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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 U.S-Mexico international trade. It consequently recommends the development of federal-aid program options to improve transportation infrastructure related to international trade. In order to take advantage of this recommendation, however, border states must monitor their transborder traffic demand and, moreover, must develop traffic circulation plans for their border cities. Thus, this report presents a 25-year traffic circulation plan for the City of Del Rio, Texas. The plan includes 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 Del Rio, as well as of international thoroughfares between Ciudad Acuña and Del Rio. 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 problems associated with additional highway capacity, pavement rehabilitation, signalization, and right-of-way needs.

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TRAFFIC CIRCULATION STUDY AND LONG-RANGE PLAN FOR DEL RIO

Angela Jannini Weissmann
Rashed Tanvir Islam

Research Report Number 2940-2

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

March 1996

IMPLEMENTATION STATEMENT

This report discusses a traffic circulation and long-range plan for the City of Del Rio, Texas. The plan includes recommendations for increasing roadway capacity, adding left-turn lanes, adding new routes to relieve congestion, and building international thoroughfares. These recommendations are discussed in this report in chronological order of recommended implementation. The recommendations and schedules discussed will assist TxDOT in planning land transport infrastructure and alleviating problems associated with additional highway capacity provisions, pavement rehabilitation, signalization, and right-of-way needs. Implementation of a traffic circulation plan requires the kind of interagency cooperation demonstrated by Ms. JoAnn Garcia, TxDOT Project Director, who organized several brainstorming meetings between TxDOT personnel and key officials in Del Rio. This initiative ensured that efforts would be coordinated with all agencies involved in the development of Del Rio's infrastructure, and that recommendations would consider equally local, state, and international traffic requirements.

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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 Del Rio, Texas. The plan includes 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 Del Rio, as well as of international thoroughfares between Ciudad Acuña and Del Rio. 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 report can assist TxDOT not only in planning land transport infrastructure, but also in alleviating problems associated with additional highway capacity, pavement rehabilitation, signalization, and right-of-way.

EXECUTIVE SUMMARY

This report presents a 25-year traffic circulation plan for the City of Del Rio, Texas. The plan was developed for two analysis scenarios, termed *low* and *high* impact. These two scenarios reflect two sources of uncertainty in future traffic demand: (1) a proposed casino to be built on the Kickapoo Indian Reservation near Eagle Pass, and (2) the possibility of Del Rio developing south, in the area between the Rio Grande and US277. In the low-impact scenario, the casino traffic component is assumed to remain small, and Del Rio develops primarily north and west. In the high-impact scenario, casino traffic is assumed to become significant, and Del Rio develops south (in addition to north and west).

The traffic plan includes an outer loop around Del Rio, which should be implemented in stages scheduled differently for each traffic demand scenario (high or low impact). The specific location of this outer loop should be determined by means of a study that takes into consideration the future position of the second international bridge, city development, and the future requirements for protecting the San Felipe Aquifer. Such a study should get underway by 2015 (or earlier if traffic grows faster than the rates used to develop this plan).

TRAFFIC CIRCULATION PLAN

This section summarizes 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) Garza Road: Smooth lay-out, removing right-angled turns. Provide shoulders on both sides. Secure right-of-way for future expansions. Verify the 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.

(2) Provide standard lane widths for Avenue F. The city should consider an ordinance restricting trucks that serve Avenue F stores to off-peak or night hours.

(3) Relocate the light poles that are too close to the outer lanes of Avenue F, Garfield Street, and US90 (between Avenue F and US277).

(4) Prohibit parking along Main Street in the downtown area.

(5) Extend Main Street up to Margaret Lane.

(6) Secure right-of-way for future expansion of all TxDOT highways: US90, US277, US239, and FM2523 (not in range shown in Figure 4.2).

(7) Secure right-of-way for future expansion of Main Street and Cienegas Road. Verify feasibility of using the sidewalks and the wide median to minimize additional right-of-way required to add a left-turn lane to Main Street.

(8) Secure right-of-way for expanding Bedell Avenue along Dodson and for implementing additional lanes afterwards.

(9) Prohibit through trucks on Las Vacas, Garfield, Pecan, Loop Road, and Main Street. Divert them to the new Spur 239 and Gibbs.

(10) Prohibit delivery trucks during the peak-hours on Avenue F.

(11) Implement and enforce truck routes shown in Figure 4.6 (Chapter 4).

(12) The intersections of Garza Road and Johnson Boulevard with Cienegas Road should be reconstructed as a single intersection.

(13) The intersection of Avenue F and US90: Relocate electric poles away from lane edge; increase available radius for turning movements; flare the intersection approaches about 60m.

(14) Provide lane markings on the intersections of Avenue F and its cross streets.

(15) Smooth as much as possible the obtuse angle of Garfield intersections with Losoya, Greenwood, and Pecan.

(16) Signalize intersection of Main Street and New Spur 239.

(17) Signalize intersection of New Spur and Las Vacas.

(18) Signalize intersection of Griner and Garfield.

(19) Synchronize signals along Avenue F and Garfield Street in downtown area.

(20) Synchronize signals along US277 (from Avenue F to Bowie).

Immediate Implementation Recommended — High-Impact Scenario

(1) Secure right-of-way for a future link between US277 (eastbound) and the international bridge, possibly through an extension of Loop Road, up to US277 near the intersection of Broadbent.

(2) Provide bilingual directional signs indicating the casino route, especially along Las Vacas, Garfield, and at the intersection of Garfield Street and US277.

Implementation Recommended by 2000 — All Scenarios

(1) Widen as much as possible existing Bedell Avenue, and extend it along Dodson up to the intersection of Stricklen and US90 (two lanes each way). Secure right-of-way for future expansions.

(2) Convert Main Street to a continuous four-lane road from Gibbs Street to 17th Street. Extend Main Street beyond 17th Street up to Cantu Road at Margaret Lane, and make it four lanes. (This will encourage use of Main Street as an alternative to Avenue F.)

(3) Secure right-of-way to expand Stricklen (between US90 and Amistad Boulevard).

(4) Secure right-of-way for expanding Cantu Road.

(5) Secure right-of-way for future expansion of Garza Road.

(6) Secure right-of-way for further extending Dodson/new Bedell to the north, either along or near Chisolm Trail and Quail Road.

(7) Determine optimal location of a new north-south thoroughfare linking the area near US90/US277 intersection with Stricklen (or King's Way) to Garza Road near the international bridge. This thoroughfare will serve Spring Lake Estates, the airport, Cienegas Terrace, and Chaparral Hills.

(8) Prohibit through trucks on Cantu Road, Stricklen, Margaret Lane, and Amistad Boulevard, and divert them to the new Bedell extension.

(9) If truck traffic increases faster than assumed in this study, prohibit through trucks on Avenue F and divert them to the new Bedell extension.

(10) Implement left-turn bays at the following intersections of Bedell Avenue/Dodson and its extension: US90/Stricklen; Braddie Drive, Cantu Road, Dodson, and old Bedell.

(11) Implement right- and left-turn bays at the intersection of old Bedell and Dodson.

(12) Implement left-turn bays at the following intersections of Avenue F: Gibbs Street, 10th, and old Bedell.

(13) Implement left-turn bays at the intersections of Main Street and Gibbs Street.

(14) Remove right angle at Margaret Lane and Amistad Boulevard intersection.

(15) Signalize intersection of Avenue T and New Spur 239.

(16) Signalize intersection of Main Street and Cantu Road.

(17) Signalize intersection of Bedell extension and Cantu Road.

(18) Signalize intersection of Bedell extension and Braddie Drive.

(19) Signalize intersection of Bedell extension and US90/US277 (at Stricklen) with actuation.

(20) Synchronize signals along old Bedell, Bedell Extension, and Stricklen.

(21) Synchronize signals along Cantu Road.

(22) Synchronize signals along New Spur 239 and Gibbs.

(23) Synchronize signals along Garfield and Las Vacas, providing at least 60 percent of green time for this route.

Implementation Recommended by 2000 — High-Impact Scenario

(1) Implement Loop Road extension (two lanes, up to US277 near the intersection of Broadbent) to divert casino demand out of the downtown area.

(2) Secure right-of-way to expand US277 from international bridge to Loop Road extension.

(3) Loop Road extension is likely to attract development; therefore, secure right-of-way along Loop Road, Pecan, Hudson, Guyler, and for further expanding the Loop Road extension described in recommendation (1) of this scenario.

(4) If Del Rio is developing south, in the area between the Rio Grande and US277, secure right-of-way along Loop Road, Pecan, Hudson, Guyler, and the Loop road extension described in recommendation (1) of this scenario.

(5) Add one lane each way to the US239/US277 segment between the Rio Grande and the new Spur 239.

(6) Direct international trucks bound to US277 South to Loop Road extension.

(7) Implement left-turn bays at the following intersections: old Loop Road and its extension; old Loop Road and US239/US277 (access to international bridge); Loop Road extension and US277.

(8) Signalize the following intersections of Loop Road (including its extension): US277 (actuated), Old Loop Road, and Guyler.

Implementation Recommended Between 2005 and 2010 — All Scenarios

The following studies should be initiated no later than 2010: environmental impacts and feasibility studies for Del Rio's Outer Loop and second international bridge; optimal location of new bridge; and optimal location of Del Rio's Outer Loop. These studies should be developed as a concerted effort among TxDOT and the City of Del Rio. International bridge studies must include input from the city of Acuña and inspection agencies on both sides of the border.

(1) Convert Cantu Road to four lanes (two lanes each direction) if possible. If right-of-way is feasible for only one additional lane, implement a continuous left-turn lane. If this study's assumptions about Del Rio northwest growth materialize, demand for Cantu will increase, and the number of turning movements will be high.

(2) Add two more lanes (one each direction) along Bedell Avenue extension.

(3) Add one lane each direction along Garza Road.

(4) Add a left-turn lane along Main Street.

(5) Add a left-turn lane along new Spur 239 and Gibbs Avenue (assumption to be verified before implementation: New land development along Spur 239 creates a high number of turning movements).

(6) Implement a new north-south thoroughfare linking the area near US90/US277 intersection with Stricklen (or King's Way) to Garza Road near the international bridge. The thoroughfare will serve Spring Lake Estates, the airport, Cienegas Terrace and Chaparral Hills. Some possible locations are:

Alternative 1: Extend from Stricklen southwards along Amistad Boulevard.

Alternative 2: Extend up to King's Way, from there southwards along Tomahawk.

Alternative 3: Extend further north and west, using currently undeveloped land.

(7) Make the north-south thoroughfare an additional truck route, and direct through trucks to this new route.

(8) Secure right-of-way along the entire length of the new north-south thoroughfare for future expansions.

(9) Secure right-of-way to extend the new north-south thoroughfare south, to serve as access to the second international bridge.

(10) Secure right-of-way to extend the new north-south thoroughfare southeast, around the aquifer and towards US277.

(11) Extend Dodson/new Bedell to the north, up to the future intersection of the new north-south thoroughfare (if optimal thoroughfare location not yet determined, extend up to King's Way).

(12) Widen Las Vacas and Garfield as far as right-of-way permits.

(13) Widen US277 segment between US90 and intersection with new Loop Road extension (one more lane each way).

(14) Implement Loop Road extension (two lanes, up to US277 near the intersection of Broadbent).

(15) The following intersections of the new north-south thoroughfare should have left-turn bays: Cienegas Road; Garza Road; Cantu Road; Amistad Boulevard; and US90/US277. Other intersections may also need left-turn bays, depending on actual development along and near this new thoroughfare.

(16) Implement left-turn bays at the following intersections of Cantu Road: Margaret Lane and Avenue F.

(17) Signalize intersection of Garza Road and US239 (access to existing bridge).

(18) Signalize intersection of Main Street extension and Cantu Road.

(19) Signalize intersection of Bedell extension and 15th Street.

(20) Signalize intersection of Bedell extension and 17th Street.

(21) Signalize intersection of US90/US277/US377 and the new North-South thoroughfare (actuated).

(22) Implement a properly designed multi-phase signal at the intersection of Bedell extension and Braddie Drive when the new extension to link the north-south thoroughfare is open to traffic.

(23) Synchronize signals along the north-south thoroughfare.

(24) Synchronize signals along Main Street.

(25) Synchronize signals along Amistad Boulevard.

(26) Either actuate signals along Avenue F, or synchronize for at least 60 percent green time on Avenue F.

(27) Update this traffic circulation plan to include new developments.

Implementation Recommended Between 2005 and 2010 — High-Impact Scenario

(1) If casino demand increases significantly: Expand Loop Road extension to four lanes.

If casino demand remains off-peak, but the area has developed enough traffic to generate high demand for turning movements: Add continuous left-turn lane.

If casino demand remains off-peak, and the area presents moderate development: Implement left-turn bays at the following intersections of Loop Road extension: Pecan and Guyler. Verify the need to upgrade and/or signalize intersections with new streets that may develop in the area.

(2) If the area has developed: Widen Guyler Avenue and extend it northwest up to the intersection of US277/SH239 and Ellis.

(3) Widen Pecan as far as right-of-way permits and extend it southeast until it intersects Loop Road extension.

(4) If the area between the Rio Grande and US277 has developed considerably: Initiate study to update traffic circulation plan based on new development patterns.

(5) Signalize intersection of Pecan extension and Loop Road extension.

(6) Verify the need to signalize intersections of future streets that may be built if the area between the Rio Grande and US277 develops.

(7) Synchronize signals along Loop Road extension.

Implementation Recommended Between 2015 and 2020 — All Scenarios

(1) Implement second International Bridge. The recommended location at this point is near the Industrial Park, at an extension of Garza Road. (Note: Specific studies should verify the need to implement earlier and detail the optimal location.)

(2) Implement Del Rio Outer Loop, using results of studies recommended in the previous section. The new north-south thoroughfare should become part of this loop. Possible Loop locations are depicted in Figure 4.5.

(3) Widen US277 from the railroad overpass to the junction of SH317.

(4) Direct through trucks to the Outer Loop. Consider prohibiting through trucks in congested thoroughfares if the Outer Loop can serve as an alternative.

(5) Provide an overpass for the Southern Pacific rail track where it intersects the new north-south thoroughfare. Conduct specific study to verify the cost-effectiveness of providing a common overpass for Cienegas Road at this intersection.

(6) Grade-separate the intersection of north-south thoroughfare and US90/US277.

(7) Signalize intersection of Outer Loop and US277, as well as new streets in the area.

(8) Update this traffic circulation plan to include new developments.

Implementation Recommended Between 2015 and 2020 — High-Impact Scenario

(1) Extend Avenue E up to Amistad Boulevard.

(2) Widen Amistad Boulevard (preferably one more lane each way).

(3) Develop traffic circulation plan for the area between Bedell and Avenue F. This plan must take into account future developments; at this point, the following alternative seems indicated to relieve congestion on Bedell: Extend Avenue K, making it continuous from Garfield to 14th Street; make Avenues J and K one-way pair; encourage traffic to use this pair as alternative to Bedell.

DISCUSSION

While numerous scholars have analyzed such events such as Mexico joining GATT (1986) and the passage of NAFTA (1993), many of their economic predictions have proved wrong. And the peso devaluation (late 1994) has further invalidated all border forecasts developed before 1994. All such uncertainties make border area traffic forecasts rather less reliable than forecasts of other, more stable areas, especially in the long-term. The traffic circulation plan presented in this report reflects these uncertainties. Moreover, it relies heavily on assumptions about future city development, air force base permanence and expansions, traffic demand, international and local traffic behavior, and agreements between Del Rio and Ciudad Acuña regarding the location of a second bridge. Since these assumptions may or may not materialize, the recommendations for 2010 (and especially those for 2020) should be verified before implementation.

Outer Loop Location and Environmental Considerations

The need to protect San Felipe Aquifer has resulted in heterogeneous land development. Developments are located primarily south of US90 East and west of Bedell Avenue. The area east

of Bedell and north of US90 is protected; about 3 percent of its area is used as right-of-way, while typical urban developments have at least 20 percent of the land used as right of way. An environmentally friendly thoroughfare linking the east/west leg of US90 to US90/US277/US377 (north-south leg) would be located too far north to serve as an effective route. A thoroughfare passing through the aquifer has the potential to contaminate it during construction, during operations, and especially as a result of new development in the area that would doubtless be attracted by the new facility. A compromise solution would be to utilize the new extended Bedell to the fullest extent possible, and to create alternatives for traffic circulation within the areas of Del Rio that are currently served by Avenue F and Main Street.

International Traffic Issues

A considerable portion of Texas-Mexico truck traffic still reflects pre-NAFTA regulations prohibiting foreign trucks beyond the commercial zone of both the U.S. and Mexico. Nevertheless, there is anecdotal evidence regarding increasing tendencies to take advantage of the more efficient new rules. If this tendency continues, the harmonization of truck weight limits throughout the NAFTA territory will become more urgent than it already is. Before implementing new infrastructure that serves international traffic, we recommend that the city verify the status of NAFTA truck size and weight harmonization, and provide an appropriate radius for Mexican and Canadian 18-wheelers, or at least secure additional right-of-way for future upgrade.

Border inspections are a major cause of international traffic congestion at Texas international bridges. 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 this is expected to cause additional traffic problems for border cities in Texas. Moreover, NAFTA is expected to increase and complicate, rather than decrease and simplify, the amount of customs inspections, owing to its requirement to verify the origin of product components for taxation. If these new procedures cause congestion in Del Rio, a new international bridge will be a solution only if it is adequately staffed. The potential effects of additional staffing on the existing infrastructure should be evaluated before implementing a new bridge. If this evaluation indicates that additional staffing will not postpone the need for a new bridge, we strongly recommend that the planning of this new bridge be undertaken in concert with inspection agencies on both sides of the border, to ensure full utilization of the physical facilities by fully staffing the new bridge.

While both Del Rio and Ciudad Acuña have railroads terminating at the border, there is no international rail bridge. Southern Pacific is not interested in a rail bridge, and Union Pacific is satisfied with its bridge in Eagle Pass. Mexican officials, however, continue to express interest in a rail bridge in Del Rio. Yet the feasibility of diverting part of Del Rio's international truck traffic to rail is uncertain and can only be determined through a specific study. While TxDOT Study 2932 investigated the most recent Mexican and U.S. data on commodity origin and destination, further studies are needed to determine the potential for diverting Del Rio's freight demand to rail. A considerable portion of truck traffic is maquiladora oriented, but data on destinations of maquiladora exports and origin of maquiladora imports are conflicting and not very recent in some cases. It is important to note that an international rail bridge capable of successfully attracting most

of the freight traffic may postpone the need for a second vehicular bridge at last until 2025. Furthermore, if transit transportation becomes a more common option in the future, this rail bridge may also be used for passenger travel, decreasing international auto traffic and further postponing the need for a second vehicular bridge.

Downtown Congestion

At the time of this study, a consultant hired by city of Del Rio to analyze downtown traffic circulation had introduced several measures to relieve downtown congestion. However, it is important to understand that the effects of any measures meant to improve downtown traffic circulation will always be temporary, because traffic demand continues to grow and, in this case, the infrastructure cannot be expanded. As elsewhere in the state and country, the only permanent solution for congestion in highly developed areas is higher occupancy and/or transit. TxDOT should consider a borderwide feasibility study for mass transit implementation. Such a study should assess mass transit impacts on Clean Air Act compliance and on energy consumption.

Rail Intersections

The proposed Outer Loop intersection with the Southern Pacific railroad could be left at-grade until there is sufficient demand to justify a grade separation. This will depend on the results of a specific study to be initiated no later than 2010. However, according to state law, any new at-grade intersection with a railroad requires closing or grade-separating two others. If the recommendation to grade-separate the intersection of Garza Road and the railroad is implemented, a good candidate for the required closing is the rail intersection of Farley Lane. In this case, Garza and Farley Lane must be linked in order to provide easy access across the railroad.

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 massive traffic demands.

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, and NAFTA is expected to increase and complicate, rather than decrease and simplify, the amount of customs inspections, owing to its requirement to verify the origin of product components for taxation purposes. A recent survey by the Center for Transportation Research (CTR) of The University of Texas at Austin 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 Del Rio developed by CTR prior to NAFTA estimated that the average yearly growth rates for the next 20 years would be between 1.5 percent and 3 percent, depending on the assumed post-NAFTA outlook (Ref. 1.2). According to early post-NAFTA data, these predictions have already been exceeded. For example, in 1994, auto traffic grew by almost 6 percent in the northbound direction, and by 4.2 percent in the southbound direction. In the first four months of 1995, northbound truck traffic increased by over 16 percent, and auto traffic increased by 2 percent with respect to the same months of 1994.

In addition to the international demand, there is another source of traffic less than 80 minutes away from Del Rio that has the potential to become significant in the future: Recently, the Kickapoo Indian Reservation (located about 100km southeast of Del Rio) requested and obtained a permit to operate the only casino available within a 200km-by-200km binational area having a population of almost 350,000. According to the tribal administrator, the casino will start operating some time in 1996.

STUDY OBJECTIVES

Study 7-2940 is one of many initiatives undertaken to survey NAFTA impacts on international traffic; like other such studies, the present study seeks to develop guidelines for providing 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.
(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 contributing were representatives from U.S. and Mexican inspection agencies, the General Services Administration, the Texas Department of Transportation, 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 100km southeast of Del Rio, and interviewed relevant officials regarding the casino to be built in the near future. This information was used to estimate casino-generated traffic from Del Rio, Ciudad Acuña, and small towns within a two-hour drive.

REPORT OBJECTIVE AND SCOPE

This report presents a long-range plan and several traffic circulation guidelines for the City of Del Rio, located on the international border between Texas and the state of Coahuila, Mexico. It contains an executive summary, four chapters, and two appendices. The *Executive Summary* presents the traffic circulation recommendations for each future scenario analyzed for Del Rio. It was written for a reader already familiar with Del Rio and Ciudad Acuña.

Chapter 1, *Introduction*, discusses the background, significance, objectives, and deliverables of this study. It describes the report objectives, scope, and organization, and 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 Del Rio and Ciudad Acuña*, discusses international traffic observed before and after NAFTA, comparing past and recent growth rates and discussing the international traffic projections used in this study. It also 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: (1) define the study network, (2) estimate the capacity of its main nodes and links, (3) obtain current and future hourly volumes for each study scenario, and (4) assign levels of service to each intersection and roadway segment. The chapter closes with a discussion of 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 Del Rio,* discusses the approach used for analyzing the two traffic demand scenarios and presents 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 are also discussed.

Appendix 1 is a *Summary of Mexican Data* obtained in this project. Appendix 2 is a *Photo Album of Del Rio* containing pictures of relevant intersections, international routes, and highway segments.

ORGANIZATION OF STUDY REPORTS

Overall, this study has three reports. Research Report 2940-1 documents the Eagle Pass traffic circulation recommendations and long-range plan. Research Report 2940-2 (this report) provides analogous documentation for Del Rio. These two reports have similar structures; they document the study objectives and organization, the study methodology and approach, data collection, and results. Research Report 2940-3F, the final report, is a bilingual executive summary discussing international traffic issues. In this case, a bilingual executive summary is an essential element in the 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

Del Rio 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: 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 with 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, as well as uncertainties about future developments, were captured 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 the substitution of ad-hoc values of dubious accuracy for unavailable data when using a pre-selected traffic assignment method.

