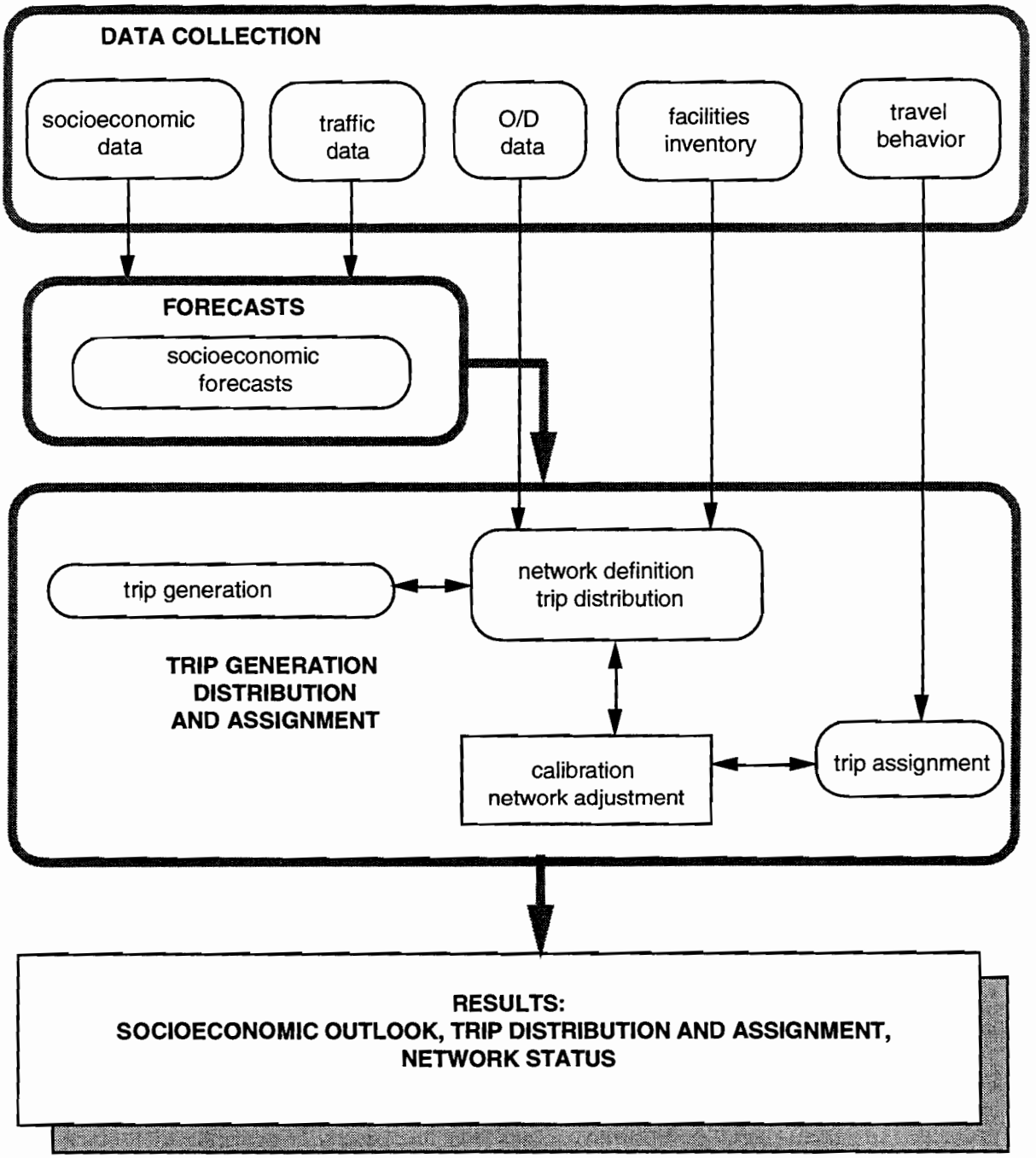

Figure 1.1 Major Phases of a Transportation Planning Process

Sources: Pignataro, 1976, Witheford, 1968 (Refs. 1.3, 1.4)

Future Demand Forecasts

Forecasting traffic demand at a Texas-Mexico border city is a complex exercise. A considerable portion of the city traffic is international, and as such is influenced by events such as NAFTA and the peso devaluation. In addition, and unknown percentage of the traffic that has origins and destinations within Eagle Pass is partly a function of trade indicators and employment, which in turn are affected by international events. The relationships between traffic and these other variables are not simple, since NAFTA is a unique socioeconomic experience whose long-term effects are still unknown. Therefore, we based our forecasts on a critical review of literature for the border area (including other CTR studies).

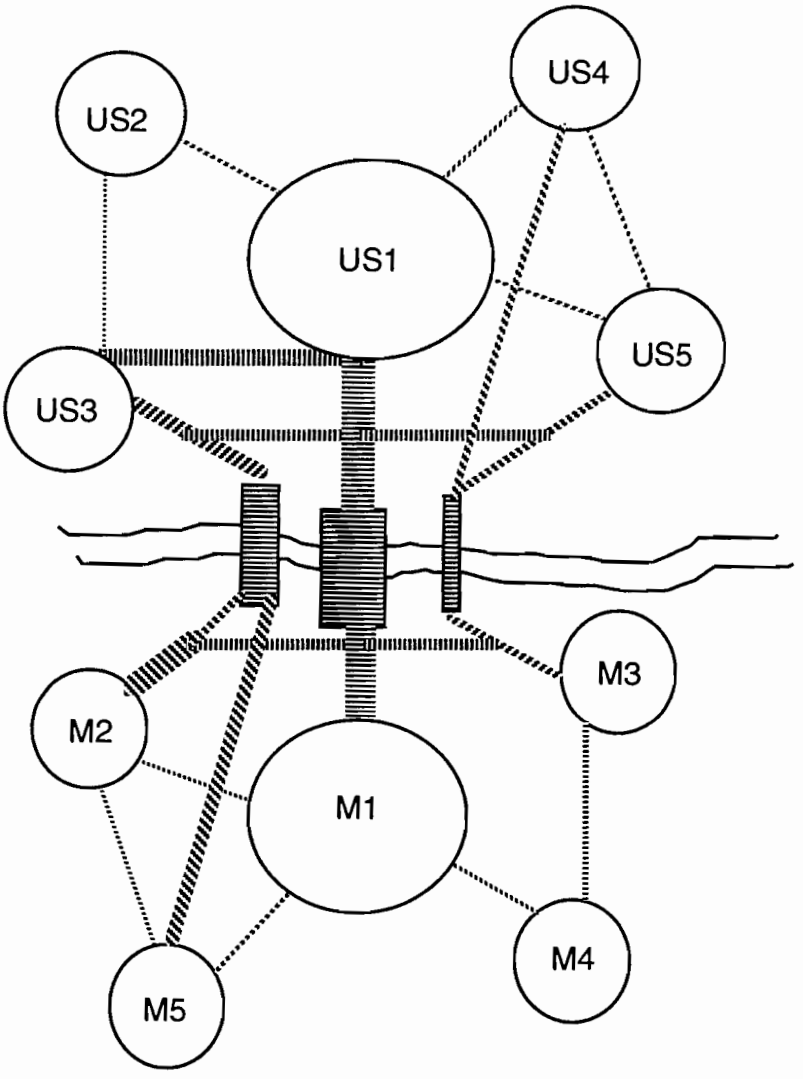

Figure 1.2. Conceptual Trip Assignment to International Area

Local traffic demand forecasts were made based on extrapolations of historical data, corrected when appropriate for local conditions. The tourism traffic forecast is the basis for the high- and low-impact scenarios, depending on the assumed impacts of the proposed casino on traffic patterns in Eagle Pass.

Capacity Utilization Analysis and Levels of Service

Capacity utilization assessments are basically comparisons of traffic demand and the facility processing capability. A capacity analysis result can be expressed in terms of a volume-to-capacity ratio (v/c), which represents the percentage of the total capacity being utilized by the current traffic demand. It is also commonly represented in terms of levels of service, a practical way to rank the quality of traffic flows from A to E, with A being the best (free flow) and E being the worst (severely congested). Both v/c ratios and levels of service (LOS) are calculated in terms of hourly volumes (Ref. 1.6).

In the Eagle Pass area, relevant traffic data are available in terms of an annual average daily traffic (AADT). Hourly volumes were estimated based on the AADT and available estimates of the k-factor (ratio between the hourly volume of interest and the AADT). Once estimates of hourly volumes on each relevant arterial and intersection are developed, capacity utilization can be estimated, and LOS can be assigned to each relevant arterial and intersection.

Capacity of the international bridges is more complex, since the inspection procedures are often the main cause of queues and traffic back-ups. CTR developed a capacity analysis approach (Ref. 1.2) that takes this fact into consideration, and assesses the capacity of a border crossing facility in a disaggregated and sequential manner. The results obtained through this procedure were used in this study.

SUMMARY AND CONCLUSION

The basic approach used in this study consists of eight basic steps, some of them sequential, others interrelated, as shown in Figure 1.3. The data collection phase included field trips, a literature survey, data collected by our Mexican subcontractor, data collected by TxDOT, data collected for other border studies, and interviews with relevant individuals in each border city. This background information is necessary for defining the study network, taking into account the relevance of each network part for TxDOT's long-term plans, and identifying where interagency cooperation is important.

The available data were then projected into the future and assigned to the study network to obtain future and current capacity utilization, to perform intersection analysis, and to estimate current and future levels of service. The time and budget constraints of this study precluded detailed accident and cost analyses of every improvement proposed over a 25-year period. Nevertheless, care was taken to consider the safety and cost effectiveness of every recommendation. The traffic circulation plan discussed in this report had the overall objective of keeping the levels of service and the overall safety acceptable, all at a reasonable cost. The recommended improvements, developed from ad-hoc relative cost estimates, always started from the least expensive alternative. A reasonable cost-benefit ratio (in terms of dollars per vehicle) was

obtained by excluding recommendations for infrastructure improvements at those locations serving small percentages of users and which could not serve as alternative routes to heavily congested thoroughfares.

Recommendations on intersection signalization and other improvements had the objective of keeping the level of service within an acceptable range, while at the same time providing safe turning at intersections. The signalization warrants from the Institute of Transportation Engineers were used to the greatest extent possible as criteria to recommend signalization, even when ad-hoc data estimates were necessary (Ref. 1.7).

The reference scenario was analyzed using a spreadsheet to determine potential and/or preferred traffic patterns. The results were used to develop a basic traffic circulation plan based on the criteria summarized above. This basic plan was later used as a basis for analyzing the two study scenarios. These two study scenarios reflect potential future traffic demands and include proposed infrastructure. The results of these scenarios and the subsequently developed traffic circulation plan are discussed in Chapter 4.

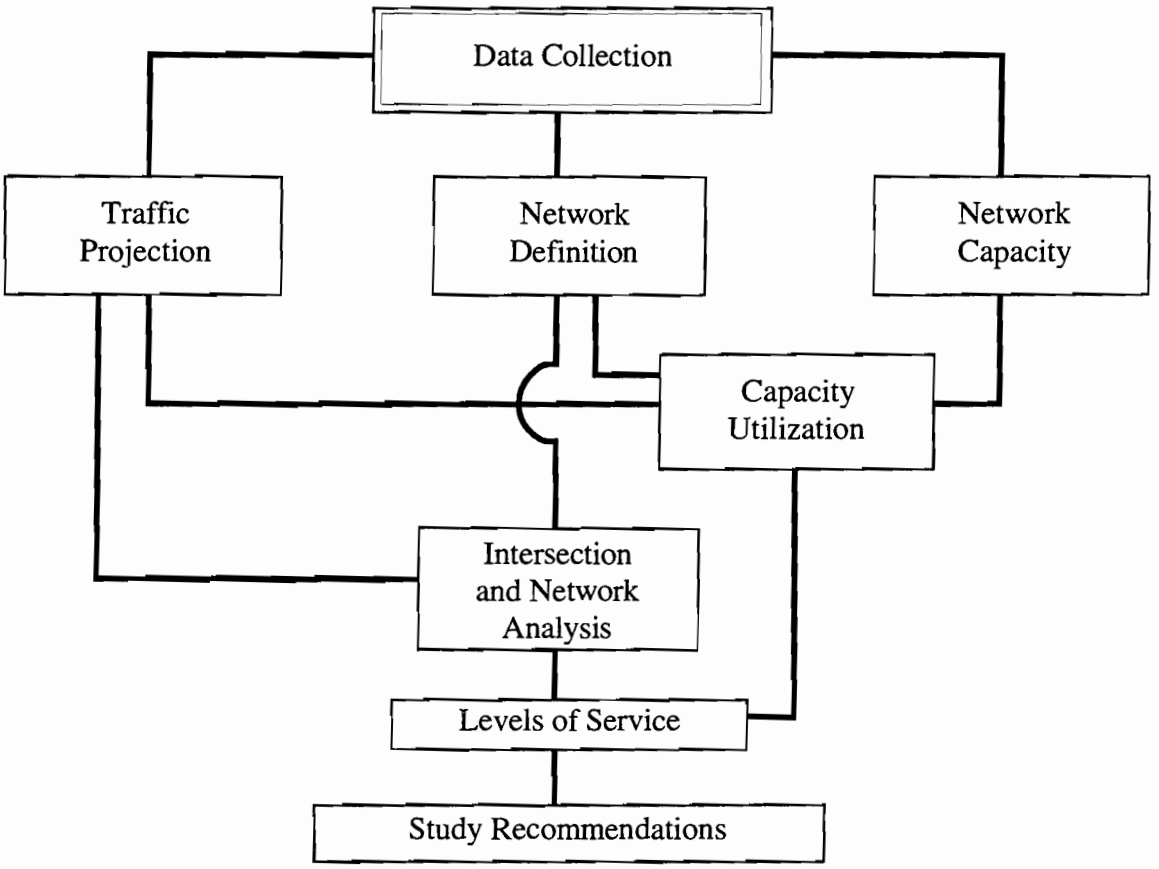

Figure 1.3 Research Approach

The practical application of the methodology discussed above begins with a comprehensive overview of the international traffic in the study area, which comprises Eagle Pass and Piedras Negras. As such, our study team visited the area several times and interviewed relevant individuals connected with both international and local traffic.

REFERENCES

1.1. Weissmann, A. J., M. Martello, J. Hanania, M. Shamieh, C. Said, R. Harrison, and B. F. McCullough, *A Comprehensive Overview of the Texas-Mexico Border: Assessment of Traffic Flow Patterns,* Research Report 1976-3, The University of Texas at Austin, Center for Transportation Research, Austin, Texas, 1994.

1.2. Weissmann, A. J., M. Martello, B. F. McCullough, and R. Harrison, *A Comprehensive Overview of the Texas-Mexico Border: Revenue and Demand Analysis of Border Segment 2—Eagle Pass to El Paso*, Research Report 1976-5, The University of Texas at Austin, Center for Transportation Research, Austin, Texas, 1994.

1.3. Pignataro, Louis J., *Traffic Engineering: Theory and Practice,* Prentice Hall, Inc., Englewood Cliffs, NJ, 07632, 1983.

1.4. Witheford, David K., *Comparative Analysis of Traffic Assignment Techniques with Actual Highway Use*, Washington, D.C., 1968.

1.5 *The Proposed Eagle Pass International Bridge II: Preliminary Engineering and Traffic Plan*, Hicks and Company, John F. Hickman and Associates, and Groves and Associates, Inc., February 1995.

1.6. Transportation Research Board, *Highway Capacity Manual.* TRB Special Report No. 209, 1994.

1.7 Kell, J. H., and I. J. Fulton, *Manual of Traffic Signal Design,* Institute of Transportation Engineers, 1983.

CHAPTER 2. INTERNATIONAL THOROUGHFARES BETWEEN EAGLE PASS AND PIEDRAS NEGRAS

BACKGROUND AND OBJECTIVES

In providing incentives for increased trade among the U.S., Canada, and Mexico, the North American Free Trade Agreement (NAFTA) could considerably liberalize freight carriage across these countries' respective borders. While Texas has a substantial economic interest in the increased trade, its border cities, which serve a considerable amount of international traffic, face increased congestion and safety hazards, as well as the risk of approaching non-attainment of air quality standards (as is already happening in El Paso).

In many border cities, a major cause of congestion is traffic back-up at the border bridges, in many instances the result of inspection procedures. NAFTA is expected to increase and complicate, rather than decrease and simplify, the amount of customs inspections, based on its requirement to verify the origin of product components for taxation purposes (Ref. 2.1, interviews with Customs officials). A recent survey conducted by the Center for Transportation Research (CTR) indicated that the staffing capabilities of both U.S. and Mexican inspection agencies are limited and that additional traffic problems will accrue to border cities (Ref. 2.1).

Given that international traffic is a significant component of traffic demand in Eagle Pass, a successful traffic circulation plan must begin with a careful examination of international traffic. The findings of such an examination can then be used to develop recommendations for international thoroughfares. Thus, this chapter discusses the international traffic moving between Eagle Pass and Piedras Negras (both before and after NAFTA); it compares past and recent growth rates, and discusses the city's major truck routes vis-`a-vis a proposed second bridge.

DATA SOURCES AND SCOPE

Northbound traffic data for Eagle Pass was obtained from two sources: Caminos y Puentes Federales (CAPUFE, the Mexican toll collection agency), and U.S. Customs. Southbound data were provided by the bridge management. Table 2.1 summarizes the scope of the international traffic data available for Eagle Pass.

Table 2.1 Summary of International Data Scope

Traffic Direction	Monthly Series	Years	Empty/ Loaded Trucks	Truck Axles	Autos	Pedestrian
Northbound	yes	1975 to 1995	no	yes	yes	yes
Southbound	yes	1983 to 1994	no	yes	yes	yes

International traffic data are routinely collected for two purposes: border inspections and toll collection. Because transportation planning is not the primary objective of any source of

transborder traffic data, the format of the data is not always suited for transportation planning purposes. Traffic counts are usually disaggregated by mode (automobiles, trucks, buses, trailers, and pedestrians), as well as by traffic direction (northbound and southbound); however, criteria for data disaggregation vary depending on the data source, year, and site. Although most agencies record data continuously, hourly counts are not available. The most basic level of disaggregation found was by month. In addition, most sources that collect data for toll accounting purposes keep records only of the fraction of vehicles that generate revenue. Consequently, comparisons among different data sources would still show discrepancies even if every data source provided error-free data. Table 2.2 compares CAPUFE and U.S. Customs northbound data for 1993 and 1994, respectively. The percent differences between sources were calculated with respect to U.S. Customs data, as shown in equation 2.1.

$$\text{Difference} = \frac{(\text{CAPUFE}) - (\text{U.S. Customs})}{(\text{U.S. Customs})} * 100 \qquad (2.1)$$

Table 2.2 1993 Northbound Data Discrepancies Between Sources

Source	Autos	Trucks	Other	Pedestrians	Total Vehicles
Customs	2,661,589	46,422	n/a	n/a	2,708,011
CAPUFE	2,426,059	54,328	4,065	617,243	2,484,452
Difference	-8.56%	17.03%	n/a	n/a	-8.12%

Vehicle discrepancies are rather difficult to explain. One reason for such differences is that CAPUFE is a toll collection agency, and as such it records only data from vehicles that generate revenues; however, the average number of toll-exempt vehicles can generally account for no more than a 5-percent difference in traffic counts.

DATA ANALYSIS

The analysis of international traffic data was undertaken in two steps: by reviewing historical pre-NAFTA traffic history, and then traffic growth after NAFTA. Additionally, post-NAFTA growth covered two periods: before and after the peso devaluation. Comparing these three traffic trends provides an indication of early NAFTA effects on international traffic demand, as well as some insight about the early effects of the peso devaluation on international traffic. Because the latter are based on only four months of data, results must be interpreted cautiously.

Historical Traffic Analysis

CTR's Transborder database contains international traffic histories for Eagle Pass, which are summarized in Figures 2.1 through 2.4 (Ref. 2.2). Figures 2.1 and 2.2 depict northbound traffic from two different sources (CAPUFE and U.S. Customs). Figures 2.3 and 2.4 depict southbound commercial and non-commercial traffic, respectively. The average differences between northbound and southbound traffic are 20.5 percent for autos and 16 percent for trucks. These figures are consistent with an origin and destination survey conducted by CTR at this site, which showed that over 80 percent of all trips have origins in Eagle Pass and destinations in Piedras Negras (Ref. 2.3). This finding also implies that 80 percent of all trips on this bridge are round trips, and that there is a less than 20-percent difference between northbound and southbound traffic volumes.

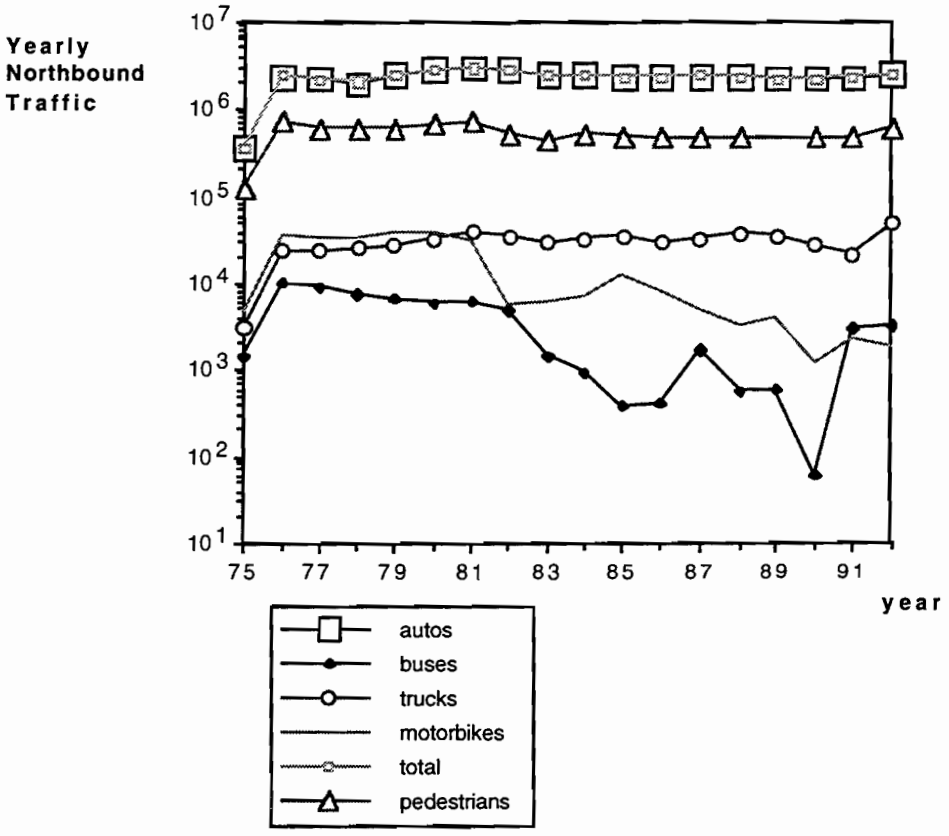

Figure 2.1 Northbound Traffic History at Eagle Pass-Piedras Negras Bridge

Source: CAPUFE

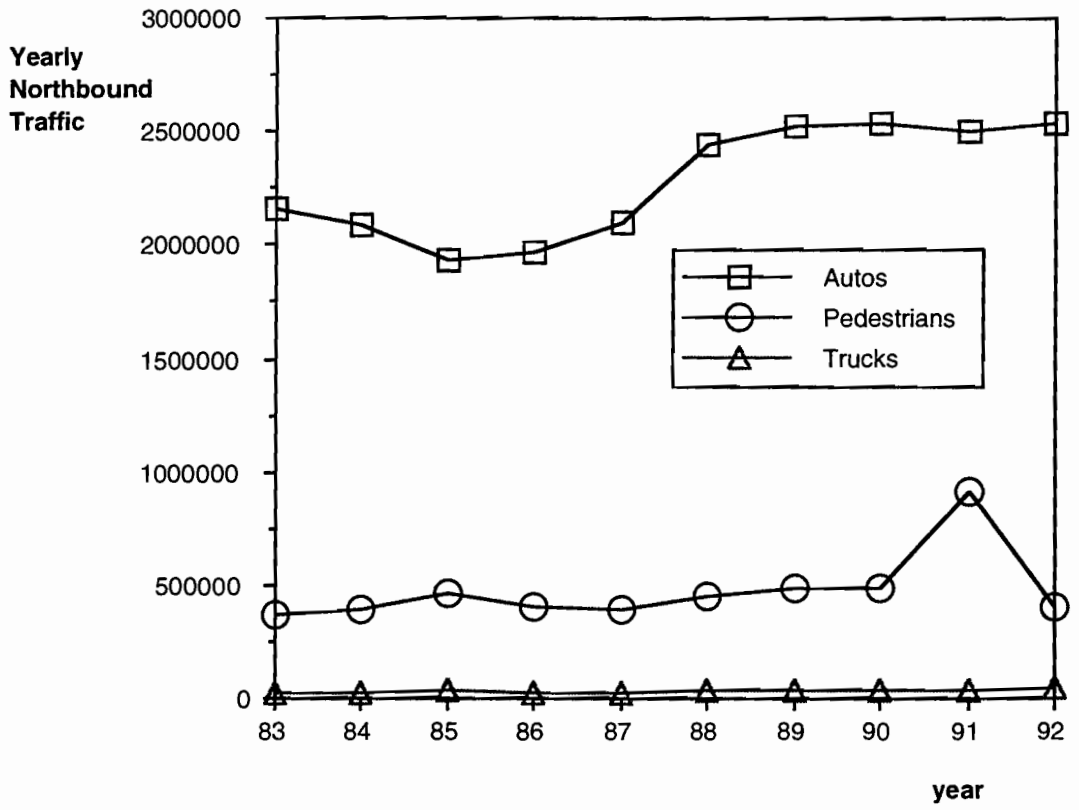

Figure 2.2 Northbound Traffic History at Eagle Pass-Piedras Negras Bridge

Source: U.S. Customs, obtained through General Services Administration (GSA)

Figures 2.1 through 2.4 consistently show low traffic growth rates at this bridge before NAFTA, except for southbound buses. On the average, the yearly growth rates for autos, trucks, and pedestrians were, respectively, 0.08 percent, 0.01 percent, and 4.3 percent for northbound traffic, and 1.57 percent, 3.82 percent, and -5.36 percent for southbound traffic. These rather low auto growth rates are consistent with the fact that the population growth for Eagle Pass was negative (-3.5 percent) from 1980 to 1990. Piedras Negras, on the other hand, had a 72-percent population growth from 1970 to 1980, and a 22.3-percent population growth from 1980 to 1990. According to Mexican Customs officials, population growth in Piedras Negras was triggered by federal investments in the energy and mining sectors, in addition to the growth of the maquiladora industry. The number of maquiladoras in Piedras Negras grew 147 percent between 1982 and

1992, while the number of maquiladora employees grew 280 percent. As a result, a considerable part of the international rail traffic in Eagle Pass derives from automotive maquiladoras located in the Saltillo area[1]. However, rail traffic also showed a small increase over the past 10 years. The observed low traffic growth has two possible explanations:

(1) vehicle ownership in Piedras Negras did not grow in the past 10 years, and/or
(2) the Eagle Pass has been operating at or over capacity levels for the past 10 to 12 years.

The first explanation cannot be verified because vehicle ownership data are available for Mexico only for 1991 (Ref. 2.2). As for the second explanation, a capacity analysis of the entire Eagle Pass "binational entry system" (i.e, access, egress, bridge lanes, toll booths, and inspection facilities on both sides of the border) indicated that in 1992 the Eagle Pass Bridge was operating at or over capacity in the following components: Mexican Customs, Mexican access and egress, U.S. Customs, and U.S. toll collection booths (Ref. 2.5).

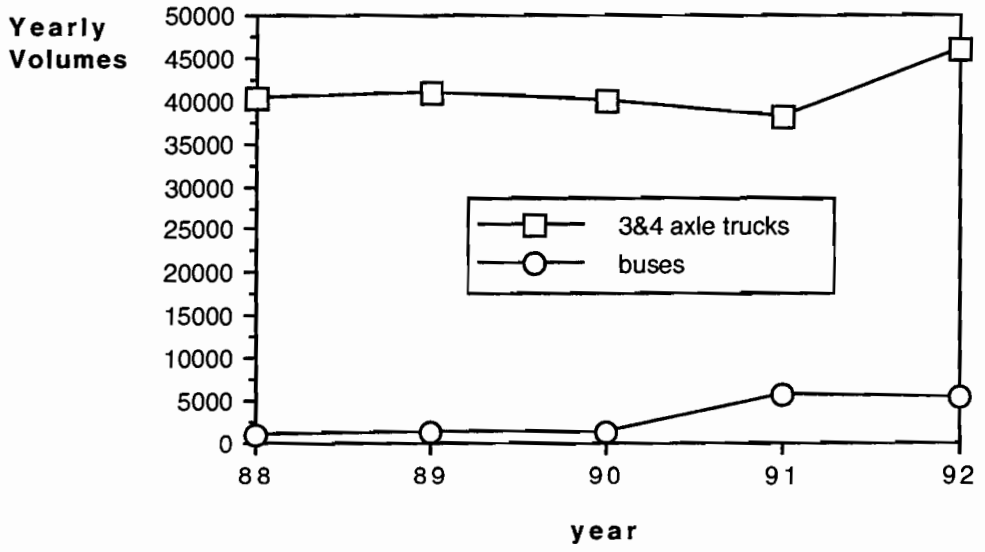

Figure 2.3 Southbound Commercial Traffic History at Eagle Pass-Piedras Negras Bridge

Source: Laredo State University, according to US Bridge Management

[1]Information provided by Mr. Noe Garcia, PE in Mexico, president of Ingenieria Gario, and project manager of CTR's subcontracted portion of this project.

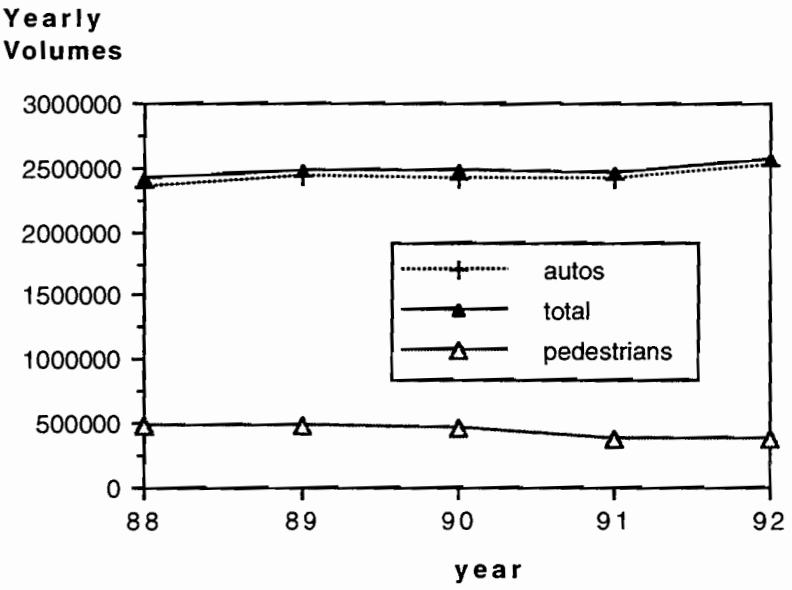

Figure 2.4 Southbound Auto, Pedestrian and Total Traffic History at Eagle Pass-Piedras Negras Bridge

Source: Laredo State University, according to US Bridge Management

Post-NAFTA Traffic Analysis

This section discusses transborder traffic growth for two different periods: 1993–1994, which reflects early NAFTA effects, and 1994–1995, which provides some insight into the early effects of the peso devaluation. The analyses are disaggregated by traffic direction, type of transport, and period. Northbound data were provided by CAPUFE and U.S. Customs; the 1993–1994 values shown in Table 2.3 were obtained by averaging the two sources. The 1994–1995 northbound analysis is based only on CAPUFE (the longest series). The 1994–1995 data growth percentages were calculated using the months of January through April, while the 1993–1994 growth always includes the entire year.

The Eagle Pass international truck demand had significant growth between 1993 and 1994 for both traffic directions. Auto traffic grew 1.4 percent in the northbound direction, and 2.2 percent in the southbound direction. The auto growth rate is 3 times higher than the average growth between 1982 and 1992. For trucks, the growth rates is 5 times higher than the 1982–1992 average. These traffic increases may be due to positive NAFTA impacts in this area.