Study Scenarios

Del Rio's 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) to diagnose current and potential traffic circulation problems, and
(2) to 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 infrastructure. In the low-impact scenario, the casino traffic demand is assumed to be small, thus having little impact on Del Rio's infrastructure. In the high-impact scenario, the casino demand will be more significant (especially from Ciudad Acuña and other Coahuila cities near Del Rio), and 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, 94 percent of all international trips have origins and destinations in Ciudad Acuña and Del Rio, 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

[1]Ingeniería Gario, from Saltillo, Coahuila.

addition, heavy trucks must utilize the local infrastructure, and their number and weight exceeds the ranges usually found in other urban areas of similar size.

The international traffic demand was projected into the future using data already available at CTR, updated by additional data specifically collected for this study. At this point, international traffic projections must rely on assumptions regarding the outcome of the peso devaluation in Mexico. Early data indicate that the peso devaluation caused a decrease only in southbound truck and (especially) pedestrian traffic, but did not affect auto or northbound truck traffic growth in Del Rio. 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: (1) data collection, (2) analysis and forecasting, and (3) 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 the Del Rio and Eagle Pass networks, and 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 used 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 Del Rio nodes (e.g., a shopping area) and "MEX" represents Ciudad Acuña nodes (e.g., maquiladoras for truck traffic). As shown in Figure 1.2, the successful and accurate development of a TRANPLAN simulation of Del Rio requires (1) detailed origin and destination data disaggregated by city zones for both Del Rio and Ciudad Acuña, 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 Del Rio were collected for statewide planning purposes, and origins and destinations are U.S. and Mexican cities, not zones within Del Rio or Ciudad Acuña. In addition, the availability of traffic counts in Del Rio is limited to arterials under TxDOT jurisdiction and to a small sample of traffic collected specifically for this project, basically for the purpose of verifying k-factors (ratio between peak-hour and average daily volume) and turning movements at some intersections. Practical use of any automated traffic assignment algorithm requires all 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 procedure where the influence of each assumption on the traffic assignment

outcome could be adequately controlled. Current international traffic hubs were defined based on qualitative origin and destination information collected during interviews, and on the results of an origin and destination survey aggregated by city that also provides trip purpose information (Ref. 1.1).

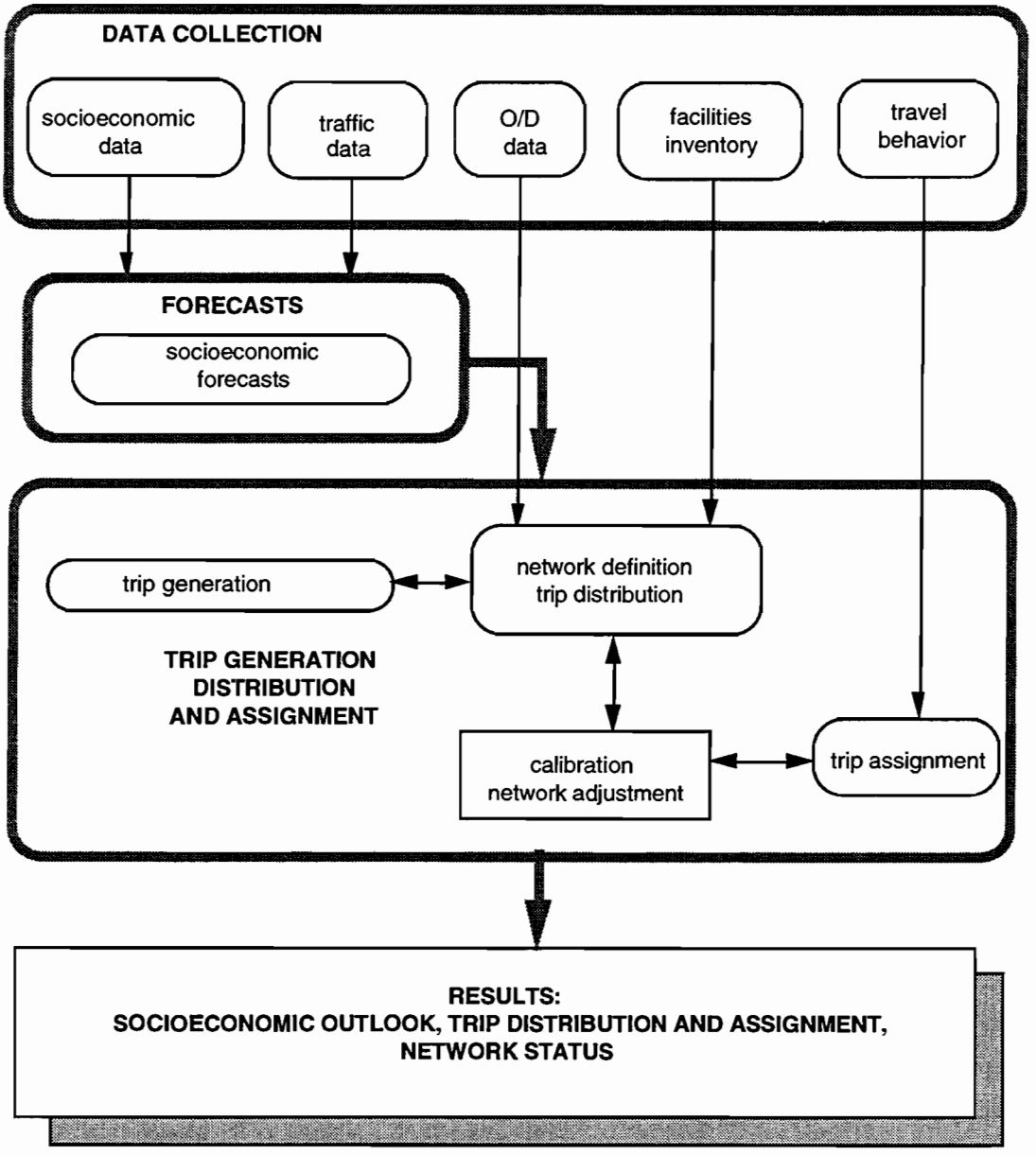

Figure 1.1 Major Phases of a Transportation Planning Process

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

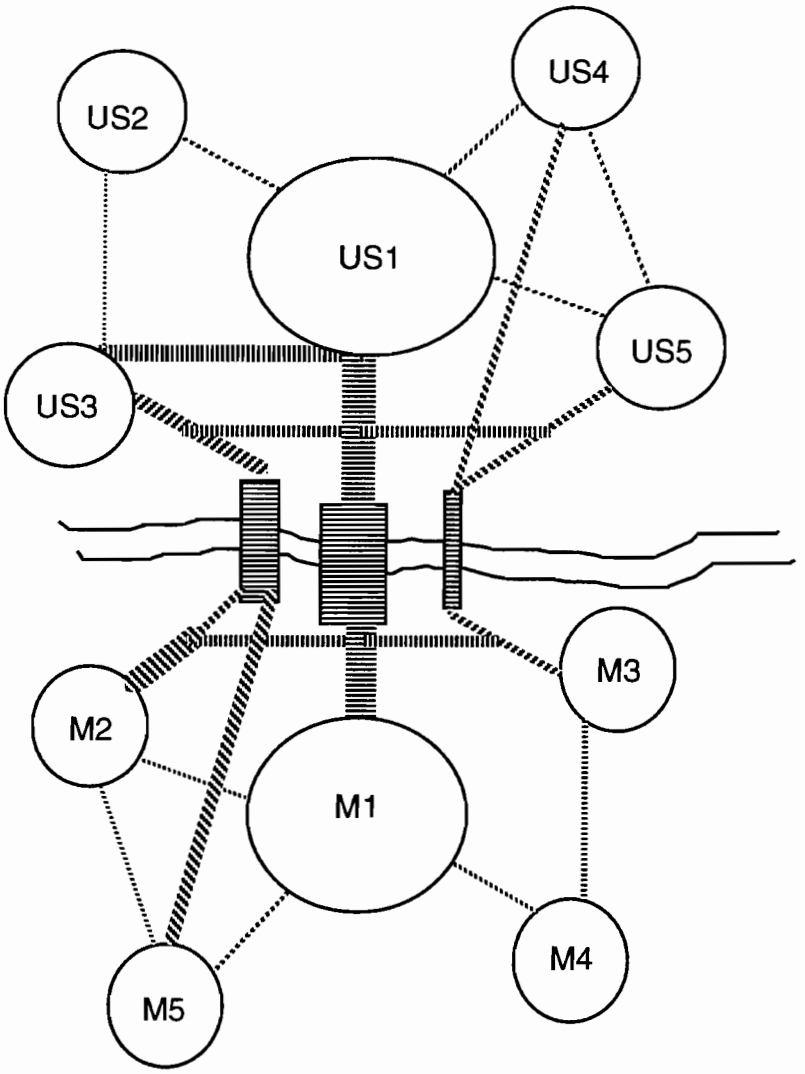

Figure 1.2. Conceptual Trip Assignment to International Area

Future Demand Forecasts

Forecasting traffic demand within 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, and unknown percentage of the traffic that has origins and destinations within Del Rio 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 the literature on the border 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 Del Rio.

Capacity Utilization Analysis and Levels of Service

Capacity utilization assessments are basically comparisons of traffic demand and the facility processing capability. Capacity analysis results 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 flow from A to E, "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. 1.5).

In the Del Rio area, relevant traffic volume data are available in terms of an annual average daily traffic (AADT). Hourly volumes were estimated based on AADT and estimated k-factor, or K (ratio of the hourly volume of interest and the ADT). 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 has developed a capacity analysis approach that takes this fact into consideration, and assesses the capacity of a border crossing facility in a disaggregated and sequential manner. This procedure, described in detail elsewhere (Ref. 1.2), provided the results that 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 conducted with relevant individuals in each border city. This background information is necessary to define the study network, taking into account the relevance of each network segment 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, perform intersections analysis, and to estimate the 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, and all at a reasonable cost. The recommended improvements were developed 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.

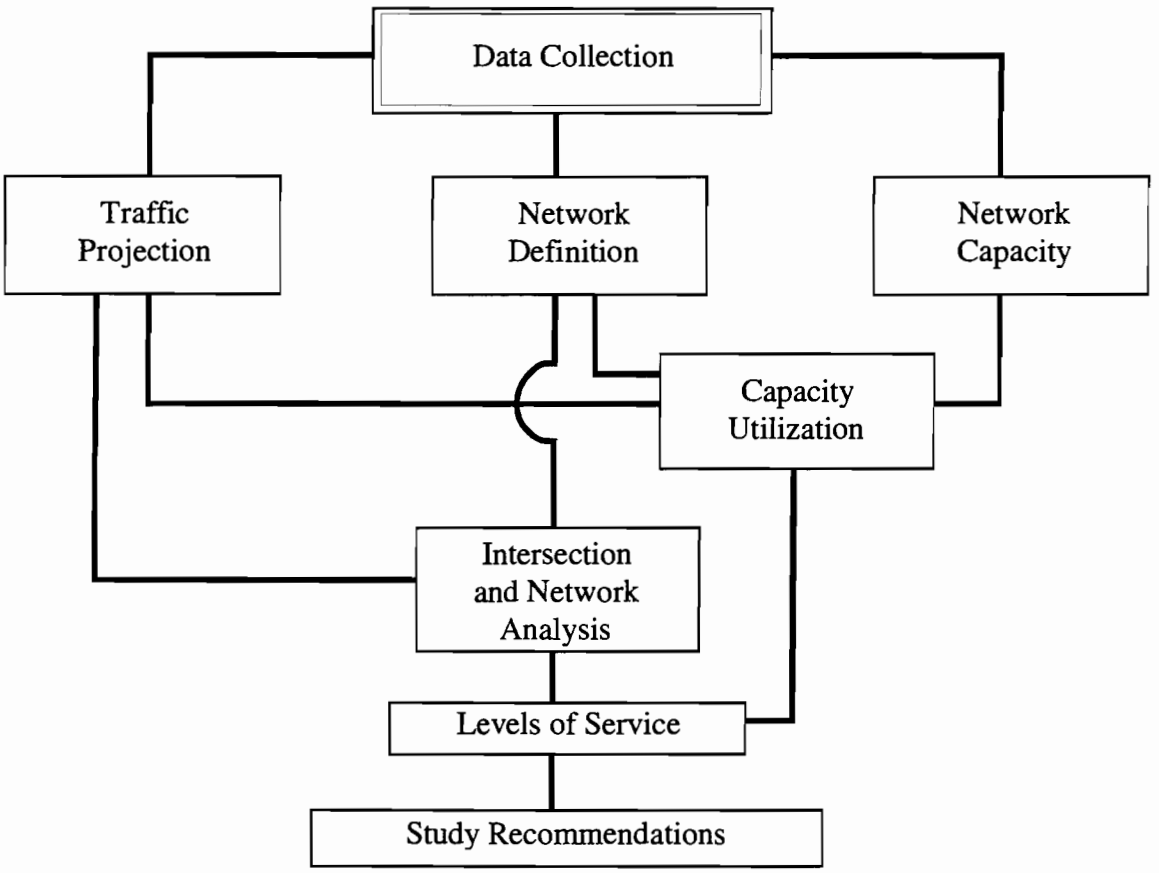

Figure 1.3 Research Approach

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 provided by 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. 1.6).

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.

The practical application of the methodology discussed above begins with a comprehensive overview of the international traffic in the study area, which comprises Del Rio and Ciudad Acuña. As such, our study team visited the area several times and interviewed relevant individuals connected with international traffic. The Del Rio/Ciudad Acuña international traffic is discussed in the next chapter of this report.

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CHAPTER 2. INTERNATIONAL THOROUGHFARES BETWEEN DEL RIO AND CIUDAD ACUÑA

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 serve a considerable amount of international traffic; the result is often increased congestion, decreased safety, and, as is already occurring in El Paso, non-attainment of air quality standards.

In many border cities, a major cause of congestion is traffic back-up at the border bridges, sometimes a result of inspection procedures. NAFTA is expected to increase and complicate, rather than decrease and simplify, the amount of customs inspections, owing to its requirement to verify the origin of product components for taxation purposes (Ref. 2.4 and interviews with Customs officials). A recent survey conducted by the Center for Transportation Research (CTR) of The University of Texas at Austin 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 (Refs. 2.4, 2.8).

Because international traffic is a significant component of traffic demand in Del Rio, an effective traffic circulation plan for that city must begin with a careful examination of international traffic, to be used later to develop recommendations regarding international thoroughfares. This chapter discusses the international traffic moving between Del Rio and Ciudad Acuña, both before and after NAFTA, comparing past and recent growth rates and discussing the major international truck routes in Del Rio.

DATA SOURCES AND SCOPE

The Del Rio sector comprises the city limits of Del Rio in Val Verde County, Texas, and the urban area of Ciudad Acuña, Coahuila. It includes two border crossings for vehicular traffic — Del Rio Bridge and Lake Amistad Dam. The Del Rio Bridge is a four-lane toll bridge owned by the City of Del Rio (U.S. side) and by the Mexican government. The Amistad Dam crossing consists of a toll-free, two-lane road over the dam structure. Traffic, restricted to non-commercial, is primarily made up of tourists. Its AADT has been below 100 for the past 10 years; its 1994 AADT was fewer than 90 vehicles.

Northbound traffic data for Del Rio comes 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 international traffic data available for Del Rio. Data for 1995 include January through April figures for both sources. Southbound data were available for 1994.

Table 2.1 Summary of International Data Scope

Traffic Direction	Monthly Series	Years	Empty/ Loaded Trucks	Truck Axles	Autos	Pedestrian
Northbound	yes	1980 to 1995	yes	yes	yes	yes
Southbound	yes	1979 to 1994	no	no	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 transborder traffic data collection effort, the data format 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 kept. 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 had an error-free data collection procedure. Table 2.2 compares CAPUFE and U.S. Customs northbound data for 1993 and 1994. 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 Northbound Data Discrepancies Between Sources

Year	Source	Autos	Trucks	Other	Pedestrians	Total Vehicles
	Customs	1,416,416	32,631	n/a	178,100	1,449,047
1993	CAPUFE	1,239,826	33,160	6,150	72,226	1,279,136
	Difference	-11.97%	1.62%	n/a	-59.45%	-11.67%
	Customs	1,527,195	32,699	n/a	193,079	1,559,894
1994	CAPUFE	1,287,305	39,788	4,801	71,998	1,331,894
	Difference	-15.35%	21.68%	n/a	-62.71%	-14.57%

Pedestrian discrepancies are of little concern in this study. Vehicle discrepancies are important, but rather difficult to explain. One reason for such differences is that CAPUFE is a toll

collection agency, and as such it records data only from vehicles that generate revenues. Another reason could be the criteria for classifying autos (privately owned vehicles, or POVs) and trucks. However, the average number of toll-exempt vehicles can generally account for no more than 5 percent difference in traffic counts. Moreover, a difference in criteria used for separating trucks from POVs is unlikely to cause 15- to 21-percent difference.

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. Post-NAFTA growth was examined in two periods: before and after the peso devaluation. A comparison among these three traffic trends provides an indication of early NAFTA effects on international traffic demand, as well as some insight into 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

Traffic histories for Del Rio, obtained from CTR's TRANSBORDER database, are summarized in Figures 2.1 through 2.4 (Ref. 2.6). Figures 2.1 and 2.2 show the southbound non-commercial and commercial traffic histories for the Del Rio Bridge. Before 1987, non-commercial traffic consisted of almost 99 percent of the southbound traffic. This percentage dropped to 97 percent after 1987, the result primarily of the steep growth rates in truck traffic, which were over 4 times the average auto growth rate for the same period. Auto traffic displays a significant growth after 1988, when the average growth rate jumped from a negative figure to almost 10 percent a year. In 1991, the growth rate declined, with an analogous situation observed for trucks. Before 1983, there was a negative growth rate of 28 percent. Between 1983 and 1986, the average growth rate increased to 26 percent, and from 1987 to 1990 it jumped to 40 percent. After 1991, it stabilized in the neighborhood of 4 percent.

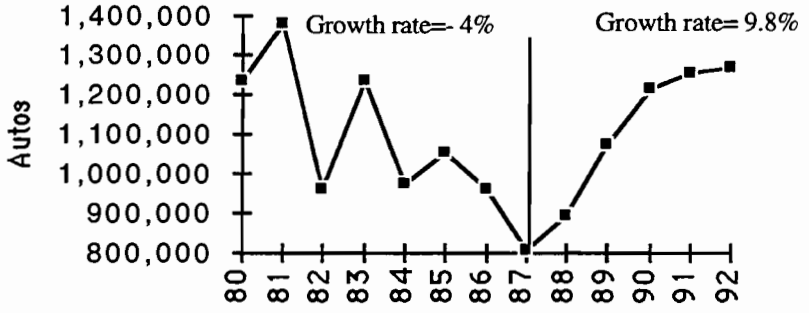

Figure 2.1 Southbound Auto Traffic History

(Source: Bridge Management)

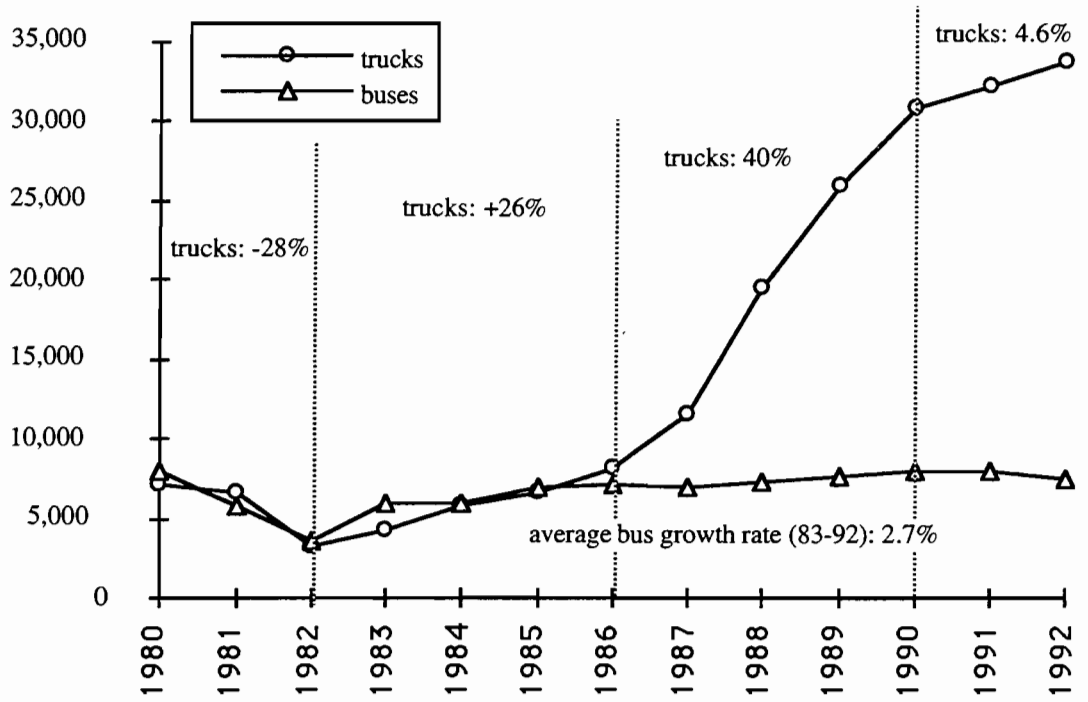

Figure 2.2 Southbound Truck Traffic History

(Source: Bridge Management)

Figures 2.3 and 2.4 show the northbound auto and truck traffic histories, respectively, for the Del Rio Bridge. Throughout the pre-NAFTA period, non-commercial northbound traffic had been fluctuating closely around an average value of 97.7 percent of the total traffic. Before 1987, northbound auto traffic had an erratic growth pattern, showing an average yearly growth rate of 2.5 percent. After 1987, a more consistent growth pattern of 4.2 percent (yearly average) is observed. For commercial truck traffic, these patterns are reversed. Before 1987, traffic growth fluctuated somewhat consistently around 19 percent. After 1987, the growth pattern becomes erratic, but the average rate jumps to 26 percent. Bus traffic was stagnant throughout the available data period.