Table 2.3 Traffic Growth — Eagle Pass

Traffic Direction	Analysis Period	Pedestrians	Autos[1]	Trucks[2]	Other	Total vehicles
	Jan-Dec 1993	617,243	2,543,824	50,375	7,814	2,602,013
	Jan-Dec 1994	627,849	2,579,274	62,073	8,320	2,649,667
North-	**Growth**	**1.7%**	**1.4%**	**23.2%**	**6.5%**	**1.8%**
bound	Jan-Apr 1994	192,433	816,174	22,010	n/a	838,184
	Jan-Apr 1995	187,323	787,353	20,877	n/a	808,230
	Growth	**-2.7%**	**-3.5%**	**-5.1%**	**n/a**	**-3.6%**
South-	Jan-Dec 1993	417,585	2,599,415	37,130	n/a	2,636,545
bound	Jan-Dec 1994	398,355	2,656,612	40,728	n/a	2,697,340
	Growth	**-4.6%**	**2.2%**	**9.8%**	**n/a**	**2.3%**

[1] In rows that have n/a in the "Other" category, this column actually represents total passenger vehicles (including buses, etc.).

[2] Loaded trucks only.

The peso devaluation reversed this trend, at least for the first four months of 1995. According to Table 2.3, which is based on CAPUFE data, auto traffic decreased 3.5 percent, truck traffic decreased 5.1 percent, and total vehicles decreased 3.6 percent. According to U.S. Customs data, these decreases are even higher. For the first three months of 1995, Customs data indicate that auto traffic decreased 7 percent and truck traffic decreased over 10 percent, with an overall 6.7-percent decrease. Interviews with Eagle Pass officials confirm the negative impacts of the peso devaluation on international traffic demand.

Northbound rail traffic grew 4.2 percent from 1993 to 1994, increasing from 14,571 to 15,177 cars. In the southbound direction, there were 17,171 cars in 1993 and 18,818 in 1994, a 9.6 percent increase. In January, February, and March of 1995, the accumulated number of rail cars was, respectively, 8,322 in 1994 and 10,564 in 1995, an almost 30-percent increase with respect to 1994. Apparently, the peso devaluation did not affect rail movements in this area. An important caveat: extrapolation of a few months' growth to the entire year is not always accurate.

The most recent study about border-wide traffic growth trends after NAFTA found that Eagle Pass had the highest northbound truck growth rate of all border sectors, and the fourth highest in the southbound direction. Auto growth was less impressive, but was still much higher than the pre-NAFTA average. These rankings exclude Los Indios, a new bridge whose growth rates reflect traffic diversion to a new facility, rather than a corresponding increase in transborder demand (Ref. 2.6).

INTERNATIONAL TRAFFIC PROJECTIONS

As discussed in Chapter 1, forecasting traffic demand at a Texas-Mexico border city is a complex exercise. A considerable portion of the city traffic is international, and as such is

influenced by such events as NAFTA and the peso devaluation. In addition, an unknown percentage of the traffic that has origins and destinations within Eagle Pass is partly a function of trade indicators and employment, which in turn are affected by international factors. The relationship between traffic and these other variables is not simple, since NAFTA is a unique socioeconomic experience whose long-term effects are still unknown. Therefore, we based our forecasts on a critical review of literature for the border area. The two major references providing detailed long-term international traffic projections for Eagle Pass are:

(1) a preliminary engineering and traffic plan developed for the proposed Eagle Pass International Bridge II (Ref. 2.7), and

(2) pre-NAFTA traffic projections developed for CTR by Wilbur-Smith Associates, whose predicted 1993 and 1994 growth rates were considerably smaller than the observed ones (Ref. 2.5).

The Eagle Pass International Bridge II study (Ref. 2.7) is more recent than the Wilbur-Smith report (Ref. 2.5), is local in scope, and its level of accuracy must be compatible with a local traffic circulation analysis. The Wilbur-Smith project was a border-wide study whose level of accuracy was consistent with its regional transportation planning purposes. Therefore, the Eagle Pass International Bridge II study information was used to project the international auto traffic. As for trucks, the analysis discussed earlier in this chapter provides valuable insights into the effects of NAFTA on international truck traffic, while the Eagle Pass International Bridge II study relies on less detailed truck data. Truck traffic projections are therefore based on a critique of observed NAFTA impacts.

The high level of observed post-NAFTA growth does not reflect diversion to rail (a future possibility and an option that we strongly recommend for the entire border). The observed pre- and post-NAFTA growth rates were averaged to reflect long-term truck traffic growth in Eagle Pass, combined with some diversion to rail.

INTERNATIONAL THOROUGHFARES AND NEW INTERNATIONAL BRIDGES

The Eagle Pass-Piedras Negras area contains one vehicular bridge and one rail bridge. The rail bridge, owned by Southern Pacific, is located approximately 1km downstream from the Eagle Pass Bridge. The vehicular bridge is a two-lane facility, owned by the City of Eagle Pass. On the Mexican side, "Puente Piedras Negras" is owned by the Mexican Government and managed by Caminos y Puentes Federales (CAPUFE). It is open 24-hours a day, seven days a week, and is a toll facility with three southbound toll-booth lanes. The U.S. border station has two commercial primary inspection lanes. As for the other facilities, a recent (1991) expansion and upgrade included:

(1) increasing the existing 10-truck dock to a 25-truck dock, expandable to 50;

(2) expanding the automobile inspection to five primary inspection lanes and twenty secondary inspection lanes; and

(3) upgrading the administration building.

On the Mexican side, the number of Customs' primary inspection lanes for privately owned vehicles (POVs) was recently expanded from 3 to 4, and a primary inspection lane exclusively for trucks was added. There are approximately 10 parking spaces for autos' secondary inspection, which are basically on the streets adjacent to the bridge. About 10 percent of the autos go through secondary inspection, which takes an average of 5 minutes. For trucks, there are approximately 12 to 15 parking spaces (recinto fiscal de entrada) where the documents for random selection are presented. Trucks undergoing detailed inspection go into the import lot, which has capacity for approximately 60 vehicles.

According to field observations, interviews in Eagle Pass, information from our Mexican consultant,[1] and data collected in other studies, the main thoroughfares for the international traffic are Main St., US 57, FM375, FM1021, Loop 431, and Industrial Park Blvd. Garrison Street, an important commercial hub in downtown Eagle Pass, is a mandatory truck and auto route. In addition, many trucks currently utilize Monroe and Adams Streets, and pass such sensitive locations as residential areas, elementary schools, and parks. US57 is the principal thoroughfare because it provides access to the international bridge. FM375 provides access to the Mall de las Aguilas and commercial areas along Main Street, having a heavy international auto demand. The main access to Eagle Pass from Del Rio is Loop 431, while US57 links Eagle Pass to San Antonio. Figure 2.5 depicts the current routes utilized by international trucks.

City officials from Eagle Pass and Piedras Negras have been proposing a second bridge for several years, and a preliminary engineering study and traffic circulation plan and an environmental assessment have been completed (Refs. 2.7, 2.8). According to Eagle Pass city officials, most of the environmental questions have either been officially resolved or will be in the near future. According to Eagle Pass city officials, the major justifications for a second bridge at the site being advocated by both Eagle Pass and Piedras Negras officials include the traffic congestion problem on the approaches to the existing bridge in Piedras Negras and the lack of right-of-way to expand these approach facilities, combined with the inadequacy of truck existing truck routes in Eagle Pass. On the Mexican side, the concession was granted, the right-of-way acquired, and the design completed (Ref. 2.5).

The final design of the new bridge and truck route has not been completed, and the exact alignment is still under scrutiny by the city. The new truck route will emerge from the new bridge and will meet FM 1021 at the intersection with FM 375 (S. Bibb Ave.). The route is supposed to be a five-lane highway with an exclusive left-turning lane. According to the city, the new bridge location has been decided, and although the new truck route alignment and detailed design may change, the overall layout of the new facilities is defined by the dashed lines in Figure 2.5.

A city ordinance prohibiting truck traffic in the old bridge once the new one is open would improve traffic not only in the downtown area, but also on Main Street, Garrison, Monroe, and in other areas that have residential and commercial uses. If the city does not prohibit trucks on the old bridge, the current truck routes will still be used, and FM3443, the proposed truck route, and the section of FM 1021 east of FM3443 will also become international truck thoroughfares.

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[1] Ingeniería Gario, from Saltillo, Coahuila.

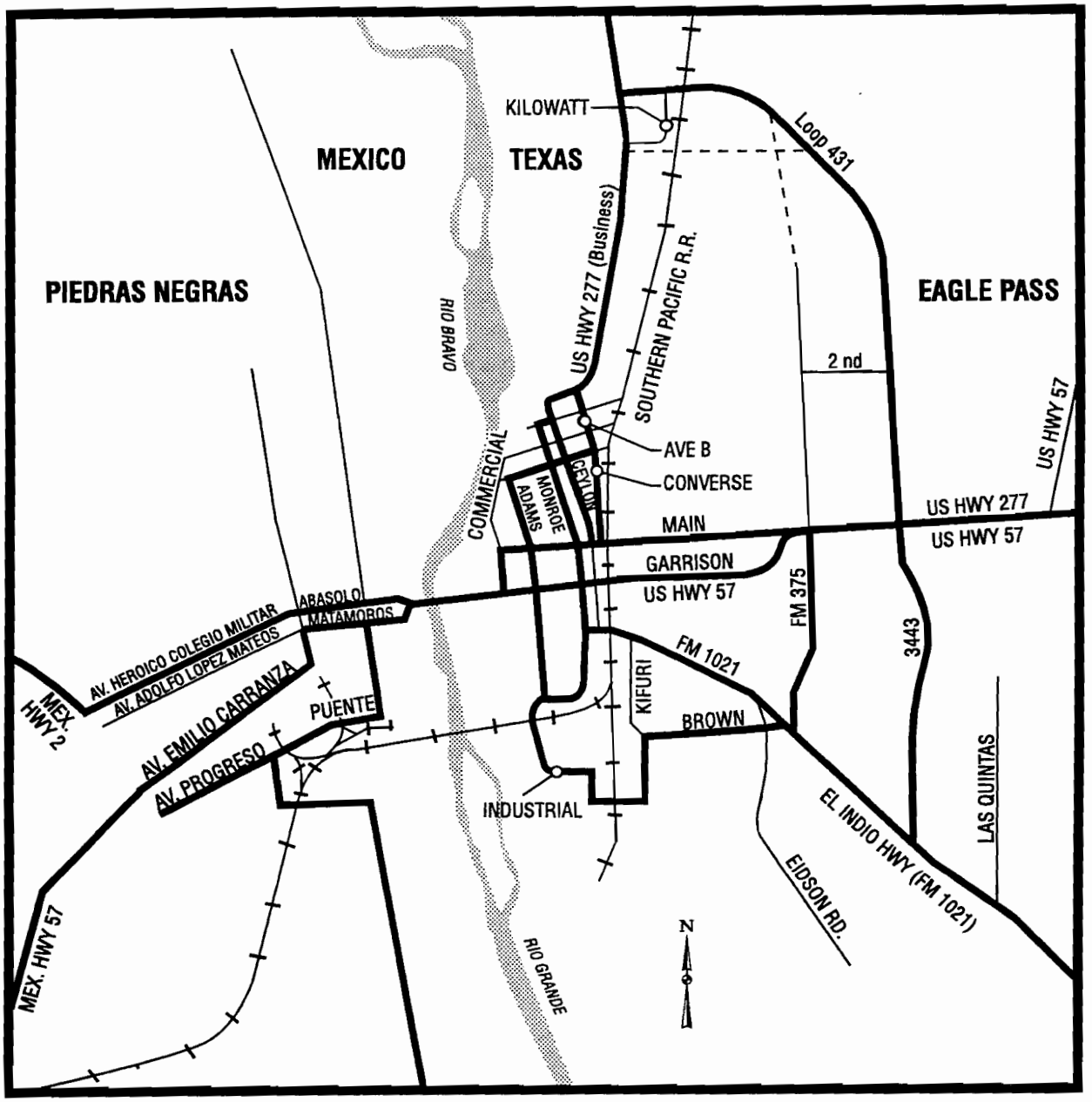


Figure 2.5 International Truck Thoroughfares

Maverick County officials have recently expressed interest in constructing a third bridge north of the city limits at the intersection of Loop 431 and US277 business. But the priorities are different on the Mexican side. Currently, Piedras Negras' preferred site for a third bridge is about 10km south of the existing bridge, linking to a proposed loop around the southern part of Piedras Negras. Eagle Pass feels it is rather premature to discuss a third bridge location, since it expects the second bridge to serve traffic for another 20 years. In Piedras Negras, preliminary locations of the third and fourth bridges appear in a development plans published in 1992 (Ref. 2.9)

DISCUSSION

Eagle Pass had been presenting insignificant or negative auto and truck growth rates for the past 10 years, but between 1993 and 1994 auto traffic grew 1.4 percent in the northbound direction and 2.2 percent in the southbound direction. For trucks, the growth rate is 5 times higher than the 1982–1992 average. The peso devaluation reversed this trend, at least for the first four months of 1995. Rail traffic increased more than vehicular traffic, especially after the peso devaluation.

Pedestrian traffic growth must be interpreted cautiously. A wide variation was found between northbound and southbound directions, a variation that must be due to discrepancies in the data collection process, since pedestrian traffic is exclusively local in nature and is necessarily two-way. In spite of these limitations, the data support field observations indicating a considerable decrease in pedestrian traffic in 1995. Non-commercial traffic data are more consistent in both directions and are more reliable than pedestrian data. Furthermore, given the comparatively high number of non-commercial vehicles, errors in data collection procedures have less impact on data reliability. One caveat: Sometimes it is impossible to know whether transit vehicles are included in the auto data. However, given the insignificance of transborder transit activity, errors in transit counts are small compared with other sources of error.

Commercial traffic growth must be interpreted cautiously, especially in terms of discrepancies between traffic directions. Origin and destination surveys conducted before NAFTA already indicated a percentage of non-local traffic higher for trucks than for autos, but actual origins and destinations of truck traffic on each bridge are still difficult to define with reasonable accuracy (Ref. 2.3). Moreover, although a considerable portion of local truck traffic still reflects pre-NAFTA regulations prohibiting foreign trucks beyond the commercial zone of both the U.S. and Mexico, there is some anecdotal information regarding increasing tendencies to take advantage of the more efficient new rules. Further analyses of truck traffic at the border are important for efficient transportation planning; careful monitoring of this traffic and periodical analyses are recommended.

Results of the 1994–1995 growth analyses are supposed to reflect peso devaluation effects, and interviews in Eagle Pass and Piedras Negras indicated an overall negative impact of the peso devaluation on transborder traffic. However, the values shown in Table 2.3 are based on only four months of data, and it is important keep in mind that extrapolation of early trends to the entire year may result in misleading conclusions that could reflect exactly the opposite of the actual yearly growth. Early peso devaluation impacts may reverse later, and more data as well as further analyses are recommended in order to draw conclusions about the peso devaluation impacts.

The data indicate that NAFTA and the peso devaluation have a tremendous potential to affect transborder traffic demand. However, it is important to keep in mind that changes in a time series after a certain event do not necessarily imply a cause-and-effect relationship. Furthermore, NAFTA is a very recent event; the peso devaluation even more recent. Both have potential to change the export-import patterns, and their effects are probably interrelated. Further studies are necessary, and periodic data monitoring is recommended in order to ascertain exactly how NAFTA and the peso devaluation affect transborder traffic.

REFERENCES

2.1 Hanania, J., A. J. Weissmann, R. Harrison, M. Martello, and B. F. McCullough, *A Comprehensive Overview of the Texas-Mexico Border: Background.* Research Report 1976-1, Center for Transportation Research, The University of Texas at Austin, January 1994.

2.2 Weissmann, A. J., J. Hanania, R. Harrison, and B. F. McCullough, *A Comprehensive Overview of the Texas-Mexico Border: Data Base*, Research Report 1976-2, Center for Transportation Research, The University of Texas at Austin, January 1994.

2.3 Weissmann, A. J., M. Martello, J. Hanania, M. Shamieh, C. Said, R. Harrison, and B. F. McCullough, *A Comprehensive Overview of the Texas-Mexico Border: Traffic Flow Patterns*, Research Report 1976-3, Center for Transportation Research, The University of Texas at Austin, April 1994.

2.4 Weissmann, Angela, Mike Martello, Rob Harrison, and B. F. McCullough, *A Comprehensive Overview of the Texas-Mexico Border: Capacity, demand and Revenue Analyses of Border Segment 1 (Gulf to Laredo)*, Research Report 1976-4, Center for Transportation Research, The University of Texas at Austin, April 1994.

2.5 Weissmann, A. J., M. Martello, B. F. McCullough, and R. Harrison, *A Comprehensive Overview of the Texas-Mexico Border: Capacity, Demand and Revenue Analyses of Border Segment 2 (Eagle Pass to El Paso)*, Research Report 1976-5, Center for Transportation Research, The University of Texas at Austin, April 1994.

2.6 Weissmann, Angela, and Rob Harrison, *Analysis of U.S. Mexico Traffic Through Texas.* Research Report 2932-2, Center for Transportation Research, The University of Texas at Austin, December 1995.

2.7 *The Proposed Eagle Pass International Bridge II: Preliminary Engineering and Traffic Plan*, Hicks and Company, John F. Hickman and Associates, and Groves and Associates, Inc., February 1995.

2.8 *Preliminary Final Environmental Assessment of the Proposed International Bridge Between Eagle Pass, Texas, an Piedras Negras, Coahuila, Mexico*, Groves and Associates, March 1992.

2.9 *Ayuntamiento de Piedras Negras. Plan Director de Desarrollo Urbano*, SEDESOL, Gobierno del Estado de Coahuila, 1992.

CHAPTER 3. NETWORK ANALYSIS

BACKGROUND AND OBJECTIVES

Traffic demand within all major hubs in Eagle Pass can be classified according to at least two categories: local and international; a third category — tourism — can be added if the nearby casino expands in the future. International traffic data and existing international thoroughfares were discussed in detail in Chapter 2. This chapter documents and discusses the available data on the other two traffic categories (local and casino traffic), and presents traffic forecasts under the three different study scenarios (reference, low-impact, and high-impact). The chapter then discusses the use of these data to:

(1) define the study network;
(2) develop traffic projections for local traffic;
(3) develop traffic projections for new tourism (casino) traffic;
(4) assign projected traffic to existing network; and
(5) identify and discuss current traffic circulation problems in Eagle Pass.

These five steps provide the necessary basis for developing a traffic circulation and long-range plan for Eagle Pass. They necessarily start with the definition of a study network to be analyzed.

STUDY NETWORK

The study network was defined based on major international thoroughfares, field observations, land use, and interviews with relevant individuals in Eagle Pass. Data availability also played a secondary role in the decision to include (or exclude) some local streets in the study network. Figure 3.1 depicts a schematic representation of the Eagle Pass study network (in heavy lines). The study network includes all TxDOT-maintained freeways, international traffic routes, and other major thoroughfares where recommendations for future changes are possible to implement. The downtown area, also part of the study, is shown in Figure 3.2. It also includes new facilities that will be built in the near future, represented by dotted lines. These facilities include the proposed bridge and truck route, as well as the new Eagle Pass expansion plan (northern part), which has already been accepted by the planning and zoning commission and is awaiting approval from the council. This plan will extend Kilowatt and Bibb Avenues up to Loop 431. A new civic center is planned at the corner of Loop 431 and Second Street, which will be extended to meet US57. The city is also considering extending Ryan Street up to US277B (at its intersection with Loop 431); however, this facility would be in the Rio Grande flood plain.

US57 (Garrison) provides direct access to the existing international bridge; it is the major arterial of the city (see photos 3 and 4 in Appendix 1). Main Street is an important commercial street partly located in the downtown area (photos 30, 31, 32, 33, 34, 35, and 36 in Appendix 1).

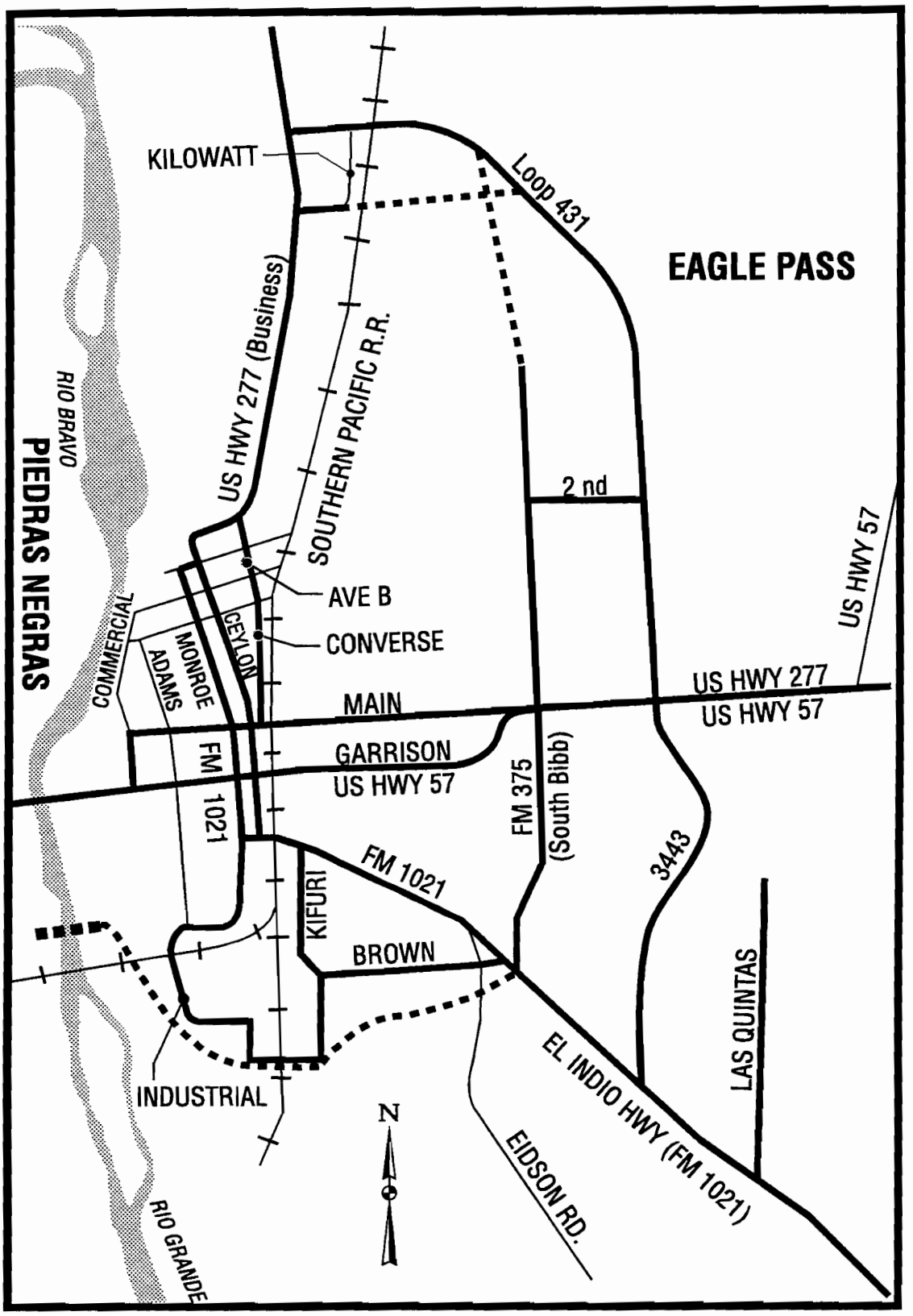


Figure 3.1 Study Network

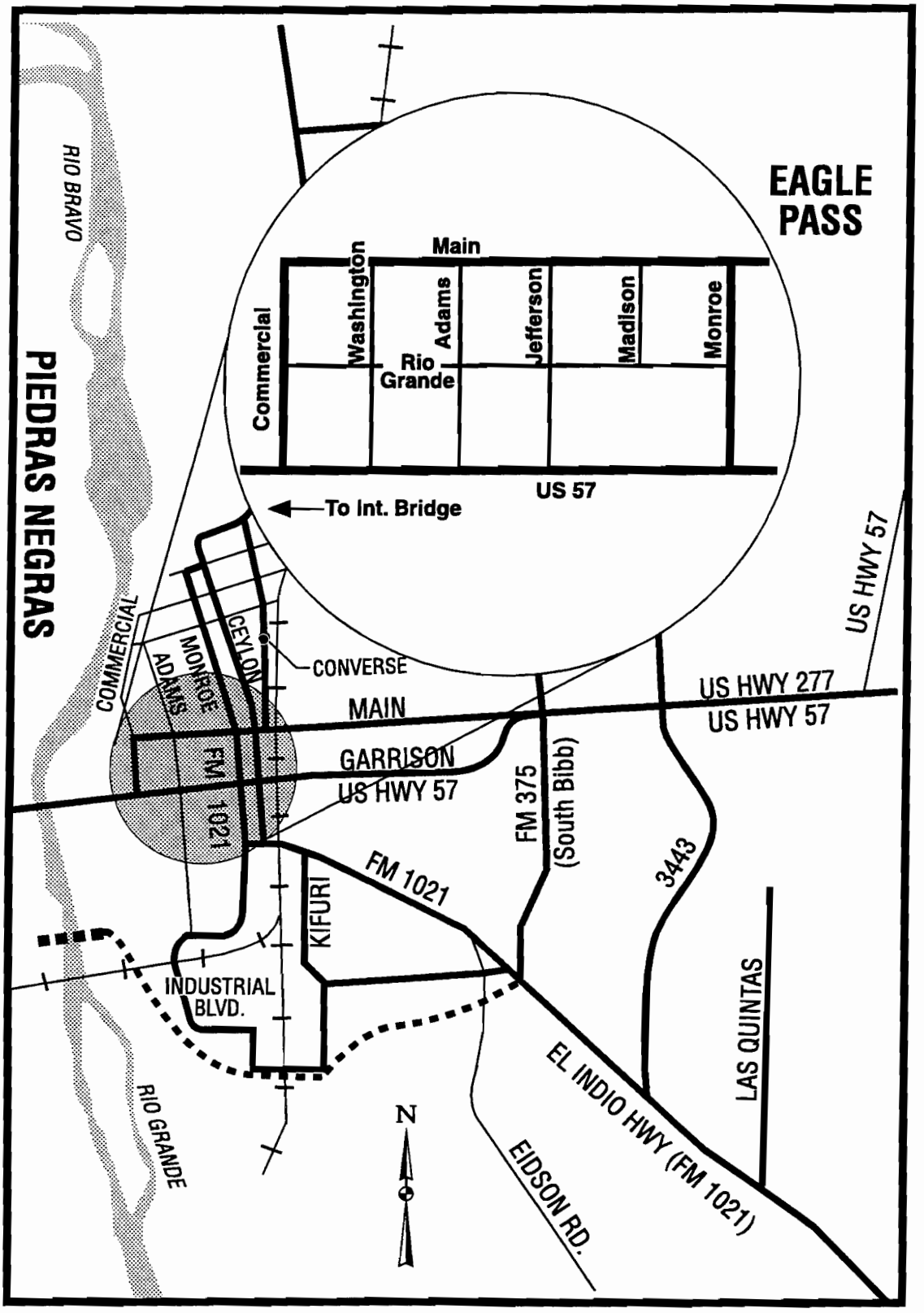


Figure 3.2 Study Network — Downtown Detail

Loop 431 connects US57 and US277 business (see photos 22 and 23). FM375 is an important commercial arterial that provides access to the Mall de Las Aguilas (see photos 6, 8, and 24). FM3443 connects US57 to FM1021 and to Loop 431. Industrial Park Blvd. serves the industries and warehouses; the city feels that truck traffic with origins and destinations in this area is almost as heavy as international truck traffic with origins and destinations outside Eagle Pass (see photos 38 and 39). US57 is the preferred route from Eagle Pass to San Antonio, and traffic from Del Rio uses US277 (see photos 5, 7, 15, 16, 17, 18, 19, 20, and 21). Not shown in the area covered by Figure 3.1 is the Rosita Valley Road, which currently provides the only access to the proposed casino relevant to the high-impact study scenario. It begins at the FM1021 intersection located about 15km southeast of Eagle Pass and ends in the Kickapoo Indian Reservation.

TRAFFIC DATA

As stated previously, traffic demand in Eagle Pass can be classified according to at least two categories: local and international; a third category — tourism — can be added if the nearby casino expands in the future. International traffic data and existing international thoroughfares were discussed in detail in Chapter 2. This section discusses the local and casino-related traffic demands.

Local Traffic Data

Local traffic histories are available from TxDOT's automatic traffic recorders (ATR) and traffic maps (Refs. 3.5, 3.6). A ten-year historical series (1984 to 1993) was retrieved for each location where either ATR data or AADT estimates were available. Although the series are interrupted for some locations, the overall data are sufficient for estimating historical traffic growth rates in major hubs. Data from ATR stations are continuously recorded throughout the year; therefore, they include hourly counts, high-hours, and actual AADT. Table 3.1 summarizes available local traffic data. As shown, there are no classification of vehicle data; truck percentages were estimated based on the number of international trucks, the limited manual classification counts taken during a field trip, and on assumptions made regarding traffic composition.

Traffic projections and assignment to the network were performed iteratively by successively applying growth rates to a network segment until it reached saturation. Local traffic was projected based on historical growth rates, except where the past growth rates seemed to reflect demand development (Loop 431). Table 3.2 shows the average observed growth rates in roadway sections where at least one year of AADT data are available. These sections are shown in Figure 3.3. The numbers in Table 3.2 match those in Figure 3.3.

The observed growth rate on Loop 431 (East of US 277) was 18.66 percent. This represents latent demand for a new facility. It was assumed that diversion to this 431 segment comes primarily from US 22 business. Traffic almost doubled within this 431 section in the last five years. The growth on the other two legs of this intersection was found to be 3.59 and 2.79 percent. Based on these figures, and assuming that most of the latent demand has developed, a growth rate of 6 percent was assumed for this segment in the traffic assignment phase. For

FM1021 and FM3443 sections number 16 and 18, there was only one year of data, and AADTs were projected assuming a 4-percent yearly growth.

Table 3.1 Scope of Local Traffic Data

Location	Source	Hourly Counts	Classification Counts	AADT
ATR Station-S029: US 277 (12km S of SH 131)	TxDOT	Yes	No	Yes
At Commercial Street	TxDOT	No	No	Yes
Intersection of Garrison (US57) and Highway Blvd. (on three legs)	TxDOT	No	No	Yes
Main Street, between Commercial and Highway Blvd (FM1021).	TxDOT	No	No	Yes
Intersection of Main St. and US 277B (2 legs)	TxDOT	No	No	Yes
Intersection of US 277 and Loop 431 (3 legs)	TxDOT	No	No	Yes
Highway Blvd. (FM1021) and FM375 (3 legs)	TxDOT	No	No	Yes
Intersection of US57 and S. Bibb Ave.	TxDOT	No	No	Yes
Intersection of US 57 and Loop 431 (3 legs)	TxDOT	No	No	Yes
Intersection of FM1021 and FM3443	TxDOT	No	No	Yes

Origin and Destination Data

Qualitative origin and destination information was collected during field trips, interviews, meetings (with city officials, TxDOT Maintenance Office, chamber of commerce, private enterprises), and through field observations. This information was used to assign trips to the network, based on additional assumptions discussed later in this report. The only origin and destination (O&D) survey available for Eagle Pass was conducted by CTR for a regional transportation planning study (Refs. 3.7, 3.8). This survey was conducted in 1993 at the southbound bridge access, and the sample included 483 autos and 15 trucks (about 35 percent of the AADT). Information gathered consisted of O&D disaggregated by Texas and Mexican cities, trip frequency, trip purpose, and state in which the vehicle was licensed.

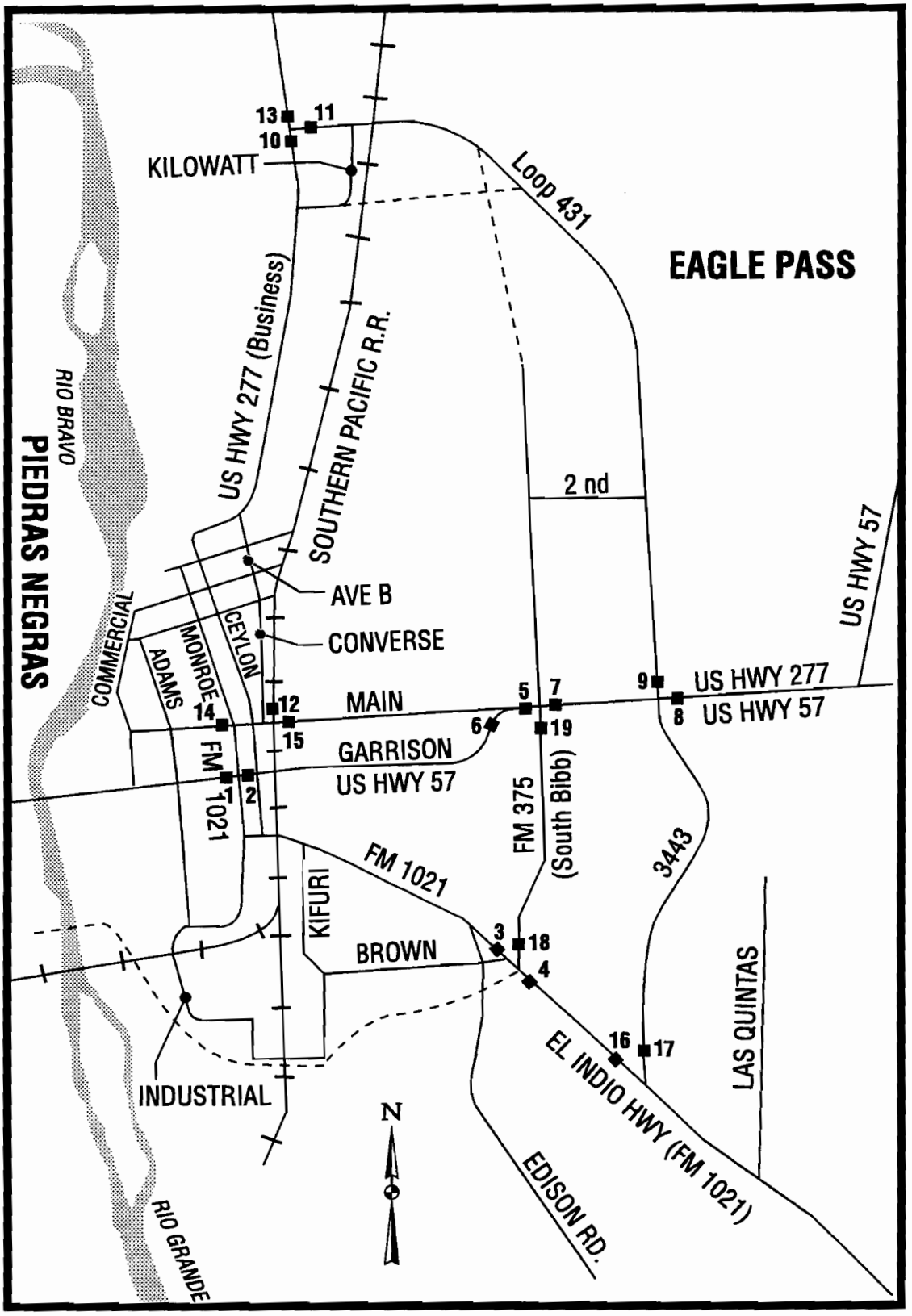


Figure 3.3 Locations of Available AADT Data

Table 3.2 Observed Historical Growth Rates

Location	Growth Rate
1. US 57 (Garrison) West of FM 1021	0.93%
2. US 57 (Garrison) East of FM 1021	-0.01%
3. FM 1021 West of FM 375	4.15%
4. FM 1021 East of FM 375	8.95%
5. US 57 West of FM 375	11.90%
6. US 57 South of Main St.	8.57%
7. US 57 East of FM 375	2.98%
8. US 57 East of Loop 431	8.12%
9. Loop 431 North of US 57	5.20%
10. US 277B South of Loop 431	2.73%
11. Loop 431 East of US 277B	18.66%
12. US 277B North of Main St.	4.32%
13. US 277 North of Loop 431	3.59%
14. Main St. West of US277B	3.64%
15. Main St. East of US277B	2.74%
16. FM 1021 West of FM3443	n/a*
17. FM 3443 North of FM 1021	n/a*
18. FM 375 North of FM 1021	4.20%
19. FM 375 South of US 57	5.52%

* Only one year of data available

Table 3.3 Observed Hourly Distribution

Time	Surveyed Trips	Percentage of AADT
6:00 a.m.- 7:00 a.m.	15	3.1
7:00 a.m. - 8:00 a.m.	74	15.3
8:00 a.m. - 9:00 a.m.	118	24.4
9:00 a.m. - 10 a.m.	25	5.2
10:00 a.m. - 11 a.m.	99	20.5
11:00 a.m. - 12:00 p.m.	41	8.5
1:00 p.m. - 2:00 p.m.	6	1.2
2:00 p.m. - 3:00 p.m.	105	21.7

Source: Weissmann et al., Ref. 3.7

For autos, the data show a morning peak from 8:00 a.m. to 9:00 a.m., a second peak from 10:00 a.m.-11:00 a.m., and another peak from 2:00 p.m. to 3:00 p.m. The survey ended at about 4:00 p.m., and it excluded the evening peak. While truck samples were small, data indicate a morning peak period from 8:00 a.m. to 10:00 a.m., and an afternoon peak period after 2:00 p.m. Table 3.3 summarizes the observed hourly counts.

The survey results indicate that over 80 percent of the auto trips and 60 percent of the truck trips are from Eagle Pass to Piedras Negras, and 90 percent of the auto and truck trips have at least one local origin or destination (Eagle Pass or Piedras Negras). Only 10 percent of the trips had both origin and destination beyond the two sister cities. Auto and truck results are summarized in the O&D matrices depicted in Tables 3.4 and 3.5, respectively. All origins and destinations other than Eagle Pass and Piedras Negras are grouped into "other," and are summarized in Table 3.6. The "other" category includes any origin or destination having less than 5 percent occurrence.

Table 3.4 Auto Origin/Destination Matrix

Origin	**Destination**		
	Piedras Negras	Other	Total (Origin)
Eagle Pass	390	40	430
	81%	8%	89%
Other	44	9	53
	9%	2%	11%
Total (destination)	434	49	483
	90%	10%	100%

Source: Weissmann et al. (Ref. 3.7)

Table 3.5 Truck Origin/Destination Matrix

Origin	**Destination**		
	Piedras Negras	Other	Total (Origin)
Eagle Pass	9	2	11
	60%	13%	73%
Other	4	0	4
	27%	0%	27%
Total (destination)	13	2	15
	87%	13%	100%

Source: Weissmann et al. (Ref. 3.7)

Table 3.6 "Other" Origins and Destinations

Other Origins	Other Destinations
El Indio (2) - Houston (1) - La Pryor (3) - Laredo (1) - Los Angeles (1) - McAllen (1) - Mississippi (1) - Quemado (1) - San Antonio (18) - Uvalde (4) -	Acuna (3) - Allende (7) - Celya (1) - DF, Mex (1) - Juarez (1) - Monclova (3) - Monterrey (1) - Morales (1) - Morelos (1) - Muzquiz (3) - Nava (7) - Nueva Rosita (2) - Rio Escondido (7) - Rosita (1) - Sabinas (6) - Saltillo (2) - San isidro (1) - Zaragoza (1)

Source: Weissmann et al. (Ref. 3.7)

Weekly frequencies for auto trips are depicted in Table 3.7 and 3.8, respectively, for non-business and business trips. There are seven instances of unknown trip purposes, which are due to the refusal of some travelers to answer this question. Over 80 percent of non-business trips are undertaken either fewer than three times a week or seven or more times a week, while over 40 percent of all business trips are undertaken seven or more times a week, and less than 30 percent are taken fewer than three times a week. The non-business trip frequencies include numerous school-related trips and other personal purposes, while the daily or more business-trip frequency may indicate individuals commuting to work.

Table 3.7 Non-Business Auto Weekly Frequencies

Frequency Category	Recorded Trips	Percentage	Cumulative Trips	Cumulative Percentage
<1	76	26%	76	26%
1≤FQ<2	57	20%	133	46%
2≤FQ<3	63	22%	196	67%
3≤FQ<4	25	9%	221	76%
4≤FQ<5	11	4%	232	80%
5≤FQ<6	12	4%	244	84%
6≤FQ<7	3	1%	247	85%
≥7	38	13%	285	98%
N/A	7	2%	292	100%
Total	292	100%		

Source: Weissmann et al. (Ref. 3.7)

Table 3.8 Business Auto Weekly Frequencies

Frequency Category	Recorded Trips	Percentage	Cumulative Trips	Cumulative Percentage
<1	18	10%	18	10%
1≤FQ<2	14	8%	32	17%
2≤FQ<3	19	10%	51	28%
3≤FQ<4	18	10%	69	38%
4≤FQ<5	7	4%	76	41%
5≤FQ<6	16	9%	92	50%
6≤FQ<7	10	5%	102	55%
≥7	78	42%	180	98%
N/A	4	2%	184	100%
Total	184	100%		

Source: Weissmann et al. (Ref. 3.7)

Table 3.9 shows the weekly frequency for truck trips. Over 50 percent of the trucks make seven or more trips per week. This reflects the drayage companies' practice of conveying cargo from one side of the border to the other. This practice is no longer necessary in 1996, and extrapolation of truck O&D results obtained from pre-NAFTA data may no longer be valid.

Table 3.9 Truck Weekly Frequencies

Frequency Category	Recorded Trips	Percentage	Cumulative Trips	Cumulative Percentage
<1	1	7%	1	7%
1≤FQ<2	2	13%	3	20%
2≤FQ<3	3	20%	6	40%
3≤FQ<4	1	7%	7	47%
≥7	8	53%	15	100%
Total	15	100%		

Source: Weissmann et al. (Ref. 3.7)

Average auto occupancy rates were 1.42 and 1.93, respectively, for business and non-business auto trips. Over 60 percent of auto respondents indicated non-business trip purposes, while 38 percent indicated business-related trips (seven respondents refused to answer). Trips to take children to or from school and personal shopping trips are considered non-business trips. Over 56 percent of all auto plates are from Texas, and 37 percent are from Coahuila, the two states linked by the Eagle Pass Bridge. The truck sample size was too small to allow meaningful conclusions. There were twelve (80 percent) Texas plates, two (13 percent) Mexico City plates,

and one (7 percent) Coahuila plate. Owing to the small truck sample size, these latter truck percentages are not statistically significant.

Tourist (Casino) Traffic

Demand for the proposed casino was estimated based on information from Mr. Robert de la Garza, tribal administrator for the Kickapoo Indian Reservation. According to Mr. de la Garza, the casino will begin operating in 1997, and will have a 2000-vehicle parking lot. Expansions will depend on initial success.

Actual demand for this type of tourist attraction is very difficult to predict with accuracy. Our Mexican subcontractor estimated that a significant percentage of the Mexican population would be attracted to a casino near the border and would be willing to drive, on a weekly basis, for up to three hours to reach this casino.

The actual percentage of the population attracted to the casino is unknown, and these uncertainties were the basis for the two scenarios (high and low impact). In the low-impact scenario, the casino demand is trivial, strictly local, and restricted to off-peak hours (between 7:00 p.m. and 3:00 a.m.). Its impact on Eagle Pass traffic demand is minimal and can be easily absorbed by the excess capacity available during the off-peak hours.

In the high-impact scenario, the casino will be more successful in attracting customers from both sides of the border. Its demand can have an impact on traffic circulation and thus should be added to the other two categories (local and international). Actual numbers are unknown, and estimated demand relies on the following assumptions:

(1) Casino demand will be half from Coahuila and half from Texas; demand from other states is trivial in both scenarios.

(2) The minimum gambling age is 21.

(3) Seventy percent of the population is over 21 years of age, and 4 percent of the employed population is over 21 years of age.

(4) Initially, demand for Piedras Negras and Eagle Pass is 8 percent of the adult population.

(5) Future demand for Piedras Negras and Eagle Pass will be 4 percent of the adult population after the year 2000.

(6) The demand from other locations will consist of 5 percent of the adult population for the first 2 years, and 2 percent after that.

(7) The average vehicle occupancy is two persons per vehicle.

(8) The casino traffic will be distributed over 3 hours as follows: 20 percent from 5 to 6 p.m., 50 percent from 6 to 7 p.m., and the remaining 30 percent from 7 to 8 p.m.

(9) The casino will close no earlier than 3:00 and no later than 5:00 a.m., and the excess capacity at these hours will be enough to absorb the traffic throughout the analysis period considered in this study.

(10) Population will grow at historical rates in both Texas and Coahuila;

(11) In addition to the auto traffic estimates based on the assumptions above, there will be bus service to the Casino from Piedras Negras with an average headway of 30 minutes during the casino peak-hours (see item 8), less after that (12 buses per day in all).

The source of Mexican data was the Annual Statistics of the State of Coahuila, 1994 (Ref. 3.4). The Mexican demand included the adult population of Acuña, Allende, Guerrero, Jimenez, Morelos, Nava, Piedras Negras, Villa Unión and Zaragoza. These cities are all located no further than 150km from the casino. Based on the advice from our Mexican Consultant, it was assumed that the demand will be higher for the first two years, stabilizing at 2 percent after 2000, for all cities except Piedras Negras and Eagle Pass (4 percent). Table 3.10 shows a summary of the casino traffic demand estimates for the peak-hours of operation (assumption number 8).

Table 3.10 Estimated Casino Demand

Year	Origin of Demand		
	Coahuila	Texas	Total
1997	2012	2012	4024
2000	1000	1000	2000
2010	1219	1219	2438
2020	1485	1485	2970

TRAFFIC ASSIGNMENT

Once non-constrained AADT projections were estimated for the three components of the traffic demand (local, international and casino), auto and truck routes were assigned to the network, and saturation levels were verified using estimates of arterial and intersection capacities and LOS. The assignment was made based on a combination of information from interviews, results of the O&D survey discussed earlier in this chapter, field observations, and information from other studies (Refs. 3.1, 3.7, 3.8).

Hourly Traffic Volumes

Traffic forecasts were made in terms of AADT, but traffic assignment requires hourly traffic volumes, which were estimated based on equation 3.1 (from Ref. 3.2).

$$DHV = \frac{AADT \cdot D(d) \cdot K}{[\, P(t) \cdot E(t) + 100 - P(t) \,]} \qquad (3.1)$$

where:

DHV = design hourly volume, (vehicles per hour, or vph),

AADT = average annual daily traffic,

D(d) = directional distribution (percent traffic in each way),

K = fraction of AADT during the design hour,

P(t) = percentage of trucks in traffic stream, and

E(t) = equivalence factor for trucks.

The only source of hourly traffic data in Eagle Pass is TxDOT Automatic Traffic Recorder (ATR) station S029, located on US277, 12km south of SH131. This location is not representative of urban traffic distributions. The K-factor observed at this station was 9.4 percent, while available hourly distributions in urban areas of similar size may lead to K-factors as high as 15 percent. For example, based on data collected by TxDOT in Del Rio specifically for this project, the K-factor is around 12 percent. During a field trip to Eagle Pass, CTR took 15-minute counts at two intersections: Main Street at Ceylon (4:30 to 4:45 p.m.) and US57 at Loop 431 (two sets, 10:00 to 10:30 a.m.). The average K-factor between these two locations and times was about 11 percent. This project used K=12 percent for two reasons: to account for the mid-morning set of counts (which may underestimate the K-factor), and because Del Rio data, which are more comprehensive, resulted in a value of 12 percent.

Truck traffic estimates were based on the following available information: percent of trucks in international traffic, qualitative estimates of the percent trucks at major Eagle Pass trade routes, and TxDOT estimates obtained from the Transportation Planning Office. The actual percent trucks in the traffic stream varies with the route, and was determined interactively during the traffic assignment, based on an initial estimate of 2.5 percent.

Other assumptions were also necessary regarding the other parameters in equation 3.1. The directional distribution was assumed to be 60 percent, except on segments where directional counts were available, namely, US 57, US 277B, Loop 431, Hwy. 3443, and Main Street. The truck equivalence factor to convert trucks into car-equivalents based on potential for causing traffic congestion (using criteria set forth in Chapter 9 of Ref. 3.2) was assumed to be equal to three.

Levels of Service and Capacity Analyses

Capacity of a roadway or a lane is defined as the maximum traffic volume that the given facility can carry at its present conditions, usually during one specific hour (Ref. 3.2). An increase in capacity requires improvements either in the physical characteristics of the roadway, or on the traffic conditions it is subject to, or both. Levels of service (LOS) are used to classify the quality of the traffic flow by assigning a letter from "A" to "F," where "A" corresponds to free flow and "F" corresponds to gridlock congestion (Ref. 3.2). The following applications of a LOS and capacity analyses of the network are relevant to this study:

(1) detect deficiencies in the existing highway system,

(2) simulate the network under capacity-restrained conditions,

(3) determine the levels of service, which are a function of the capacity utilization of a facility, and

(4) identify problems and propose changes in the existing highway system, traffic circulation, signalization, and traffic operations.

The capacity and LOS analyses included intersections and roadway segments. According to the 1994 Highway Capacity Manual (Ref. 3.2), intersection levels of service (LOS) can be assigned based on the intersection stopped time delay per vehicle. This method was used in this project.

As for arterials, there are two methods for assigning LOS to lane groups, both of which were used. The first method is based on volume-to-capacity ratios. Capacities are estimated by correcting the ideal saturation flow rate (passenger car per hour of green time, per lane, or *pcphgpl*). Saturation flow rates are corrected based on several factors, which in turn require some unavailable data, such as turning movements and vehicle classification. Eagle Pass' major intersections are actuated. Non-actuated signal data are available, but were received close to the end of the project. Capacity estimates were based on field observations for cycle lengths, as well as on the following assumptions for values of green time per cycle (based on Ref. 3.2)[1]:

0.60 for major arterial, 0.40 for cross street, and

0.50 for each side if both are major arterial.

Assuming a range of possible data for the correction factors, all capacities resulted in between 680 and 1100 pcphpl, a range whose mid-point is close to 800pcphpl, a value recommended in Ref. 3.2 for urban arterials in average conditions. These capacity values were used to estimate volume-to-capacity ratios (v/c), which in turn were used to assign LOS to the arterial segments. The v/c method has the advantage of providing capacity utilization estimates; in this case, however, v/c estimates are based on several assumptions about the correction factors. Moreover, all available traffic data are at intersections, so all v/c calculations are implicitly assuming that intersection traffic data are valid for the entire arterial segment beyond the intersection. In order to verify this assumption, arterial capacities were re-estimated based on the average arterial speed, using criteria for urban and suburban arterials (Ref. 3.2). The average arterial speeds were calculated by dividing the length of the arterial segment by the time to travel the segment, including the stopped time at intersections. The running times were calculated theoretically, then verified and adjusted using field observations.

Analysis Approach and Study Scenarios

An ideal traffic circulation study would require a myriad of traffic data that include hourly traffic distributions in each network segment, turning movements at each major intersection, average and peak-hour impedances (travel times) at each network segment, vehicle classification

(1) Non-actuated signal data are available, but were received close to the end of the project.

data, and a detailed origin and destination matrix for auto and truck trips. Since Eagle Pass is a border city where international traffic is an important component of the local demand, and where a new bridge is expected to be constructed, the study network—and thus all the data listed above—must also include all parts of Piedras Negras that are relevant to international traffic circulation. Such detailed data are not readily available and could not be collected within the time and budget constraints of this study. Our traffic analysis approach took advantage of the available traffic data and existing traffic projections, and used those to project traffic into the future and assign it to the network.

The analysis and assignment of projected traffic volumes are based on a review of three scenarios of traffic demand development that may occur. These scenarios are:

(1) *Reference scenario*: This scenario projects and assigns traffic volumes to the existing infrastructure only; this is a theoretical scenario used only to identify potential problems and analyze the impacts of the proposed infrastructure improvements.

(2) *Low-impact scenario*: This scenario projects and assigns traffic volumes considering the proposed second bridge and truck route, and the Kilowatt and Bibb extensions, assuming that the tourist traffic component (casino) is small.

(3) *High-impact scenario*: This scenario projects and assigns traffic volumes considering the proposed second bridge and truck route, and the Kilowatt and Bibb extensions, assuming that the tourist traffic component (casino) is significant.

The formulation of a traffic circulation plan for the city of Eagle Pass consists of several phases, or tasks, which include preliminary data collection, traffic projection, capacity analysis, capacity utilization and field surveys. A critical examination of these data provides sufficient information to define the problem, identify current and potential traffic circulation deficiencies, and develop preliminary recommendations. These recommendations are refined based on the results of further traffic assignments to the "improved" network, in an iterative process that results in final recommendations.

TRAFFIC CIRCULATION DEFICIENCIES AND PRELIMINARY RECOMMENDATIONS

The levels of service (LOS) assigned according to the approach described above assist in the identification of traffic circulation problems in Eagle Pass. In the first step, the LOS were assigned to the reference case, which includes exclusively the existing infrastructure. The impacts of the planned and recommended infrastructure are discussed in the other study scenarios.

Besides the assumptions necessary to project AADT data and convert them to hourly volumes, traffic assignment to the roadway system required several assumptions about local origin and destination of the traffic and future land use. Among those, the following assumptions merit specific discussion:

(1) The international truck traffic entering Eagle Pass goes primarily through US57. Some of the trucks go to Industrial Park using FM1021, and from there they use FM1021, FM375 and Loop 431.

(2) International auto traffic uses primarily US57. From US57 they go to Main St. and FM375 for their shopping and business purposes.

(3) Eagle Pass future land use will follow the current patterns, and the city will expand primarily in the northern part.

In order to interpret the LOS results correctly, it is important to keep in mind that the only intersection/arterial interaction reflected in LOS presented here is the effect of intersection delays in arterial speed. Actually, the interactions are more complex than that. For example, poor traffic flow at arterial segments (such as that occurring at entrances to busy facilities) can also hinder efficient traffic circulation at the nearest intersections. This and other types of "second degree" interactions are not reflected by the LOS presented in Table 3.11. The objective of these levels of service was to investigate the causes of poor traffic circulation, which in turn requires that each intersection and arterial segment be examined independently.

Reference Scenario LOS

Table 3.11 depicts the current and future levels of service obtained for arterial segments and intersections in the reference scenario. The specific locations of these intersections are shown in Figure 3.4. For arterials, the levels of service are depicted in Figures 3.5 through 3.8, respectively, for years 1995, 2000, 2010, and 2020.

Table 3.11 Reference Scenario LOS

Int. No[1]	Arterial Segment	Arterial LOS				Intersection LOS			
		1995	2000	2010	2020	1995	2000	2010	2020
1	US 277 Business (NB)	B	C	F	F	B	E	F	F
2	US 277 Business (SB)	B	C	F	F	C	E	F	F
3	Loop 431 (NB)	A	B	F	F	B	E	F	F
4	Loop 431 (SB)	A	B	F	F	C	F	F	F
5	FM 375 (NB)	B	C	E	F	B	B	F	F
6	FM 375 (SB)	B	C	D	F	B	B	F	F
7	FM 3443 (SB)	A	A	B	C	B	B	B	D
8	Main St.WB, US57 to Ceylon	B	C	D	F	B	C	F	F
9	Main St.EB, Commercial to Ceylon	B	C	D	F	B	C	F	F
10	FM1021(US57 to FM375)	A	B	D	F	B	B	E	F
11	FM1021(FM 375 to FM 3443)	A	B	F	F	B	C	F	F
12	US57 EB (FM1021 to FM375)	B	C	F	F	B	E	F	F
13	US57 WB (FM 375 to FM 1021)	A	C	F	F	B	B	F	F
14	US57 WB (FM 375 to Loop 431)	B	C	F	F	B	F	F	F
15	US 57 (East of Loop 431)	B	C	F	F	B	C	F	F
16	US277(N of Loop 431)	B	C	F	F	C	C	F	F

[1] See Figure 3.4 for intersections.

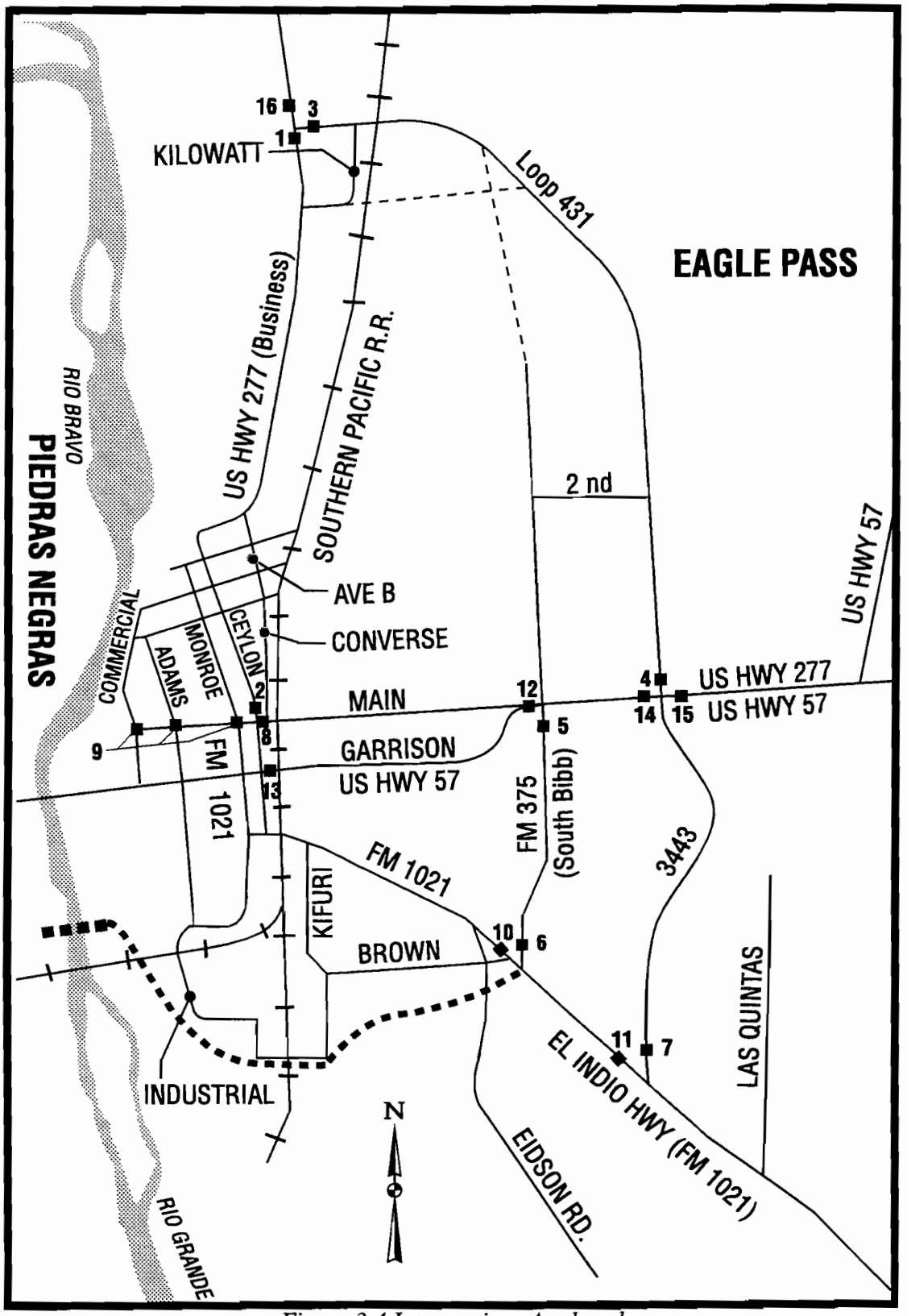


Figure 3.4 Intersections Analyzed

In 1995, Eagle Pass intersections were still performing at a satisfactory level of service, with the exception of some legs of US277 at Loop 431, US277B at Main Street, and Loop 431 at US57. These intersections are already nearing capacity. In the year 2000, the north and south ends of Loop 431 will reach levels E and F, respectively, both on the Loop (intersections 3 an 4 in Fig. 3.4 and Table 3.11) and on US277 business (intersections 1 and 16 in Fig. 3.4 and Table 3.11). US57 business LOS will be E at its intersection with Main Street. Loop 431 itself can serve traffic rather well if back-ups at the intersections are corrected (arterial LOS is in the lower limits of B). Main Street will need attention both in its intersections and its lanes, which will be at high and low limits of level C, respectively. The only arterials that will still be either A or B by 2000 are Loop 431, FM1021, and FM3443 (under the assumption that Eagle Pass will expand primarily to the north).

The levels of service predicted for the year 2010 definitely indicate that, unless Eagle Pass growth stops (and this seems an unlikely hypothesis), the only arterial that will remain at a satisfactory LOS is FM3443, and only under the assumption that the southern part of town will remain sprawled and that growth will be in the northern part. Main Street lanes will have a theoretical LOS of D, but since its intersections are rather closely spaced and are all at LOS F, one would experience an overall LOS more similar to high E or low F. In 2020, there will be gridlock congestion in all major highways if no additional infrastructure is provided.

Traffic Circulation Deficiencies

During field trips to Eagle Pass, we verified the results discussed above. The peso devaluation has decreased downtown traffic demand, but demand for the Mall was less affected. The city believes that a sudden traffic increase of 40 percent is not unrealistic once the Mexican economy absorbs the impacts of the peso devaluation. According to bridge managers, international traffic peak hours for autos are as follows:

7:00-10:00 a.m.	Cars and Pedestrians
12:00 noon	Both directions for lunch
3:00-6:00 p.m.	Shopping (photo 29 in Appendix 1)
Weekends	Constant throughout the day

Traffic is generally heavier during 4:00-6:00 p.m. on weekdays, and international traffic is heavy on weekends. Truck traffic is heavier between 9:30 and 11:00 a.m., 1:30 and 4:00 p.m., and after 5:30 p.m. One important hindrance for free traffic flow is the train schedule: 8:00 a.m., 12:00 noon, and 5:00 p.m., which coincides with peak hours for both local and international traffic (see photo 38 in Appendix 1).

Main Street has heavy traffic near the downtown area, and the capacities are not adequate, especially due to the parking lanes, which are protected by curb extensions that hinder the turning maneuvers and which decrease available capacity (see photos number 30, 31, 32, 33, 34, 35 and 36 in Appendix 1). Downtown parking availability is viewed as important by the public, and the

city is trying to schedule a hearing to determine the viability of increasing Main Street capacity by prohibiting parking. Main Street's lanes need painting and maintenance.

FM375 (S. Bibb Ave.) is a four-lane arterial, but traffic attracted by the Mall de las Aguilas hinders traffic flow, especially left turns. The right-angle turn on US277 Business near Ceylon Street is hazardous for traffic and reduces both speed and capacity (see photos 13 and 14 in Appendix 1). Industrial Park Blvd. is an important route for the truck traffic, but its alignment is too meandering for trucks (see photos 38 and 39 in Appendix 1).

The signals along US57 (Garrison) and its cross streets are not synchronized, a fact that often results in long queues on the cross streets. This situation sometimes cause the queues to spill back on US57 (a busy arterial), hampering its traffic flow.

Basic Recommendations

Major routes such as Garrison, FM1021, Bibb, and Loop 431 have sufficient right-of-way for expanding at least the intersections. But there are some limitations. The Rio Grande flood plain and the local topography preclude infrastructure expansion north and west of Commercial Street. There is a steep slope along the flood plain, and the elevation of the present development is rather high. Ryan Street may be viable topographically, but it is located in the flood plain area.

Recommendations must avoid new at-grade intersections with the Union Pacific railroad, because current state law provides that a new at-grade intersection with a rail line can be built only if two others are either grade-separated or closed. Given these limitations, the analysis discussed above indicates that at least the following segments and intersections need additional capacity or other improvements:

(1) **Industrial Park Blvd.** needs pavement rehabilitation and improvement of its design (as much as possible).

(2) **Main Street** should be a one-way street westbound from Monroe St. up to Commercial Street. Parking should be prohibited, and the projected curbs should be removed. It also needs lane markings.

(3) **US277 (Business).** The right angle at Ceylon Street should be replaced by a smoother curve (see photos 13 and 14 of Appendix 1). US277B section between Ceylon and Avenue B should have lane markings indicating four lanes (rather than the current two).

(4) **FM375 (S. Bibb Ave.)** should have an exclusive left-turning lane, especially along the access to the mall.

(5) **Loop 431** traffic demand is expected to increase once the city starts expanding on the north, and right-of-way for future expansions should be secured.

(6) **Intersection of US57 and FM375** needs another lane on the FM 375 leg, and the exclusive right-turning lane should be a shared right-turning lane (photos 5, 6, 7, and 8 in Appendix 1).

(7) **Intersection of Main Street and US57 (Garrison)** is a Y-intersection and should have proper signalization to channelize the traffic (photo 37 in Appendix 1).