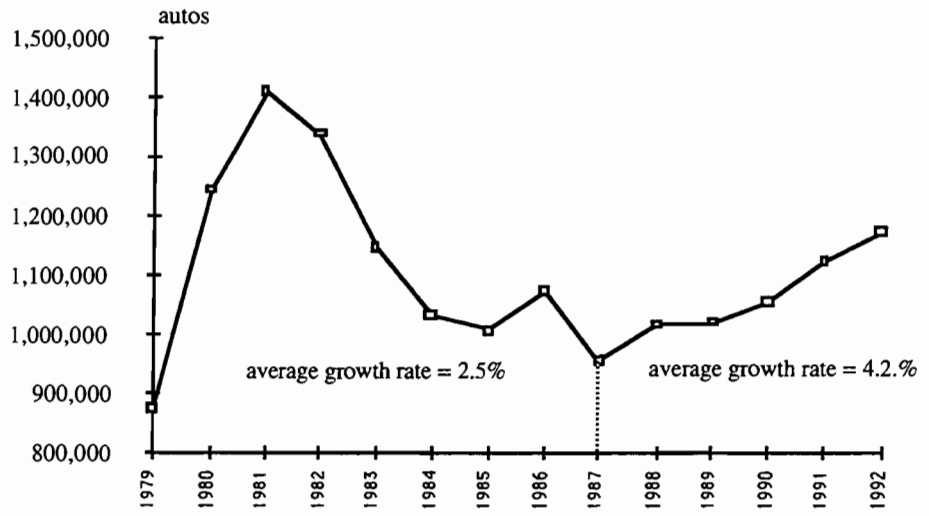

Figure 2.3 Northbound Auto Traffic History

(Source: CAPUFE)

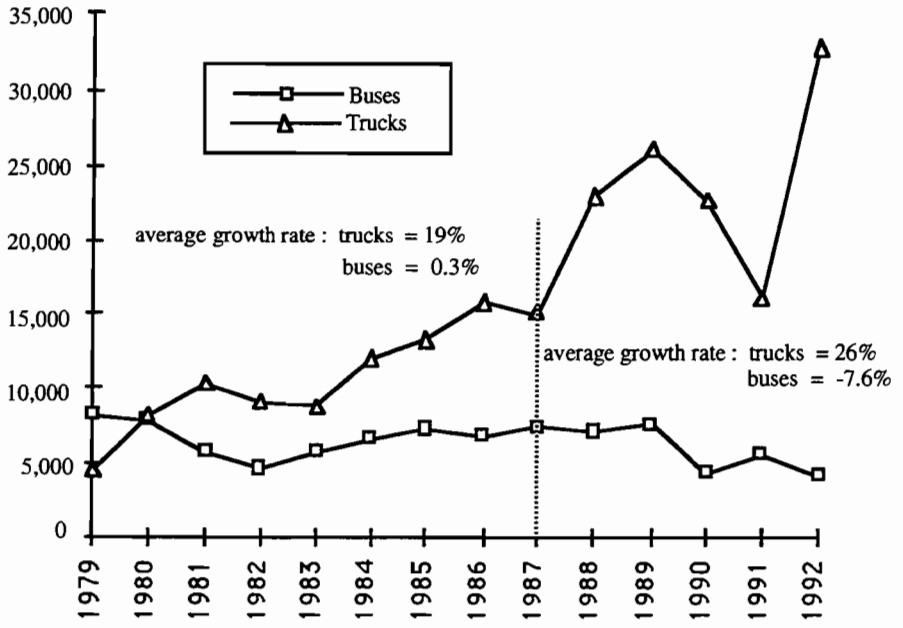

Figure 2.4 Northbound Truck Traffic History

(Source: CAPUFE)

The somewhat sudden traffic increase observed after 1987 in Del Rio was the result of a combination of causes. GATT, which took effect in 1986, caused a borderwide increase in economic activity, which in turn led to increased traffic demands. The number of maquiladoras in Ciudad Acuña increased from 26 in 1986 to 35 in 1988, while the number of maquiladora employees increased by almost 40 percent during the same two-year period. Maquiladora activity has been steadily increasing since then, though growth has slowed. International traffic growth rates also increased after 1988, the first operational year of the new four-lane Del Rio Bridge (such growth may have reflected a latent demand not being met by the old facility).

Post-NAFTA Traffic Analysis

This section discusses transborder traffic growth during two different periods: 1993–1994, which reflects early NAFTA effects; and 1994–1995, the period following the peso devaluation. The analyses are disaggregated by traffic direction, type of transport, and period. Data are shown in Table 2.3. Southbound traffic data were provided by the bridge management. Northbound data were provided by CAPUFE and U.S. Customs; northbound values shown in Table 2.3 were obtained by averaging the two sources. The 1994–1995 growth rates were calculated using the months of January through April, while the 1993–1994 growth includes the entire year.

Table 2.3 Traffic Growth — Del Rio Sector

Traffic Direction	Analysis Period	Pedestrians	Passenger Vehicles	Trucks	Total vehicles
North-bound	Jan-Dec 1993	125,163	1,331,679	32,896	1,364,575
	Jan-Dec 1994	132,539	1,410,039	36,244	1,446,283
	Growth	**5.9%**	**5.9%**	**10.2%**	**6.0%**
	Jan-Apr 1994	25,120	454,524	11,565	466,089
	Jan-Apr 1995	27,654	463,716	13,424	477,140
	Growth	**10.1%**	**2.0%**	**16.1%**	**2.4%**
South-bound	Jan-Dec 1993	83,207	1,445,245	34,759	1,480,004
	Jan-Dec 1994	61,061	1,506,322	33,622	1,539,944
	Growth	**-26.6%**	**4.2%**	**-3.3%**	**4.1%**

Del Rio showed significant growth in northbound truck demand between 1993 and 1994. Southbound truck data, however, indicate a decrease. In the same period, auto traffic grew by almost 6 percent in the northbound direction, and over 4 percent in the southbound direction. In the northbound direction, the peso devaluation did not reverse these growth trends, at least for the first four months of 1995. Rather, 1995 truck traffic increased over 16 percent, and auto traffic increased 2 percent with respect to the same months of 1994. The Del Rio Chamber of Commerce and the Customs Port Director feel that the peso devaluation had little impact on Del Rio because the city's economy depends more on U.S. than Mexican tourism, and because the Del Rio Port of

Entry serves the maquiladoras in Ciudad Acuña. During another set of interviews, two maquiladora managers in Ciudad Acuña indicated that the demand for their products increased after the peso devaluation, which made prices more competitive.

INTERNATIONAL TRAFFIC PROJECTIONS

Forecasting traffic demand for 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, the peso devaluation, and Mexican socioeconomic activity. In addition, an unknown percentage of the traffic that has origins and destinations within Del Rio 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.

A borderwide study conducted by CTR before NAFTA includes one of the few existing traffic forecasts for the Del Rio area. This study assumed three post-NAFTA scenarios, and the data indicate that the highest forecasts are more accurate, especially before the peso devaluation. For autos, CTR predicted an average yearly growth rate of 5 percent for the 1993–1998 period, and 3 percent afterwards. The 1993–1994 growth rate was 4.2 percent in the southbound direction and 5.9 percent northbound.

Truck traffic demand, which derives basically from the maquiladoras, was assumed to continue indefinitely. CTR's high growth scenario predicted a 15 percent average yearly rate between 1993 and 2002, and a 3 percent rate thereafter. The moderate growth scenario predicted an initial post-NAFTA growth rate of about 5 percent, dropping to 3 percent afterwards. Northbound trucks average data for 1993 and 1994 indicate a 10.2 percent growth; however, the two sources present serious discrepancies. U.S. Customs reports a northbound growth of 0.2 percent in this period. Southbound data indicate a 3 percent decrease, which is more compatible with U.S. Customs northbound data.

These discrepancies were handled by extrapolation and by taking into account other border studies and average growth rates observed on the nearest highways (Refs. 2.6, 2.10). This procedure implicitly assumes that the peso devaluation will have a temporary negative effect on international traffic demand.

INTERNATIONAL THOROUGHFARES AND NEW INTERNATIONAL BRIDGE

The Del Rio/Ciudad Acuña area comprises the city limits of Del Rio in Val Verde County, Texas, and the urban area of Ciudad Acuña, Coahuila. It includes the Del Rio Bridge and the Lake Amistad Dam crossing. The Del Rio Bridge is located approximately 105km northwest of Eagle Pass, while Amistad Dam is located approximately 21km northwest of the Del Rio Bridge.

Existing Border Crossings

In 1988, the old Del Rio Bridge was replaced with a new four-lane toll bridge, owned by the City of Del Rio (U.S. side) and by the Mexican government. U.S Customs facilities soon became congested, and the General Services Administration (GSA) bought a 218,000m^2 lot to

implement a multi-phase project to upgrade the inspection facilities. In the first phase, GSA expanded the administration building (already concluded). Next, they will build a 15-dock import lot (expandable to 100), scheduled to open in 1998. It will have a warehouse, a chemical waste containment set, and scales to weigh trucks. Until 1998, U.S. Customs is using a temporary 7-dock lot that opened in May 1995. There is also a 5-truck export lot for shipment declarations. There are not very many inspections of exports, though Customs expects more with NAFTA rules of origin of product components.

GSA's capacity model predicts that the new lot will adequately handle all inspections up to the year 2010 (Ref. 2.4). U.S. Customs feels that the four primary inspection lanes for private vehicles have been sufficient for handling auto traffic, but that they will need additional lanes for inspecting private vehicles at some point. Phase III of GSA's master plan, which is not required until the year 2010, consists of building a new border station facility and requires the relocation of part of Rio Grande Road.

The City of Del Rio has recently completed an improvement of the toll plaza. It now has four automated toll booths (with automatic vehicle identification, or AVI), an upgrade that has improved international traffic circulation. The city feels that the improvements in U.S. Customs and toll collection will provide effective circulation of international traffic for at least another 5 years.

On the Mexican side, "Puente Internacional de Ciudad Acuña" has three primary inspection booths, two for autos and one for trucks. There are six secondary inspection lanes for autos, in which eighteen vehicles can be simultaneously inspected. The import lot can accommodate approximately ten trucks at one time. There are no plans to expand Mexican Customs on the Mexican side.

The northbound toll facilities, operated by CAPUFE, consist of two toll booths for autos, trucks, and pedestrians. CTR observed no significant congestion at the international bridge, although Ciudad Acuña's access/egress is rather inadequate, and insufficient inspection staffing and facilities cause long processing times on the Mexican side. Also slowing international traffic circulation is a Mexican flag ceremony that takes place every day at 6:00 p.m., and for which all traffic stops for about 10 minutes.

The Amistad Dam, built in 1969, consists of a two-lane road over the dam structure. It is jointly owned by the U.S. and Mexican governments and is toll-free. This dam crossing has a very low traffic volume (AADT below 100), and is used almost exclusively as a tourist attraction.

Proposed Border Crossings

There is a rail line in Del Rio and another in Acuña, but no rail bridge; consequently, all international trains must go to Eagle Pass. A rail bridge connecting both rail line spurs in Del Rio and Ciudad Acuña was proposed to Southern Pacific Railroad, but Southern Pacific's response to the proposal was that the existing rail bridge in Eagle Pass/Piedras Negras had sufficient capacity (Ref. 2.4). Nevertheless, Ciudad Acuña sent a representative to the XVII Binational Meeting on Bridges and Border Crossings to make a presentation on the need for a new rail bridge between Del Rio and Ciudad Acuña (Ref. 2.2).

Some business leaders, Del Rio city officials, and Val Verde County officials have expressed some interest in a second bridge at Del Rio, but the idea has not yet been formally pursued. One preliminary proposal was to construct a commercial truck-only bridge near Amistad Dam. Opponents of this proposed bridge argue that the existing auto/truck bridge in Del Rio is too recent (1988), and the new bridge would make it more difficult to pay off the existing bond.

Before the recent expansion of the import lot at Del Rio, Ciudad Acuña's officials suggested the possibility of diverting the commercial traffic to Amistad Dam, given that the maquiladoras are located on the northwest side of Ciudad Acuña not far from Amistad. However, this plan was abandoned, and there is an initiative in Mexico to further develop its recreational area around Lake Amistad.

During interviews conducted for this project, Del Rio and Ciudad Acuña officials indicated that they consider the construction of a second international bridge rather premature. Currently, the preferred location from Del Rio's point of view is near the Industrial Park. This accords with Ciudad Acuña's preferred site for a second bridge, which is northwest of the existing one, at a future extension of their south loop (Libramiento Sur). This location would meet Del Rio's infrastructure about 600 to 700m south of a hypothetical extension of Johnson/Garza towards the river. This tentative location appears in Ciudad Acuña's development plan published in 1992 (Ref. 2.1). Figure 2.5 shows the Del Rio/Ciudad Acuña border crossings, main highways, and the proposed location for the second international bridge according to Ciudad Acuña's development plan (Ref. 2.1).

International Thoroughfares

According to several sources in Del Rio and to a regional origin and destination study conducted in 1993 (Ref. 2.8), long-range international traffic is almost non-existent, and the main traffic circulation problems are a result of traffic moving between Del Rio and Ciudad Acuña, most of which concentrates in downtown Del Rio. The peak day for shopping-related international traffic is Sunday, with considerable traffic on Saturdays as well. Monthly peak is on or near the first day of the month.

A considerable portion of international truck traffic is maquiladora related; according to 1994 there are 45 plants in Ciudad Acuña, though anecdotal information obtained in 1995 place this number at 52. Future forecasts are conflicting. According to some sources, the labor supply at Ciudad Acuña is reaching depletion, with the twin plants threatening to move south. However, American managers prefer to live on the U.S. side. Some of those managers interviewed for this project had no plans to move south nor did they complain about lack of labor. Most maquiladoras generate two to three trucks per day. Trucks with raw materials and other maquiladora input go directly to Ciudad Acuña, while assembled goods go northbound either to a warehouse or directly to their destination.

The preferred truck routes (before the new Spur 239) include: US90, US277 (Garfield) at downtown, Avenue F, and Garza Road (near the international bridge). The peak hours of truck traffic are the same as those for auto traffic. TxDOT just built a new spur (239) connecting US239 to US90 at the Gibbs Street intersection. The Spur, scheduled to be completed by February 1996,

is expected to reduce traffic in the downtown area. Figure 2.5 depicts the international truck routes, including the new spur about to open to traffic. Gray lines indicate truck routes observed during the development of this study. After March 1996, the new Spur 239 will become a major truck route, diverting trucks from Garfield and the downtown area.

DISCUSSION

Del Rio has been presenting erratic auto and truck growth rates for the past 15 years, but between 1993 and 1994 auto traffic grew nearly 6 percent in the northbound direction, and 4 percent in the southbound direction. For trucks, the growth rates have been very erratic.

The peso devaluation did not much affect Del Rio traffic, at least for the first four months of 1995; traffic demand has not decreased at the same levels observed in other locations. According to local authorities and business leaders, Del Rio's traffic demand depends only partly on international traffic. Attractions such as fishing tournaments, Amistad Dam, and Big Bend National Park bring tourists.

The peso devaluation has affected primarily small businesses, especially downtown, where the effects drove some retailers out of business. Shopping malls suffer less from these effects because part of their sales come from "winter Texans" (individuals who live elsewhere but spend the winter in Del Rio). Plaza del Sol Mall's business has decreased by a 12-15 percent compared with last year, which is considered a mild effect of the peso devaluation. Stores that accept pesos are still doing good business, such as Walmart. McDonald's and Burger King, not available in Cd. Acuña, attract many Mexican customers.

Pedestrian traffic growth must be interpreted cautiously. The wide variation found in both northbound and southbound directions could be the result of 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 for 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 also 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, though actual origins and destinations of truck traffic at each bridge are difficult to define (Ref. 2.8). Moreover, a considerable portion of local truck traffic still reflects pre-NAFTA regulations prohibiting foreign trucks beyond the commercial zone of both U.S. and Mexico.

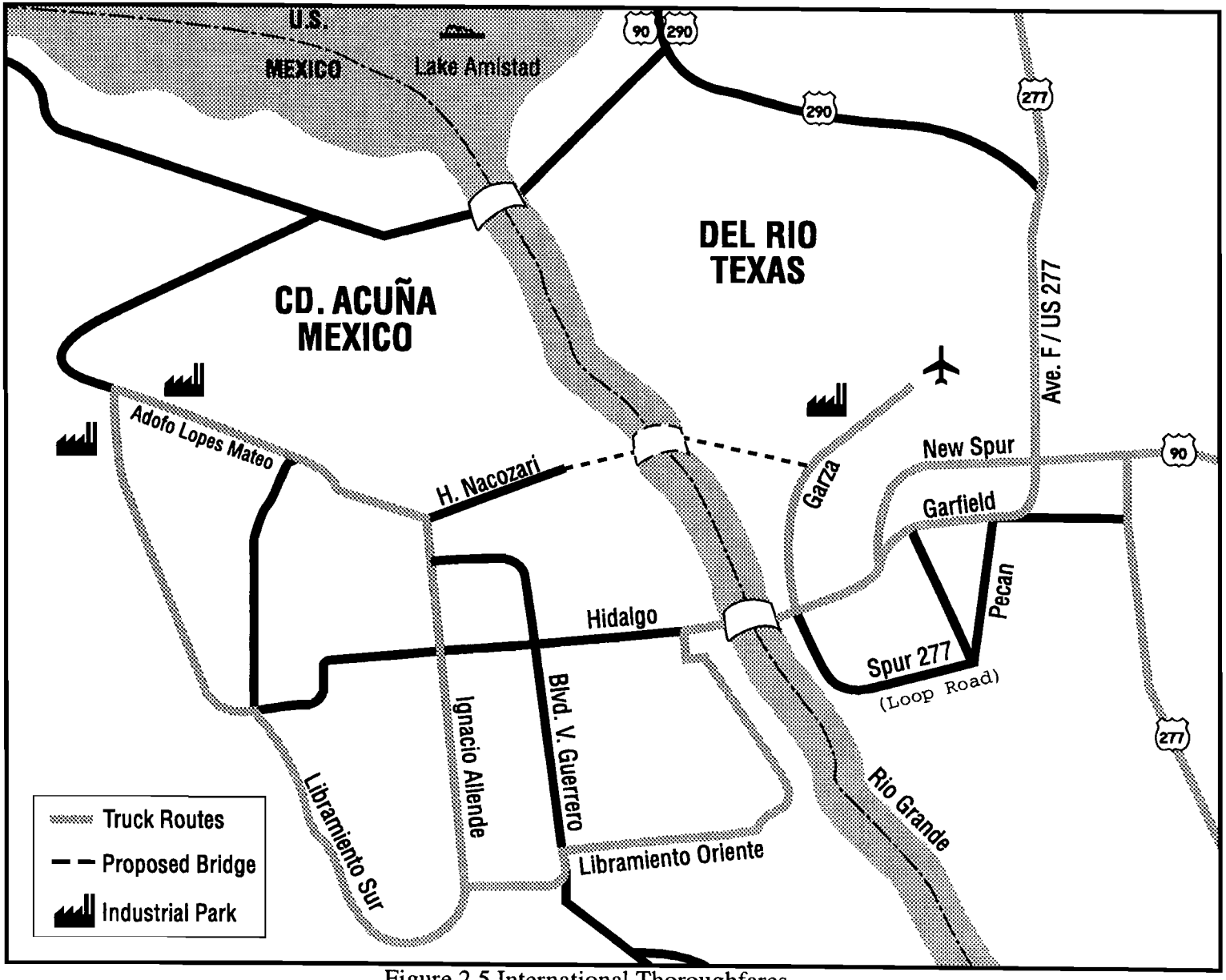

Figure 2.5 International Thoroughfares

Nevertheless, there is anecdotal evidence regarding an increasing tendency to take advantage of the more efficient new rules. Further analyses of truck traffic at the border are essential for efficient transportation planning; careful monitoring of this traffic and periodical analyses are recommended.

Results of the 1994-1995 growth analyses should reflect peso devaluation effects, and interviews in Del Rio and Ciudad Acuña indicated little impact of the peso devaluation on transborder traffic. The observed growth rates for the first four months of 1995 confirm these data, but they are based on only four months of data. It is important keep in mind that extrapolation of early trends to the entire year may result in misleading conclusions that 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 to draw conclusions about the peso devaluation impacts.

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CHAPTER 3. NETWORK ANALYSIS

BACKGROUND AND OBJECTIVES

Traffic demand within all major hubs in Del Rio can be classified as either local or international; a third category — tourism — can be added if the casino scheduled to open near Eagle Pass attracts a considerable number of customers from Del Rio and Ciudad Acuña. While international traffic data and current international thoroughfares were discussed in Chapter 2, this chapter documents and discusses the available data on the other two traffic categories, namely, local and casino traffic, presenting traffic forecasts under the three different study scenarios (reference, low impact, and high impact). The chapter then discusses how these data are used to:

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

These five steps provide the necessary basis for developing a traffic circulation and long-range plan for Del Rio. 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 Del Rio. Data availability also played a secondary role in the decision to include (or exclude) some local streets in the study network. Figure 3.1 is a schematic representation of the Del Rio study network. The study network includes all TxDOT-maintained freeways, international traffic routes, and other major thoroughfares where future changes are possible. Some recommendations for the downtown area are also discussed, though it should be noted that the City of Del Rio has retained a consultant to develop a traffic circulation plan for the downtown area only (Ref. 3.7)

Del Rio's development has been based on the need to protect the San Felipe Aquifer, an area extending roughly between the east and north legs of US90. The aquifer area has to date been successfully protected, with its area less developed than that of the rest of the city. For example, typical urban developments require that at least 20 percent of the land be used as right-of-way, while the aquifer area has about 3 percent of its area used as right-of-way (Ref. 3.2). Development is located primarily south of US90 East and west of Bedell Avenue.

US277 (Garfield) provides direct access to the existing international bridge and is an important arterial of the city (see photos 14–19, 27, 28, in Appendix 2). Garfield Street runs through the downtown area; before the new Spur 239 was opened, it was the only street linking

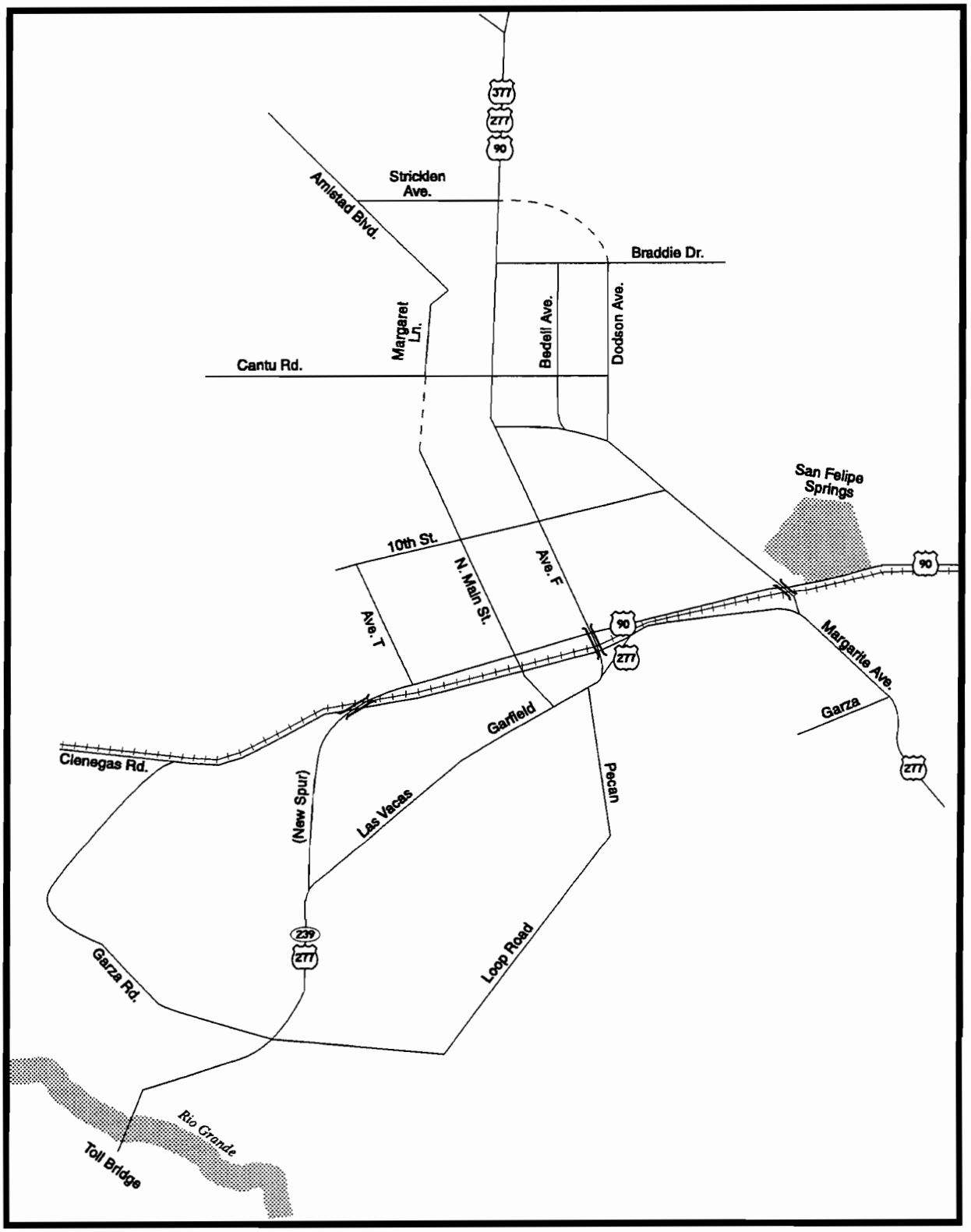

Figure 3.1 Study Network

the international bridge to the city. US90 East is the preferred route from Del Rio to San Antonio. Traffic from Eagle Pass uses US277 (see photos 22, 23, 31, 32 in Appendix 2).

Avenue F serves as the main commercial thoroughfare for Del Rio (see photos 4–6, 10, 11, 20, 21, 39 in Appendix 2). It provides access to the Mall, and it also connects US90 East to US90 North. Most businesses and fast food restaurants are either located on this avenue, or Avenue F provides direct access to these business. Moreover, truck traffic coming from the east uses Avenue F to go north towards El Paso. Avenue F has very little right-of-way for future expansions, and alternative routes must be encouraged.

Bedell Avenue, which currently connects US90 East and Avenue F, is not a popular alternative to Avenue F (see photos 30, 33 in Appendix 2). Main Street is a major arterial of Del Rio, running parallel to Avenue F through residential areas (see photos 27, 28, 29 in Appendix 2). It provides access to downtown and, if properly maintained, can serve as an alternative to Avenue F. Garza Road provides access to the industrial park of Del Rio (see photos 34, 35, 36 in Appendix 2). Cienegas Road also serves the industrial park (see photos 34, 35, 36 in Appendix 2). The Laughlin Air Force Base is located on US90 east (not shown in Figure 3.1).

TRAFFIC DATA

Traffic demand in Del Rio can be classified as either local or international; a third category — tourism — can be added if the casino near Eagle Pass attracts a considerable number of customers from Del Rio and Ciudad Acuña. International traffic data and existing international thoroughfares were discussed in detail in Chapter 2. This section discusses the local and casino-related traffic data, as well as the historical growth rates observed in Del Rio.

Local Traffic Data

Local traffic histories are available from TxDOT's automatic traffic recorders (ATR) and traffic maps (Refs. 3.4, 3.5). Because data from ATR stations are continuously recorded throughout the year, they therefore include hourly counts, high-hours, and actual AADT. Only one ATR station is available near Del Rio, and it does not represent urban traffic. TxDOT's traffic maps provide more comprehensive coverage of the Del Rio urban area, but the AADT data are based on extrapolations of 24-hour samples taken once a year. Table 3.1 summarizes available local traffic data.

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 were sufficient for estimating historical traffic growth rates within major hubs. Table 3.2 shows the average growth rates observed in roadway sections where at least two years of AADT data are available. The data locations are shown in Figure 3.2 (the numbers in Table 3.2 match those shown in Figure 3.2).

Table 3.1 Scope of Local Traffic Data (from TxDOT)

Location	Hourly Counts	AADT	Location	Hourly Counts	AADT
ATR Station-S103: US90 (0.5km NW of US377)	Yes	Yes	Intersection of US277 and Garza	No	Yes
US277, US377 @ US90 (3 legs)	No	Yes	Intersection of US277 and Garfield	No	Yes
Intersection of Avenue F and Cantu Road	No	Yes	At Garfield Street (between Ave. F and US277)	No	Yes
Intersection of Avenue F and 17th Street	No	Yes	At the intersection of Garfield St. and Avenue F (2 legs)	No	Yes
Intersection of Avenue F and US90 (4 legs)	No	Yes	At the intersection of Garfield St. and Main St. (2 legs)	No	Yes
Intersection of Bedell Avenue and US90 (2 legs)	No	Yes	At the intersection of Las Vacas and the new Spur	No	Yes
Intersection of US90 and FM2523	No	Yes	At US 239 (between Int. Bridge and the new spur)	No	Yes

Source: TxDOT, Refs. 3.4, 3.5

Table 3.2 Observed Historical Growth Rates

Location	Growth Rate
1. US90 West of Y-intersection with US277/ US377	2.67
2. US277/ US377 North of Y-intersection with US90	1.34
3. US277/ US377/US90 South of Y-intersection	1.52
4. US90 @ Cantu Road	0.90
5. US90 @ 17th Street	1.40
6. Avenue F North of US90 (Gibbs)	1.40
7. Avenue F South of US90 (Gibbs)	1.39
8. Gibbs Street (US90) West of Avenue F	2.31
9. Gibbs Street (US90) East of Avenue F	1.12
10. US90 West of Bedell Avenue and US277	1.12
11. US90 East of Bedell Avenue and US277	3.18
12. US277 South of US90 (N. of Garfield St.)	5.40
13. Garfield St. West of US277	4.11
14. US277 South of Garfield St.	4.39
15. US277 @ Garza	10.68
16. Garfield St. West of Avenue F	3.88
17. Garfield St. East of Avenue F	4.12
18. Garfield St. East of Main St.	4.63
19. Garfield St. West of Main St.	5.09
20. Las Vacas @ new Spur	5.13
21. At US 239 (near International bridge)	2.07

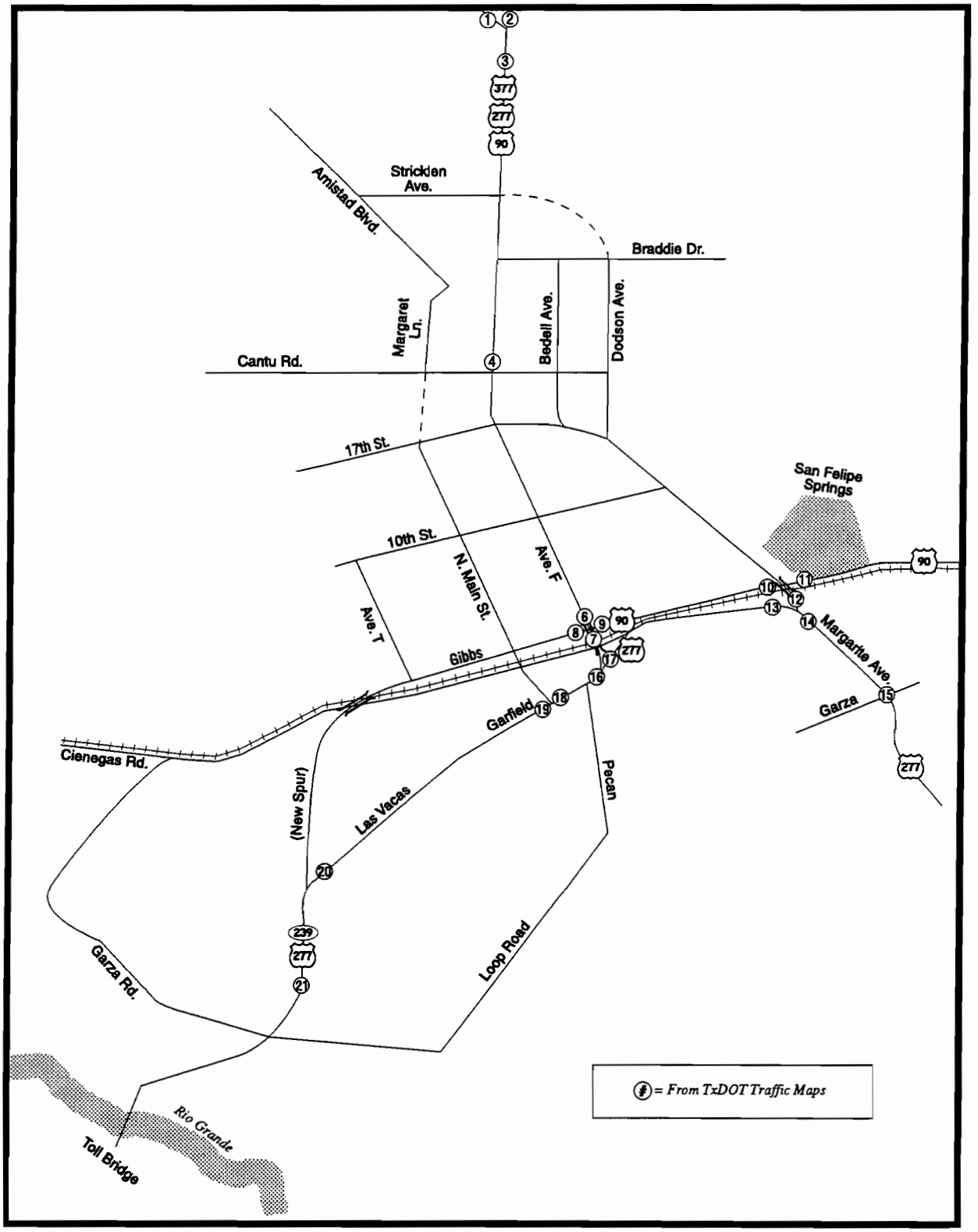

Figure 3.2 Locations of Available AADT Data

The highest growth rate was observed at the intersection of Garza Road and US277 East (the highway to Eagle Pass). This high growth rate does not seem related to through traffic at US277, because traffic growth at the northern leg of US277 (near the "Y" intersection with US90) was, on the average, 5.8 times less. In terms of typically urban traffic growth, the data indicate an increasing demand for Garfield Street/Las Vacas and Avenue F, which had growth rates in the neighborhood of 5 percent. Local collectors serving residential areas (such as Cantu Road and 17th Street) had the lowest growth rates. Arterials that serve primarily international traffic (US239 near the bridge) had an average growth rate slightly over 2 percent. The historical growth rates indicate that local traffic in commercial areas is the fastest growing type of traffic demand within Del Rio; international traffic ranks second, and through traffic third.

As shown in Table 3.1, the traffic data available for Del Rio include neither vehicle classifications nor turning movements at important intersections. Moreover, peak hours and K-factors are available only for the ATR station, which does not represent urban traffic and, thus, needed to be adjusted. Detailed data were collected in Del Rio specifically for this study by TxDOT's Laredo District. TxDOT staff manually counted turning movements and vehicle mix at eight intersections during morning and afternoon peaks and during two off-peak periods, 15 minutes per period. Table 3.3 shows the data collected by TxDOT, while Figure 3.3 shows the locations of the eight intersections surveyed by TxDOT. K-factors shown in Table 3.3 were calculated by dividing 4 times the peak 15-minute traffic by the nearest available AADT estimates (from TxDOT traffic maps in locations shown in Figure 3.2).

Table 3.3 Intersection Traffic Counts

Intersection Location: US277 @ Garza (number 1 in Figure 3.3)

Time	Movement	NB		SB		EB		WB	
		Auto	**Truck**	**Auto**	**Truck**	**Auto**	**Truck**	**Auto**	**Truck**
5:45 PM	Left-Turn	3	0	24	0	22	0	1	0
to	Straight	37	4	15	4	19	0	18	0
6:00 PM	Right-Turn	1	2	22	0	5	0	25	0
TOTAL		41	6	61	4	46	0	44	0
7:45 AM	Left-Turn	6	0	10	3	27	0	32	2
to	Straight	53	4	24	5	12	2	21	0
8:00 AM	Right-Turn	0	0	12	1	3	0	0	0
TOTAL		59	4	46	9	42	2	53	2
10:15 AM	Left-Turn	3	0	3	0	15	0	0	0
to	Straight	22	2	26	10	11	2	14	1
10:30 AM	Right-Turn	1	0	6	0	1	0	19	0
TOTAL		26	2	35	10	27	2	33	1
2:36 PM	Left-Turn	2	1	16	0	18	2	0	0
to	Straight	21	5	21	3	16	3	16	3
2:51 PM	Right-Turn	3	1	16	0	4	0	11	1
TOTAL		26	7	53	3	38	5	27	4

AADT = 5,390; **K- FACTOR** AM = 11.28% PM = 11.95%

Table 3.3 Intersection Traffic Counts — Continued

Intersection Location: US90 (Avenue F) @ Cantu Road (number 2 in Figure 3.3)

Time	Movement	NB		SB		EB		WB	
		Auto	Truck	Auto	Truck	Auto	Truck	Auto	Truck
8:31 AM	Left-Turn	17	2	10	0	6	1	2	0
to	Straight	82	9	123	3	4	0	7	0
8:46 AM	Right-Turn	2	0	10	0	12	1	4	0
TOTAL		101	11	143	3	22	2	13	0
9:30 AM	Left-Turn	18	0	5	0	15	0	5	0
to	Straight	120	8	145	4	25	0	11	0
9:45 AM	Right-Turn	1	0	17	1	15	2	5	0
TOTAL		139	8	167	5	55	2	21	0
12:00 PM	Left-Turn	22	2	20	1	21	0	15	0
to	Straight	208	6	232	10	16	1	24	1
12:15 PM	Right-Turn	7	0	20	1	32	2	9	0
TOTAL		237	8	272	12	69	3	48	1
3:26 PM	Left-Turn	13	0	10	0	9	0	10	0
to	Straight	164	7	160	13	14	0	23	0
3:41 PM	Right-Turn	12	0	7	0	15	1	10	0
TOTAL		189	7	177	13	38	1	43	0

AADT = 19,061; **K- FACTOR:** AM = 5.75% PM = 11.46%

Intersection Location: Garfield St. @ S. Main St. (number 3 in Figure 3.3)

Time	Movement	NB		SB		EB		WB	
		Auto	Truck	Auto	Truck	Auto	Truck	Auto	Truck
6:13 PM	Left-Turn	One	way	1	0	16	1	3	0
to	Straight	South Bound		10	0	94	2	88	2
6:28 PM	Right-Turn			10	0	0	0	3	0
TOTAL				21	0	110	3	94	2
9:14 AM	Left-Turn	One	way	10	0	12	0	9	0
to	Straight	South Bound		28	1	59	7	49	5
9:29 AM	Right-Turn			5	0	2	0	3	0
TOTAL				43	1	73	7	61	5
10:00 AM	Left-Turn	One	way	6	2	14	0	15	0
to	Straight	South Bound		33	0	36	2	58	2
10:15 AM	Right-Turn			11	0	4	0	5	0
TOTAL				50	2	54	2	78	2
11:30 AM	Left-Turn	One	way	11	0	19	0	17	0
to	Straight	South Bound		43	0	72	2	69	2
11:45 AM	Right-Turn			5	0	3	0	17	0
TOTAL				59	0	94	2	103	2

AADT = 11,265; **K- FACTOR:** AM = 6.25% PM = 7.74%

Table 3.3 Intersection Traffic Counts — Continued

Intersection Location: Avenue F @ Garfield St. (number 4 in Figure 3.3)

Time	Movement	NB		SB		EB		WB	
		Auto	Truck	Auto	Truck	Auto	Truck	Auto	Truck
6:35 PM	Left-Turn	One	way	17	0	No	counts	0	0
to	Straight	Southbound		16	0	Available		23	0
6:50 PM	Right-Turn			109	3			31	1
TOTAL				142	3			54	1
7:45 AM	Left-Turn	One	way	21	0	104	3	1	0
to	Straight	Southbound		32	2	21	2	28	1
8:00 AM	Right-Turn			117	3	0	0	52	0
TOTAL				170	5	125	5	81	1
10:45 AM	Left-Turn	One	way	0	4	36	3	0	0
to	Straight	Southbound		39	0	21	2	21	1
11:00 AM	Right-Turn			100	0	1	0	36	3
TOTAL				139	4	58	5	57	4
11:29 AM	Left-Turn	One	way	20	1	116	2	2	0
to	Straight	Southbound		22	0	19	1	25	1
11:44 AM	Right-Turn			122	3	1	0	31	0
TOTAL				164	4	136	3	58	1

AADT = 15,971

K- FACTOR: AM = 7.21%

Intersection Location: Avenue F @ 10th St. (number 5 in Figure 3.3)

Time	Movement	NB		SB		EB		WB	
		Auto	Truck	Auto	Truck	Auto	Truck	Auto	Truck
9:00 AM	Left-Turn	14	1	0	0	24	1	1	1
to	Straight	117	7	133	8	6	1	11	1
9:15 AM	Right-Turn	3	0	5	0	11	0	31	1
TOTAL		134	8	138	8	41	2	43	3
9:40 AM	Left-Turn	9	0	0	0	15	1	5	0
to	Straight	137	8	161	12	9	0	7	1
9:55 AM	Right-Turn	0	0	8	1	10	2	6	0
TOTAL		146	8	169	13	34	3	18	1
12:01 PM	Left-Turn	13	6	8	0	37	1	6	0
to	Straight	167	8	137	3	18	2	22	0
12:16 PM	Right-Turn	12	0	11	1	20	2	16	0
TOTAL		192	14	156	4	75	5	44	0
3:30 PM	Left-Turn	10	6	3	0	17	0	15	0
to	Straight	200	8	187	8	8	0	25	0
3:45 PM	Right-Turn	6	0	13	0	9	2	21	0
TOTAL		216	14	203	8	34	2	61	0

AADT = 21,592; **K- FACTOR:** AM = 7.28% (Note: Lunch time peak); PM = 8.98%

Table 3.3 Intersection Traffic Counts — Continued

Intersection Location: Avenue F @ 15th St. (number 6 in Figure 3.3)

Time	Movement	NB		SB		EB		WB	
		Auto	Truck	Auto	Truck	Auto	Truck	Auto	Truck
9:30 AM	Left-Turn	4	0	5	0	5	0	8	0
to	Straight	120	8	155	5	5	2	5	0
9:45 AM	Right-Turn	0	0	6	0	25	0	6	0
TOTAL		124	8	166	5	35	2	19	0
9:58 AM	Left-Turn	2	0	5	0	13	0	10	1
to	Straight	119	6	144	6	9	0	11	0
10:13 AM	Right-Turn	1	0	5	0	3	0	6	4
TOTAL		122	6	154	6	25	0	27	5
12:45 PM	Left-Turn	18	0	6	0	15	0	12	0
to	Straight	245	0	215	3	15	0	43	0
1:00 PM	Right-Turn	1	0	15	0	7	0	12	0
TOTAL		264	0	236	3	37	0	67	0
3:15 PM	Left-Turn	16	0	14	0	28	1	8	0
to	Straight	173	0	209	3	17	0	21	0
3:30 PM	Right-Turn	3	0	8	0	13	0	7	0
TOTAL		192	0	231	3	58	1	36	0

AADT = 21,592; **K- FACTOR:** PM = 9.48%

Intersection Location: Avenue F @ US90 (Gibbs St.) (number 7 in Figure 3.3)

Time	Movement	NB		SB		EB		WB	
		Auto	Truck	Auto	Truck	Auto	Truck	Auto	Truck
8:07 AM	Left-Turn	2	0	36	3	12	0	22	1
to	Straight	85	3	63	1	20	6	15	3
8:22 AM	Right-Turn	12	0	12	0	0	0	20	5
TOTAL		99	3	111	4	32	6	57	9
10:28 AM	Left-Turn	2	0	27	6	11	2	42	1
to	Straight	77	4	88	2	12	1	24	0
10:43 AM	Right-Turn	17	3	9	0	2	0	33	7
TOTAL		96	7	124	8	25	3	99	8
11:30 AM	Left-Turn	2	0	100	22	14	0	43	3
to	Straight	126	4	177	12	32	2	63	0
11:45 AM	Right-Turn	8	0	26	7	7	0	37	12
TOTAL		136	4	303	41	53	2	143	15
12:22 PM	Left-Turn	7	0	41	12	13	0	37	0
to	Straight	126	0	105	2	29	0	17	3
12:37 PM	Right-Turn	25	1	10	0	14	0	48	4
TOTAL		158	1	156	14	56	0	102	7

AADT = 20,358; **K- FACTOR:** AM = 11.67 PM = 7.45%

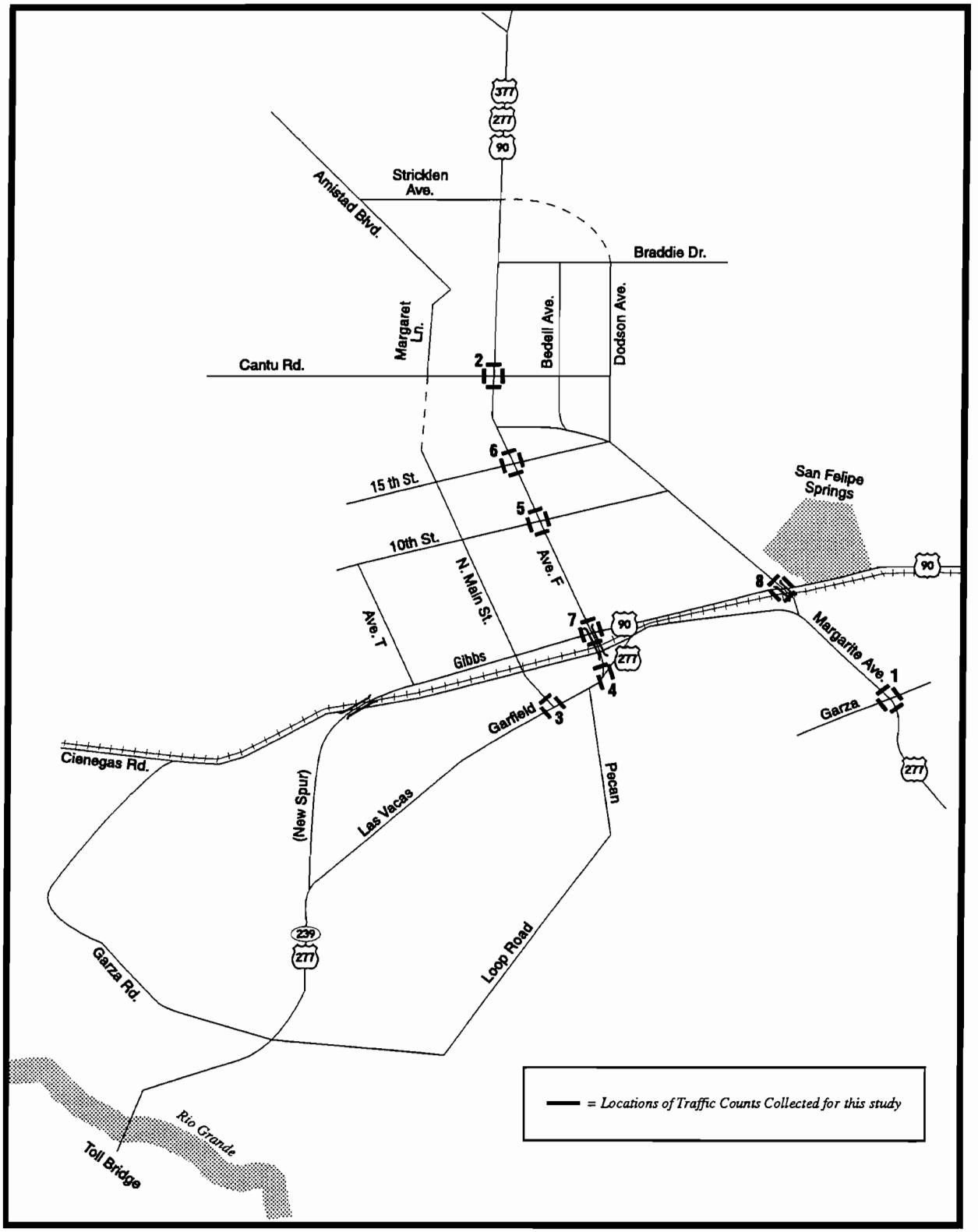

Figure 3.3 Locations of Traffic Counts Collected in This Project

Table 3.3 Intersection Traffic Counts — Continued

Intersection Location: US90 @ US277 & Bedell Ave. (number 8 in Figure 3.3)

Time	Movement	NB		SB		EB		WB	
		Auto	Truck	Auto	Truck	Auto	Truck	Auto	Truck
5:25 PM	Left-Turn	37	5	71	3	4	1	9	0
to	Straight	82	2	102	0	35	3	63	7
5:40 PM	Right-Turn	7	0	3	0	55	3	58	0
TOTAL		126	7	176	3	94	7	130	7
8:15 AM	Left-Turn	31	3	27	0	13	0	14	0
to	Straight	80	7	32	7	39	5	28	6
8:30 AM	Right-Turn	0	0	11	0	9	0	29	0
TOTAL		111	10	70	7	61	5	71	6
10:30 AM	Left-Turn	25	0	58	1	7	1	5	1
to	Straight	50	0	45	1	24	3	37	3
10:45 AM	Right-Turn	3	1	7	0	22	2	5	1
TOTAL		78	1	110	2	53	6	47	5

AADT = 11,711; **K- FACTOR:** AM = 5.43 PM = 8.03%

Source: TxDOT Laredo District

K-factor values varied between 5.8 and 12 percent, with an average of 8.6 percent. The nearest ATR station has a K-factor of 11 percent. This project used K=11.5 percent, a conservative value according to the available data. Turning movements from Table 3.2 were used to calculate the arterial levels of service.