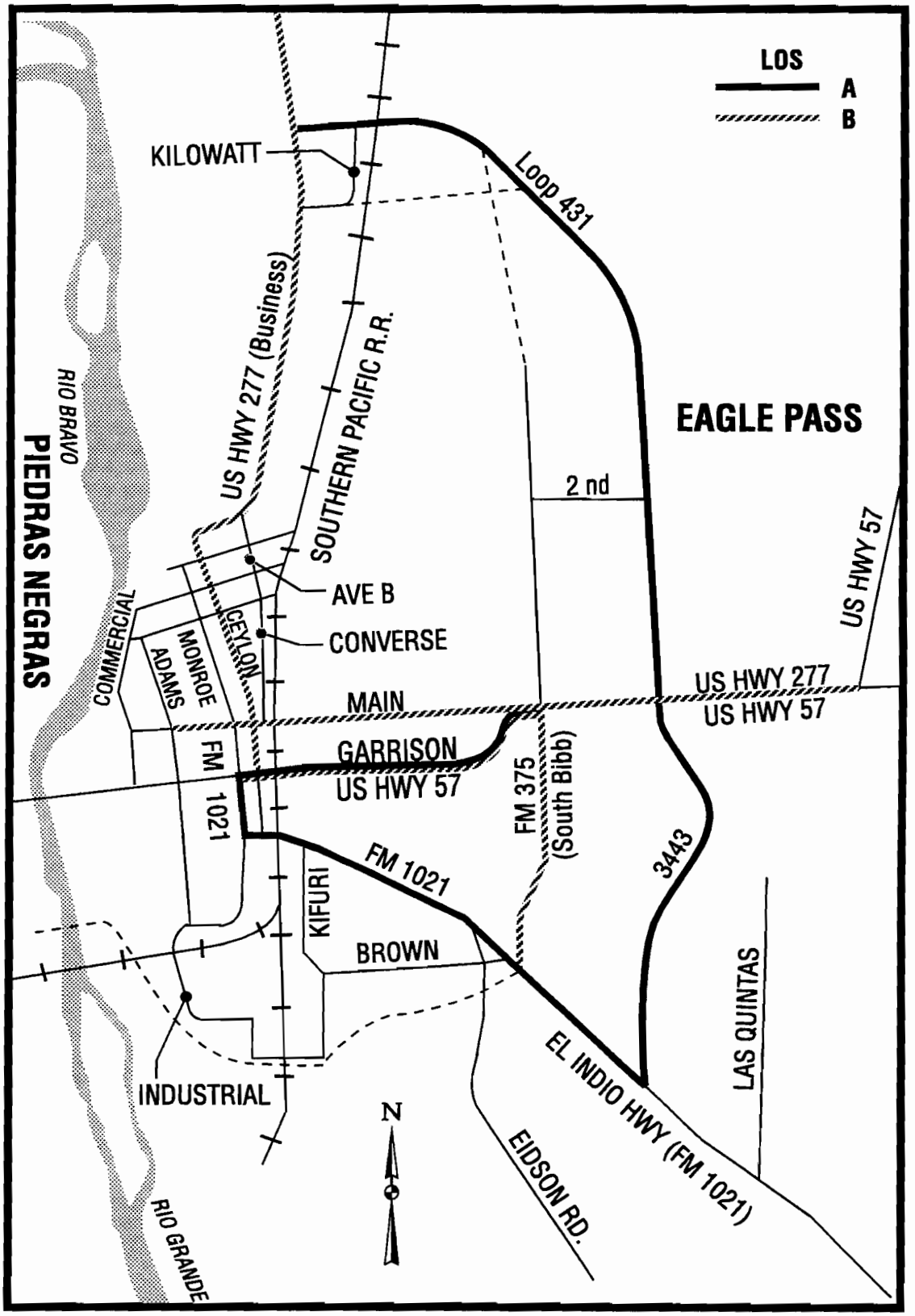


Figure 3.5 Year 2000 Arterial LOS — Reference Scenario

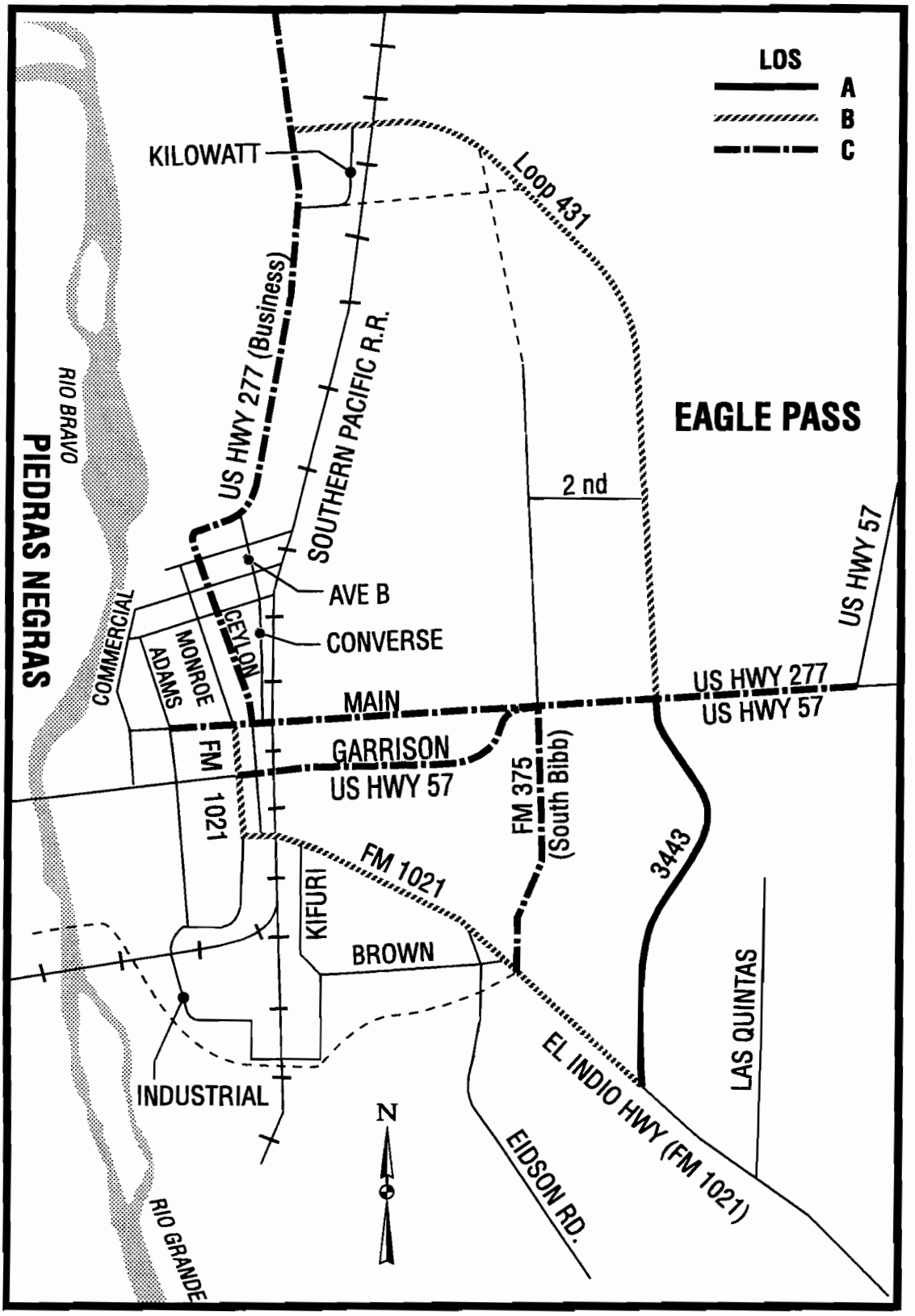


Figure 3.6 Year 2000 Arterial LOS — Reference Scenario

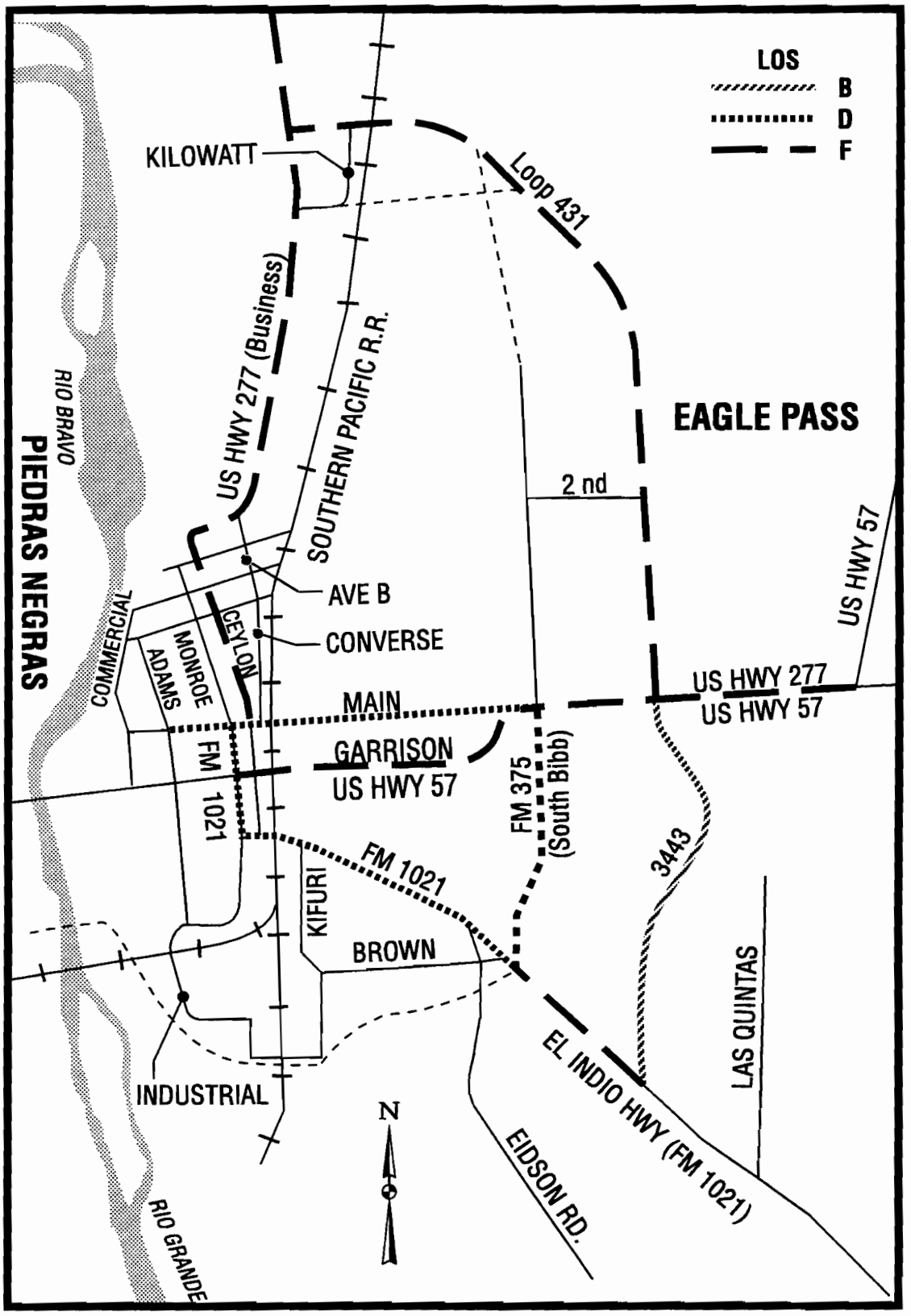


Figure 3.7 Year 2010 Arterial LOS — Reference Scenario

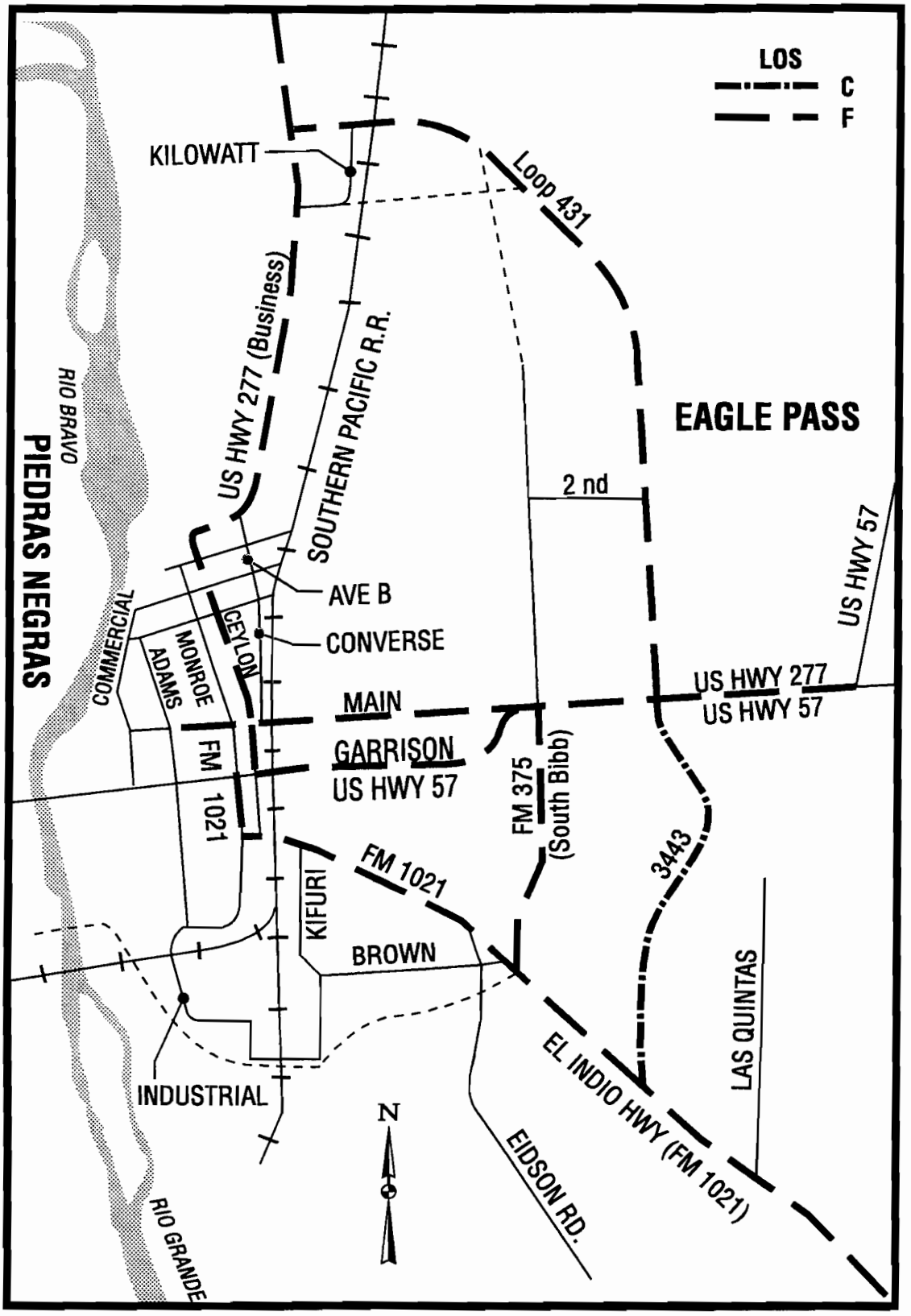


Figure 3.8 Year 2020 Arterial LOS — Reference Schenario

SUMMARY AND CONCLUSION

This traffic circulation plan was developed for three different scenarios: low impact, high impact, and reference. The first two are hypothetical scenarios of possible future traffic demand. The reference scenario is theoretical, and consists of a "do-nothing" situation that serves as a basis for identifying traffic circulation problems in the existing network and for evaluating impacts of proposed improvements. The reference scenario includes neither the planned extensions of Kilowatt, Second, and Bibb; the recommendations discussed above; nor the proposed international bridge and truck route.

The basic recommendations for improved traffic circulation are based on three different criteria: levels of service, accident probability, and cost of proposed improvements. Levels of service were estimated as accurately as possible from the available data, using two linked spreadsheets, one for intersections and another for arterials. The time and budget constraints of this study preclude detailed accident and cost analyses of every improvement proposed for a 25-year period. Nevertheless, the recommendations developed in this chapter, as well as those to be discussed later in Chapter 4, had the overall objective of keeping the levels of service and the overall safety acceptable. The recommended improvements were selected based on ad-hoc relative cost estimates, and always started from the least expensive alternative. A reasonable cost-benefit ratio (in terms of dollars per vehicle) was ensured by disregarding infrastructure improvements at locations where such improvements would serve only a small percentage of users, and which would not be likely to serve as alternative routes to heavily congested thoroughfares.

Recommendations on intersection signalization and other improvements had the objective of keeping the level of service within an acceptable range, while at the same time providing safe turning maneuvers at intersections. The signalization warrants from the Institute of Transportation Engineers were used to the greatest extent possible as criteria to recommend signalization, even when ad-hoc data estimates were necessary (Ref. 3.9).

The reference scenario was analyzed using a spreadsheet to determine potential and/or preferred traffic patterns. The results were used to develop a basic traffic circulation plan based on the criteria summarized above. This basic plan was later used as a basis for analyzing the two study scenarios. These two study scenarios reflect potential future traffic demands, and include proposed infrastructure. The results of these scenarios and the subsequently developed traffic circulation plan are discussed in Chapter 4.

REFERENCES

3.1 *The Proposed Eagle Pass International Bridge II: Preliminary Engineering and Traffic Plan*, Hicks and Company, John F. Hickman and Associates, and Groves and Associates, Inc., February 1995.

3.2 Transportation Research Board, *Highway Capacity Manual*, TRB Special Report No. 209, 1994.

3.3 Pignataro, Louis J., *Traffic Engineering: Theory and Practice*, Prentice-Hall, Inc. Englewood Cliffs, New Jersey, 1973.

3.4 *Anuário Estadístico del Estado de Coahuila*, Instituto Nacional de Geografía, Estadística, e Informatica, Coahuila, 1994.

3.5 Texas Department of Transportation, *Traffic Maps*. 1984 to 1994.

3.6 Texas Department of Transportation, *Automated Traffic Recorders*. 1984 to 1994.

3.7 Weissmann, A. J., M. Martello, J. Hanania, M. Shamieh, C. Said, R. Harrison, and B. F. McCullough, *A Comprehensive Overview of the Texas-Mexico Border: Traffic Flow Patterns*, Research Report 1976-3, Center for Transportation Research, The University of Texas at Austin, April 1994.

3.8 Weissmann, A. J., M. Martello, B. F. McCullough, and R. Harrison, *A Comprehensive Overview of the Texas-Mexico Border: Capacity, demand and Revenue Analyses of Border Segment 2 (Eagle Pass to El Paso)*, Research Report 1976-5, Center for Transportation Research, The University of Texas at Austin, April 1994.

3.9 Kell, James H., and I. J. Fullerton, *Manual of Traffic Signal Design*, Institute of Transportation Engineers, 1983.

CHAPTER 4. EAGLE PASS TRAFFIC CIRCULATION PLAN

This chapter presents and discusses a 25-year traffic plan for Eagle Pass. The plan contains guidelines and priorities to alleviate and/or prevent current and potential traffic circulation problems. Along with recommendations for on-system roadways that need added capacity or continuous left turn lanes, this chapter discusses truck routes, inadequate intersection configurations, intersections that warrant signalization, international traffic routes, and right-of-way needs for future expansions.

APPROACH TO DEVELOP THE TRAFFIC CIRCULATION PLAN

The approach used to develop the traffic circulation plan consisted of four steps: traffic projections, network revision, traffic assignment, and levels of service (LOS). In the first step, AADT projections were estimated for the three components of the traffic demand (local, international, and casino), using the methodology discussed in Chapter 3. The year 2000 study network was then revised to include the proposed new bridge and truck route, the Kilowatt and Bibb extensions, and the basic recommendations outlined in Chapter 3. Next, auto and truck routes were assigned to the network, and saturation was verified using estimates of arterial and intersection capacities and LOS. When the results indicated the need for additional improvements, we added these to the network and undertook another round of estimates. Figure 4.1 summarizes this approach.

Study Scenarios

The traffic plan was developed based on one reference scenario and two analysis scenarios. The analysis scenarios, termed *low* and *high impact*, include the proposed infrastructure and other measures to improve traffic circulation. These two scenarios refer to one major source of uncertainty in future traffic demand, namely, a proposed casino to be located on the nearby Kickapoo Indian Reservation. The three scenarios were analyzed as follows:

(1) *Reference scenario*: This scenario projects and assigns traffic volumes to the existing infrastructure until the end of the analysis period (year 2020). This is a theoretical scenario used only to identify potential problems and to analyze the impacts of the proposed infrastructure improvements.

(2) *Low-impact scenario:* This scenario projects and assigns traffic volumes considering the proposed infrastructure, and assuming that the tourist traffic component (casino) is small.

(3) *High-impact scenario:* This scenario projects and assigns traffic volumes considering the proposed infrastructure, and assuming that the tourist traffic component (casino) is significant.

The analysis of the reference scenario, discussed in Chapter 3, provided the initial input for analyzing the two other scenarios. This chapter discusses the results of the traffic demand

scenarios (high- and low-casino impact), and presents a 25-year traffic circulation plan for Eagle Pass (1995 to 2020).

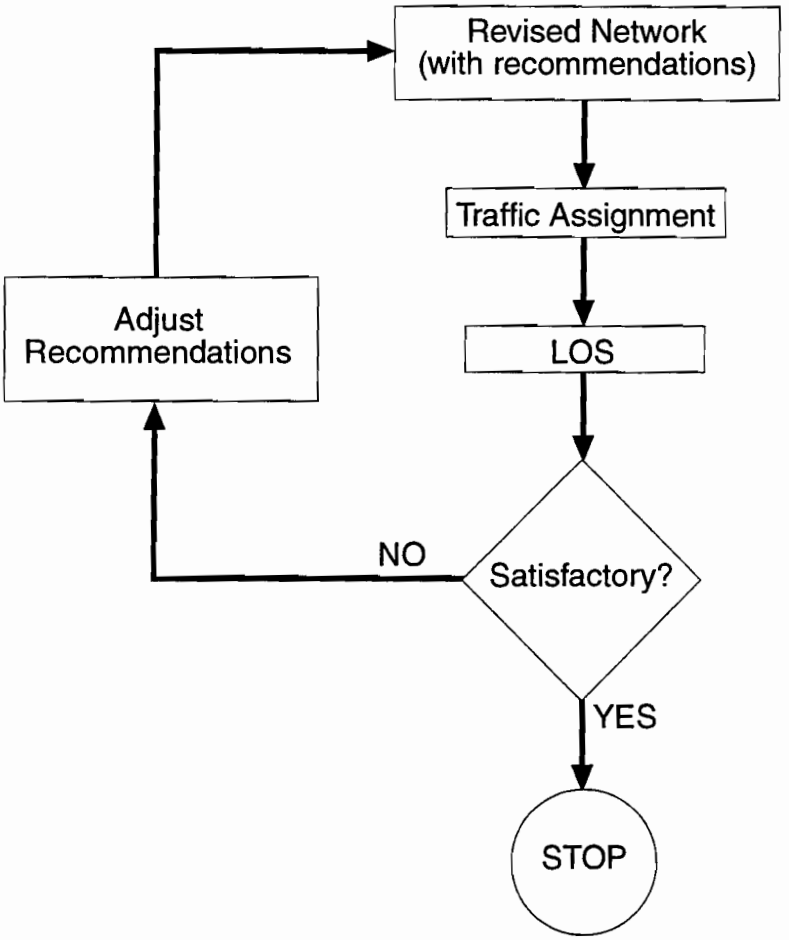


Figure 4.1 Approach for Developing Traffic Plan

Traffic Assignment

The need to take advantage of qualitative information precluded efficient utilization of automated traffic assignment programs. Spreadsheets were used to project AADTs, adjust the impacts of proposed infrastructure, estimate hourly volumes and intersection delays, and obtain the LOS. Owing to a lack of important data (e.g., local origin and destination matrices), several assumptions were necessary to assign traffic to both the existing and (especially) the proposed infrastructure. The assumptions used in the reference scenario (discussed in Chapter 3) were also used in the two analysis scenarios. In addition, several other assumptions were necessary to assign traffic. The most significant of these other assumptions are the following:

(1) The international bridge and new truck route will open in 2000. The route will have four lanes plus a dedicated left-turn lane.

(2) International trucks will be prohibited from using the existing international bridge once the new one is open (year 2000). They will use the new truck route to access FM375, FM1021, Loop 431, and/or FM3443.

(3) Half of the international auto traffic will use the new bridge, but only 20 percent of it will use the new truck route and Loop 431. The other 80 percent will access downtown and the northern part of Eagle Pass using Monroe, Adams, Ceylon, and Converse Streets.

(4) Eagle Pass will develop primarily in the north, somewhat less in the east, and comparatively little in the south. Commercial developments (new malls and big stores) will concentrate along Loop 431, with US57 (east/west bound) as a secondary location.

(5) The city will open the proposed Kilowatt, Bibb, and Second Street extensions by 2000.

For the high-impact scenario (in which the casino traffic is significant), the following assumptions were used (in addition to those used to project traffic into the future, as discussed in Chapter 3):

(1) The casino demand is equally split among local and international traffic.

(2) About 85 percent of international traffic demand for the casino will be from Piedras Negras; the other 15 percent will come from Ciudad Acuña and other Coahuila cities such as Saltillo.

(3) Ninety percent of the casino demand originating in Ciudad Acuña will cross the river in Del Rio, and from there proceed to the casino[1].

(4) Casino demand out of the Del Rio and Laughlin areas will use the inner Loop 431 and FM3443 to reach the casino. Once the proposed outer loop is built, they will use that.

(5) Ninety percent of the casino demand originating in Piedras Negras will use the new bridge once it is built.

Constraints for Eagle Pass Infrastructure Expansion

Information about the prospects for and limitations of infrastructure expansion is essential for effective traffic circulation planning. The prospects have already been included in the low- and high-impact scenarios, and currently consist of the new bridge and truck route, and the extensions of Kilowatt Avenue, Bibb Avenue, and Second Street.

Major routes such as Garrison, FM1021, Bibb Avenue, and Loop 431 have some right of way for expansions, but there are some limitations. Infrastructure expansion west of Commercial Street is not advisable owing to the Rio Grande flood plain and to the local topography. There is a steep slope along the flood plain, while the elevation of present development is rather high. Ryan Street may be viable topographically, but it is located in the flood plain area. Its proposed

[1] Assumption based on information concerning existing and proposed infrastructure between Piedras Negras and Ciudad Acuña. May not materialize if Mexican plans change and new infrastructure is built on the Mexican side.

extension, still controversial when this traffic plan was being prepared, was not included in the study scenarios. Moreover, the traffic circulation plan does not include recommendations that might require the use of areas located too near the Rio Grande flood plain.

The traffic plan avoided recommendations requiring new at-grade intersections with the Union Pacific railroad (since, according to state law, a new at-grade intersection with a rail line can be built only if two others are either grade-separated or closed). The only exceptions to this rule are the inner and outer loop sections that intersect with the railroad.

Cost and Safety Considerations

The basic recommendations for improved traffic circulation are based on three different criteria: levels of service, accident probability, and cost of proposed improvements. Levels of service were estimated as accurately as possible from the available data, using two linked spreadsheets, one for intersections and another for arterials. The time and budget constraints of this study precluded detailed accident and cost analyses of every improvement proposed for a 25-year period. Nevertheless, care was taken to consider safety and cost effectiveness of every recommendation. The recommended improvements were selected based on ad-hoc relative cost estimates, and always started from the least expensive alternative. A reasonable cost-benefit ratio (in terms of dollars per vehicle) was ensured by disregarding infrastructure improvements at locations where they would serve only a small percentage of users, and which could not serve as alternative routes to heavily congested thoroughfares.

Recommendations on intersection signalization and other improvements had the objective of keeping the level of service within an acceptable range, while at the same time providing safe maneuvers at intersections. The signalization warrants from the Institute of Transportation Engineers were used to the greatest extent possible as criteria for signalization recommendations, even when ad-hoc data estimates were necessary to verify warrants (Ref. 4.7).

Summary

Intersection and arterial LOS were estimated for the analysis scenarios based on the approach and assumptions discussed above. The results provided the basis for identifying sources of poor traffic circulation and for developing traffic plan recommendations. These recommendations are presented below, classified according to the following categories: additional capacity, new routes that relieve congestion, intersection configurations, signalization and signal synchronization, and international traffic. The impact of these recommendations on future intersection and arterial LOS is discussed later in this chapter.

ROADWAYS THAT NEED ADDITIONAL CAPACITY

This section presents recommendations regarding needs for additional capacity in Eagle Pass. Changes in regulations, such as making a two-way street one-way, are also discussed in this section, since such changes result in higher capacity.

Figures 4.2 through 4.4 summarize the recommendations regarding additional capacity needs for both the low- and high-impact scenarios, respectively, for implementation immediately,

in 2000, and in 2010. These figures represent recommendations that require new construction, as well as those that can or must be handled through a change in regulations. The figures also depict recommendations about right-of-way acquisition, and they illustrate the general location of proposed infrastructure, such as the proposed international bridge and truck route.

The recommendations include an outer loop around Eagle Pass, which should be implemented in stages scheduled differently for each traffic demand scenario (high or low impact). The outer loop is outside the current city limits and links the US277–FM1589 intersection to US57, going south through FM3443 and meeting the proposed truck route where it concurs with Industrial Park Boulevard (if the third international bridge is implemented in the location recommended here). Figure 4.5 shows the overall location of this outer loop with respect to present city limits. A specific study is necessary to determine the best loop location and to develop its design, taking into consideration the future position of the third international bridge. The study should start around 2015 (or earlier if traffic grows faster than the rates predicted in this study).

Immediate Implementation Recommended

All Scenarios

(1) Make US 277 Business a four-lane highway from Main St. to Loop 431. (Caveat: there is not sufficient right-of-way for standard lane widths.)

Alternative: Make US277 Business a one-way street southbound; make Avenue B and Converse a one-way route northbound. Coordinate with the City; there is sufficient right-of-way along Avenue B available for purchase.

(2) Make US277 a four-lane highway from the Loop 431 intersection up to the junction with FM1589. Secure right-of-way for future extension up to the junction with FM1588 (outside range of Figure 4.3).

(3) Make Main Street four lanes by providing appropriate lane markings from US277B to US57. (Caveat: There is insufficient right-of-way for standard lane widths.)

Alternative: Make Main Street and Garrison (from Commercial to FM375) one-way, the former westbound, the latter eastbound.

(4) Industrial Park Boulevard: Smooth the design and rehabilitate the pavement.

(5) Secure right-of-way for future expansions along all highways and along Brown Street and Edison Road (south and east legs, not within range of Figure 4.2).

(6) Provide "NO PARKING SIGNS" where parking is prohibited.

High-Impact Scenario

(1) Secure right-of-way to extend Las Quintas to US57 (north) and to expand the FM1021 segment east of FM3443.

Implementation Recommended by 2000

All Scenarios

(1) FM375: Add one lane each way, and secure right-of-way for additional lanes in 2010.

(2) FM375 and FM3443 should be connected to provide an alternative to the intersection of FM375 and US57.

(3) Implement a continuous left-turn lane along the US277/US57 segment east of FM375.

(4) Implement a left-turn lane along Loop 431 and secure right-of-way for future expansions.

(5) Coordinate loop extension with City, which has plans to extend Loop 431 as shown in Figure 4.3. Many landowners already agreed to provide a 60m right-of-way for this loop.

(6) Implement new international bridge and truck route. Ensure a proper design, with turning radius and slopes appropriate to large trucks. Verify status of NAFTA truck size and weight harmonization, and provide appropriate radius for Mexican and Canadian 18-wheelers, or secure additional right-of-way for future upgrade.

High-Impact Scenario

(1) Upgrade FM3443 to four lanes (two each way).

(2) Upgrade the FM1021 segment east of FM3443 to six lanes to accommodate high casino demand.

(3) Duplicate and pave Rosita Valley Road (off FM1021), which provides access to the casino. This should be coordinated with the County.

(4) Extend Las Quintas northward up to US57.

(5) Initiate a study to develop preliminary plans for the outer Loop, which will link US57 to the junction of US277 and FM1589 (located north of current Eagle Pass city limits), and continue around the current southern city limits up to Industrial Park Boulevard (and/or new international truck route). Secure right-of-way for this loop.

Implementation Recommended by 2010

All Scenarios

(1) Extend Loop 431 along FM3443, then to the west until it intersects the new truck route at Industrial Park Blvd. (see Figure 4.4).

(2) Add two lanes (one each way) along Loop 431, matching its extensions along FM3443 and the proposed south extension.

(3) Initiate plans and design of third international bridge (see year 2020). Coordination with Piedras Negras is paramount for implementing this new international route.

(4) Extend Las Quintas northward up to US57 (year 2000 for high-impact scenario).

(5) Extend Kilowatt in the north/south direction, starting at existing Loop 431 intersection up to Gates Street north of city limits (outside range of Figure 4.4). This will provide an alternative to congested US277.

(6) Make US277 segment from intersection with FM1589 to the intersection with FM1588 a four-lane highway (outside range of Figure 4.4).

(7) Initiate a study to develop preliminary plans for the outer Loop, which will link US57 to the junction of US277 and FM1589 (located north of current Eagle Pass city limits), and continue around the current southern city limits up to Industrial Park Boulevard

(and/or new international truck route). Secure right-of-way for this loop (Year 2000 for high impact scenario).