Truck percentages varied with route and time of day. Table 3.4 shows the mean, minimum and maximum truck percentages observed for the overall traffic at the eight intersections surveyed by TxDOT (Table 3.3 and Figure 3.3). The lowest percentage (0.5 percent) was observed at Avenue F and 15 Street (off-peak), and the highest (over 16.5 percent) was measured at US277 and Garza (off-peak). Avenue F had truck percentages varying between a 8.9 and 0.49 percent, and it is relevant to note that, although the highest truck percentage was observed off-peak, Avenue F's overall tendency is for high percentages during the morning peak.

Table 3.4 Observed Truck Percentages

Intersection		Percent Trucks		
Number	Name	Mean	Minimum	Maximum
1	US277 @ Garza	10.51%	6.80%	16.55%
2	US90 (Avenue F) @ Cantu Road	4.35%	3.69%	5.42%
3	Garfield St. @ S. Main St.	3.44%	1.54%	6.84%
4	Avenue F @ Garfield St.	2.97%	2.00%	4.87%
5	Avenue F @ 10th Street	5.28%	4.46%	6.38%
6	Avenue F @ 15th St.	2.59%	0.49%	4.93%
7	Avenue F @ US90 (Gibbs St.)	6.81%	4.45%	8.90%
8	US90 @ US277 & Bedell	5.74%	4.36%	8.21%

Origin and Destination Data

Qualitative origin and destination information was collected during field observations and interviews with local agencies, including city officials, TxDOT's Maintenance Office, the chamber of commerce, and private enterprises. This information was used to complement the only origin and destination (O&D) survey available for Del Rio, which was conducted by CTR for a borderwide transportation planning study (Refs. 3.8, 3.9). Data were collected during a 13-hour-long survey conducted on April 29, 1993, from 6:00 a.m. to 7:00 p.m., at the southbound bridge access. The sample included 859 vehicles, or about 30 percent of the April ADT at the bridge. Information gathered consisted of O&D disaggregated by Texas and Mexican cities, trip frequency, and trip purpose.

Table 3.5 summarizes the origin and destination matrix, which shows that 94 percent of all trips have origins in Del Rio and destinations in Ciudad Acuña, and 96 percent or more have at least one local origin or destination (Del Rio or Ciudad Acuña). Only 1.1 percent of the trips had both origins and destinations beyond the two sister cities. The "other" category includes any origin or destination having less than a 5 percent occurrence. Table 3.6 shows the "other" origins and destinations.

Table 3.5 Origin/Destination Matrix

Origin	**Destination**		
	Ciudad Acuña	Other	Total (Origin)
Del Rio	807	16	823
	94%	2%	96%
Other	30	6	36
	3.1%	1.1%	4.2%
Total (destination)	837	22	859
	97%	3%	100%

Source: Weissmann et al., Ref. 3.9

Table 3.6 "Other" Origins and Destinations

Other Origins	**Other Destinations**
Abilene (2) - Austin (1) - Bakersfield (1) - Brownsville (1) - Brownwood (1) - California (1) - Carta Valley (2) - Cleveland (1) - Comstock (1) - Dallas (1) - Des Moines (1) - Eagle Pass (3) - El Paso (1) - Ft Worth (1) - Harper (1) - Houston (2) - Laredo (1) - Laughlin (1) - Meoste (1) - New Orleans (1) - Robert Lee (1) - Rock Springs (1) - San Antonio (5) - Uvalde (2).	Allende (2) - DF, Mex (2) - Honduras (1) - Jimenez (2) - Mendoza (1) - Mex (1) - Monclova (1) - Monterey (1) - Nueva Rosita (1) - Piedras Negras (3) - Presa Amistad (1) - San Carlos (1) - San Miguel (1) - Zaragoza (3).

Source: Weissmann et al., Ref. 3.9

Weekly frequencies for auto and truck trips are depicted in Table 3.7. About 34 percent of auto frequencies are less than three times a week, while about the same percentage use the bridge six times a week or more. As for trucks, over half of all trips are made at least once a day, reflecting maquiladora commerce and the activities of drayage companies within the commercial zone enforced before NAFTA.

Table 3.7 Weekly Frequencies of International Trips

Frequency Category	Autos		Trucks	
	Trips	Percent	Trips	Percent
<1	95	11.5%		
1≤FQ<2	96	12.0%	1	3%
2≤FQ<3	84	10.0%	3	9%
3≤FQ<4	42	5.0%	3	9%
4≤FQ<5	18	2.0%		
5≤FQ<6	232	28.0%	6	18%
6≤FQ<7	21	2.5%		
≥7	219	27.0%	18	55%
N/A	17	2.0%		
Total	824	100%	33	100%

Source: Weissmann et al., Ref. 3.9

Table 3.8 shows the average auto occupancy by trip purpose. Auto occupancy is slightly over two for non-business trips, and under 1.5 for business-related trips. Trip purpose is equally split between business and non-business trips, the remainder (4 percent) representing respondents refusing to answer.

Table 3.8 Average Auto Occupancy — Del Rio Bridge

Trip Purpose	Sample Size (%)	Auto Occupancy			
		Mean	Std. Dev.	Minimum	Maximum
N/A	33 (4%)	1.27	0.63	1	3
Non-business	388 (48%)	2.19	1.32	1	9
Business	392 (48%)	1.40	0.84	1	8
Total	813 (100%)				

Source: Weissmann et al., Ref. 3.9

The results indicate that the vast majority of international trips at the Del Rio International Bridge are local. The majority of business trips seemed to be related to Del Rio residents working at Ciudad Acuña's maquiladoras. A significant number of non-business trips were related to personal activities, such as school, visits to relatives, medical appointments, and shopping. The Del Rio O&D survey was part of a borderwide study that included most other bridges along the

Texas-Mexico border. At most of those other bridges, the trip purpose response was split at approximately 70–30 percent between non-business and business. In Del Rio, these percentages were equally split between the two purposes. During the morning peak, several carpools were observed with both white- and blue-collar workers going to Ciudad Acuña's maquiladoras. This phenomenon was not observed elsewhere at the border with the same intensity, and may explain the higher number of business-related trips in Del Rio.

Tourist (Casino) Traffic

Demand for the proposed casino was estimated based on information obtained from Mr. Robert de la Garza, tribal administrator for the Kickapoo Indian Reservation near Eagle Pass. According to Mr. de la Garza, the casino will begin operating in 1997, and will have a 2,000-vehicle parking lot. Expansions will depend on initial success, since demand for this type of tourist attraction is very difficult to predict with accuracy. Our Mexican subcontractor estimates that a significant percentage of the Mexican population will be attracted to a casino near the border, and would be willing to drive on a weekly basis the two to three hours required to reach the casino.

The actual percentage of the population that will be 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 Del Rio 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 a larger area on both sides of the border. Its demand can have an impact on traffic circulation and thus should be taken into consideration. Actual numbers are unknown, and estimated demand relied on the following assumptions:

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

(2) The minimum gambling age is 21 years.

(3) Seventy percent of the population is over 21 years of age, and 14 percent of the employed population is over 21 years of age.

(4) The demand from Acuña will consist of 5 percent of its adult population for the first two years, and 2 percent after that.

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

(6) The casino traffic during the peak hour (5-6 p.m.) will be assumed distributed as follows: 60 percent of casino demand from Acuña, 25 percent from Del Rio.

(7) The casino will close no earlier than 3:00 a.m. and no later than 5:00 a.m.

(8) Population will grow at historical rates in both Texas and Coahuila.

(9) Demand from Ciudad Acuña and nearby Mexican cities will cross the border in Del Rio.

The source of Mexican data was the Annual Statistics of the State of Coahuila, 1994 (Ref. 3.1). 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 Mexican demand will be higher for the first two years, stabilizing at 2 percent of the population after 2000, for all cities except Piedras Negras and Eagle Pass (4 percent). Table 3.9 summarizes the total casino traffic demand for the peak-hour of operation.

Table 3.9 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. 3.2, 3.7, 3.8, 3.9).

Hourly Traffic Volumes

Traffic forecasts were made in terms of AADT, though traffic assignments require hourly traffic volumes, which were estimated based on equation 3.1 (from Ref. 3.6).

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

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 Del Rio is TxDOT's Automatic Traffic Recorder (ATR) station S103, located on US90, 0.5km north-west of US377. This location is not

representative of urban traffic distributions. The K-factor observed at this station was 11 percent, while available hourly distributions in urban areas of similar size may lead to K-factors as high as 15 percent. Based on data collected by TxDOT in Del Rio specifically for this project (Table 3.3), urban K-factors varied between 5.8 and 12 percent, with an average of 8.6 percent. This project used K=11.5 percent, a conservative value according to the data.

Truck demand was estimated based on the following available information: percent of trucks in international traffic, an estimate obtained from the TxDOT's Transportation Planning Office (about 2.5 percent for overall demand), and data discussed in Tables 3.3 and 3.4. The future truck percentages in the traffic stream were estimated iteratively during the traffic assignment procedure.

Additional assumptions were necessary regarding the other parameters in equation 3.1. The directional distribution was assumed 60 percent where sufficient data were not available. Trucks were converted into car-equivalents based on criteria set forth in the Transportation Research Board's *Highway Capacity Manual* (Ref. 3.6). For most locations, it was 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 condition, usually during one specific hour (Ref. 3.6). An increase in capacity requires improving either the physical characteristics of the roadway, or 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. 3.6). The following applications of 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.
(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. 3.6), 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, and both 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. Capacity estimates were

based on field observations for cycle lengths, plus the following assumptions for values of green time per cycle (based on Ref. 3.6)[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 800 pcphpl, a value recommended in the 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 the assumptions, arterial capacities were also estimated based on the average arterial speed, using criteria for urban and suburban arterials found in the *Highway Capacity Manual* (Ref. 3.6). 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 first calculated theoretically, then verified and adjusted through field observations.

Analysis Approach and Study Scenarios

The peak-hours, K-factors (ratio between selected peak-hour and AADT), truck percentages and turning movements were estimated using the ATR station data combined with data specifically collected for this project, as discussed earlier in this chapter. Trucks were converted to passenger vehicles by using truck equivalency factors discussed in the *Highway Capacity Manual* (Ref. 3.6). The analysis and assignment of projected traffic volumes were based on 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 (including the new Spur 239).

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

(3) *High-impact scenario:* This scenario projects and assigns traffic volumes considering the recommended infrastructure, and assuming that the tourist traffic component (casino) is significant, and/or Del Rio develops in the area between the Rio Grande and US277.

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

A critical examination of the reference scenario provides enough information to define the problem, identify current and potential traffic circulation deficiencies, develop initial recommendations, and analyze the impacts of infrastructure improvements. Chapter 4 discusses the other study scenarios in detail.

TRAFFIC CIRCULATION DEFICIENCIES AND PRELIMINARY RECOMMENDATIONS

The levels of service (LOS) were estimated according to the approach described above, to assist in the identification of traffic circulation problems in Del Rio. Most assumptions necessary to project AADT data and then convert them to hourly volumes were discussed previously. It is worth mentioning, however, that traffic assignment to the roadway system required assumptions about local origins and destinations of the traffic and future land use, which were made as the assignment progressed. The most important of these assumptions: Del Rio future land use will follow the recommendations of the environmental protection study for the San Felipe Springs (Ref. 3.2).

Reference Scenario LOS

Table 3.10 shows the current and future levels of service obtained for arterial segments and intersections in the reference scenario, i.e., only with existing infrastructure. The specific locations of these intersections were shown in Figure 3.4. Arterials and intersection LOS are depicted in Figures 3.5 through 3.8, respectively, for years 1995, 2000, 2010, and 2020.

Table 3.10 Reference Scenario LOS

Int. No[1]	Arterial Segment	Intersection LOS				Arterial LOS			
		1995	2000	2010	2020	1995	2000	2010	2020
1	US 239 (NB), Int. bridge to Spur	B	B	D	E	A	A	B	C
2	Garfield St. (WB), Spur to Ave. F	B	D	D	F	B	C	F	F
3	Garfield St., Ave. F to US 277	B	B	B	C	A	A	B	C
4	US 90, Ave. F to US 277	B	B	B	C	A	A	B	C
5	Ave. F (NB), Gibbs St. to 17th St.	C	D	F	F	C	C	C	E
6	Ave. F (SB), 17th St. to Gibbs St.	D	E	F	F	C	D	D	F
7	Ave. F, US 90 to Garfield	C	C	C	D	C	C	C	D
8	US 90, 17th St. to Stricklen	B	B	B	E	A	A	B	E
9	US 90, US 277 to Hwy. 2523	B	B	B	F	A	A	A	C
10	US 277, US 90 to Bowie	B	B	C	C	B	B	D	F
11	Gibbs Street	B	B	C	C	B	B	D	F
12	Bedell Avenue	A	A	B	F	B	C	E	F
13	Main Street	A	B	C	E	B	C	E	F

[1] See Figure 3.4 for intersections.

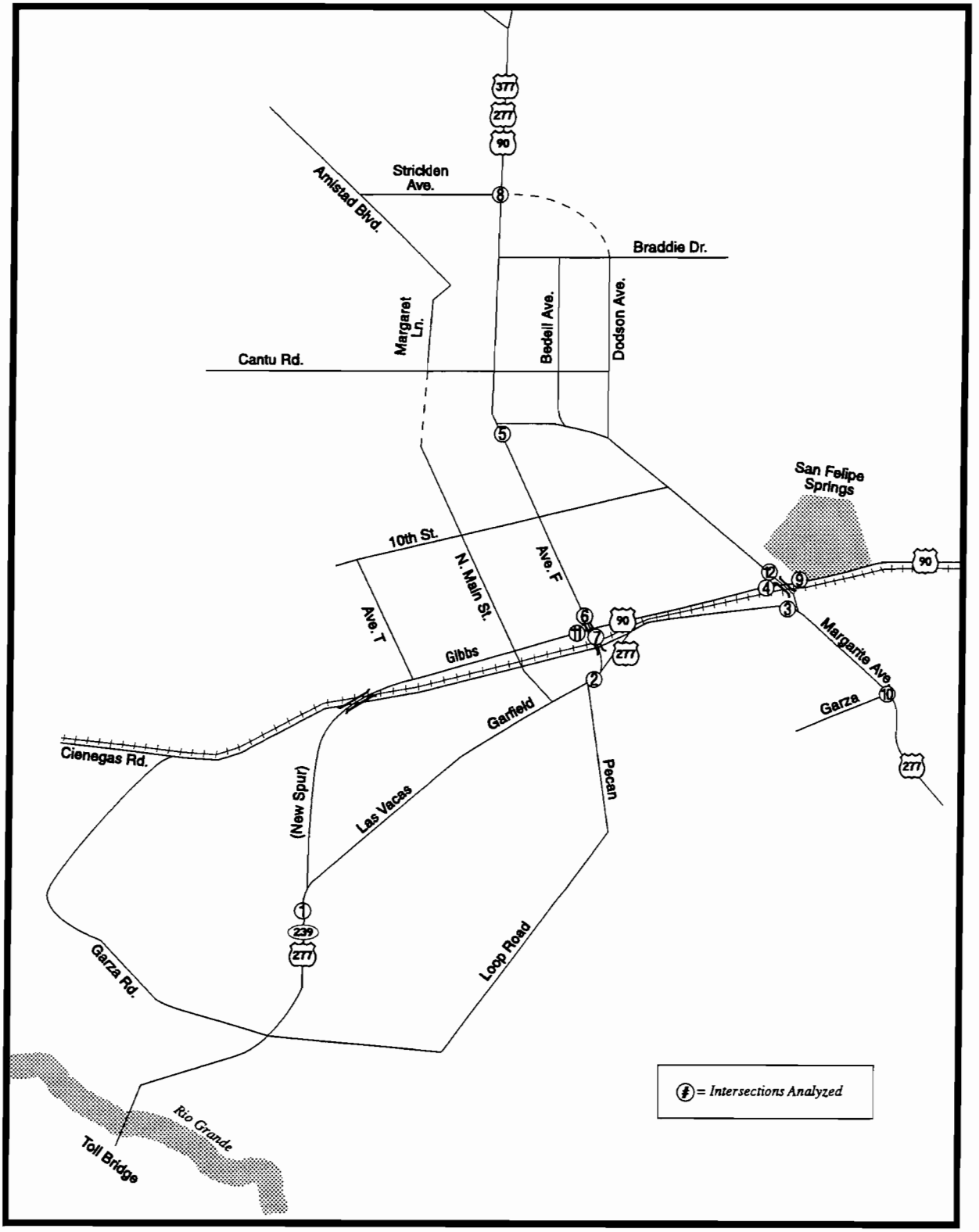

Figure 3.4 Intersections Analyzed

In order to interpret the LOS results correctly, it is important to keep in mind that the only intersection/arterial interaction reflected in the LOS presented in Table 3.10 is the effect of intersection delays on 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 may not be reflected by the LOS presented in Table 3.10, because 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.

Traffic Circulation Deficiencies

In 1995, Del Rio intersections were still performing at a satisfactory level of service, except for the north and south ends of Avenue F. These intersections are already nearing capacity. In the year 2000, the north and south ends of Avenue F will reach levels D and E, respectively, (intersections 5 and 6 in Fig. 3.4 and Table 3.10). Avenue F itself will not serve traffic well if back-ups at its intersections are not corrected (arterial LOS is in the C and D range). Garfield Street will need attention both in its intersections and its lanes, which will be at levels D and E, respectively. Only the parts of Del Rio that are still rather undeveloped will still be at an acceptable LOS by 2000.

In the year 2010, there would be serious congestion in lanes and/or intersections of all major arterials, such as Avenue F, Garfield Street, US277, and Bedell Avenue if no additional infrastructure is provided. In the year 2020, traffic circulation would be very poor everywhere except for the protected areas near San Felipe Aquifer — owing to the assumption that the aquifer will be successfully protected throughout the analysis period.

During field trips to Del Rio, some of the results discussed were verified and other relevant information was gathered. The peso devaluation has decreased downtown traffic demand, but demand for the Mall has been less affected. The city believes that a sudden traffic increase of 30 to 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 2)
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 early in the morning and after 4:00 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.

Main Street can divert a significant amount of traffic with a downtown destination off Avenue F, but Main Street capacity is not adequate in the downtown area, especially owing to the parking lanes. The city should schedule a hearing to determine the viability of increasing Main Street capacity by prohibiting parking. Main Street's lanes need painting and maintenance.

Avenue F is a four-lane arterial, but traffic attracted by the Mall and other business hinders traffic flow, especially because of inadequate capacity to absorb an unusual number of turning maneuvers at entrances and exits. Truck traffic moving towards the roadside businesses along Avenue F also hinders traffic flow (photos 20 and 21). Moreover, the signals along Avenue F and Garfield are not synchronized, resulting in frequent stops. The right-angle turn on Garza Road near the international bridge is hazardous for truck traffic and reduces both speed and capacity.

Basic Recommendations

The proposed traffic plan must avoid new infrastructure that might attract development inside the San Felipe Aquifer area. Moreover, recommendations must avoid new at-grade intersections with the Southern Pacific railroad, since, according to state law, a new at-grade intersection with a rail line can only be built if two others are either grade-separated or closed. Given these limitations, plus the fact that the new Spur 239 will be open when this study is concluded, the analysis already indicates that, at a minimum, the following segments and intersections need additional capacity or other improvements:

(1) **Garza Road** needs pavement rehabilitation and improvement of its design (as straight as possible).

(2) **Main Street** should be expanded to four lanes and have as much right-of-way as possible secured for future expansions. It also needs left-turn bays and lane markings. No parking along Main Street in the downtown area (photo 29) is recommended.

(3) **Avenue F**'s lanes should be widened to standard width. Signals should be synchronized. The city might also want to consider an ordinance requiring trucks that serve Avenue F stores to operate only during off-peak hours or at night (photos 4, 5, 20, 21, 39).

(4) **Bedell Avenue** should have an exclusive left-turning lane (photos 33, 41).

(5) **Cantu Road**'s traffic demand is expected to increase once the city starts expanding northwest, and right-of-way for future expansions should be secured.

(6) **Del Rio's outer loop** should be properly designed to accommodate future growth in accordance with environmental requirements.

(7) **Intersection of US90 and Avenue F** needs another lane on all legs, and a greater turning radius (see photos 6, 7, 8, 10, 11, 12, 13).

SUMMARY AND CONCLUSIONS

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, and include proposed infrastructure. The reference scenario is theoretical, and consists of a "do-nothing" approach that serves as a basis for identifying traffic circulation problems within the existing network and for evaluating impacts of proposed improvements. As such, it does not include the extensions of US239 and Bedell Avenue, the recommendations discussed above, or the proposed outer loop.

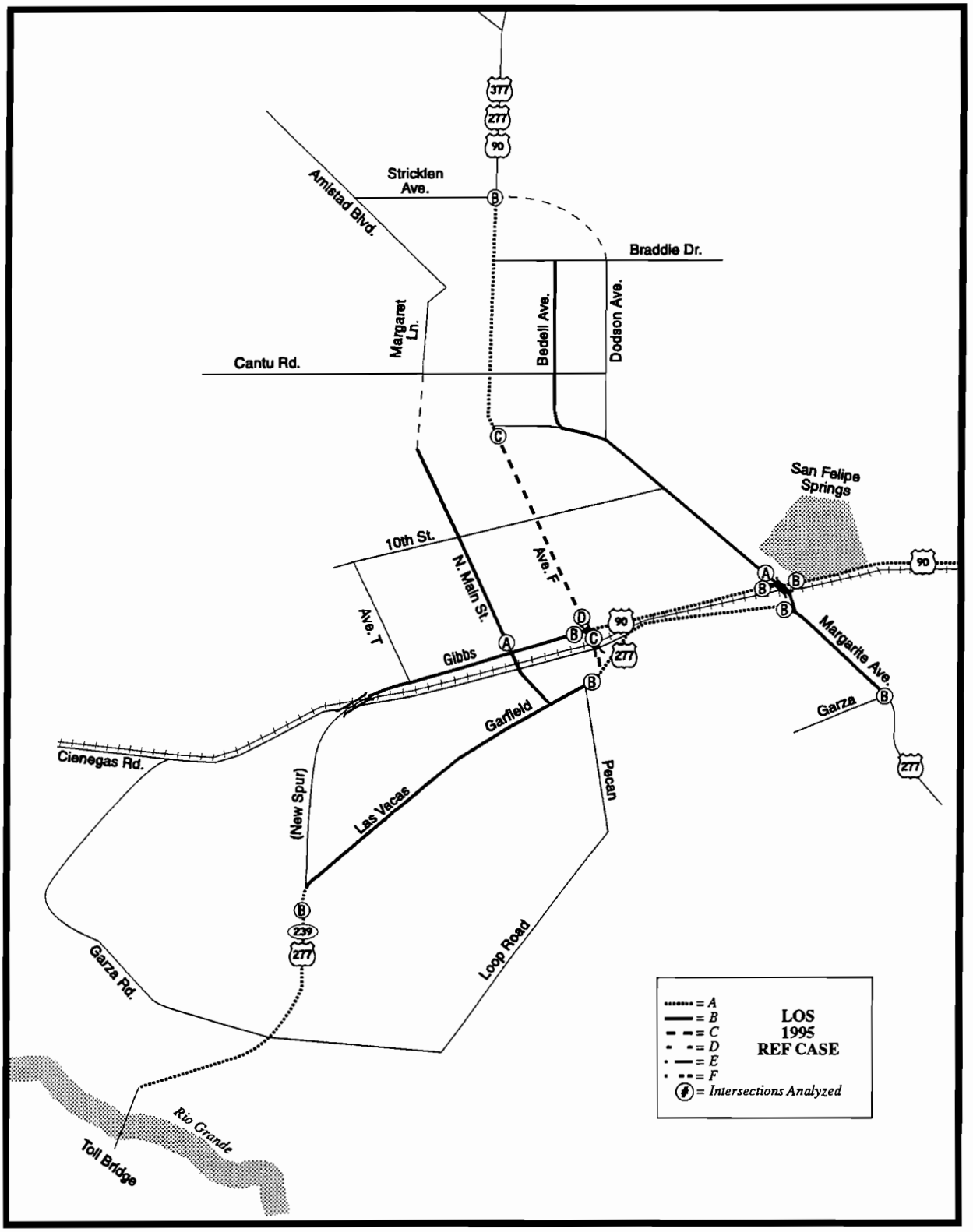

Figure 3.5 1995 Levels of Service — Reference Scenario

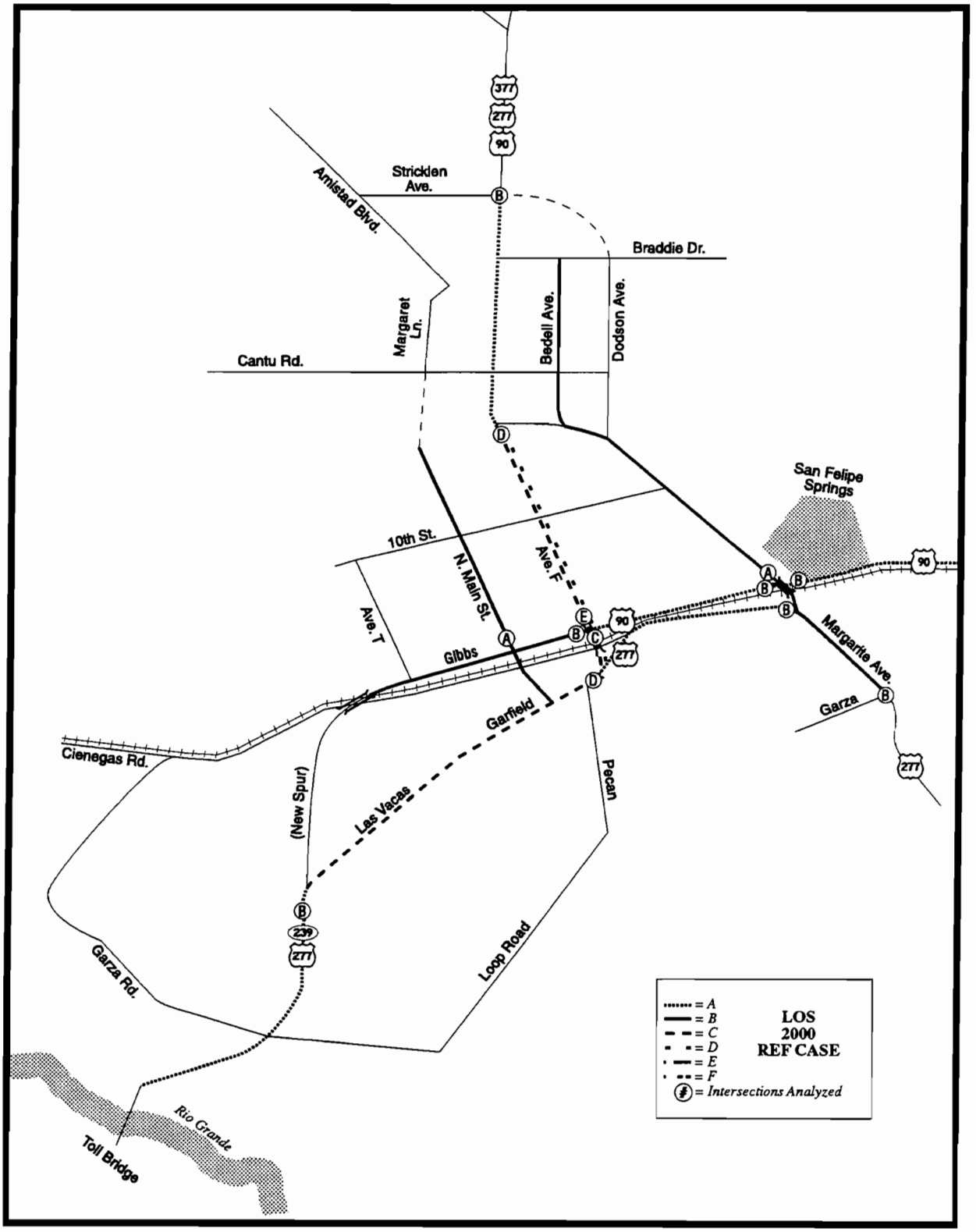

Figure 3.6 2000 Levels of Service — Reference Scenario

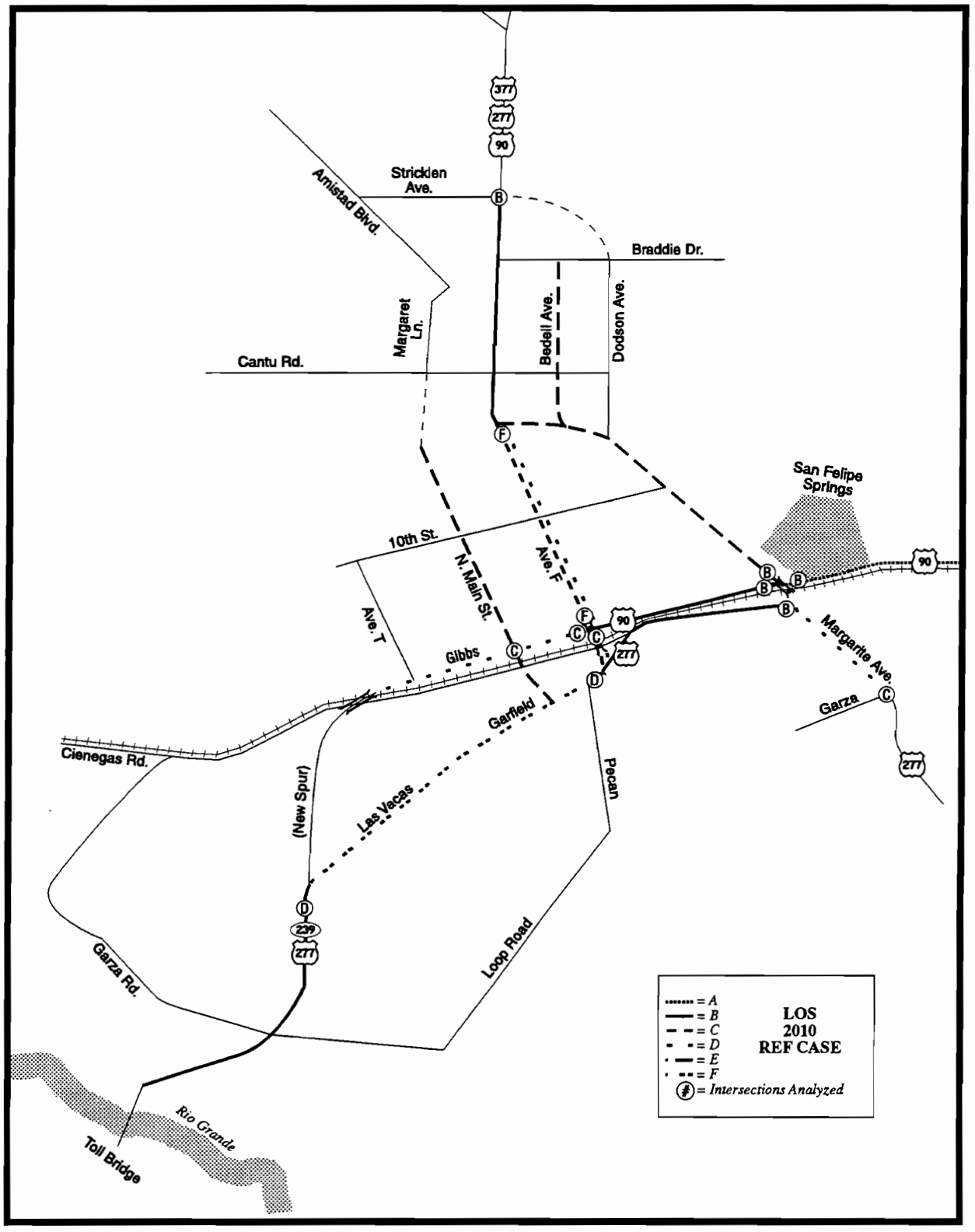

Figure 3.7 2010 Levels of Service — Reference Scenario

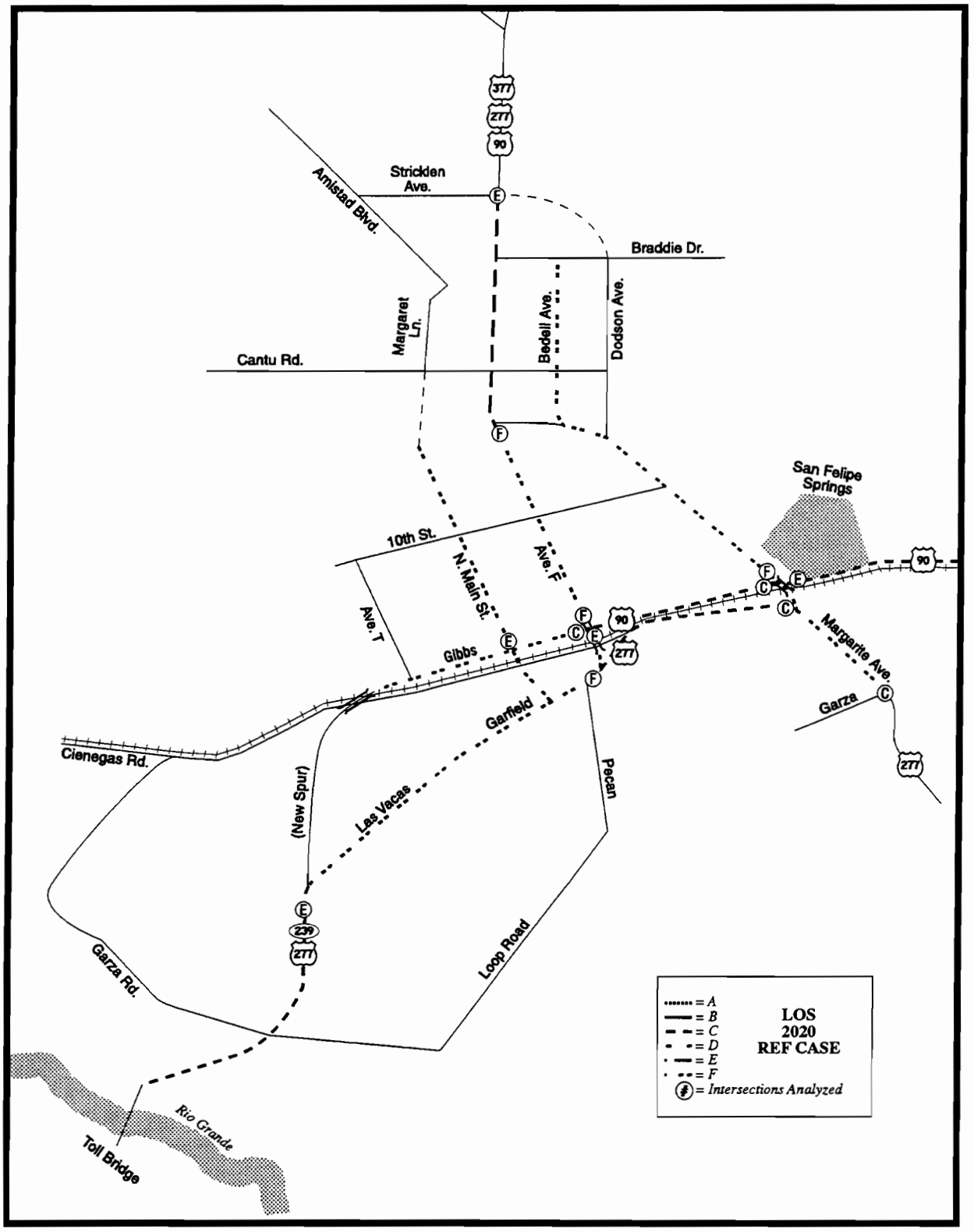

Figure 3.8 2020 Levels of Service — Reference Scenario

The recommendations for improved traffic circulation are based on three criteria: levels of service, accident probability, and cost. Levels of service were estimated as accurately as possible from the available data, using two linked spreadsheets (one for intersections and another for arterials). Time and budget constraints precluded detailed accident and cost analyses of every improvement proposed over a 25-year period. Nevertheless, the recommendations developed in this chapter, as well as those in Chapter 4, had the overall objective of keeping the levels of service and overall safety acceptable. The recommendations were selected based on ad-hoc relative cost estimates, and always started from the least expensive alternative. A reasonable cost-benefit ratio was ensured by disregarding improvements at locations serving 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 in an acceptable range, while at the same time providing safe turning maneuvers at intersections. The signalization warrants provided by Kell and Fulton (Ref. 3.10) were used as criteria to recommend signalization, even when ad-hoc data estimates were necessary.

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

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

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

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

3.7 Tutt, Paul R., and E. P. Hamilton III, *Del Rio Downtown Traffic Study—Technical Memorandum*. E. P. Hamilton and Associates, Inc., Pflugerville, Texas, January 1995.

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3.9 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.

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CHAPTER 4. DEL RIO TRAFFIC CIRCULATION PLAN

This chapter discusses a 25-year traffic circulation plan for Del Rio. The plan contains guidelines and priorities for alleviating and/or preventing current and potential traffic circulation problems. Its recommendations for on-system roadways address capacity upgrades, continuous left-turn lanes, 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, data, and assumptions discussed in Chapters 2 and 3. Once this traffic was assigned to the existing network, levels of service were then estimated and basic recommendations were developed. These recommendations, outlined in Chapter 3, served as a starting point for the two other study scenarios, which were analyzed by assigning auto and truck routes to the network and then verifying saturation based on arterial and intersection capacities and LOS. When the results indicated the need for additional improvements, these were added to the network, with another round of estimates then undertaken. Figure 4.1 depicts a flowchart summarizing this approach.

Study Scenarios

The traffic plan was developed based on one reference scenario and two analysis scenarios. The analysis scenarios were termed *low* and *high impact*, and they include the proposed infrastructure and other measures to improve traffic circulation. These two scenarios refer to two major sources of uncertainty in future traffic demand:

(1) the possibility of Del Rio expanding in the area between the Rio Grande and US277 (a possible but unlikely hypothesis according to current city plans), and

(2) a proposed casino on the Kickapoo Indian Reservation near Eagle Pass.

These contingencies could have similar and interrelated impacts on Del Rio's traffic demand in the area between the Rio Grande and US277. The casino will be the only gambling facility available near Ciudad Acuña and Del Rio, and as such it may attract a significant number of customers. Considering that Ciudad Acuña's population is more than three times greater than Del Rio's (around 36,000), about 75 percent of the casino demand is likely to come from across the Rio Grande. This will increase traffic demand in the area in question. Moreover, if the casino traffic results in the need for additional infrastructure in the area, this in turn is likely to attract development and thus generate more traffic.

Currently, the Mexican highway linking Ciudad Acuña to Piedras Negras is in worse condition than US277, and there are no plans to upgrade or improve it. Therefore, we

assumed all casino demand from Ciudad Acuña would cross the Rio Grande in Del Rio, using Garfield to reach US277 and then Eagle Pass.

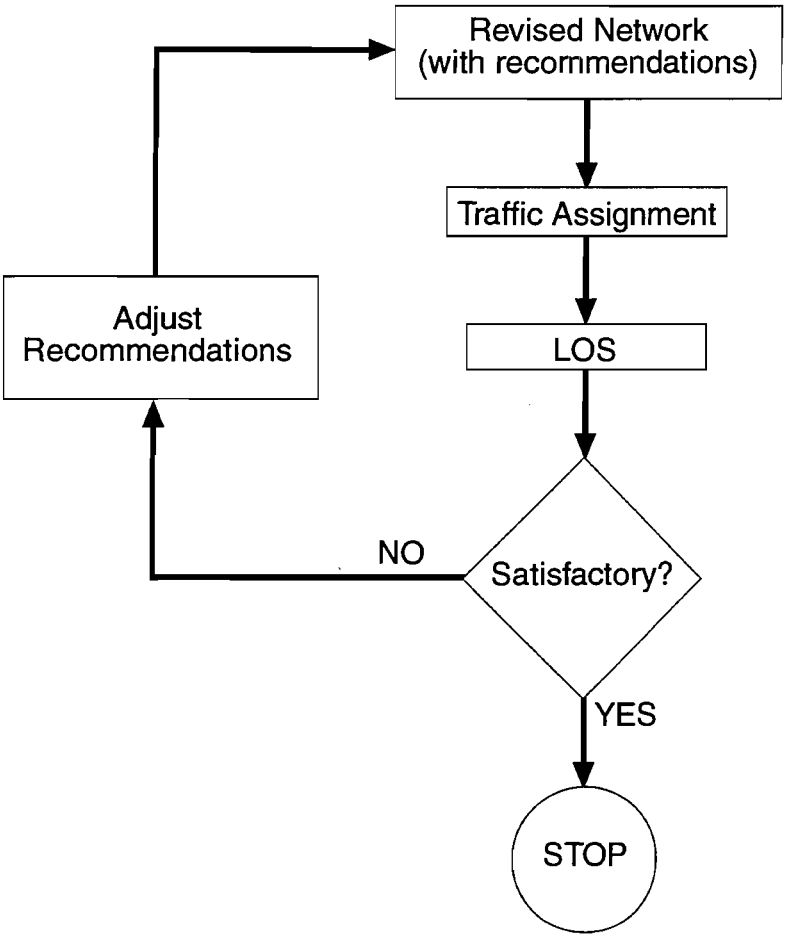

Figure 4.1 Approach for Developing Traffic Plan

After 2000, Eagle Pass' second bridge is expected to be open, and the casino traffic — large or small — may cross the river in Eagle Pass. Based on these considerations, three scenarios were analyzed:

(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 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 too small to have an impact on Del Rio's infrastructure, its Mexican component will

cross the river at Eagle Pass, and/or Del Rio will not develop in the area between the Rio Grande and US277.

(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 and that most of its Mexican component from (or passing through) Ciudad Acuña crosses at Del Rio. This also reflects the assumption that Del Rio will develop in the area between the Rio Grande and US277.

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 Del Rio (1995 to 2020).

Traffic Assignment

A lack of important data (e.g., local origin and destination matrices) resulted in the need to take advantage of qualitative information. This precluded the efficient use of automated traffic assignment programs. A spreadsheet was used to project AADTs, to adjust the impacts of proposed infrastructure, to estimate hourly volumes and intersection delays, and to obtain the LOS. All 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 future traffic to the two study scenarios. The most relevant of these other assumptions are listed below.

(1) Environmental protection of San Felipe Aquifer will be a priority throughout the analysis period, and the recommendations of the latest environmental study will be enforced (Ref. 4.3).

(2) Laughlin Air Base will operate throughout the analysis period.

(3) Ciudad Acuña's industrial area will continue to grow throughout the analysis period; furthermore, the current pattern of maquiladora imports and exports will remain unchanged.

(4) The international truck traffic entering Del Rio goes primarily through US239 (new spur). At most, 20 percent of the trucks go to Industrial Park using Garza Road, and from there they use Cienegas Road, Avenue F, and US90.

(5) International auto traffic will use primarily Spur 239 and Garfield Street. Between 80 and 90 percent of this traffic will go to Avenue F and US90.

(6) Del Rio will develop primarily north and west, especially in the areas near Spring Lake Estates (northwest) and near the "Y" intersection of US277.

(7) Bedell extension will attract development; additional cross streets will be built in that area.

(8) The second international bridge and outer loop will open at the end of the analysis period (2020). The loop will have four lanes and will divert trucks from the new Spur 239.

(9) International trucks will be prohibited from using the existing international bridge once the new one is open.

(10) After the second bridge is open, international auto traffic will be distributed as follows: 50 percent on existing bridge and new Spur 239, 25 percent on existing bridge and Garfield, and 25 percent on new bridge and truck route.

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

(1) The casino demand using Del Rio infrastructure is about 25 percent local (Del Rio) and 75 percent international, either from Ciudad Acuña or passing through/near it to reach the casino.

(2) Nearly 100 percent of the casino demand originating in Ciudad Acuña will cross the river at Del Rio, and from there proceed to the casino[1].

Constraints for Del Rio Infrastructure Expansion

Major routes such as Garfield, Avenue F, and the collector streets in that area have little right-of-way available for expansions. In addition, according to state law, a new at-grade intersection with a rail line can only be built if two others are either grade-separated or closed. The traffic plan thus avoided recommendations requiring new at-grade intersections with the Southern Pacific railroad. The only exception is the outer loop intersection with the railroad (recommended no earlier than 2015).

In Del Rio, the most significant constraint for infrastructure expansion (as well as for real estate development) is the environmentally sensitive San Felipe Aquifer. San Felipe Springs provides between 120,000 and 350,000 cubic meters of water a day and serves the primary water source for Del Rio (Ref. 4.3). Underscoring the importance of this source, the city of Del Rio retained a consultant to draft a development plan for Del Rio that protects the aquifer (Ref. 4.3). Below is a list of the most relevant recommendations (all of which have been taken into account).