High-Impact Scenario

(1) Implement outer loop (from FM1021 to the junction of US277 and FM1589). This new road should have two lanes each way. The southern part should be implemented (or not) according to the results of a specific study that should get underway no earlier than 2005. This study should update traffic projections and establish implementation dates, which could be earlier than those recommended here.

Implementation Recommended by 2020

All Scenarios

(1) Implement third international bridge, preferably at a westward extension of Loop 431 (see Figure 4.5). This is the most convenient location for Eagle Pass at this point, given all the assumptions regarding its future development. These assumptions may or may not materialize; moreover, Piedras Negras is growing south and west, and its urban development plan published in 1992 predicts a third bridge about 15km south of the location proposed in Figure 4.3 (Ref. 4.4).

(2) Implement a link between third bridge and the proposed outer loop, to divert international trucks out of Loop 431 and its proposed extensions, and into the proposed outer loop.

(3) Extend Kilowatt in the north/south direction, from Gates up to FM1588 (outside city limits, not within range of Figures 4.2, 4.3, and 4.4).

(4) Implement northern part of outer loop (from US57 to the junction of US277 and FM1588). This new road should have two lanes each way. The southern part should be implemented (or not) according to results of specific study that should get underway no later than 2010. This study should also update traffic projections and establish implementation dates, which could be earlier than those recommended here (see year 2010 for high-impact scenario).

NEW ROUTES THAT RELIEVE CONGESTION

This section outlines the recommendations regarding new routes that relieve congestion. These improvements include changes in regulations, traffic direction, and truck routes. It complements the discussions in the section regarding added capacity.

Immediate Implementation Recommended for All Scenarios

(1) The downtown area should follow the regulations shown in Figure 4.6.

(2) Remove the protruding curbs along Main Street in the downtown area, and consider prohibiting or restricting parking in the area.

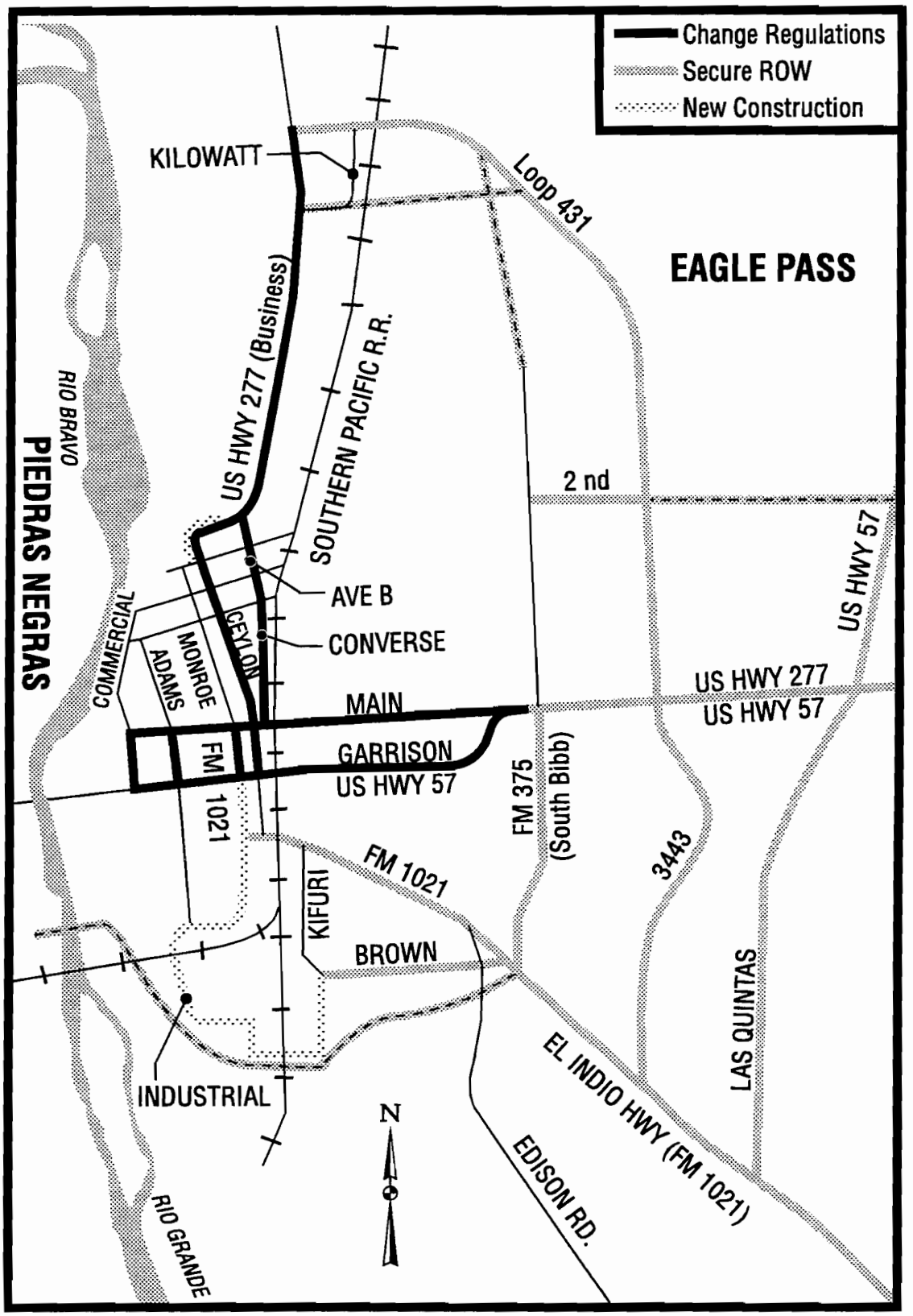


Figure 4.2 Roadways That Need Additional Capacity (Immediate Implementation)

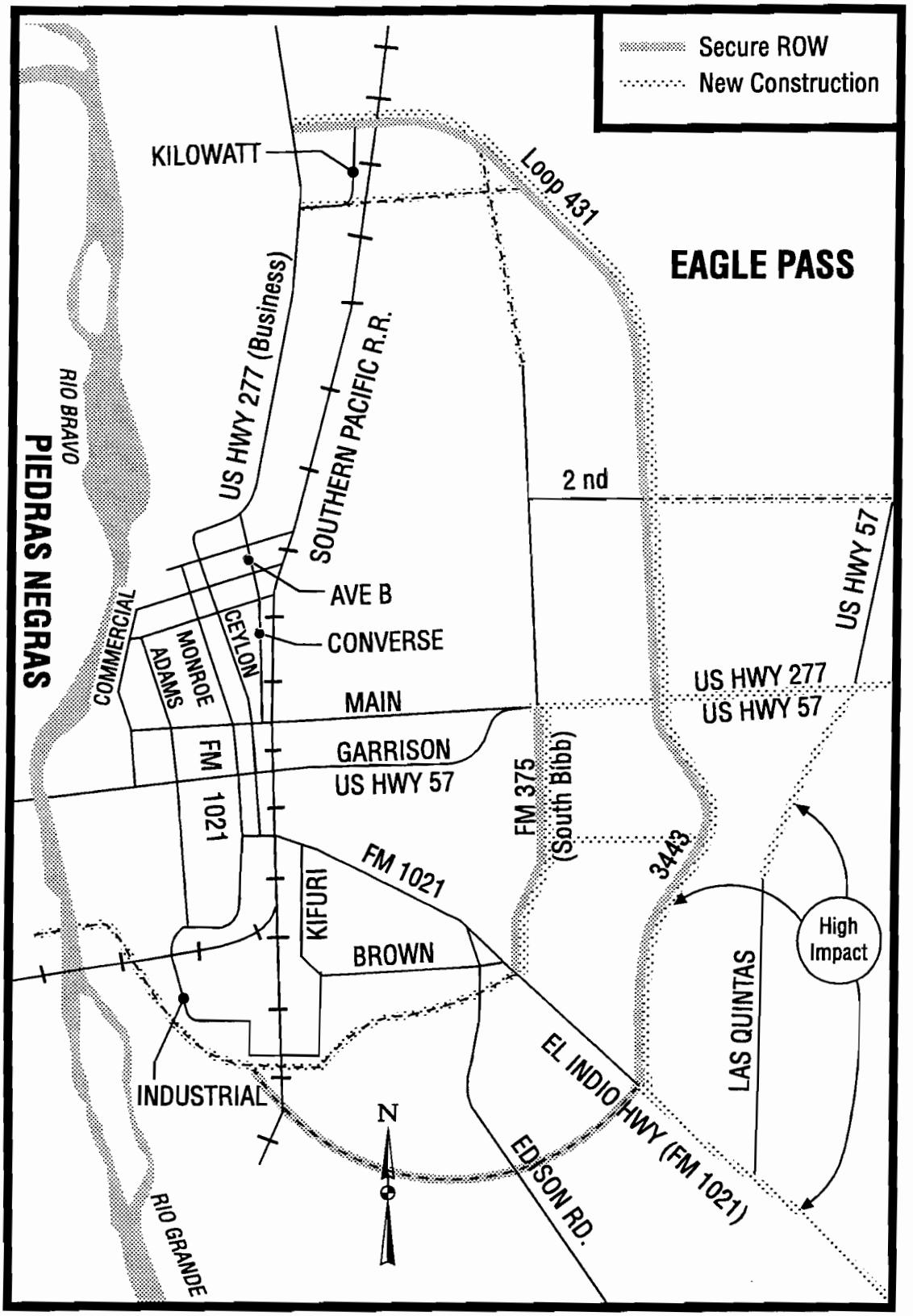


Figure 4.3 Roadways That Need Additional Capacity (Implementation by 2000)

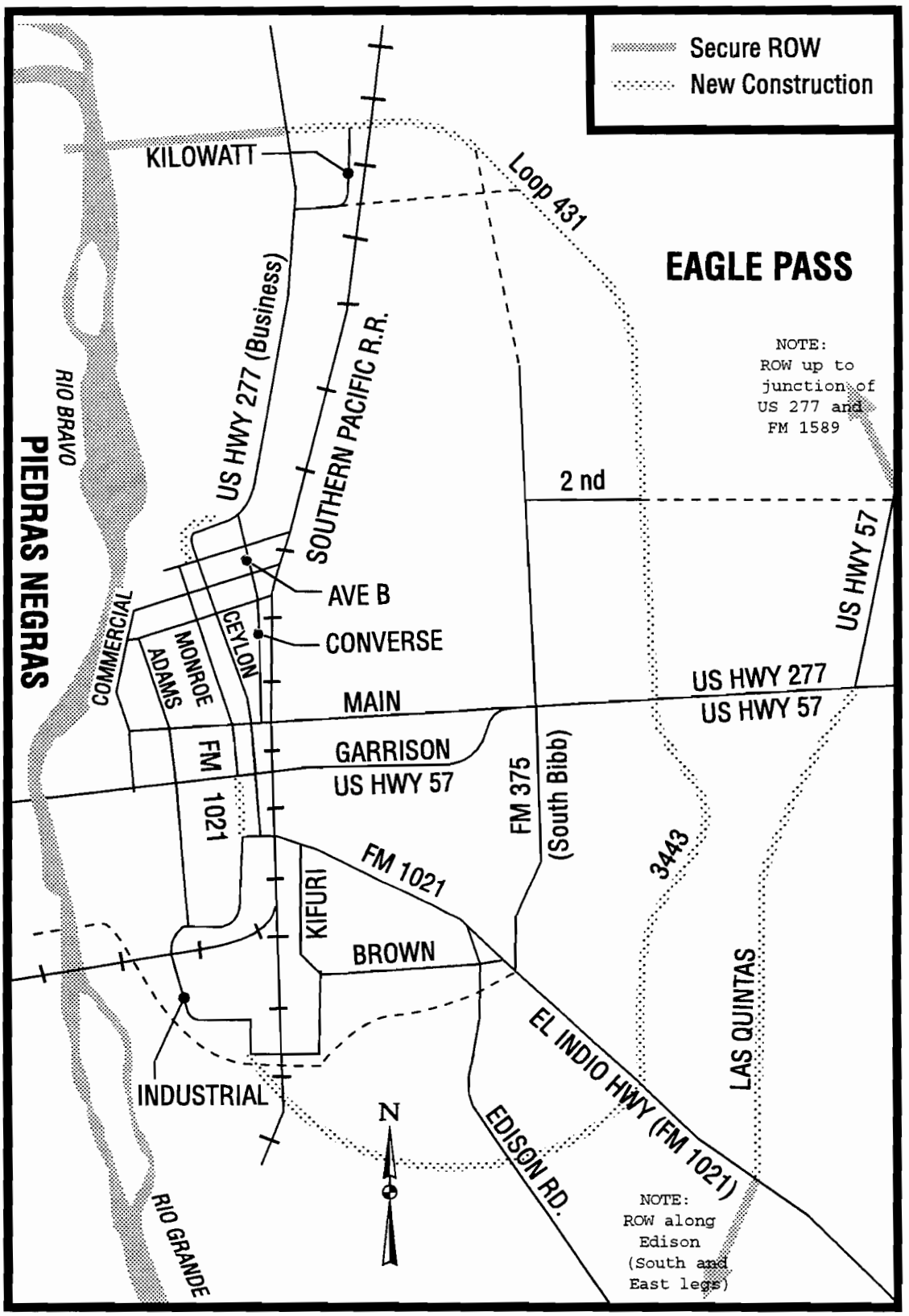


Figure 4.4 Roadways That Need Additional Capacity (Implementation by 2010)

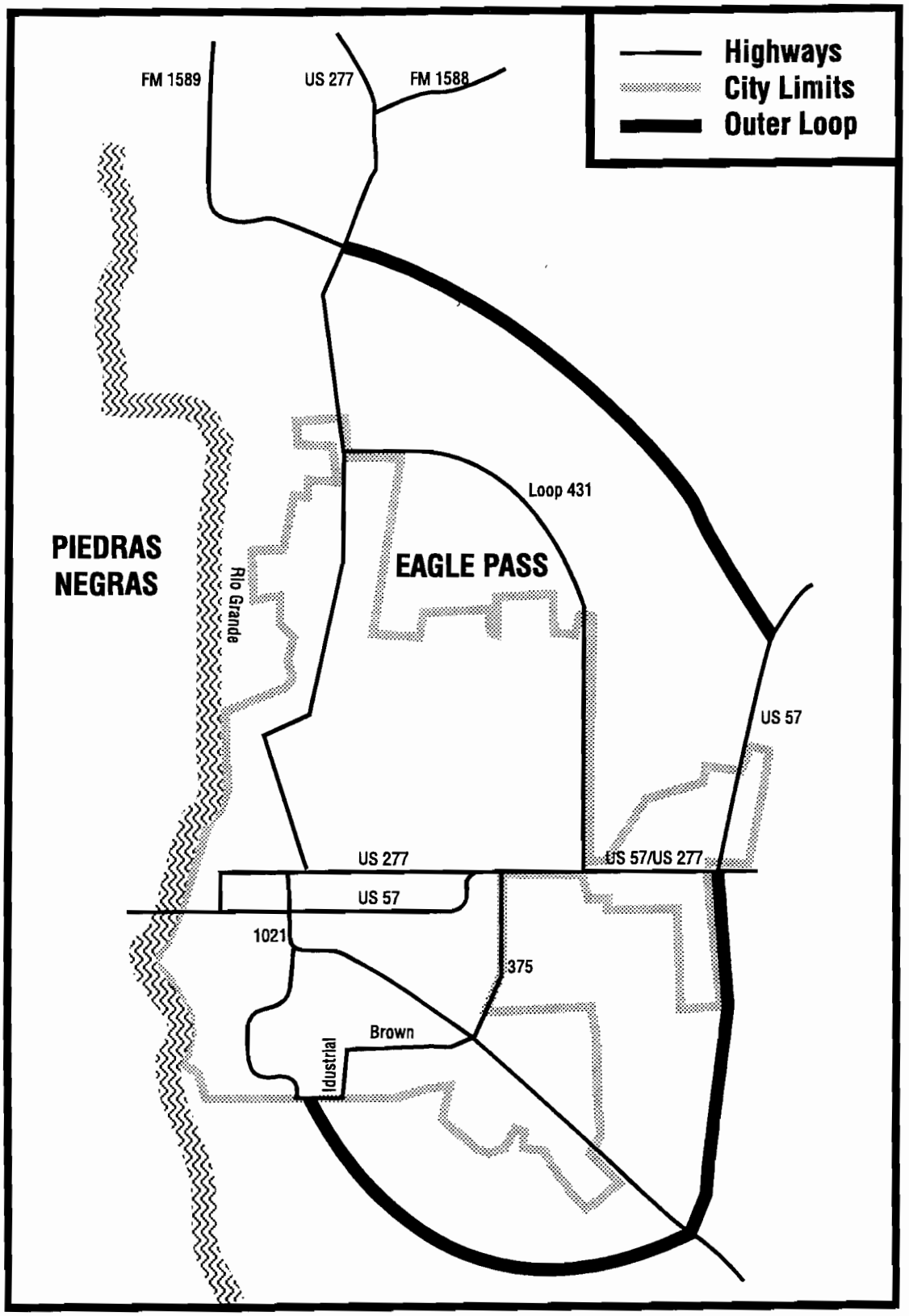


Figure 4.5 Eagle Pass Outer Loop

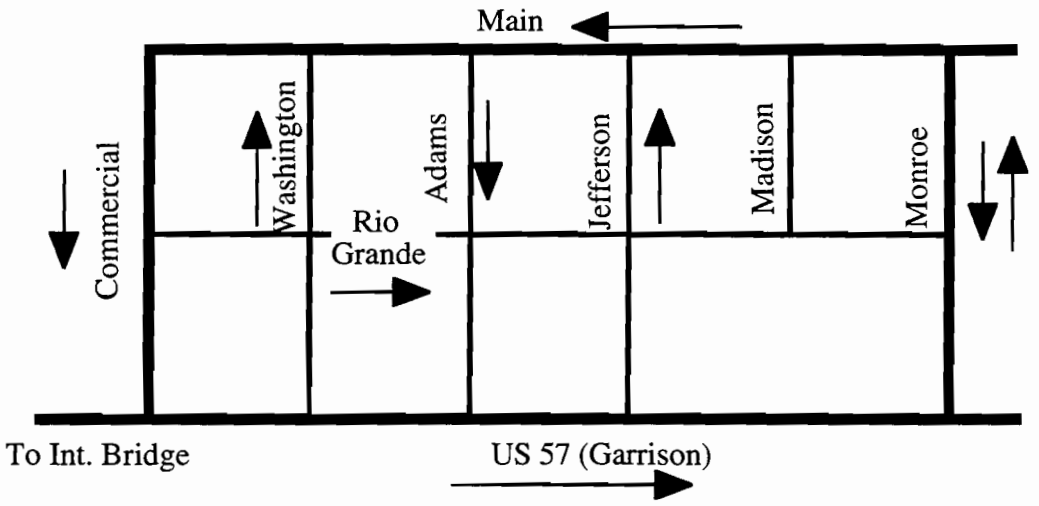


Figure 4.6 Recommended Traffic Circulation in the Downtown Area

Implementation Recommended by 2000

All Scenarios

(1) Implement and enforce truck routes shown in Figure 4.7; prohibit through trucks within CBD area once the proposed truck route is built.

(2) See recommendations about design and capacity of new international truck route (section regarding added capacity).

High-Impact Scenario

(1) Keep the old international bridge open at least until midnight once the new bridge is in operation.

Implementation Recommended for 2010

(1) Prohibit through trucks at FM375 and Bibb extension, and at proposed link between FM375 and FM3443.

Implementation Recommended for 2020

(1) Prohibit through trucks on the inner loop (431 and its proposed extensions) once the outer loop is built.

(2) Prohibit through trucks on the proposed Kilowatt extension in the N/S direction.

INADEQUATE INTERSECTION CONFIGURATIONS

This section outlines the recommendations regarding intersections that need such improvements as left-turn bays, changes in traffic regulations, and lane markings. Intersection

signalization is discussed in the next section, which complements this discussion. Figure 4.9 summarizes all recommendations regarding intersections.

Immediate Implementation Recommended for All Scenarios

(1) Provide left-turn lanes or bays at the intersection of FM 375 and US 57, and also along the Mall de Las Aguilas.

(2) "Y" intersection of US 57 and Main Street: Provide pavement markings and post a sign clearly showing that when the two eastbound lanes of Main Street meet Garrison, they become three lanes, the right-most lane for right turns, the left-most for left turns, and the middle lane for both movements. This intersection is depicted in Figure 4.8. (Note: recommendation must be revised in case the alternative to recommendation 2 of the section on added capacity is implemented.)

(3) Intersection of US 277 B and Main Street: Prohibit parking at least half a block from intersection (along Main).

(4) Smooth right angle at the intersection of Ceylon Street and Second Street along US 277 Business.

Implementation Recommended by 2000 for All Scenarios

(1) Loop 431 intersections with Second Street, Kilowatt, and Bibb should have left-turn bays.

(2) Ensure a properly designed intersection of FM375 and the new truck route, with turning radius and slopes appropriate for large trucks. Verify status of NAFTA truck size and weight harmonization and provide appropriate radius for Mexican and Canadian 18-wheelers, or at least secure additional right-of-way for future upgrade in case these larger trucks are authorized.

(3) Intersection of US57 and proposed Second Street extension should have left-turn bays.

(4) Both ends of proposed FM375–FM3443 link should have left-turn bays.

(5) Secure right-of-way to provide left- and right-turn bays at the intersection between FM1021 and FM3443.

Implementation Recommended by 2010

All Scenarios

(1) Provide grade separation for Loop 431 at US57 (intersections 4, 14, and 15 in Figure 3.4).

(2) Provide left-turn bay for intersection of proposed Las Quintas extension and US277/US57.

High-Impact Scenario

(1) Secure right-of-way to grade-separate intersection of FM3443 with FM1021.

(2) Secure right-of-way to grade-separate intersection of US277B with Loop 431.

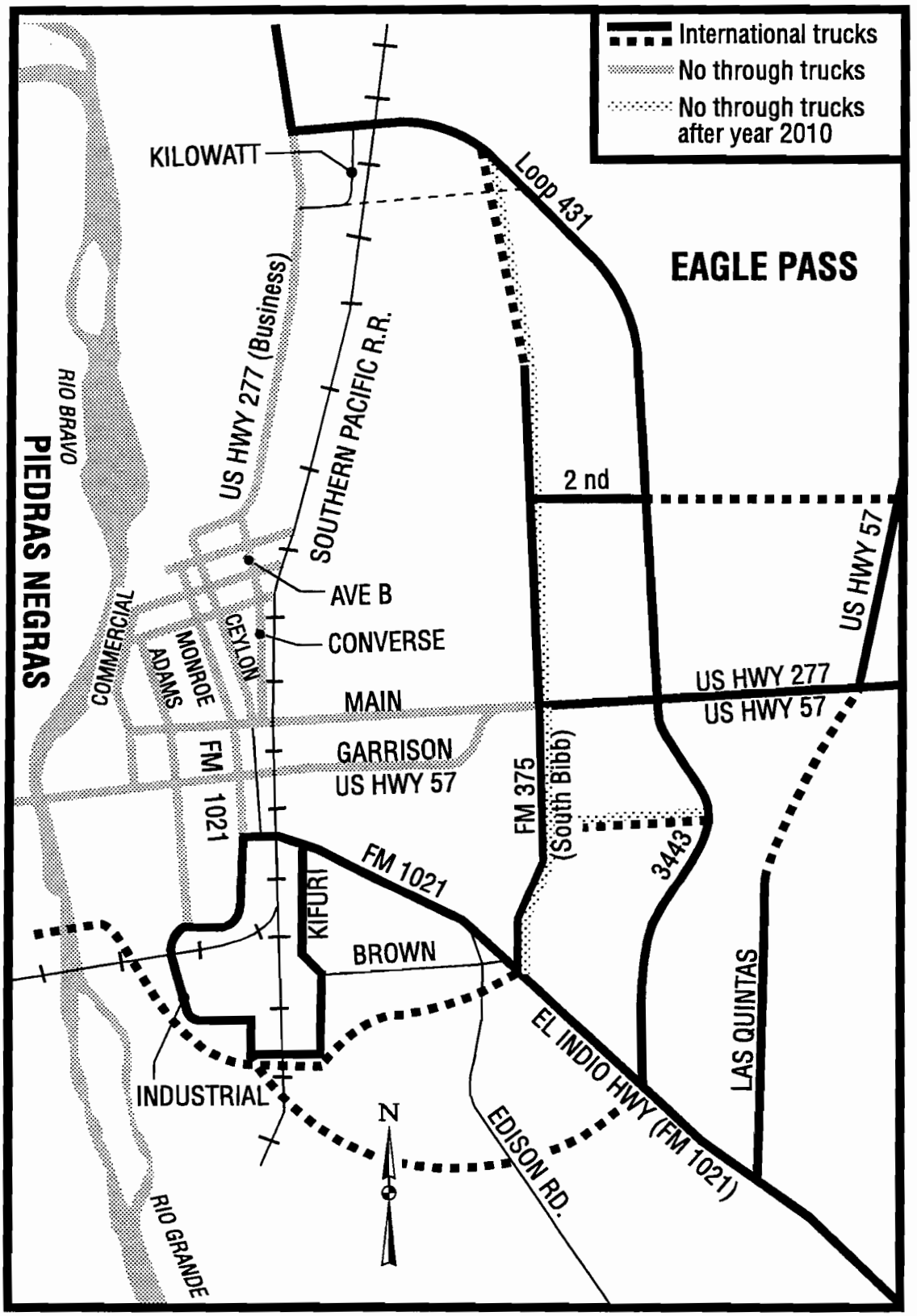


Figure 4.7 Recommended Truck Routes

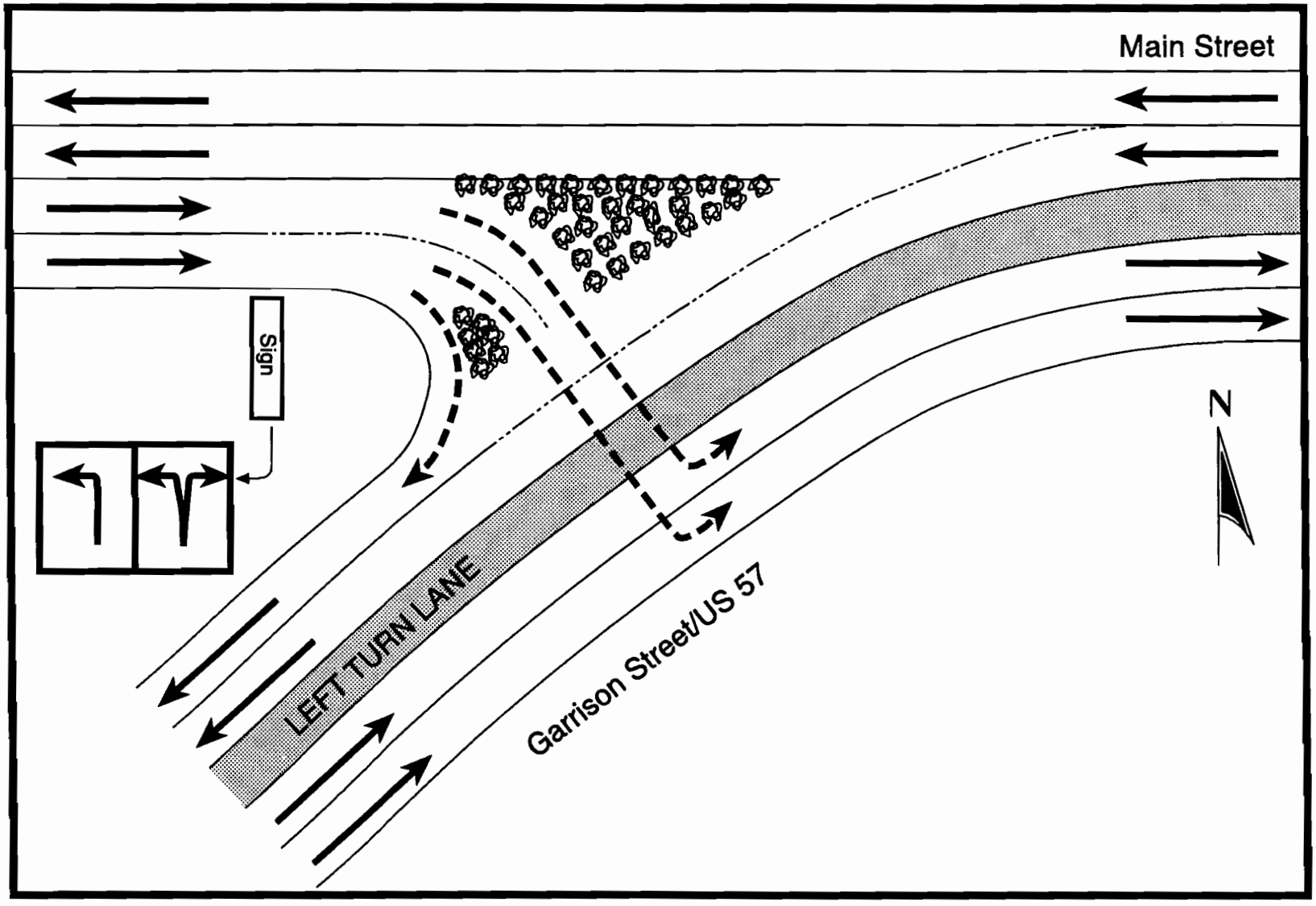


Figure 4.8 Recommended Signs for US57 and Main Street Intersection

Implementation Recommended by 2020

All Scenarios

(1) Provide grade separation for new truck route and FM1021.

(2) Provide grade separation for Loop 431 and UP railroad.

(3) Provide left- and right-turn bays at the intersection between FM1021 and FM3443.

High-Impact Scenario

(1) Provide grade separation for intersection of FM3443 with FM1021.

(2) Provide grade separation for intersection of US277B with Loop 431.

SIGNALIZATION AND/OR SIGNAL SYNCHRONIZATION

This set of recommendations includes intersections that warrant signalization, as well as signals that warrant synchronization. Both existing and proposed intersections are discussed. Recommendations on intersection signalization were based primarily on the Institute of Transportation Engineers' recommendations. These recommendations consist of ten warrants for signalization of an intersection (Ref. 3.9):

(1) Minimum volume (8 hours of an average day)

(2) Interruption of continuous traffic (on minor street crossing a major arterial)

(3) Minimum pedestrian volume (requires pedestrian data)

(4) School crossings

(5) Progressive movement (signalize to maintain platoon)

(6) Accidents (requires accident data, including costs of damage)

(7) Systems (i.e., signalize to encourage traffic to utilize certain routes)

(8) Combination of warrants (i.e., signalize when no warrant is fully satisfied but two or more are partially satisfied)

(9) Peak-hour delay and volume (combination of stop-sign delay and traffic volume)

(10) Four hour (analogous to warrants 1 and 2, but use four-hour rather than eight-hour volumes)

As discussed in Chapter 3, there is not sufficient data to verify all ten warrants. In most cases, signalization recommendations were made when the estimated traffic volumes met or exceeded warrants 1 (or 9). When available, qualitative information regarding accident probability was taken into consideration. Pedestrian data were not available, but in some cases field observations indicated the need to take pedestrian movement into consideration. Figure 4.9 summarizes recommendations regarding intersections.

Immediate Implementation Recommended for All Scenarios

(1) Signalize intersection of Monroe Street and FM1021.

(2) Signalize intersection of Kifuri and Highway Blvd. (FM1021).

(3) Signalize intersection of Garrison and Travis Streets.

(4) Synchronize signals of cross streets perpendicular to US57 (Garrison Street) with actuated signals at US57..

(5) Synchronize signals along Main Street and Rio Grande Street (downtown area).

Implementation Recommended by 2000

All Scenarios

(1) Synchronize signals of intersections along FM375, including the new truck route and the recommended link between FM375 and FM3443.

(2) Signalize both ends of proposed FM375–FM3443 link.

(3) Signalize the intersections of the Second, Kilowatt, and Bibb extensions with Loop 431 if sufficient demand has developed; if so, synchronize signals along Loop 431.

(4) Synchronize signals along Bibb Avenue after its extension is completed.

High-Impact Scenario

(1) Signalize intersection of FM 1021 and Rosita Valley Road (not within range of Figure 4.9). Signal cycles should vary during the day according to casino demand.

Implementation Recommended by 2010 (All Scenarios)

(1) Signalize intersection of Las Quintas and US277/US57.

(2) Signalize intersection of proposed Loop 431 extension and FM1021, Edison Road, and new truck route.

(3) Synchronize all signals along Loop 431.

Implementation Recommended by 2020 (All Scenarios)

(1) Signalize intersection of US277B and access to third international bridge (proposed).

(2) Signalize major intersections and synchronize all signs along proposed outer loop.

(3) Signalize intersection of Kilowatt extension (N/S) and FM1588.

(4) Signalize intersection of Kilowatt extension (N/S) and new outer loop.

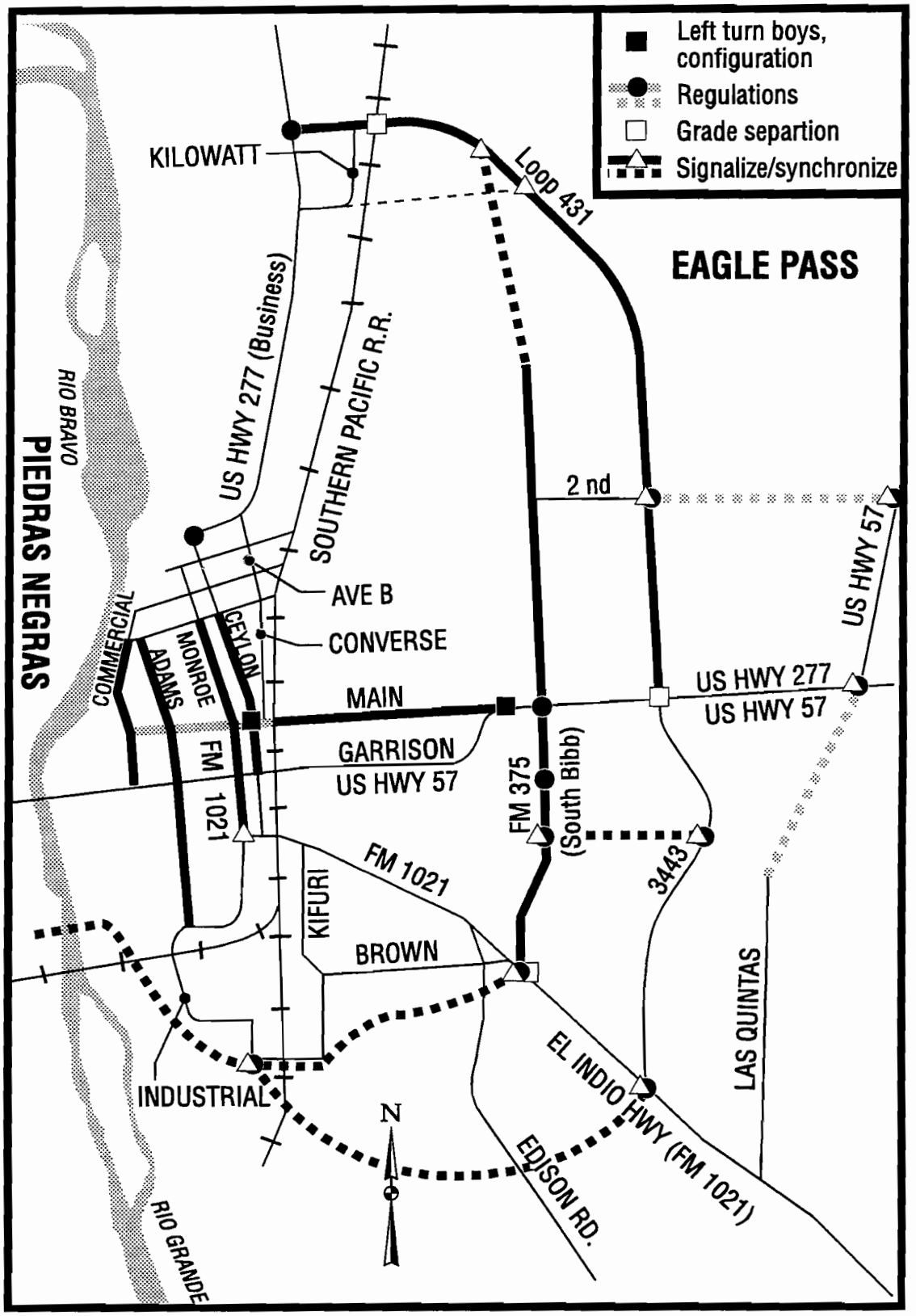


Figure 4.9 Intersection Configurations and Signalization

INTERNATIONAL THOROUGHFARES AND THIRD INTERNATIONAL BRIDGE

The recommendations regarding international thoroughfares and the third international bridge were presented along with the other infrastructure improvements. There are, however, some issues that warrant further discussion. Maverick County officials have recently expressed interest in constructing a third bridge north of the city limits near the intersection of Loop 431 and US277 business, as shown in Figures 4.2, 4.3, 4.4, and 4.7. This location is recommended as the most convenient for Eagle Pass, given all the assumptions regarding its future development. But the priorities are different on the Mexican side. Preliminary locations of the third and fourth international bridges appear in Piedras Negras' development plan published in 1992 (Ref. 4.4). These locations are both outside the current Eagle Pass city limits. Piedras Negras is growing south and west, and its preferred site for a third bridge is about 10 to 15km south of the existing bridge, linking to a proposed loop around the southern part of Piedras Negras. If this third bridge location is implemented, the southwest part of the proposed outer loop should be modified to serve this other location of the future third bridge.

LEVELS OF SERVICE

The impacts of the proposed infrastructure were evaluated based on LOS improvements on the study network. Intersection and arterial LOS were calculated separately to identify the source of traffic circulation problems (bad intersection configuration, poor lane capacity, or other). The predicted levels of service are used to discuss the potential for improvements owing to implementation of the traffic circulation plan. This discussion is based on comparisons between LOS in the reference scenario (no infrastructure improvements) and LOS in the two analysis scenarios (which include improvements).

Low-Impact Scenario

Tables 4.1 and 4.2 show the intersection and arterial levels of service (LOS), respectively, for the low-impact scenario. These tables have two sets of columns with LOS, the first showing the reference scenario (existing infrastructure), and the second set showing the low impact scenario (which includes the traffic circulation plan). The bottom rows of these tables show the proposed infrastructure. Existing intersections are numbered 1 through 16, and are shown in Figure 3.4 (Chapter 3). Proposed intersections are listed at the bottom of Table 4.1.

High-Impact Scenario

Tables 4.3 and 4.4 show the intersection and arterial levels of service, respectively, obtained for the high-impact scenario. This scenario corresponds to the assumption that the Kickapoo Indian Reservation casino will be very successful, attracting high traffic volumes, and expanding in the future. In order to clearly depict a high casino impact, the year 1997 (when the casino is assumed to be fully operational) was included in the analysis. FM1021 segment east of FM3443, which gives access to the Indian Reservation, was also included in the analysis. Proposed intersections are listed at the bottom of Table 4.3.

Table 4.1 Low-Impact Scenario: Intersection LOS

Int.	Arterial Segment	Reference Scenario				Low-Impact Scenario			
		1995	2000	2010	2020	1995	2000	2010	2020
1	US 277 Business (NB)	B	E	F	F	A	B	B	D
2	US 277 Business (SB)	C	E	F	F	B	B	B	C
3	Loop 431 (NB)	B	E	F	F	B	B	C	E
4	Loop 431 (SB)	C	F	F	F	C	B	A	B
5	FM 375 (NB)	B	B	F	F	B	B	C	E
6	FM 375 (SB)	B	B	F	F	B	B	B	A
7	FM 3443 (SB)	B	B	B	D	B	B	B	D
8	Main St.WB, US57 to Ceylon	B	C	F	F	B	B	B	B
9	Main St.EB, Commercial to Ceylon	B	C	F	F	B	B	B	C
10	FM1021(US57 to FM375)	B	B	E	F	B	B	D	B
11	FM1021 (FM375 to FM3443)	B	C	F	F	B	B	D	E
12	US57 EB (FM1021 to FM375)	B	E	F	F	B	B	B	D
13	US57 WB (FM375 to FM1021)	B	B	F	F	B	B	C	B
14	US57 WB (FM375 to Loop 431)	B	F	F	F	B	B	A	A
15	US 57 (East of Loop 431)	B	C	F	F	B	B	A	A
16	US277 (N of Loop 431)	C	C	F	F	E	B	B	C
17	FM375—FM3443 link[2]						A	B	B
18	New international truck route[2]						B	B	B
19	Loop 431 extension[2]							A	A
20	Las Quintas extension[2]						A	A	B
21	Kilowatt extension (N/S direction)[2]							A	A
22	Outer loop[2]								B

[1]See Figure 3.4 (Chapter 3) for intersections 1 through 16.

[2]Proposed facilities.

Proposed intersections are as follows:

17 New link at FM375 and at FM3443
18 Truck route at FM1021
19 New Loop at new truck route
20 Las Quintas at US277
21 Kilowatt N/S extension and FM1588
22 Outer loop at FM1589.

Table 4.2 Low-Impact Scenario: Arterial LOS

Int. No[1]	Arterial Segment	Base Case				Low-Impact Scenario			
		1995	2000	2010	2020	1995	2000	2010	2020
1	US 277 Business (NB)	B	C	F	F	B	B	B	C
2	US 277 Business (SB)	B	C	F	F	B	B	B	B
3	Loop 431 (NB)	A	B	F	F	A	A	A	A
4	Loop 431 (SB)	A	B	F	F	A	A	A	A
5	FM 375 (NB)	B	C	E	F	B	C	C	D
6	FM 375 (SB)	B	C	D	F	B	C	C	B
7	FM 3443 (SB)	A	A	B	C	A	A	A	B
8	Main St.WB, US57 to Ceylon	B	C	D	F	B	B	B	B
9	Main St.EB, Commercial to Ceylon	B	C	D	F	D	D	D	E
10	FM1021(US57 to FM375)	A	B	D	F	A	A	B	A
11	FM1021 (FM375 to FM3443)	A	B	F	F	A	A	B	A
12	US57 EB (FM1021 to FM375)	B	C	F	F	B	A	B	C
13	US57 WB (FM375 to FM1021)	A	C	F	F	B	A	B	C
14	US57 WB (FM375 to Loop 431)	B	C	F	F	B	B	C	D
15	US 57 (East of Loop 431)	B	C	F	F	B	B	A	A
16	US277 (N of Loop 431)	B	C	F	F	B	A	A	A
17	FM375—FM3443 link[2]						A	A	A
18	New international truck route[2]						A	A	A
19	Loop 431 extension[2]							A	A
20	Las Quintas extension[2]						A	A	A
21	Kilowatt extension (N/S direction)[2]							A	A
22	Outer loop[2]								A

[1]See Figure 3.4 (Chapter 3) for intersections 1 through 16.

[2]Proposed facilities. See bottom of Table 4.1 for proposed intersections.

Table 4.3 High-Impact Scenario: Intersection LOS

Int. No[1]	Arterial Segment	Reference Scenario					High-Impact Scenario				
		1995	1997	2000	2010	2020	1995	1997	2000	2010	2020
1	US 277 Business (NB)	B	E	E	F	F	B	B	B	B	A
2	US 277 Business (SB)	C	E	E	F	F	B	B	B	C	E
3	Loop 431 (NB)	B	E	E	F	F	B	F	B	D	A
4	Loop 431 (SB)	C	F	F	F	F	C	F	B	A	B
5	FM 375 (NB)	B	B	B	F	F	B	B	B	C	E
6	FM 375 (SB)	B	B	B	F	F	B	B	B	B	A
7	FM 3443 (SB)	B	B	B	B	D	B	E	B	B	A
8	Main St.WB, US57 to Ceylon	B	C	C	F	F	B	B	B	B	D
9	Main St.EB, Com. to Ceylon	B	C	C	F	F	B	B	B	B	D
10	FM1021(US57 to FM375)	B	B	B	E	F	B	C	B	E	B
11	FM1021(FM375 to FM3443)	B	C	C	F	F	B	C	C	D	A
12	US57EB (FM1021 to FM375)	B	E	E	F	F	B	B	B	B	F
13	US57WB (FM375 - FM1021)	B	B	B	F	F	B	C	B	C	F
14	US57WB(FM375 - Loop 431)	B	F	F	F	F	B	C	C	A	A
15	US57 (East of Loop 431)	B	C	C	F	F	B	B	B	A	A
16	US277(N of Loop 431)	C	C	C	F	F	F	B	B	B	A
17	FM375—FM3443 link[2]	—	—	—	—	—	—	—	A	B	B
18	New truck route[2]	—	—	—	—	—	—	—	B	B	B
19	Loop 431 extension[2]	—	—	—	—	—	—	—	—	A	A
20	Las Quintas extension[2]	—	—	—	—	—	—	—	A	A	B
21	Kilowatt extension (N/S)	—	—	—	—	—	—	—	—	A	A
22	Outer loop[2]	—	—	—	—	—	—	—	—	—	C
23	FM1021 (East of FM3443)[2]	—	—	—	—	—	—	—	A	B	B

[1]See Figure 3.4 (Chapter 3) for intersections 1 through 16.

[2]Proposed facilities. Proposed intersections are as follows:

17 New link at FM375 and at FM3443
18 Truck route at FM1021
19 New Loop at new truck route
20 Las Quintas at US277
21 Kilowatt N/S extension at FM1588
22 Outer loop at FM1589
23 FM1021 at Las Quintas

Table 4.4 High-Impact Scenario: Arterial LOS

Int. No[1]	Arterial Segment	Reference Scenario					High-Impact Scenario				
		1995	1997	2000	2010	2020	1995	1997	2000	2010	2020
1	US 277 Business (NB)	B	C	C	F	F	B	B	B	B	C
2	US 277 Business (SB)	B	C	C	F	F	B	B	B	B	B
3	Loop 431 (NB)	A	B	B	F	F	A	B	A	A	A
4	Loop 431 (SB)	A	B	B	F	F	A	B	A	A	A
5	FM 375 (NB)	B	C	C	E	F	B	C	C	C	D
6	FM 375 (SB)	B	C	C	D	F	B	C	C	C	B
7	FM 3443 (SB)	A	A	A	B	C	A	B	A	A	B
8	Main St.WB, US57 to Ceylon	B	C	C	D	F	B	B	B	B	B
9	Main St.EB, Com. to Ceylon	B	C	C	D	F	D	D	D	D	F
10	FM1021(US57 to FM375)	A	B	B	D	F	A	A	A	B	A
11	FM1021(FM 375 to FM3443)	A	B	B	F	F	A	A	B	C	A
12	US57EB (FM1021 to FM375)	B	C	C	F	F	B	B	B	B	D
13	US57WB (FM 375 - FM1021)	A	B	C	F	F	B	B	A	B	D
14	US57 WB (FM375-Loop 431)	B	C	C	F	F	B	C	C	D	D
15	US57 (East of Loop 431)	B	C	C	F	F	B	B	B	C	B
16	US277(N of Loop 431)	B	C	C	F	F	B	A	A	A	A
17	FM375—FM3443 link[2]	—	—	—	—	—	—	—	A	A	A
18	New truck route[2]	—	—	—	—	—	—	—	A	A	B
19	Loop 431 extension[2]	—	—	—	—	—	—	—	—	A	A
20	Las Quintas extension[2]	—	—	—	—	—	—	—	A	A	B
21	Kilowatt extension (N/S)	—	—	—	—	—	—	—	—	A	A
22	Outer loop[2]	—	—	—	—	—	—	—	—	—	A
23	FM1021 (East of FM3443)[2]	—	—	—	—	—	—	—	A	A	A

Conclusions

Currently, most Eagle Pass intersections are performing at satisfactory levels of service (A or B). The exceptions are US277 intersections with Loop 431 and with Main Street, and Loop 431 intersection with US57/US277, which are LOS C (intersections 2, 4, and 16 in Figure 3.4). This situation will continue less than 5 years in the low-impact scenario, and less than 2 years in the high-impact scenario. Before the middle of the analysis period (2010), Eagle Pass traffic would be reduced to gridlock congestion if no measures are taken to improve and expand the infrastructure (reference scenario).

By contrast, the proposed traffic circulation plan has potential to keep most intersections at LOS C or better throughout the analysis period. In the low-impact scenario, the only intersections with LOS D or worse in 2020 are Loop 341 and US277B, FM375 and Main Street, and FM3443 and FM1021. Main Street intersections in the downtown area will remain at LOS C if all recommendations are implemented and if the study assumptions do materialize. In the high-impact

scenario, the intersections between US277B and Loop 431, and between FM3443 and FM1021 need to be grade-separated by 2020, unless a successful program is implemented to discourage autos as the main transport mode.

Arterial levels of service are no worse than the mid-range of B in 1995. In 2000, the reference scenario results indicate a pressing need to improve traffic circulation, since many important arterials are at level C, and none are at level A. The improvements and measures suggested in the traffic circulation plan have the potential to keep all arterial LOS at C or better until the end of the analysis period, except for the downtown part of Main Street, the US57 segment between FM375 and Loop 431, and the FM375 segment near the Mall. In the high-impact scenario, US57 congestion would be worse and could include other segments. LOS would be E at downtown Main Street.

Arterial LOS is worse than intersection LOS along the downtown segment of Main Street because there are many closely spaced intersections. There is no right-of-way available for expansions, and the city is expecting downtown traffic demand to increase. The solution to downtown congestion is actually mass transit and/or higher vehicle occupancy. Towards the end of the analysis period, two other arterial segments are expected to have worse LOS than their individual intersections: FM375 segment between FM1021 and Main, and US277/US57 segment east of Loop 431 intersection. This is due to entrances and exits of commercial developments along these arterials (existing and assumed to be built in the future).

Discussion

The LOS results were used to identify the sources of poor traffic circulation and are presented here to provide a measure of the improvements resulting from the implementation of the traffic circulation plan. In order to interpret the LOS results correctly, it is important to keep in mind that the only intersection/arterial interaction reflected in LOS presented here is the effect of intersection delays in arterial speed. Actually, the interactions are more complex than that. For example, poor traffic flow at arterial segments (such as that occurring at entrances to busy facilities) can also hinder efficient traffic circulation at the nearest intersections, increasing the delay. This and other types of "second degree" interactions are not reflected by the LOS presented in Tables 4.1 through 4.4. The objective of these calculations was to investigate the causes of poor traffic circulation, and this requires that each intersection be examined separately.

DISCUSSION

While events such Mexico joining GATT (1986) and the passage of NAFTA (1993) have been studied by numerous scholars, most economic predictions related to these events have not materialized. And the peso devaluation (late 1994) further invalidated forecasts developed before 1994 for the border economic activity and traffic demand. All these uncertainties make traffic forecasts within the border area rather less reliable than elsewhere, especially for the long-term. The traffic circulation plan presented in this report reflects these uncertainties. Moreover, it relies heavily on assumptions made about future city development, local traffic demand, international traffic behavior, and about Piedras Negras' accession to Eagle Pass' preferred location for a third

bridge. These assumptions may or may not materialize; thus, the recommendations for 2010 and especially those for 2020 should be updated before implementation. Below is a discussion of the principal issues that should be monitored and updated for efficient implementation in the future.

Third Bridge and Outer Loop

The Eagle Pass traffic plan recommends constructing a third bridge north of the city limits near the intersection of Loop 431 and US277 business; yet the priorities are different on the Mexican side. Preliminary locations of the third and fourth bridges appear in Piedras Negras' development plan published in 1992 (Ref. 4.4). These locations are both outside the current Eagle Pass city limits. Piedras Negras is growing south and west, and its preferred site for a third bridge is about 10 to 15km south of the existing bridge, with links to a proposed loop around the southern part of Piedras Negras.

TxDOT should verify the status of negotiations regarding the third international bridge, especially before implementing infrastructure recommended for 2010 and afterwards. Some of the recommendations discussed in the traffic plan were based on the assumption that a third bridge would be built in the northern part of Eagle Pass, as suggested. A good example is the basic location of the outer loop. It must be adjusted if the third bridge is actually located in the southern part of Eagle Pass. In this case, the outer loop must be extended further south, possibly along the westbound leg of Edison Road, until it meets the third bridge.

The general outer loop location shown in Figure 4.5 must be adjusted and refined by a specific study. For example, the specific location where the outer loop will intersect US57 will need a detailed study, one that takes into account future developments in the area. The intersection of the outer loop and the new proposed truck route (along Industrial Park Boulevard) will require careful design.

Rail Intersections

The outer loop will have an intersection with the Union Pacific (UP) railroad, which should be left at-grade until there is sufficient demand to justify a grade separation. According to state law, this new intersection will require closing or grade-separating two others. If the recommendation to grade-separate the intersection of Loop 431 and the railroad is implemented, the best candidate for closing is the intersection of Gates Street and the UP railroad (northern part of Eagle Pass, outside city limits). Local links between Gates and other nearby streets and outer loop must be properly designed and implemented, since the outer loop will be the only UP railroad crossing in that part of town.

Congestion in Densely Developed Areas

This traffic circulation plan was developed based on the assumption that current modal split patterns will remain the same throughout the analysis period. Demand diversion to transit, higher occupancy of privately owned vehicles, and/or implementation of transportation control measures (TCM) in Eagle Pass were not taken into account in this study. Consequently, the measures recommended here for downtown congestion will have only temporary effect, since traffic demand

grows continuously and the infrastructure cannot be expanded in that area. As elsewhere in the state and country, the only permanent and efficient solution for congestion is higher auto occupancy and/or transit.

Eagle Pass, in concert with TxDOT, should develop a plan to shift demand from single- and double-occupant autos to higher occupancy and mass transit. Preliminary studies could start by 2000, and detailed studies should start no later than 2010. Issues to be investigated include:

(1) high-occupancy-vehicle (HOV) lanes on the existing and proposed loops, on the second international bridge, and perhaps also along US57 and US277;

(2) staggered hours for offices and schools in congested neighborhoods; and

(3) park-and-ride lots serving routes to congested areas.

According to city officials, existing downtown shopping areas are likely to grow, and additional shopping areas will open near the new bridge. TxDOT and the city should consider a park-and-ride lot where the golf course currently is, to serve both the new and the existing international bridge. There should be bus routes from this lot to downtown, Mall de Las Aguilas, Main Street, and to any future developments. Possible bus routes could use the new truck route, FM375, Loop 431, FM1021, US277, and US57. Specific bus routes and frequencies, financial feasibility of transit routes, and other transit issues warrant specific studies.

Other Recommendations

The intersection of FM3443 and FM1021 is predicted to reach LOS E in the low-impact scenario, and F in the high-impact scenario by the end of the analysis period. There is no recommendation to grade-separate this intersection in the low-impact scenario because, if some assumptions used in the traffic assignment do not materialize, traffic diversion to new routes such as the outer loop might be sufficient to keep this intersection at a lower LOS. On the other hand, if some assumptions used in this study are actually exceeded in the future, a grade separation is recommended for this intersection in the low-impact scenario (intersections 11 and 7 in Figure 3.4). TxDOT should monitor the traffic at this intersection and verify future demand development before deciding when (or if) to grade-separate the intersection of FM3443 and FM1021.

Implementation of statewide transportation control measures (TCMs) appears indicated when one considers environmental problems such as pollution from mobile sources and excessive energy consumption in the transportation sector. TCMs also seem indicated when one considers the cost of infrastructure required to support low-occupancy autos as the primary transportation option in the future. The TCM potential to reduce energy consumption and improve air quality in Texas was recently investigated by Euritt, Weissmann, and others (Refs. 4.5, 4.6). These reports list numerous other studies that investigated other TCM impacts, including the cost of providing increasingly expensive infrastructure. TxDOT should update the recommendations of this traffic circulation plan in the event that a successful TCM program is implemented in the Eagle Pass area.

REFERENCES

4.1 Hanania, J., A. J. Weissmann, R. Harrison, M. Martello, and B. F. McCullough, *A Comprehensive Overview of the Texas-Mexico Border: Background*, Research Report 1976-1, Center for Transportation Research, The University of Texas at Austin, January 1994.

4.2 Weissmann, A. J., M. Martello, J. Hanania, M. Shamieh, C. Said, R. Harrison, and B. F. McCullough, *A Comprehensive Overview of the Texas-Mexico Border: Traffic Flow Patterns*, Research Report 1976-3, Center for Transportation Research, The University of Texas at Austin, April 1994.

4.3 Weissmann, A. J., M. Martello, B. F. McCullough, and R. Harrison, *A Comprehensive Overview of the Texas-Mexico Border: Capacity, demand and Revenue Analyses of Border Segment 2 (Eagle Pass to El Paso)*, Research Report 1976-5, Center for Transportation Research, The University of Texas at Austin, April 1994.

4.4 *Ayuntamiento de Piedras Negras. Plan Director de Desarrollo Urbano.* SEDESOL, Gobierno del Estado de Coahuila, 1992.

4.5 Euritt, M., A. J. Weissmann, R. Harrison, M. Martello, J. Qin, S. Varada, S. Bernow, J. Decicco, M. Fulmer, J. Hall, and I. Peters, *An Assessment of Transportation Control Measures, Transportation Technologies, and Pricing/Regulatory Policies.* Research Report SEDC-1, Texas Transportation Study for the Texas Sustainable Energy Development Council, The University of Texas at Austin's Center for Transportation Research and the Tellus Institute, June 1995.

4.6 Euritt, M., A. J. Weissmann, R. Harrison, M. Martello, J. Qin, S. Varada, S. Bernow, J. Decicco, M. Fulmer, J. Hall, and I. Peters, *Strategies for Reducing Energy Consumption in the Texas Transportation Sector.* Research Report SEDC-2, Texas Transportation Study for the Texas Sustainable Energy Development Council, The University of Texas at Austin's Center for Transportation Research and the Tellus Institute, June 1995.

4.7 Kell, James H., and I. J. Fullerton. *Manual of Traffic Signal Design*, Institute of Transportation Engineers, 1983.

APPENDIX 1

EAGLE PASS AND PIEDRAS NEGRAS PHOTO ALBUM

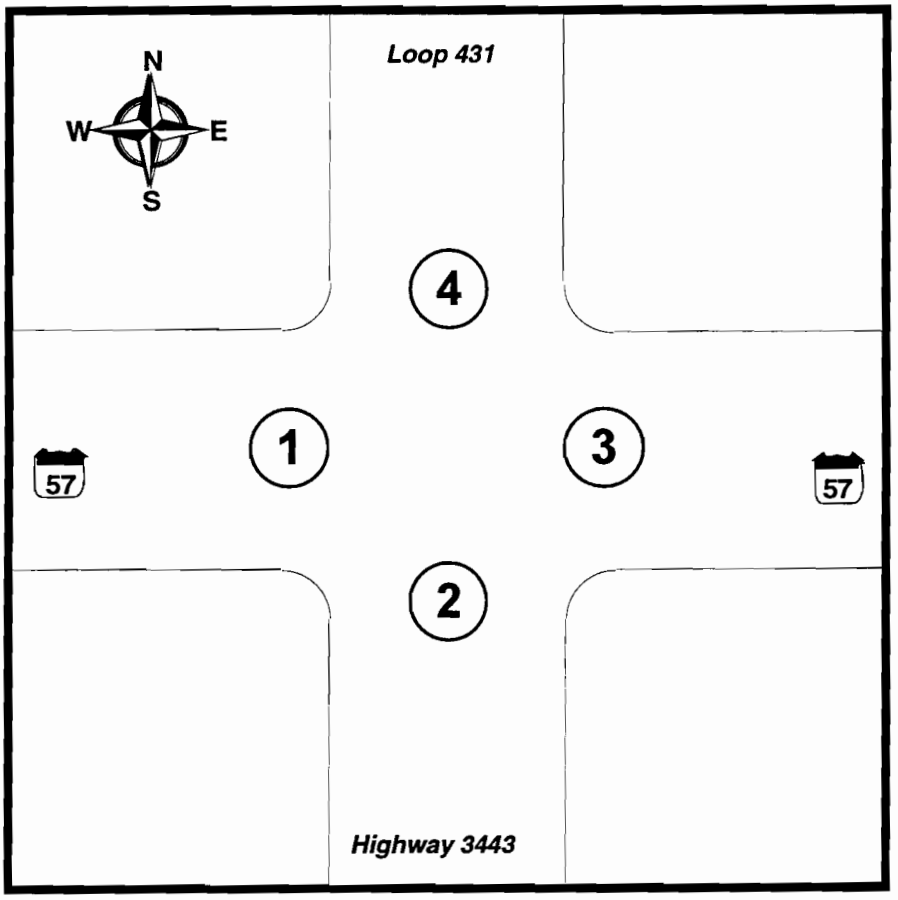
INTRODUCTION

This photo album contains Eagle Pass' and Piedras Negras' pictures of strategic locations that have been essential for the development of Project 2940, *Traffic Circulation Plan for Del Rio and Eagle Pass.* These photographs provide a better understanding and a view of the specific intersections or traffic problems that are discussed in the report. A list of the photographs is also included.

Each photograph has a description of the exact location where it was taken. The description given at the bottom of each of the photographs specifies the view shown and *not* where the picture was taken. To clarify this description and to ensure no misunderstanding, a brief explanation will be given. Please see the example on the next page for photograph locations.