(1) Multi-family, retail, and commercial land uses should be restricted to the areas along US90 (no further than 300m from the highway);

(2) The 100-year flood plain should be left in its natural state, and used only for recreation;

(3) No land use capable of producing pollution should be allowed within a 1.5km radius of the San Felipe Creek flood plain;

(4) Thoroughfares should be designed and located in order to discourage through traffic within the environmentally sensitive area;

(5) The area between northbound and eastbound legs of US90 should be predominantly single-family residential;

(6) All proposed developments that might pose a threat to San Felipe Springs should submit an environmental impact study to the city, county, and state;

(7) The number of bridges over San Felipe Creek should be minimized.

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[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.

Cost and Safety Considerations

The recommendations for improved traffic circulation are based on three 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 over a 25-year period. Nevertheless, care was taken to consider the 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 to recommend signalization, 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, constraints, and assumptions discussed above. These results provided the basis for identifying sources of poor traffic circulation and for developing the traffic plan recommendations. These recommendations are presented below, classified according the following categories: additional capacity, new routes that relieve congestion, intersection configurations, signalization and signal synchronization, and international traffic.

ROADWAYS THAT NEED ADDITIONAL CAPACITY

This section presents recommendations regarding additional capacity needs. Changes in regulations (e.g., parking prohibitions) are also discussed in this section, insofar as they result in additional capacity. Likewise, international thoroughfares and new international bridge location are also discussed.

Figures 4.2 through 4.4 summarize the recommendations regarding additional capacity needs for the low- and high-impact scenarios, respectively, for implementation immediately, in 2000, and in 2010. These figures represent recommendations that require new construction (such as additional lanes), as distinguished from those that can or must be handled through a change in city ordinances or regulations. In addition, the figures depict recommendations regarding right-of-way acquisition, and also illustrate the general outline of proposed infrastructure, such as the Bedell extension.

The recommendations include an outer loop around Del Rio, which should be implemented in stages scheduled according to the traffic demand scenario (high or low impact). Figure 4.5

shows the possible locations of this outer loop with respect to present city limits. Specific studies will be necessary to determine the best loop location and to develop its design, taking into consideration the future position of the new international bridge and the need for protecting the San Felipe Aquifer. The studies should start between 2010 and 2015 (earlier if traffic grows faster than the rates used to develop this plan).

Immediate Implementation Recommended

All Scenarios

(1) Garza Road: Smooth lay-out, removing right-angled turns. Provide shoulders on both sides. Secure right-of-way for future expansions. Verify the 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.

(2) Provide standard lane widths for Avenue F. The city should consider an ordinance restricting trucks that serve Avenue F stores to off-peak or night hours.

(3) Relocate the light poles that are too close to the outer lanes of Avenue F, Garfield Street, and US90 (between Avenue F and US277).

(4) Prohibit parking along Main Street in the downtown area.

(5) Extend Main Street up to Margaret Lane.

(6) Secure right-of-way for future expansion of all TxDOT highways: US90, US277, US239, and FM2523 (not in range shown in Figure 4.2).

(7) Secure right-of-way for future expansion of Main Street and Cienegas Road. Verify feasibility of using the sidewalks and the wide median to minimize additional right-of-way required to add a left-turn lane to Main Street.

(8) Secure right-of-way for expanding Bedell Avenue along Dodson and for implementing additional lanes afterwards.

High-Impact Scenario

(1) Secure right-of-way for a future link to US277 (eastbound) and the international bridge, possibly through an extension of Loop Road, up to US277 near the intersection of Broadbent.

Implementation Recommended by 2000

All Scenarios

(1) Widen as much as possible of the existing Bedell Avenue, and extend it along Dodson up to the intersection of Stricklen and US90 (two lanes each way). Secure right-of-way for future expansions.

(2) Convert Main Street to a continuous four-lane road from Gibbs Street to 17th Street. Extend Main Street beyond 17th Street up to Cantu Road at Margaret Lane, and convert it to four lanes. (This will encourage use of Main Street as an alternative for Avenue F.)

(3) Secure right-of-way to expand Stricklen (between US90 and Amistad Boulevard).

(4) Secure right-of-way for expanding Cantu Road.

(5) Secure right-of-way for future expansion of Garza Road.

(6) Secure right-of-way for further extending Dodson/new Bedell to the north, either along or near Chisolm Trail and Quail Road.

(7) Determine optimal location of a new north-south thoroughfare linking the area near US90/US277 intersection with Stricklen (or King's Way) to Garza Road near the international bridge. This thoroughfare will serve Spring Lake Estates, the airport, Cienegas Terrace, and Chaparral Hills (see Figure 4.3).

High-Impact Scenario

(1) Implement Loop Road extension (two lanes, up to US277 near the intersection of Broadbent) to divert casino demand from the downtown area.

(2) Secure right-of-way to expand US277 from international bridge to Loop Road extension.

(3) Loop Road extension is likely to attract development; therefore, secure right-of-way along Loop Road, Pecan, Hudson, and Guyler; right-of-way will also allow further expansion of the Loop Road extension described in recommendation (1) of this scenario.

(4) If Del Rio develops south in the area between the Rio Grande and US277, secure right-of-way along Loop Road, Pecan, Hudson, Guyler, and the Loop road extension described in recommendation (1) of the high-impact scenario.

(5) Add one lane each way to the US239/US277 segment between the Rio Grande and the new Spur 239.

Implementation Recommended Between 2005 and 2010

The following studies should be initiated no later than 2010: (1) environmental impacts and feasibility studies for Del Rio's outer loop and second international bridge; (2) optimal location of new bridge; and (3) optimal location of Del Rio's outer loop. These studies should be developed as a concerted effort between TxDOT and the City of Del Rio. International bridge studies must include input from the city of Acuña and from inspection agencies on both sides of the border.

All Scenarios

(1) Convert Cantu Road to four lanes (two lanes each direction), if possible. If right-of-way is feasible for only one additional lane, implement a continuous left-turn lane. If this study's assumptions regarding Del Rio's northwest growth materialize, demand for Cantu will increase, along with the number of turning movements.

(2) Add two more lanes (one each direction) along Bedell Avenue extension.

(3) Add one lane each direction along Garza Road.

(4) Add a left-turn lane along Main Street.

(5) Add a left-turn lane along new Spur 239 and Gibbs Avenue (assumption to be verified before implementation: new land development along Spur 239 generates a high number of turning movements).

(6) Implement a new north-south thoroughfare linking the area near US90/US277 intersection with Stricklen (or King's Way) to Garza Road near the international bridge.

The thoroughfare will serve Spring Lake Estates, the airport, Cienegas Terrace, and Chaparral Hills. Some possible locations are (see Figure 4.4):
Alternative 1: Extend from Stricklen southwards along Amistad Boulevard.
Alternative 2: Extend up to King's Way, from there southwards along Tomahawk.
Alternative 3: Extend further north and west, using currently undeveloped land.

(7) Secure right-of-way along the entire length of the new north-south thoroughfare for future expansions.

(8) Secure right-of-way to extend the new north-south thoroughfare south, to serve as access to the second international bridge.

(9) Secure right-of-way to extend the new north-south thoroughfare southeast, around the aquifer and towards US277.

(10) Extend Dodson/ new Bedell to the north, up to the future intersection of the new north-south thoroughfare (if optimal thoroughfare location not yet determined, extend up to King's Way).

(11) Widen Las Vacas and Garfield as far as right-of-way permits.

(12) Widen US277 segment between US90 and intersection with new Loop Road extension (one more lane each way).

(13) Implement Loop Road extension (two lanes, up to US277 near Broadbent intersection).

High-Impact Scenario

(1) If casino demand increases significantly: Expand Loop Road extension to four lanes.

If casino demand remains off-peak but the area has developed sufficiently to generate high demand for turning movements: Add left-turn lane instead of implementing recommendation (1) of high-impact scenario, year 2010, section on intersection configurations.

(2) If the area has developed: Widen Guyler Avenue and extend it northwest up to the intersection of US277/SH239 and Ellis.

(3) Widen Pecan as far as right-of-way permits and extend it southeast until it intersects Loop Road extension.

(4) If the area between the Rio Grande and US277 has developed considerably: Initiate study to update traffic circulation plan based on new development patterns.

Implementation Recommended by 2020

All Scenarios

(1) Implement second international bridge. The recommended location at this point is near the Industrial Park, at an extension of Garza Road. (Note: specific studies should verify need to implement earlier and detail the optimal location.)

(2) Implement Del Rio outer loop, using results of studies recommended in the previous section. The new north-south thoroughfare should become part of this loop. Possible loop locations are depicted in Figure 4.5.

(3) Widen US277 from the railroad overpass to the junction of SH317.

High-Impact Scenario

(1) Extend Avenue E up to Amistad Boulevard.

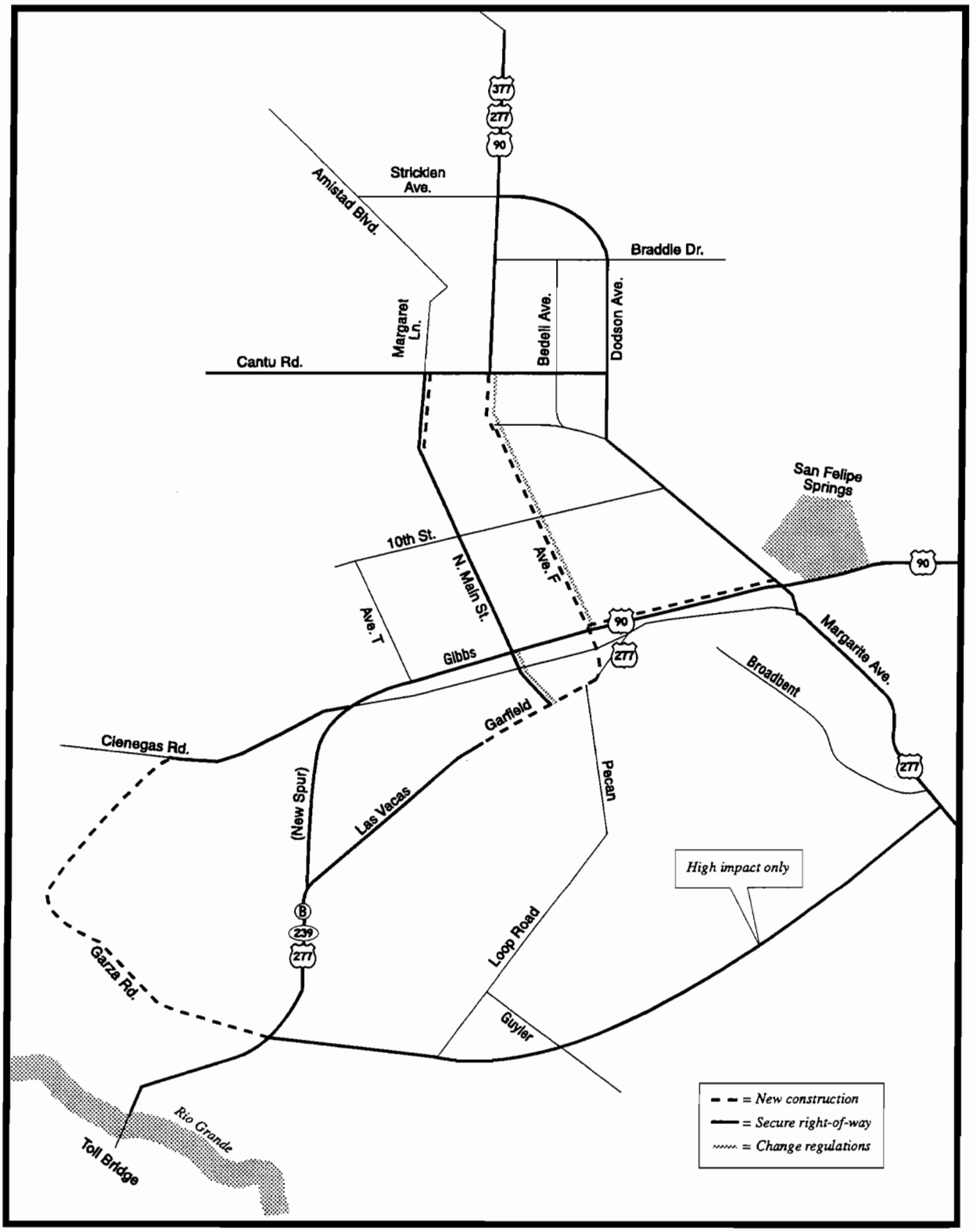

Figure 4.2 Roadways That Need Additional Capacity: Immediate Implementation Recommended

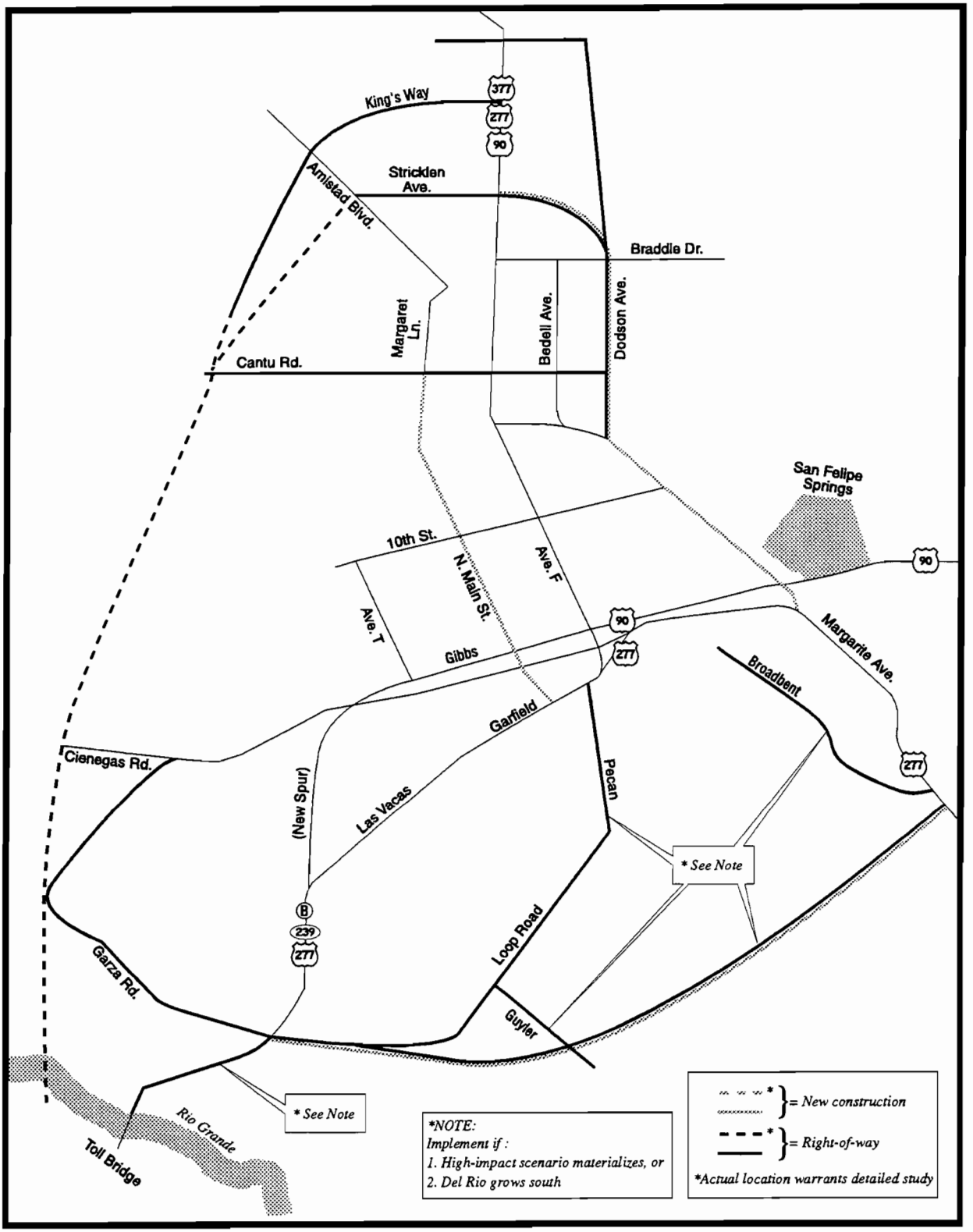

Figure 4.3 Roadways That Need Additional Capacity: Implementation by 2000

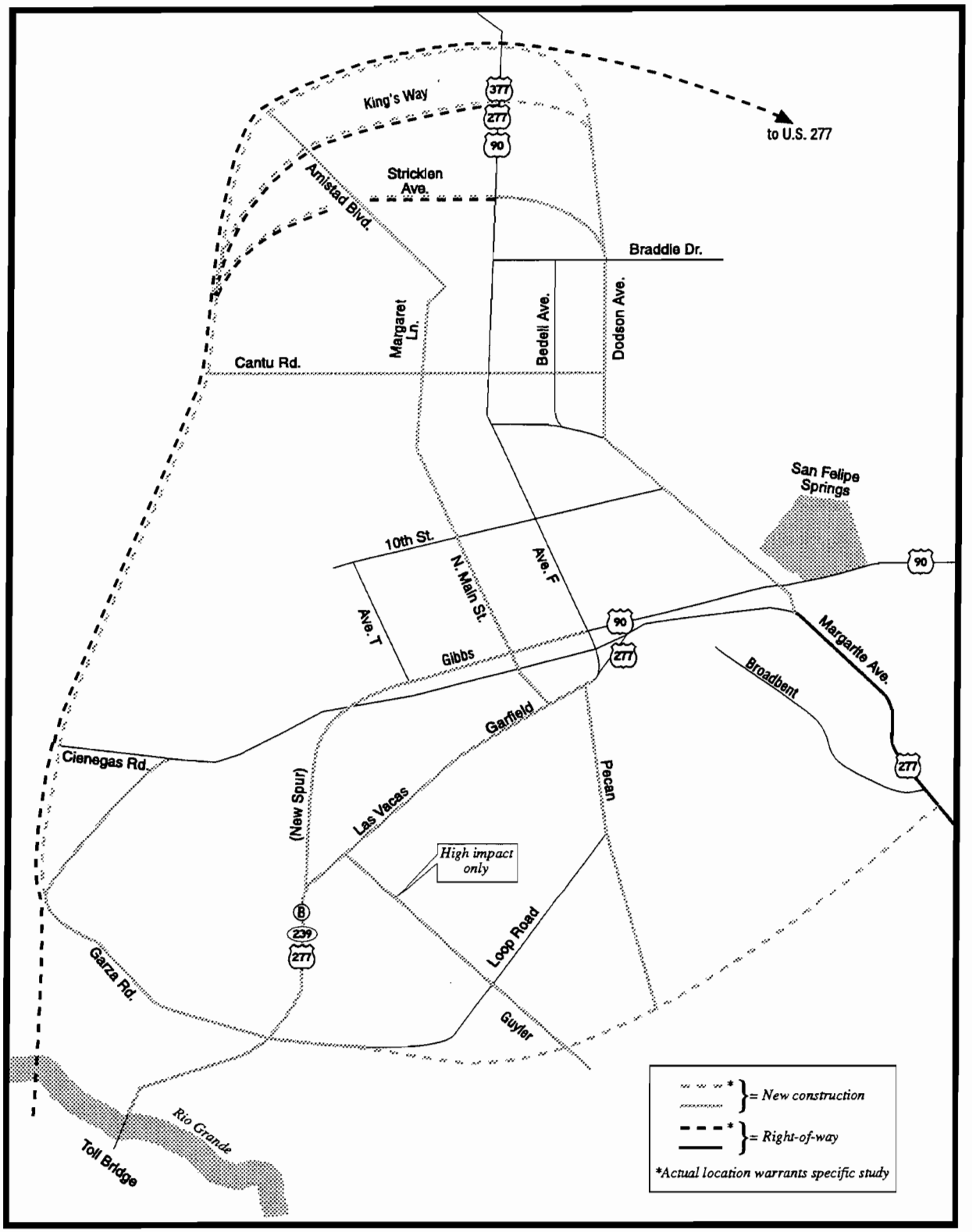

Figure 4.4 Roadways That Need Additional Capacity: Implementation Between 2005 and 2010

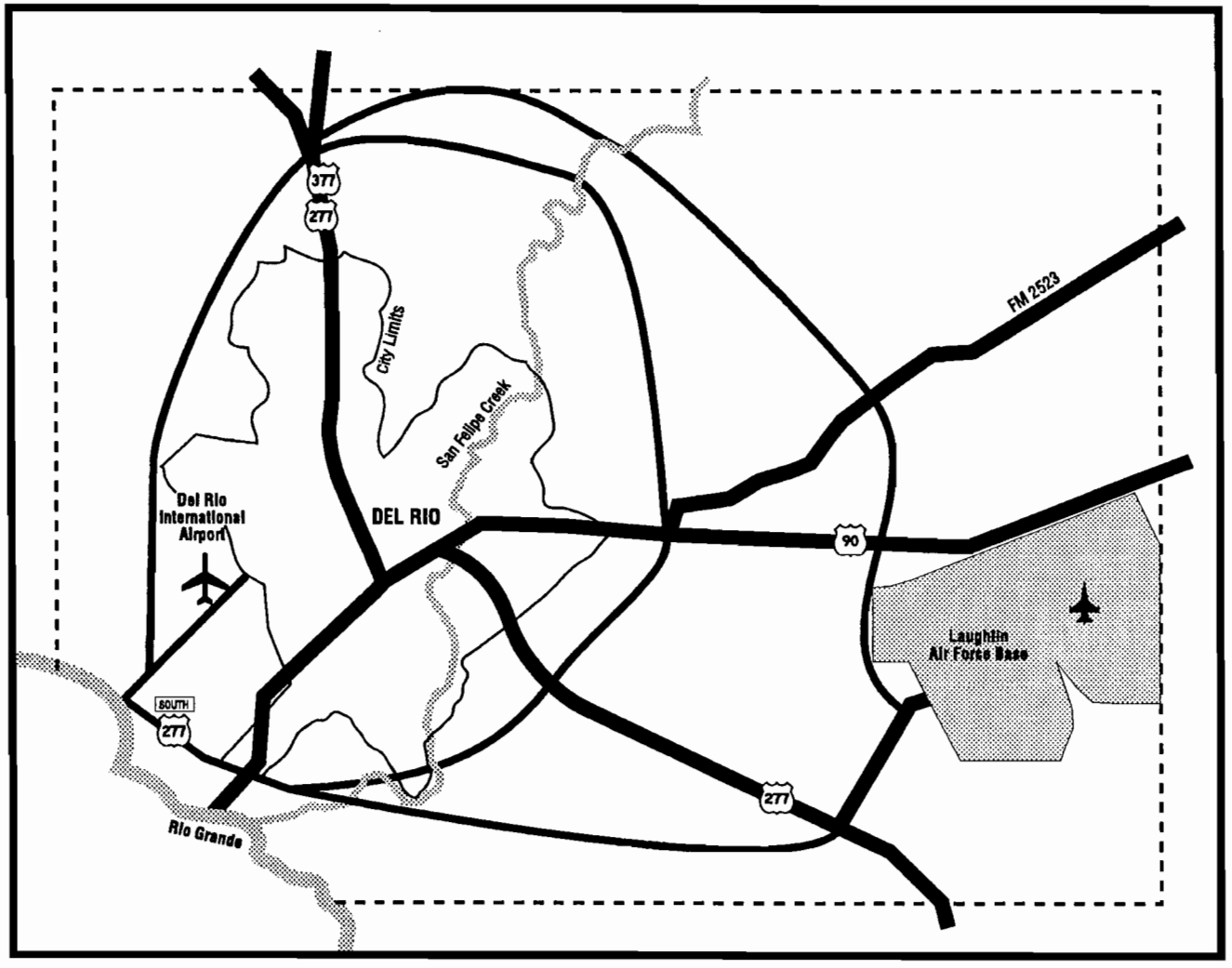

Figure 4.5 Del Rio Outer Loop (Implementation Between 2015 and 2020)

(2) Widen Amistad Boulevard (preferably one more lane each way).