EXAMPLE

For example, in the following intersection of Loop 431, Highway 3443, and US 57:



1. Specifies photograph of area 1. Would be called:
   US 57 West of Loop 431
   or US 57 West of Highway 3443
2. Specifies photograph of area 2. Would be called:
   Highway 3443 South of US 57
3. Specifies photograph of area 3. Would be called:
   US 57 East of Loop 431
   or US 57 East of Highway 3443
4. Specifies photograph of area 4. Would be called:
   Loop 431 North of US 57

LIST OF EAGLE PASS PHOTOGRAPHS

1. Main St. East of US 277 Business (Ceylon St.)
2. US 277 Business (Ceylon St.) North of Main St.
3. Main St. West of US 277 Business (Ceylon St.)
4. Main St. West of US 277 Business (Ceylon St.)
5. US 57 West of FM 375
6. FM 375 North of US 57
7. US 57 East of FM 375
8. FM 375 South of US 57
9. Loop 431 East of US 277
10. US 277 North of Loop 431
11. US 277 South of Loop 431
12. Intersection of Ave. B, US 277 Business & Second St.
13. Right Angled turn on the US 277 Business
14. Right Angled turn on the US 277 Business
15. Intersection of US 57 and Loop 431
16. US 57 East of Loop 431
17. US 57 West of Loop 431
18. US 57 East of FM 1021 (Near City Hall)
19. US 57 West of FM 1021 (Near City Hall)
20. FM 1021 South of US 57 (Near City Hall)
21. Intersection of FM 1021 AND US 57
22. Loop 431 North of FM 1021
23. FM 1021 East of Loop 431
24. FM 375 North of FM 1021
25. FM 1021 West of FM 375
26. Intersection of FM 1021 AND FM 375
27. Brown St. South of FM 1021
28. International Bridge
29. Traffic on the International Bridge
30. Main St. at Downtown on Saturday
31. Main St. at Downtown on Saturday

Eagle Pass

Photo 1. Main Street East of US 277 Business (Ceylon Street)

Photo 2. US 277 Business (Ceylon Street) North of Main Street

Eagle Pass

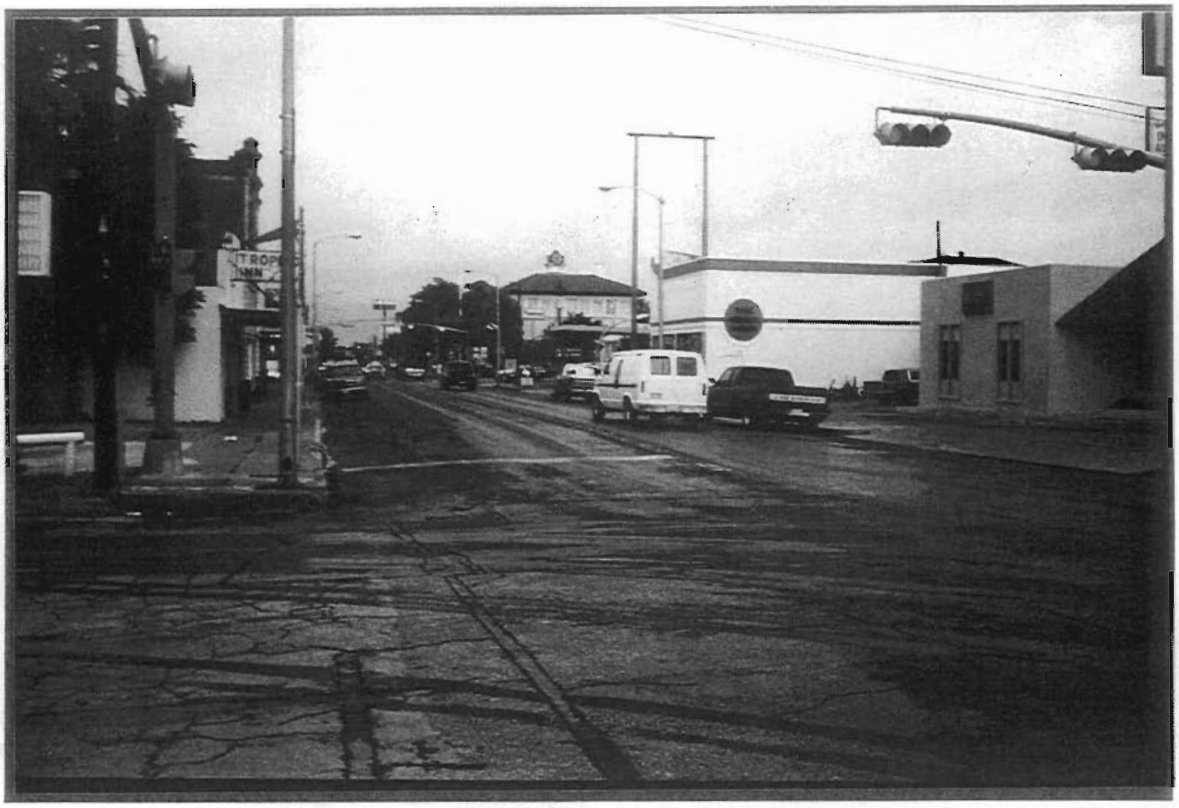


Photo 3. Main Street West of US 277 Business (Ceylon Street)

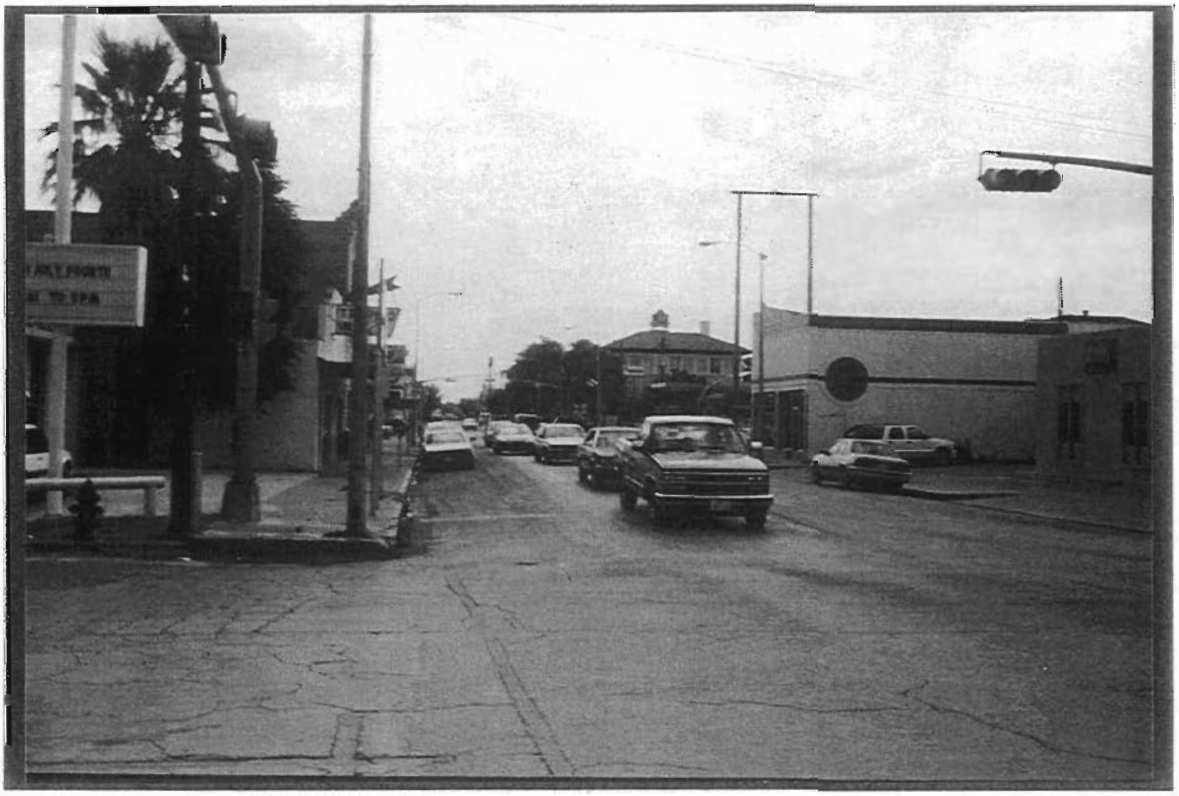


Photo 4. Main Street West of US 277 Business (Ceylon Street)

Eagle Pass

Photo 5. US 57 West of FM 375

Photo 6. FM 375 North of US 57

Eagle Pass

Photo 7. US 57 East of FM 375

Photo 8. FM 375 South of US 57

Eagle Pass

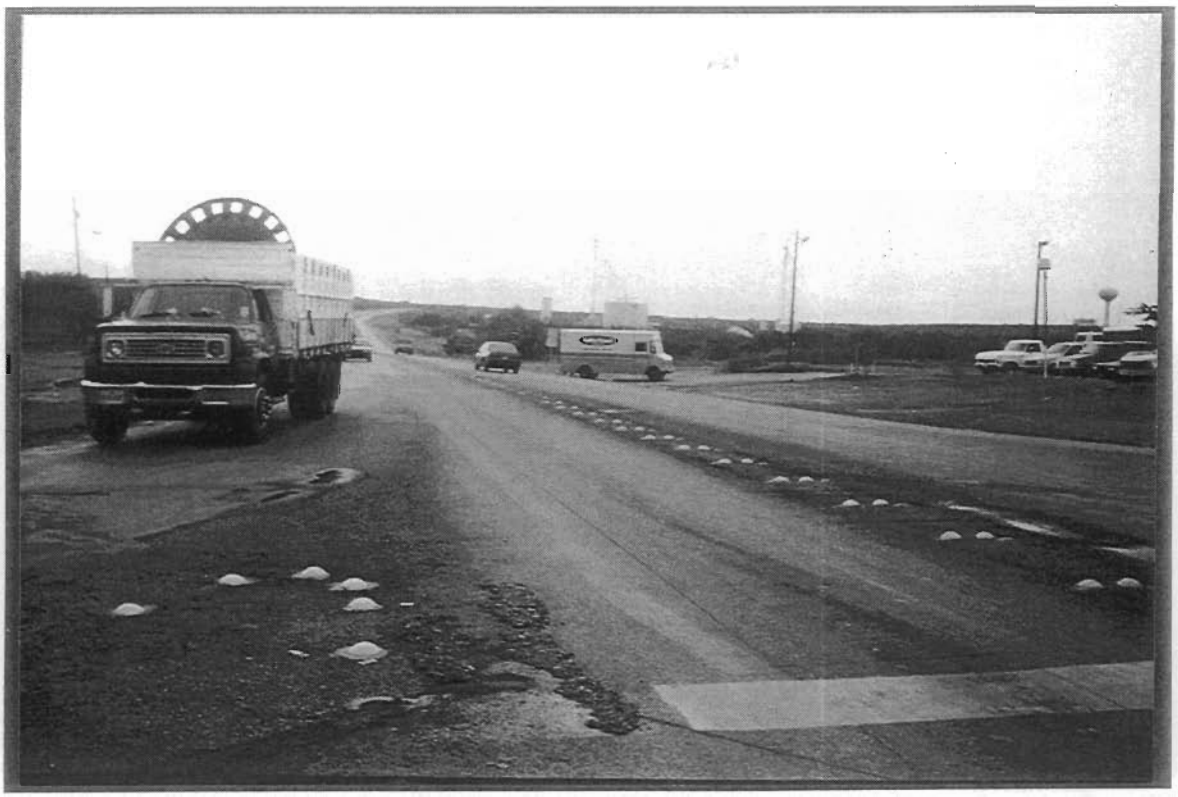


Photo 9. Loop 431 East US 277

Photo 10. US 277 North of Loop 431

Eagle Pass

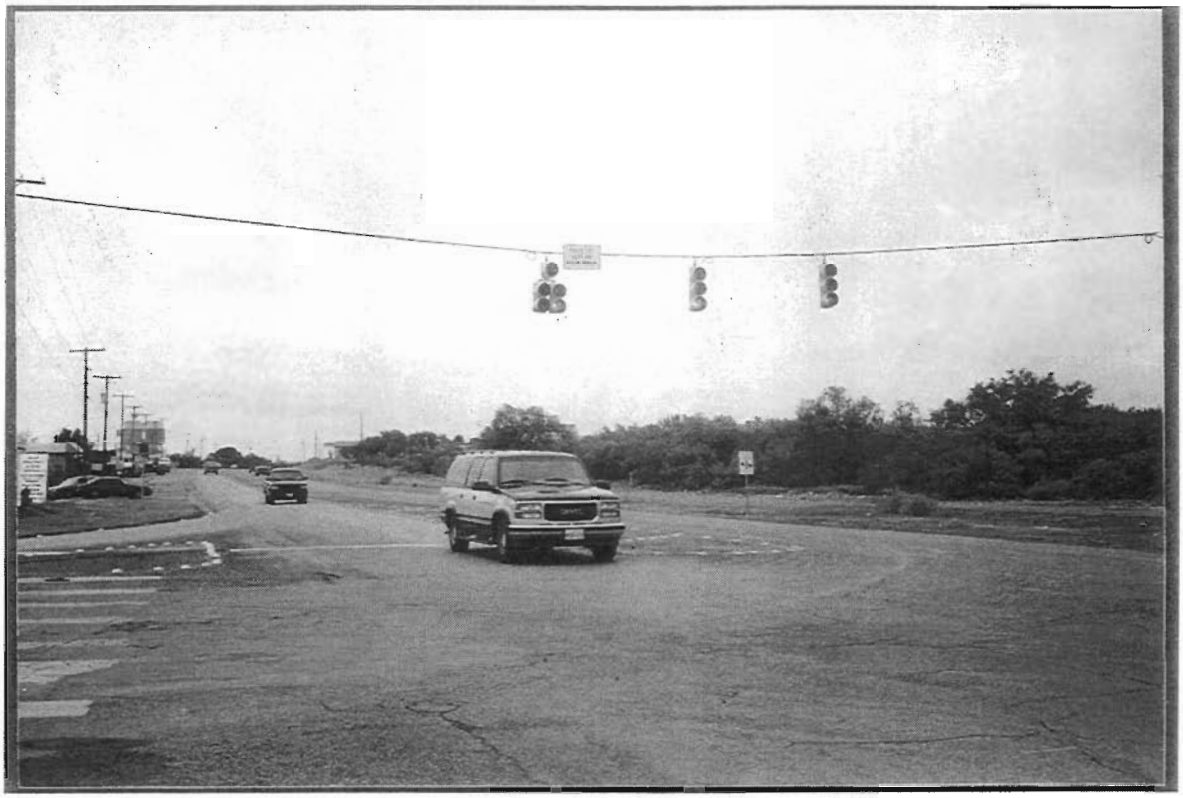


Photo 11. US 277 South of Loop 431

Photo 12. Intersection of Avenue B, US 277 Business and Second Street

Eagle Pass

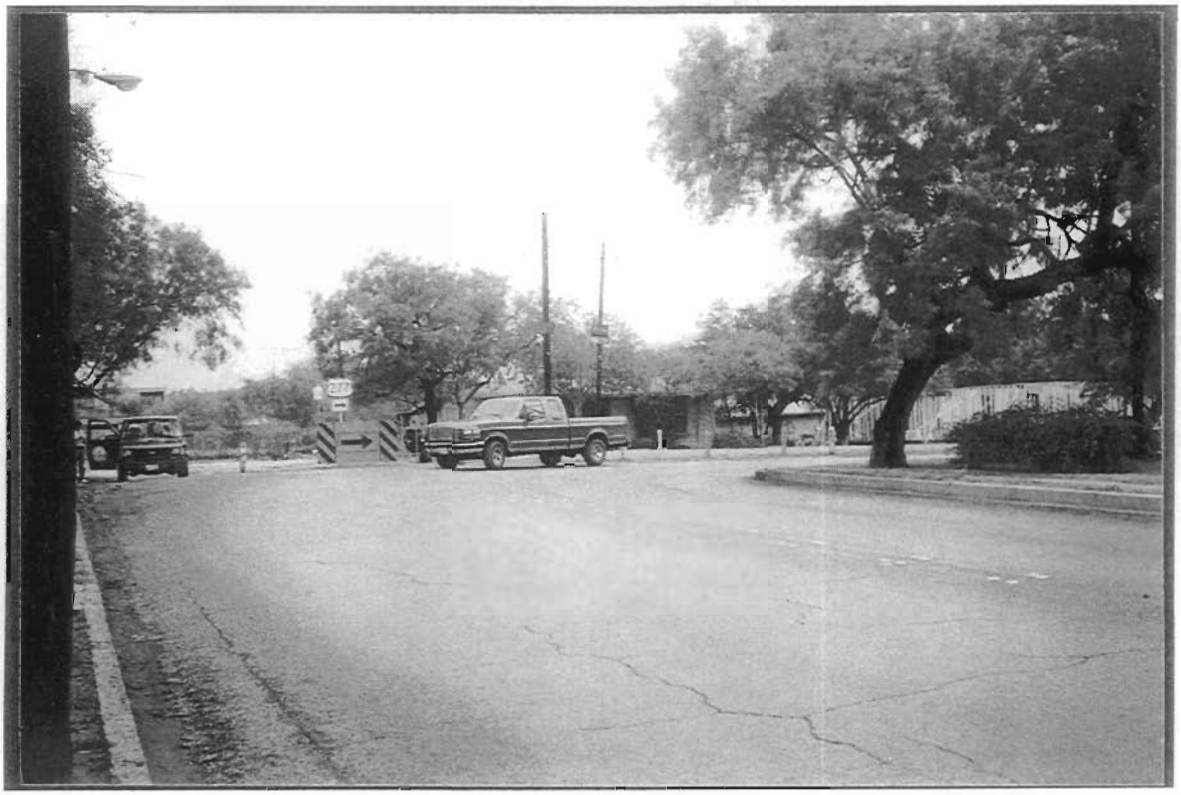


Photo 13. Right Angled turn on the US 277 Business

Photo 14. Right Angled turn on the US 277 Business

Eagle Pass

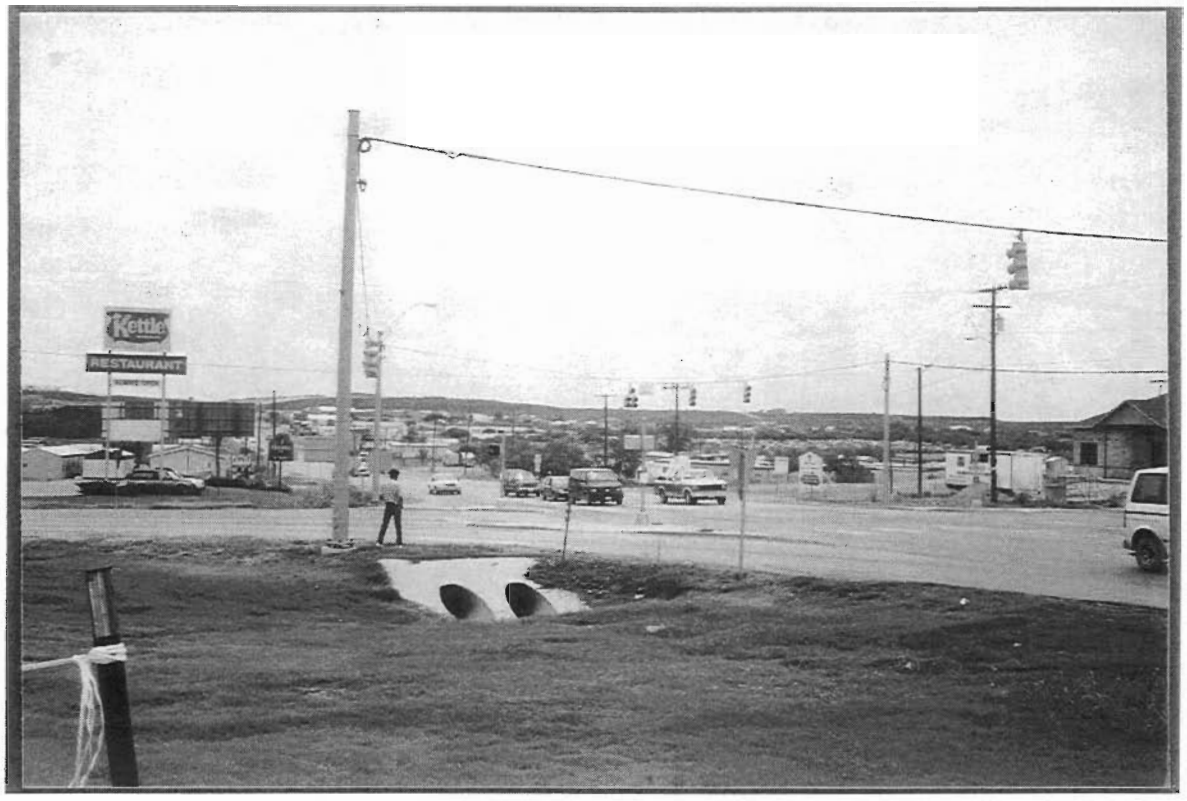


Photo 15. Intersection of US 57 and Loop 431

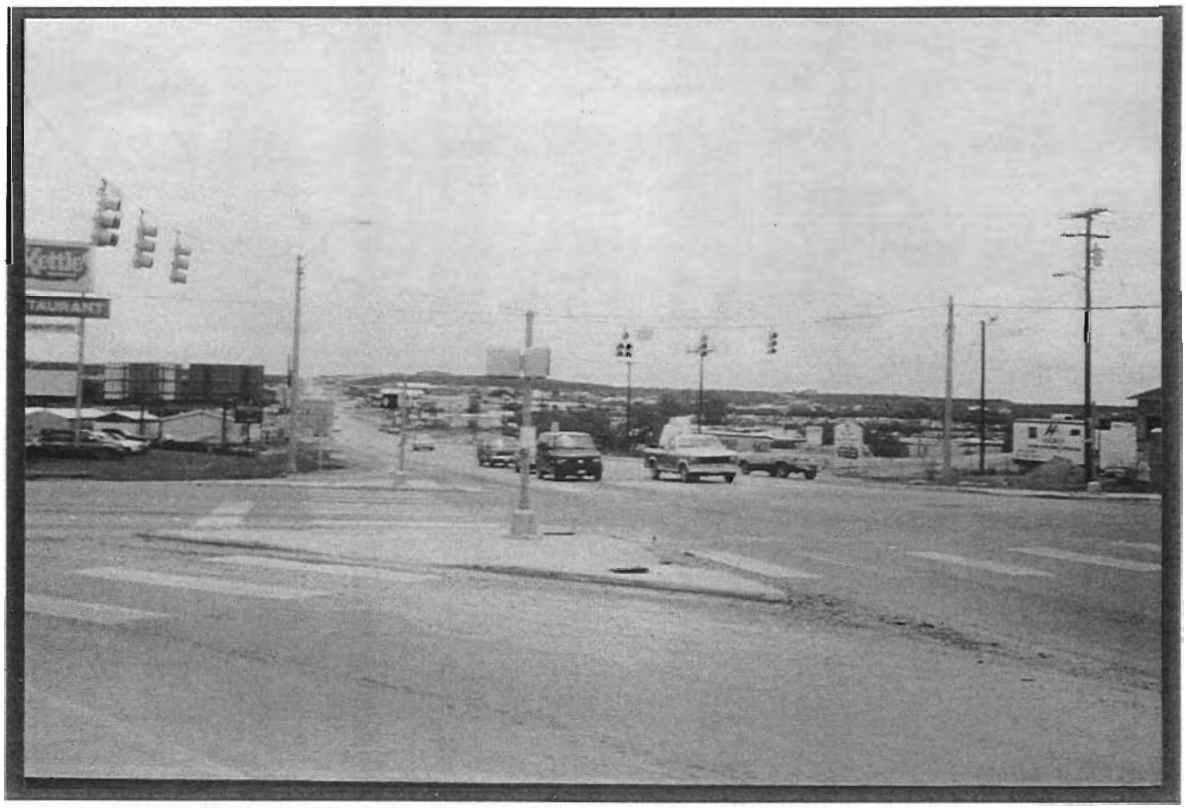


Photo 16. US 57 East of Loop 431

Eagle Pass

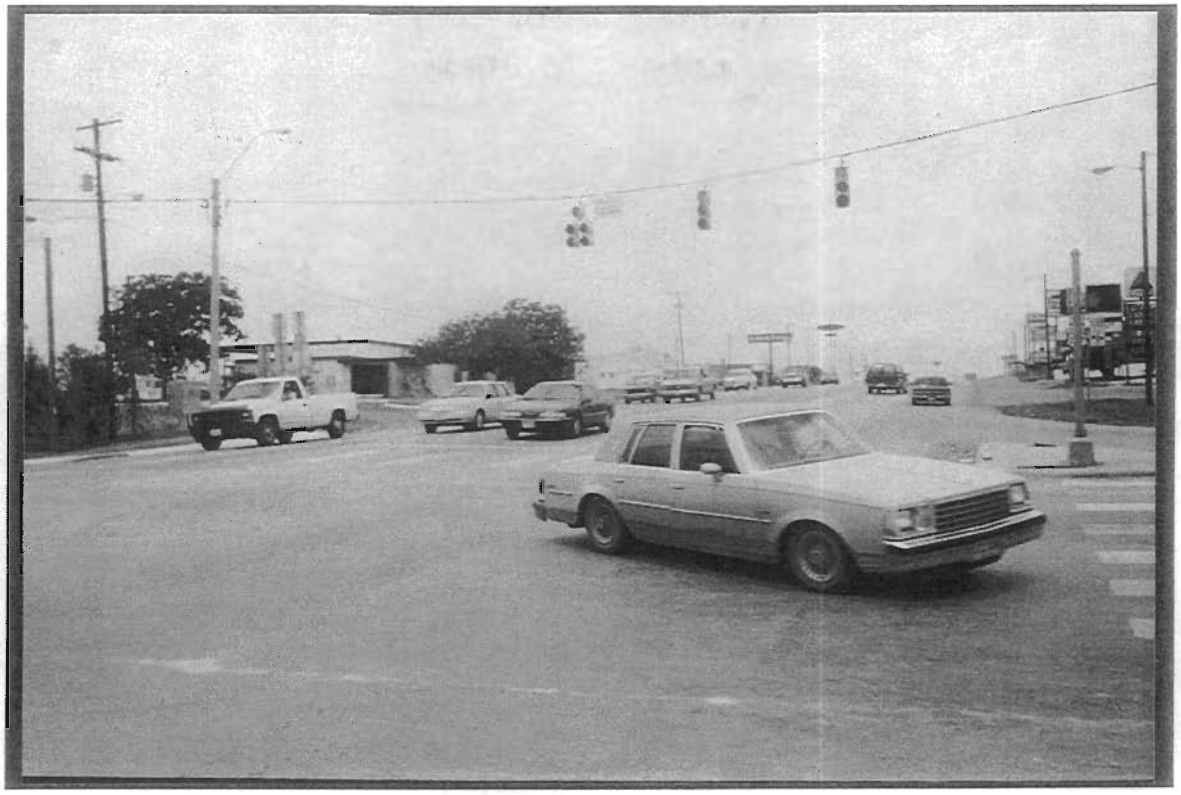


Photo 17. US 57 West of Loop 431

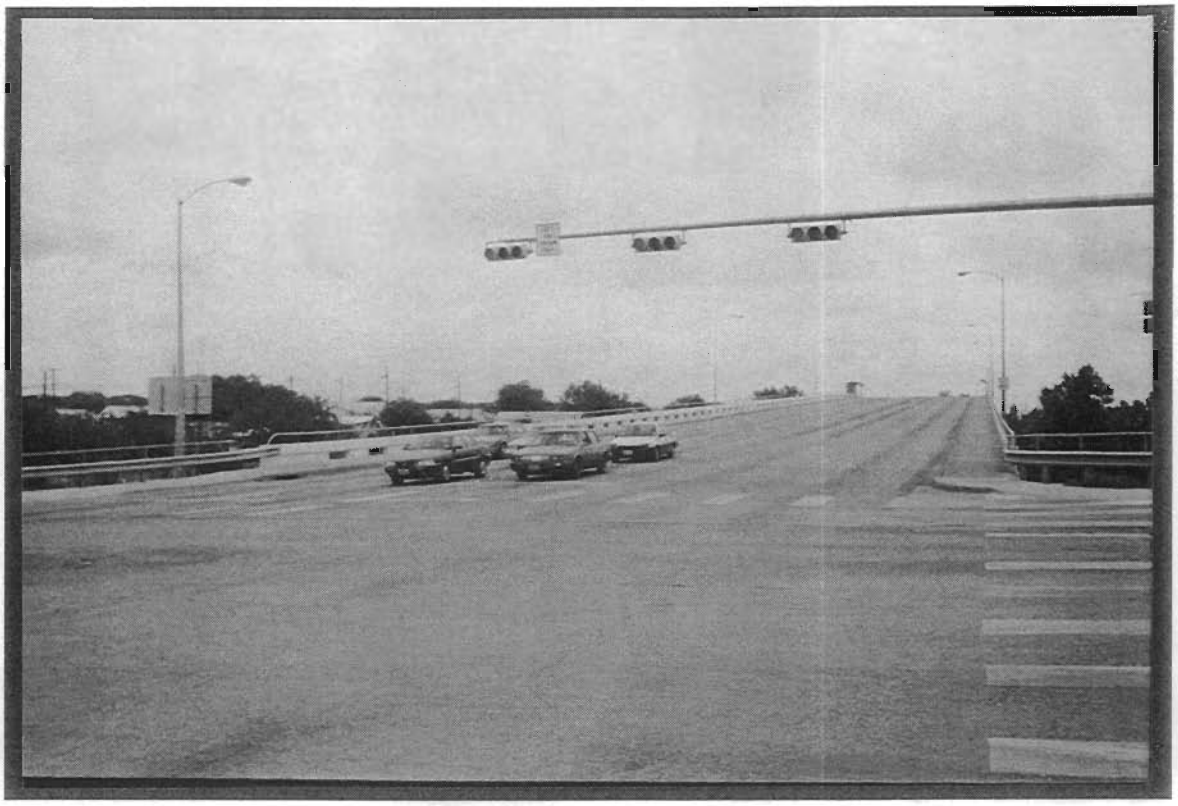


Photo 18. US 57 East of FM 1021 (Near City Hall)

Eagle Pass

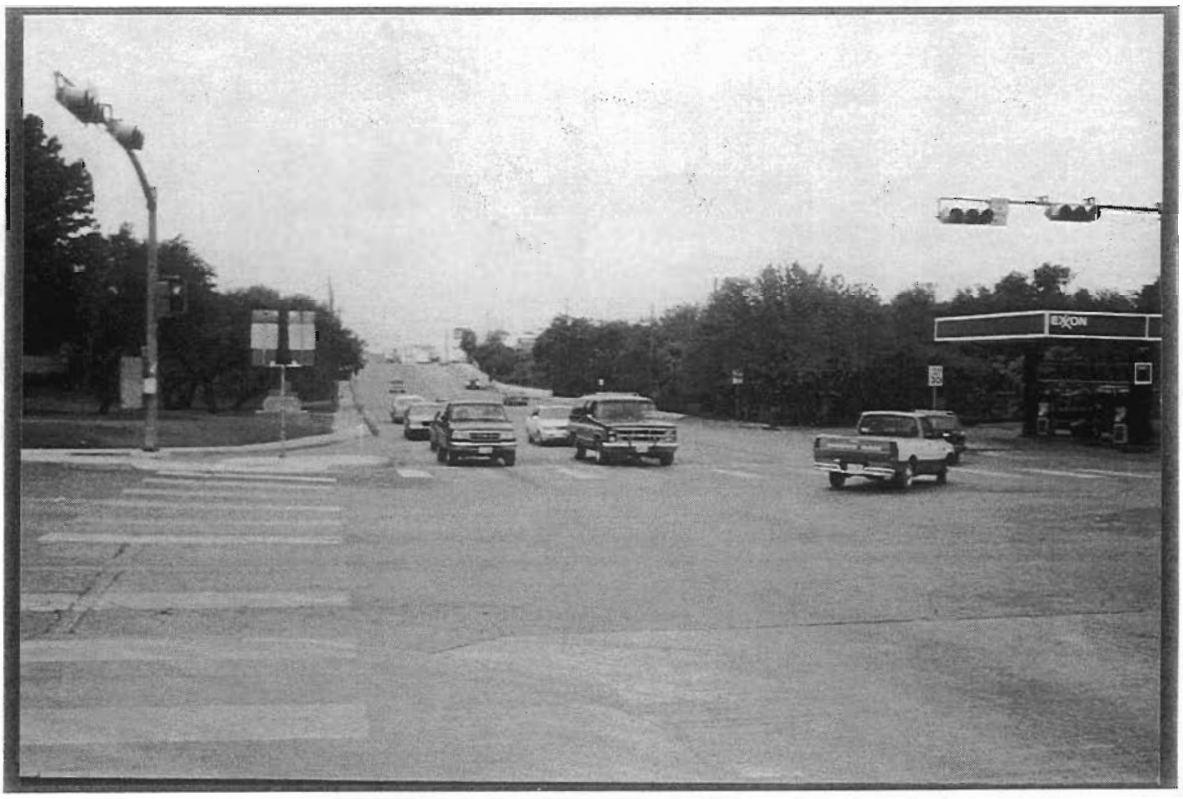


Photo 19. US 57 West of FM 1021 (Near City Hall)

Photo 20. FM 1021 South of US 57 (Near City Hall)

Eagle Pass

Photo 21. Intersection of FM 1021 and US 57

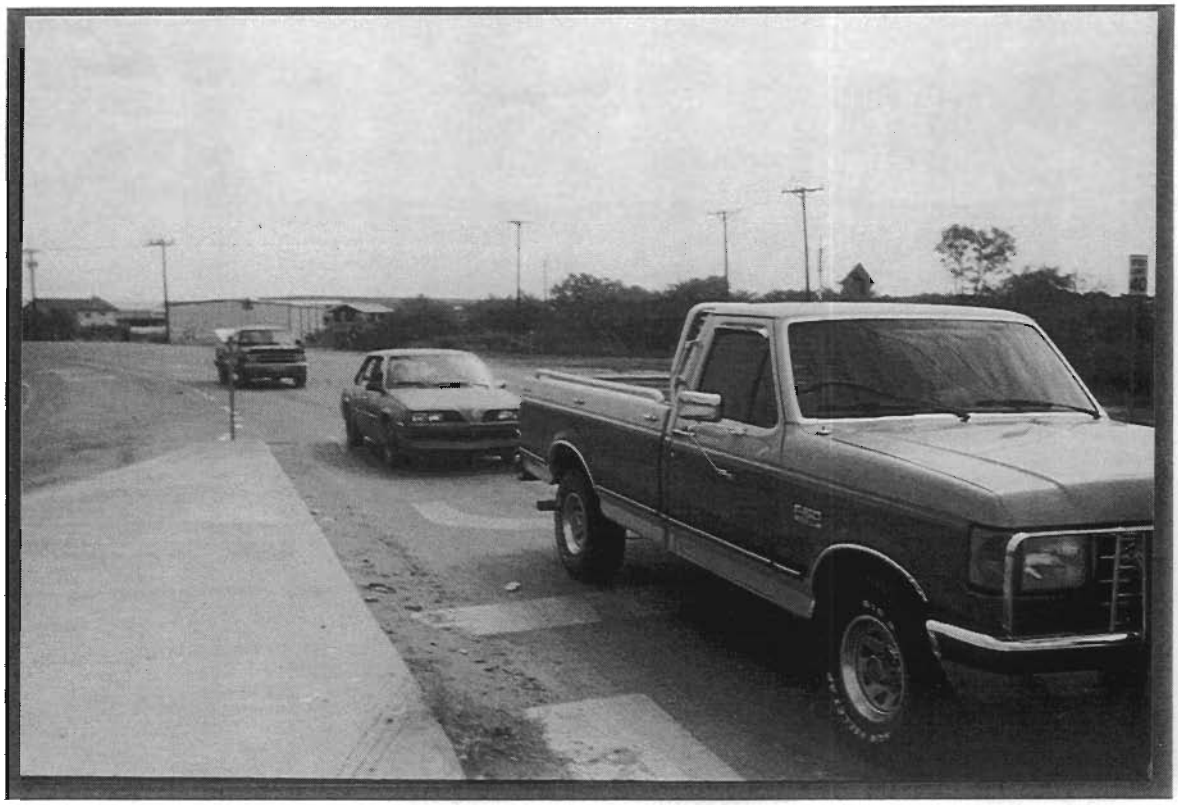


Photo 22. Loop 431 North of FM 1021

Eagle Pass

Photo 23. FM 1021 East of Loop 431

Photo 24. FM 375 North of FM 1021

Eagle Pass

Photo 25. FM 1021 West of FM 375

Photo 26. Intersection of FM 1021 and FM 375

Eagle Pass

Photo 27. Brown Street South of FM 1021

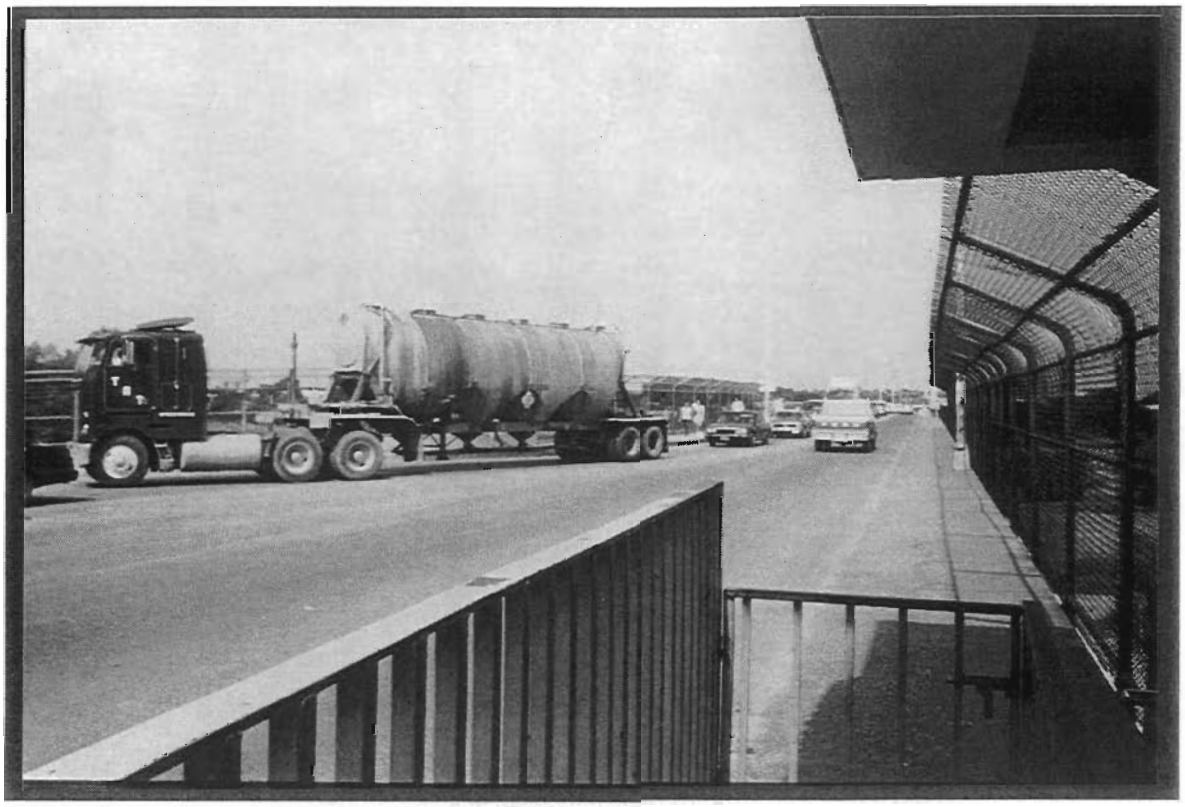


Photo 28. International Bridge

Eagle Pass

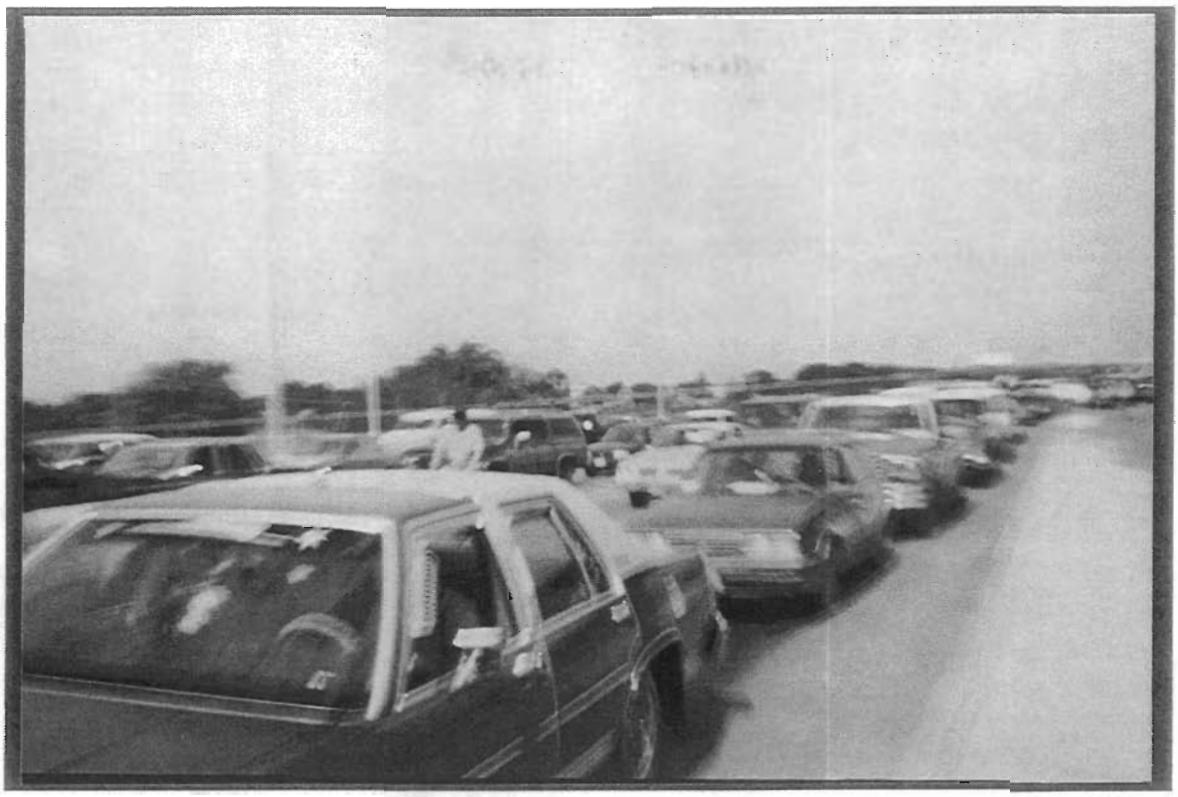


Photo 29. Traffic on the International Bridge

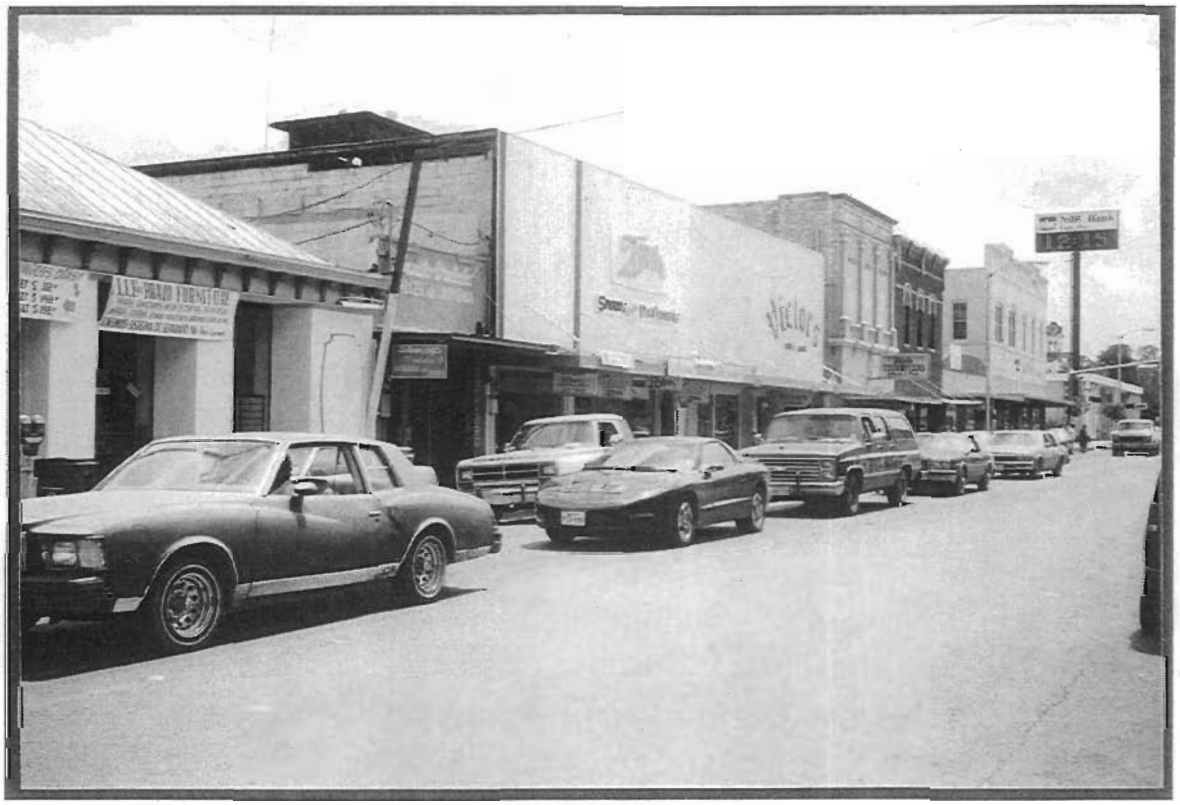


Photo 30. Main Street at Downtown on Saturday

Eagle Pass

Photo 31. Main Street at Downtown on Saturday

Eagle Pass

Photo 32. Main Street at Downtown on Saturday

Photo 33. Main Street at Downtown on Saturday

Eagle Pass

Photo 34. Main Street

Photo 35. Parking Lanes on Main Street

Eagle Pass

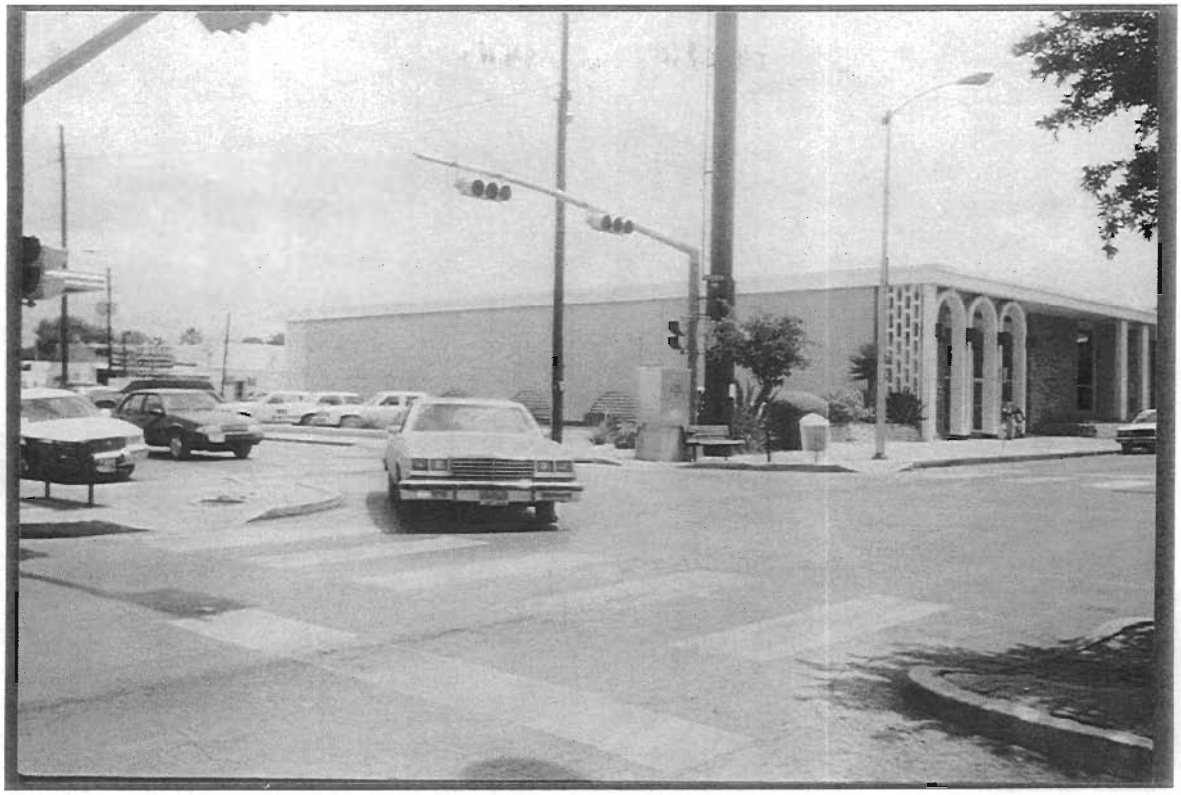


Photo 36. Turning Problem due to Projected Curb along Main Street

Photo 37. Intersection of Main Street and US 57

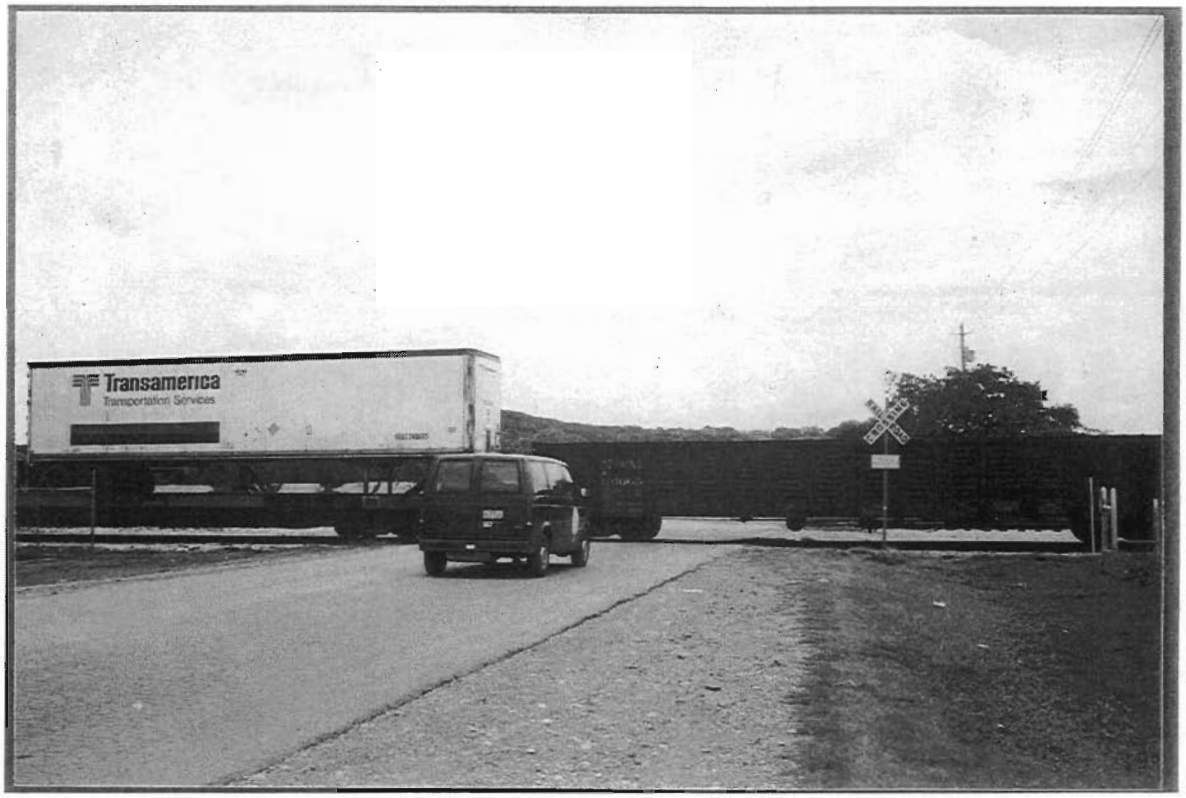


Photo 38. Industrial Park Boulevard's Rail Crossing

Photo 39. Industrial Park Boulevard

PIEDRAS NEGRAS PHOTOGRAPHS

1. Rail Bridge
2. Rail Terminal
3. Toll Booths
4. Toll Booths
5. Entrance to Mexico
6. Entrance to Mexico

Piedras Negras

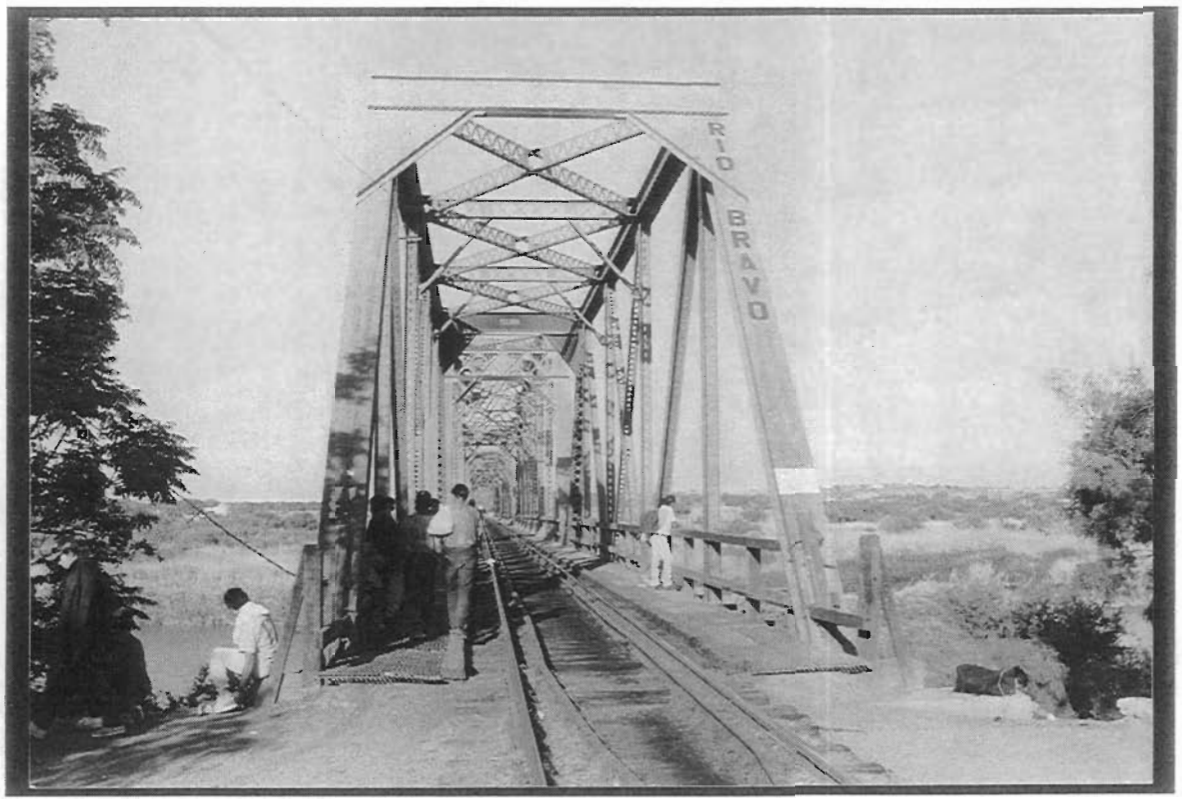


Photo 1. Rail Bridge

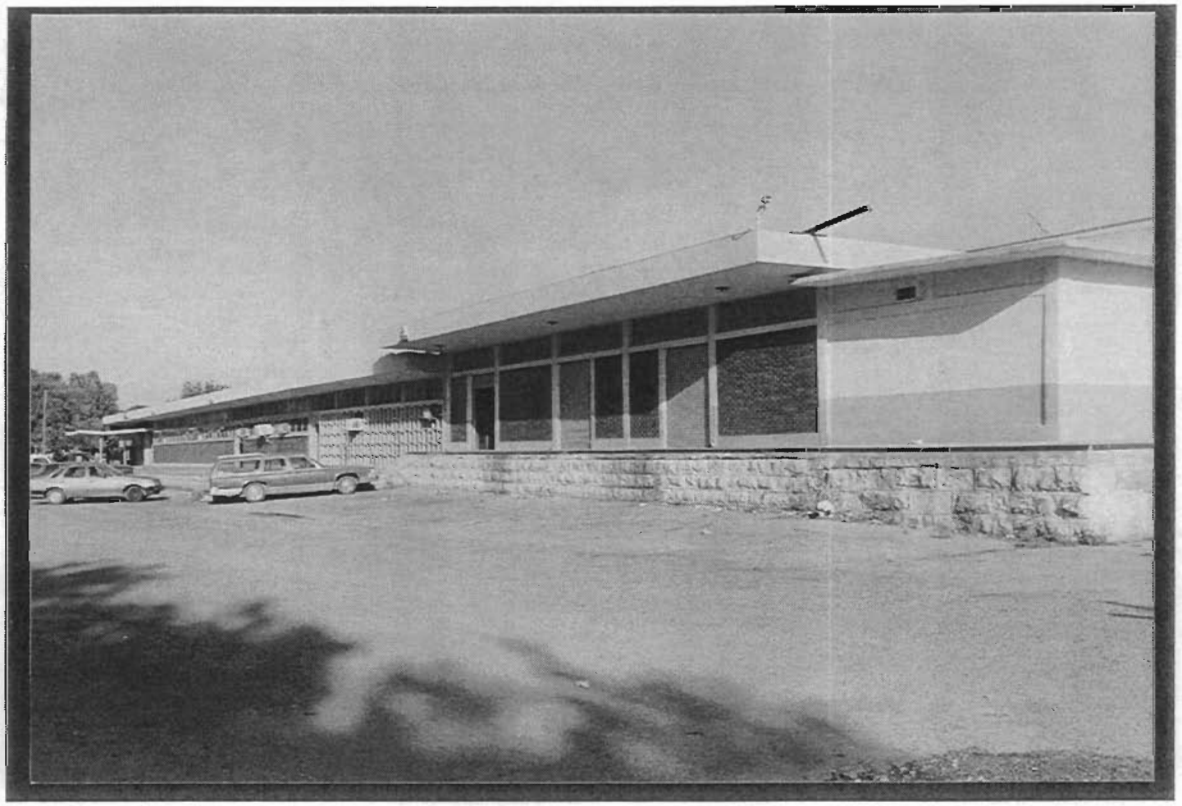


Photo 2. Rail Terminal

Piedras Negras

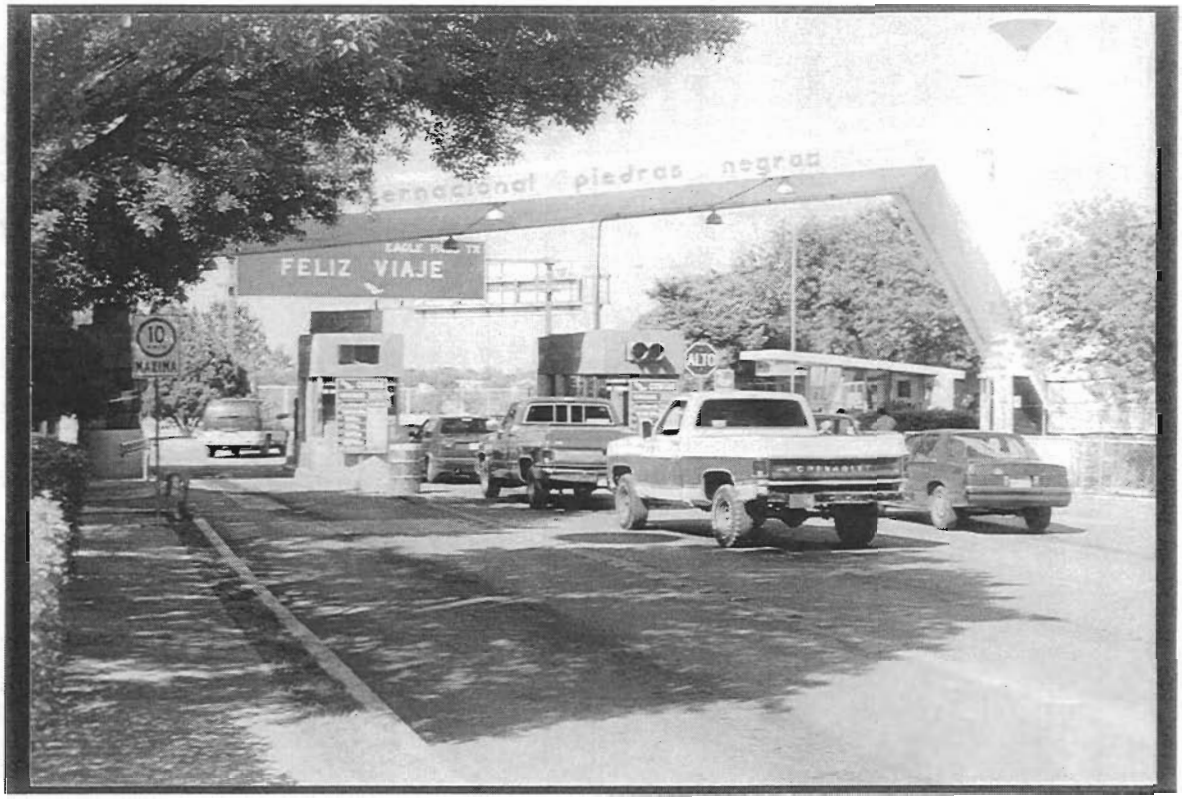


Photo 3. Toll Booths

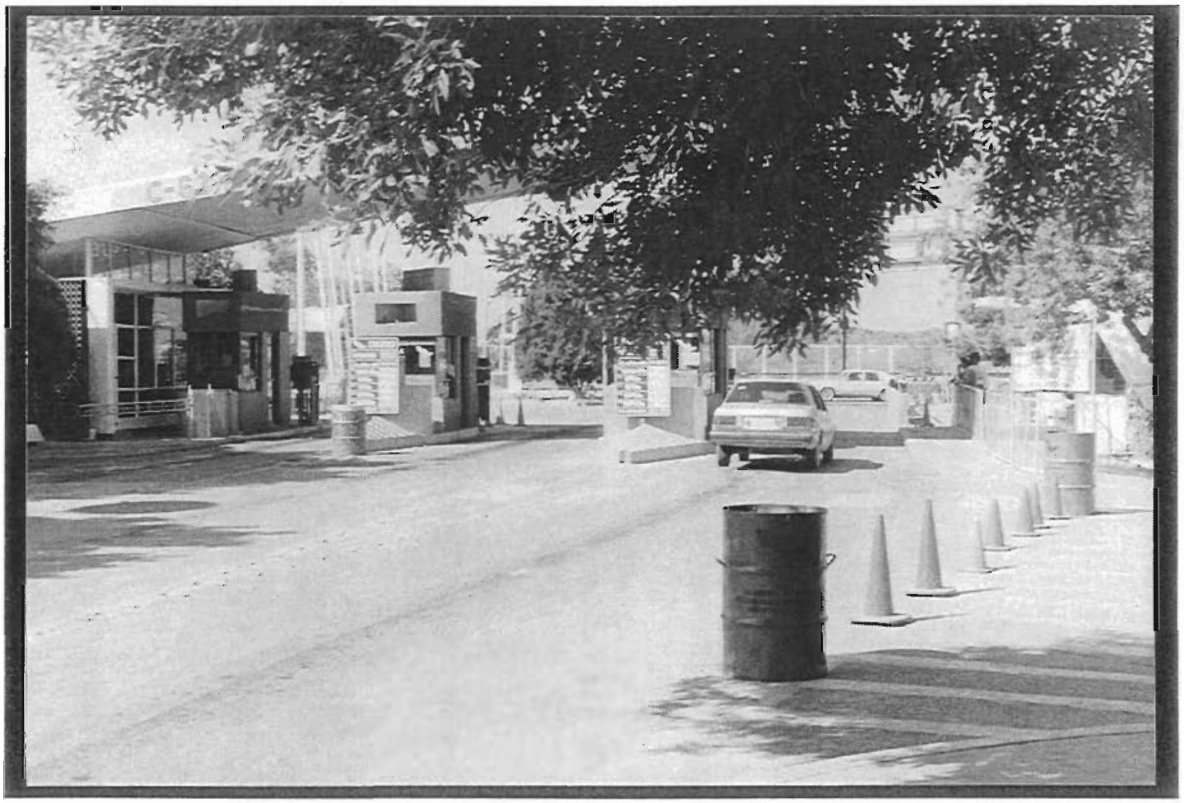


Photo 4. Toll Booths

Piedras Negras

Photo 5. Entrance to Mexico

Photo 6. Entrance to Mexico

APPENDIX 2.

SUMMARY OF MEXICAN DATA

APPENDIX 2. SUMMARY OF MEXICAN DATA

BACKGROUND

The Mexican data were collected by our Mexican subcontractor, Ingeniería Gario, led by Mr. Noe García-Rojas, a professional engineer with 23 years of experience in transportation, who served as director in state commissions and has valuable contacts with state and local city planners in Ciudad Acuña and Piedras Negras, and the state of Coahuila.

During the data collection process, Ingeniería Gario contacted city planners, local authorities, representatives of Coahuila transportation department, and other relevant officials, and obtained qualitative information to support the quantitative data. Ingeniería Gario also sent information on traffic management plans, urban development, peak-hour condition, identification of peak periods, additional (historic) traffic data, and other relevant information, such as recent developments on all proposed international bridge locations, and planned public works that may affect local and international traffic in Ciudad Acuña and Piedras Negras. The objective of this Appendix is to report to TxDOT a summary of the available data, which include:

PIEDRAS NEGRAS

(1) Updated Urban Development Plan 1992. State of Coahuila Government
(2) Municipal Statistical Notebook 1994 Edition (INEGI)
(3) Notebook with basic information for Municipal Planning (INEGI)
(4) Photograph of Infrastructure Plan. State of Coahuila Government
(5) Infrastructure Plan for Rail and Highways
(6) General Plan of Nomenclature
(7) Plan of Total Population by (A.G.E.B.)
(8) Plan of Population Economically Active by (A.G.E.B.)
(9) Plan of Population with Income from 2 to 5 minimum salaries by (A.G.E.B)

CIUDAD ACUÑA

(1) Updated Urban Development Plan 1992. State of Coahuila Government
(2) Notebook with basic information for Municipal Planning (INEGI)
(3) Photograph of Infrastructure Plan. State of Coahuila Government
(4) Infrastructure Plan for Rail and Highways
(5) General Plan of Nomenclature
(6) Plan of Total Population by (A.G.E.B.)
(7) Plan of Population Economically Active by (A.G.E.B.)
(8) Plan of Population with Income from 2 to 5 minimum salaries by (A.G.E.B.)

NORTHERN REGION OF COAHUILA.

(1) Statistical Yearbook for the State of Coahuila 1994 Edition. (INEGI)
(2) Directory of the Maquiladoras of the States of Tamaulipas, Nuevo Leon and Coahuila.
(3) Tourist map of the border region of Coahuila, map of the north part of the state of Coahuila, containing traffic volumes.

STATISTICS FOR PIEDRAS NEGRAS

(1) Historic description of the population 1950-1993-2012.
(2) Rural and urban population 1950-1995.
(3) Men population of 12 years old or older by activity.
(4) Women population of 12 years old or older by activity.
(5) Distribution of the use of the land.
(6) Pedestrian and Vehicle Capacity, International Bridge.
(7) Total load in rail station by type of product received.
(8) Total load in rail station by type of product delivered.
(9) Population 1950 - 1993 - 2012 for Piedras Negras.
(10) Rural and Urban Population 1950 - 1995 for Piedras Negras.
(11) Population of men ages 12 of more for activity condition, for Piedras Negras.
(12) Population of women ages 12 of more for activity condition, for Piedras Negras.
(13) Land use in Piedras Negras.
(14) Pedestrian and vehicle traffic for International bridge (Eagle Pass-Piedras Negras).
(15) Reception (into Mexico) Station for Piedras Negras Railroad.
(16) Remission (out of Mexico) Station for Piedras Negras Railroad.

STATISTICS FOR CIUDAD ACUÑA

(1) Historic description of the population 1950-1993-2012.
(2) Population economically active by activity.
(3) Development of the maquiladora industry 1970-1979.
(4) Vehicle Capacity, International Bridge.
(5) Total load in rail station by type of product received.
(6) Total load in rail station by type of product delivered.
(7) Population 1950 - 1993 - 2012 for Ciudad Acuña.
(8) Population of men and women ages 12 of more for activity condition, for Ciudad Acuña.

(9) Manufacturers in Ciudad Acuña.
(10) Traffic for International bridge (Ciudad Acuña-Del Rio).
(11) Reception (into Mexico) Station for Ciudad Acuña Railroad.
(12) Remission (out of Mexico) Station for Ciudad Acuña Railroad.