(3) Develop traffic circulation plan for the area between Bedell and Avenue F. This plan must take into account future developments; at this point, the following alternative seems indicated to relieve congestion on Bedell: Extend Avenue K, making it continuous from Garfield to 14th Street; make Avenues J and K one-way pair; encourage traffic to use this pair as alternative to Bedell.

NEW ROUTES THAT RELIEVE CONGESTION

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

Immediate Implementation Recommended for All Scenarios

(1) Prohibit through trucks on Las Vacas, Garfield, Pecan, Loop Road, and Main Street. Divert them to the new Spur 239 and Gibbs.

(2) Prohibit delivery trucks during peak-hours on Avenue F.

(3) Implement and enforce truck routes shown in Figure 4.6.

Implementation Recommended by 2000

All Scenarios

(1) Prohibit through trucks on Cantu Road, Stricklen, Margaret Lane and Amistad Boulevard, and divert them to the new Bedell extension.

(2) If truck traffic increases faster than assumed in this study, prohibit through trucks on Avenue F and divert then to the new Bedell extension.

High-Impact Scenario

(1) Direct international trucks bound to US277 South to Loop Road extension.

Implementation Recommended Between 2005 and 2010

(1) Make the north-south thoroughfare an additional truck route, and direct through trucks to this new route.

Implementation Recommended Between 2015 and 2020

(1) Direct through trucks to the outer loop. Consider prohibiting through trucks in congested thoroughfares if the outer loop can serve as an alternative.

INADEQUATE INTERSECTION CONFIGURATIONS

This section outlines 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 4.7 summarizes all recommendations regarding intersections.

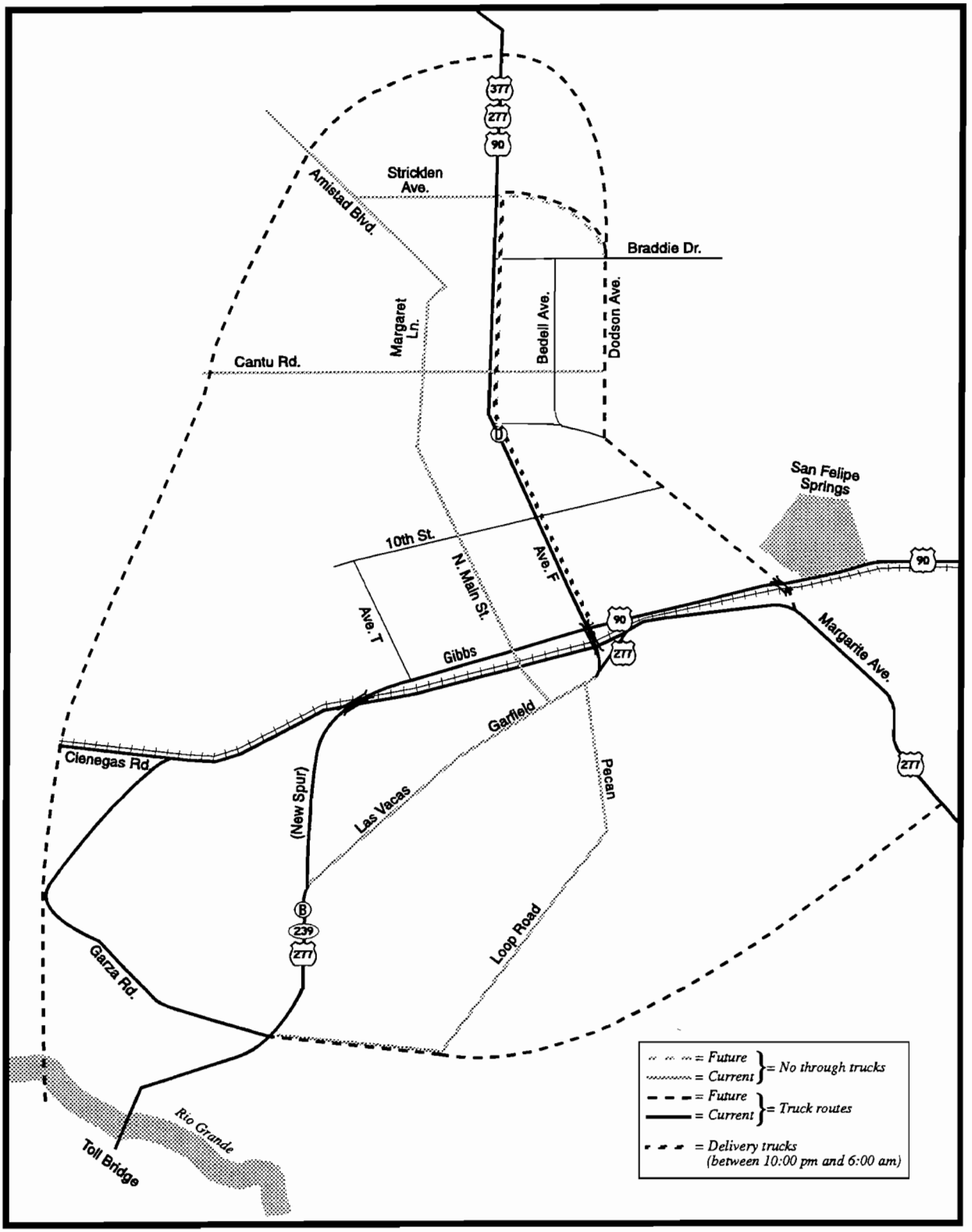

Figure 4.6 Recommended Truck Routes

Immediate Implementation Recommended for All Scenarios

(1) The intersections of Garza Road and Johnson Boulevard with Cienegas Road should be reconstructed as one single intersection.

(2) Intersection of Avenue F and US90: Relocate electric poles away from lane edge; increase available radius for turning movements; flare the intersection approaches about 60m.

(3) Provide lane markings on the intersections of Avenue F and its cross streets.

(4) Smooth as much as possible the obtuse angle of Garfield intersections with Losoya, Greenwood, and Pecan.

Implementation Recommended by 2000

All Scenarios

(1) Implement left-turn bays at the following intersections of Bedell Avenue/Dodson and its extension: US90/ Stricklen, Braddie Drive, Cantu Road, Dodson, and old Bedell

(2) Implement right- and left-turn bays at the intersection of old Bedell and Dodson.

(3) Implement left-turn bays at the following intersections of Avenue F: Gibbs Street, 10th, and old Bedell.

(4) Implement left-turn bays at the intersections of Main Street and Gibbs Street.

(5) Remove right angle at Margaret Lane and Amistad Boulevard intersection.

High-Impact Scenario

(1) Implement left-turn bays at the following intersections: old Loop Road and its extension; old Loop Road and US239/US277 (access to international bridge); Loop Road extension and US277.

Implementation Recommended by 2010

All Scenarios

(1) The following intersections of the new north-south thoroughfare should have left turn bays:

Cienegas Road

Garza Road

Cantu Road

Amistad Boulevard

US90/US277

More intersections may also need left-turn bays, depending on actual development along and near this new thoroughfare.

(2) Implement left-turn bays at the following intersections of Cantu Road: Margaret Lane and Avenue F.

High-Impact Scenario

(1) Implement left-turn bays at the following intersections of Loop Road extension: Pecan and Guyler. Verify the need to upgrade intersections with new streets that may develop in the area. See recommendation (1) of high impact scenario, section on added capacity.

Implementation Recommended by 2020 for All Scenarios

(1) Provide an overpass for the Southern Pacific rail track where it intersects the new north-south thoroughfare. Conduct specific study to verify the cost-effectiveness of providing a common overpass for Cienegas Road at this intersection.

(2) Grade-separate the intersection of north-south thoroughfare and US90/US277

SIGNALIZATION AND/OR SIGNAL SYNCHRONIZATION

The following recommendations pertain to intersections that warrant signalization and to 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. 4.11):

(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 ("Traffic Data"), 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. While pedestrian data were not available, in some cases field observations indicated the need to take pedestrian movement into consideration. Figure 4.7 summarizes the recommendations regarding intersections.

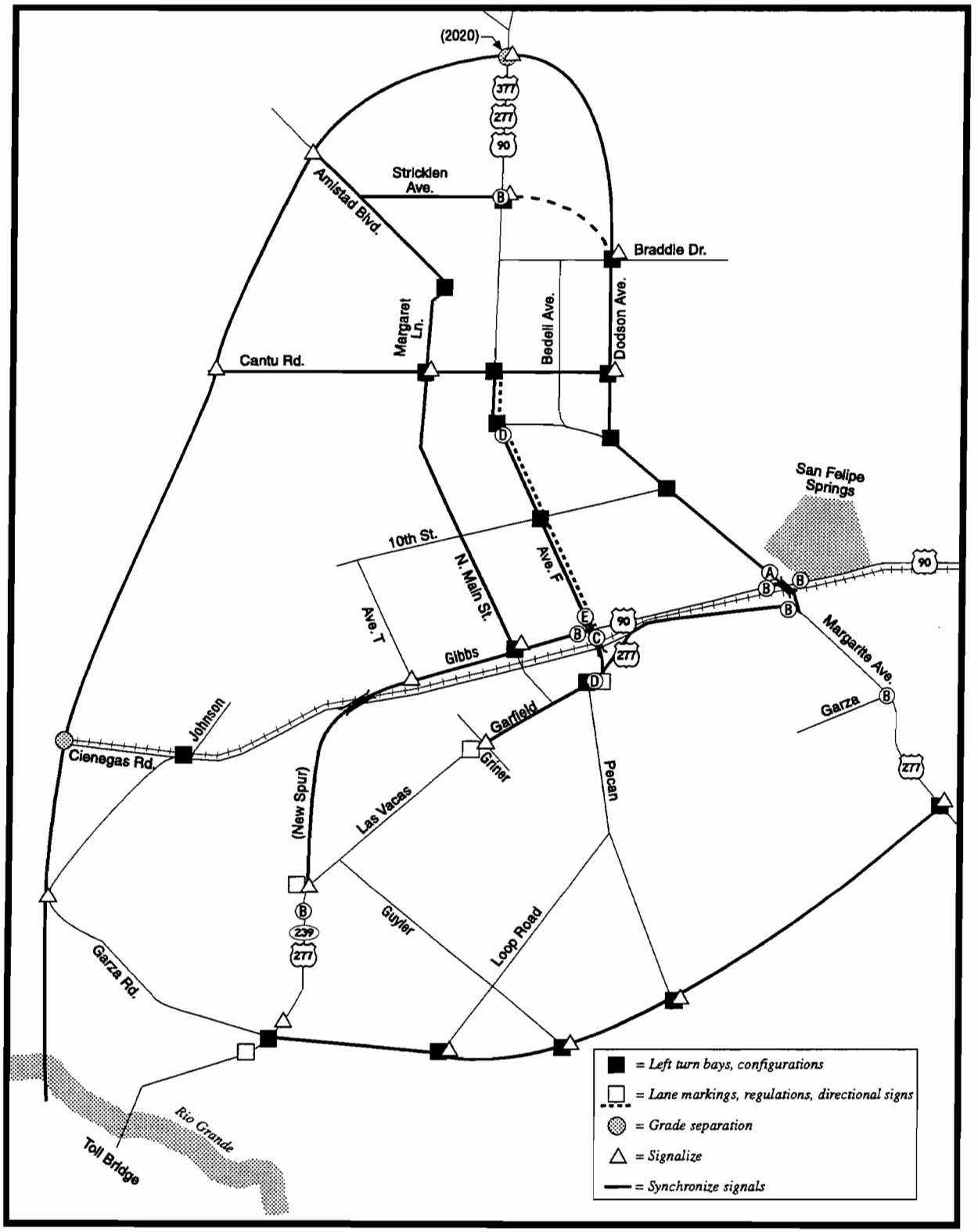

Figure 4.7 Intersection Configurations and Signalization

Immediate Implementation Recommended for All Scenarios

(1) Signalize intersection of Main Street and New Spur 239.

(2) Signalize intersection of New Spur and Las Vacas.

(3) Signalize intersection of Griner and Garfield.

(4) Synchronize signals along Avenue F and Garfield Street in downtown area .

(5) Synchronize signals along US277 (from Avenue F to Bowie).

High-Impact Scenario

(1) Provide bilingual directional signs indicating the casino route, especially along Las Vacas, Garfield, and at the intersection of Garfield Street and US277.

Implementation Recommended by 2000

All Scenarios

(1) Signalize intersection of Avenue T and New Spur 239.

(2) Signalize intersection of Main Street and Cantu Road.

(3) Signalize intersection of Bedell extension and Cantu Road.

(4) Signalize intersection of Bedell extension and Braddie Drive.

(5) Signalize intersection of Bedell extension and US90/US277 (at Stricklen) with actuation.

(6) Synchronize signals along old Bedell, Bedell Extension, and Stricklen.

(7) Synchronize signals along Cantu Road.

(8) Synchronize signals along New Spur 239 and Gibbs.

(9) Synchronize signals along Garfield and Las Vacas, providing at least 60 percent of green time for this route.

High-Impact Scenario

(1) Signalize the following intersections of Loop Road (including its extension): US277 (actuated), Old Loop Road, and Guyler.

Implementation Recommended by 2010

All Scenarios

(1) Signalize intersection of Garza Road and US239 (access to existing bridge).

(2) Signalize intersection of Main Street extension and Cantu Road.

(3) Signalize intersection of Bedell extension and 15th Street.

(4) Signalize intersection of Bedell extension and 17th Street.

(5) Signalize intersection of US90/US277/US377 and the new north-south thoroughfare (actuated).

(6) Implement a properly designed multi-phase signal at the intersection of Bedell extension and Braddie Drive when the new extension to link to the north-south thoroughfare is open to traffic.

(7) Synchronize signals along the north-south thoroughfare.

(8) Synchronize signals along Main Street.

(9) Synchronize signals along Amistad Boulevard.

(10) Either actuate signals along Avenue F, or synchronize for at least 60 percent green time on Avenue F.

(11) Update this traffic circulation plan to include new developments.

High-Impact Scenario

(1) Signalize intersection of Pecan extension and Loop Road extension.

(2) Verify the need to signalize intersections of future streets that may be built if the area between the Rio Grande and US277 develops.

(3) Synchronize signals along Loop Road extension.

Implementation Recommended by 2020 (All Scenarios)

(1) Signalize intersection of outer loop and US277, as well as new streets in the area.

(2) Update this traffic circulation plan to include new developments.

LEVELS OF SERVICE

The impacts of the proposed infrastructure were evaluated based on LOS improvements within the study network. Intersection and arterial levels of service were calculated separately to identify the source of traffic circulation problems (e.g., bad intersection configuration, poor lane capacity, or other). This section presents the predicted LOS and discusses the potential for improvements resulting from implementation of the traffic circulation plan. This discussion is based on comparisons between LOS in the reference scenario (no infrastructure improvements) and 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 (infrastructure existing in 1995), and the second showing the low-impact scenario (which includes the new Spur 239 and the recommendations of this traffic circulation plan). The bottom rows of these tables show the proposed infrastructure. Existing intersections are numbered 1 through 12, and are shown in Figure 3.4 (Chapter 3). Proposed intersections are listed at the bottom of Table 4.1 and shown in Figures 4.8 through 4.10. These figures summarize the intersection and arterial LOS, respectively, for years 2000, 2010, and 2020.

Table 4.1 Low-Impact Scenario—Intersection LOS

Int. No.	Arterial Segment	Reference Scenario				Low-Impact Scenario			
		1995	2000	2010	2020	1995	2000	2010	2020
1	US 239 (NB), Int. bridge to Spur	B	B	D	E	B	B	A	A
2	Garfield St. (WB), Spur to Ave. F	B	D	D	F	B	B	B	B
3	Garfield St., Ave. F to US 277	B	B	B	C	B	A	A	A
4	US 90, Ave. F to US 277	B	B	B	C	B	B	B	B
5	Ave. F (NB), Gibbs St. to 17th St.	C	D	F	F	C	B	B	B
6	Ave. F (SB), 17th St. to Gibbs St.	D	E	F	F	D	B	B	B
7	Ave. F, US 90 to Garfield	C	C	C	D	C	C	B	B
8	US 90, 17th St. to Stricklen	B	B	B	E	B	B	B	B
9	US 90, US 277 to Hwy. 2523	B	B	B	F	B	B	B	B
10	US 277, US 90 to Bowie	B	B	C	C	B	B	C	C
11	Gibbs Street	B	B	C	C	B	B	C	C
12	Bedell Avenue	A	A	B	F	A	A	A	B
13	Main Street	A	B	C	E	A	A	B	B
14	New Spur 239[2]						A	A	A
15	Bedell Extension[2]						B	A	B
16	North-South thoroughfare[2]							A	B
17	Loop Road extension[2]							A	A
18	Outer Loop[2]								B

[1]See figure 3.4 (chapter 3) for intersections 1 through 12.

[2]Proposed or new facilities. Proposed/new intersections are:

13: Main Street and Gibbs
14: New Spur and Avenue T
15: Bedell extension and Braddie Drive
16: North-south thoroughfare and US90/US277
17: Loop Road extension and US277
18: Outer Loop and US90

Table 4.2 Low-Impact Scenario—Arterial LOS

Int. No[1]	Arterial Segment	Reference Scenario				Low-Impact Scenario			
		1995	2000	2010	2020	1995	2000	2010	2020
1	US 239 (NB), Int. bridge to Spur	A	A	B	C	A	A	A	A
2	Garfield St. (WB), Spur to Ave. F	B	C	F	F	B	B	B	B
3	Garfield St., Ave. F to US 277	A	A	B	C	A	A	A	A
4	US 90, Ave. F to US 277	A	A	B	C	A	A	A	A
5	Ave. F (NB), Gibbs St. to 17th St.	C	C	C	E	C	B	B	B
6	Ave. F (SB), 17th St. to Gibbs St.	C	D	D	F	C	C	B	B
7	Ave. F, US 90 to Garfield	C	C	C	D	C	C	B	B
8	US 90, 17th St. to Stricklen	A	A	B	E	A	A	B	A
9	US 90, US 277 to Hwy. 2523	A	A	A	C	A	A	A	A
10	US 277, US 90 to Bowie	B	B	D	F	B	B	C	B
11	Gibbs Street	B	B	D	F	B	B	B	C
12	Bedell Avenue	B	C	E	F	B	B	B	B
13	Main Street	B	C	E	F	B	B	B	B
14	New Spur 239[2]						A	A	A
15	Bedell Extension[2]						A	A	A
16	North-South thoroughfare[2]							A	A
17	Loop Road extension[2]							A	A
18	Outer Loop[2]								A

[1]See Figure 3.4 (Chapter 3) for intersections 1 through 12.
[2]Proposed or new facilities. See bottom of Table 4.1 for intersections 13 through 18.

High-Impact Scenario

Tables 4.3 and 4.4 show the intersection and arterial levels of service, respectively, obtained for the high-impact scenario. Figures 4.11 through 4.13 summarize these LOS. This scenario corresponds to the assumption that the casino on the Kickapoo Indian Reservation near Eagle Pass will be successful, attracting high traffic volumes and expanding in the future. Moreover, it also reflects the possibility of Del Rio growth in the area between the Rio Grande and US277.

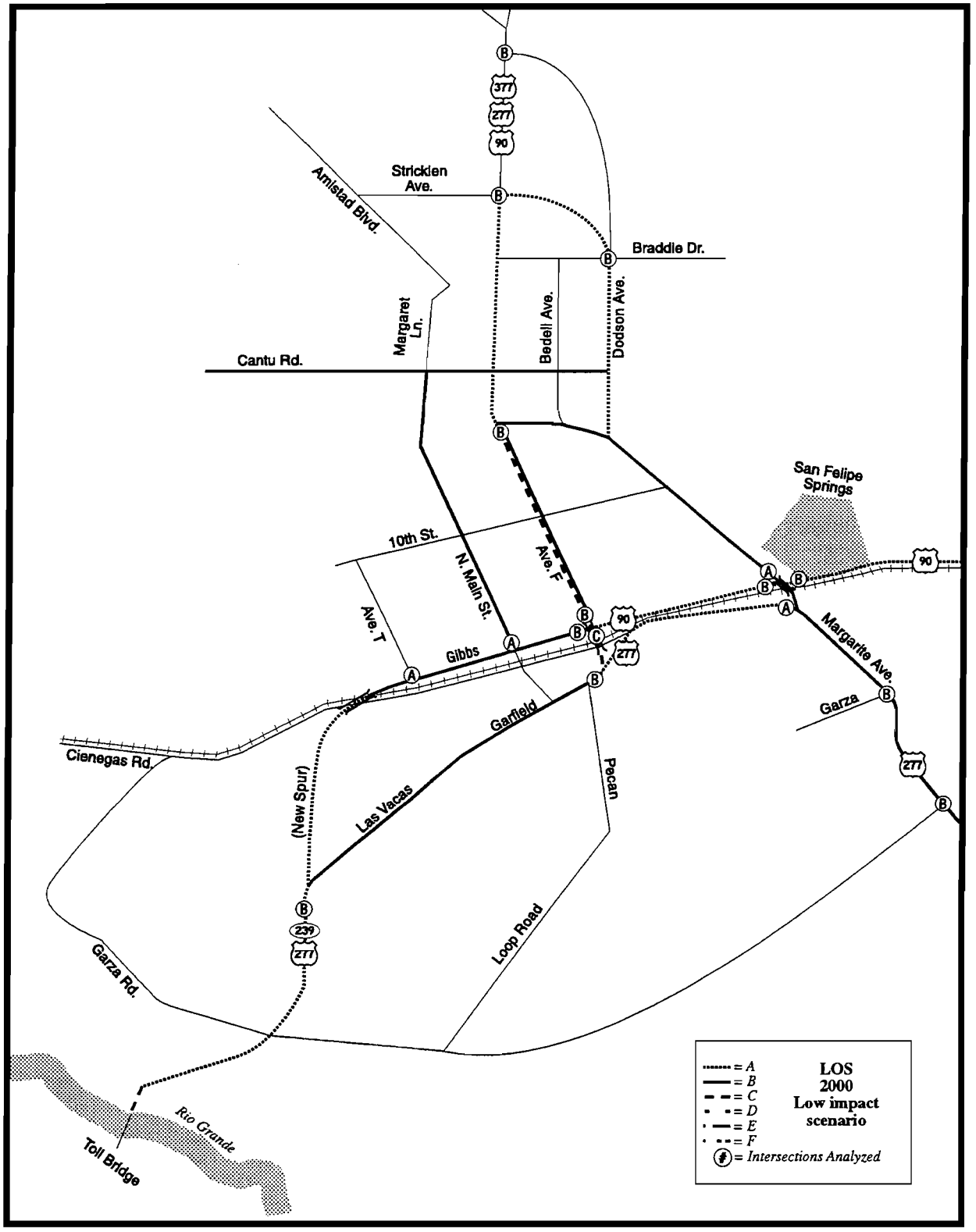

Figure 4.8 2000 Levels of Service — Low Impact Scenario

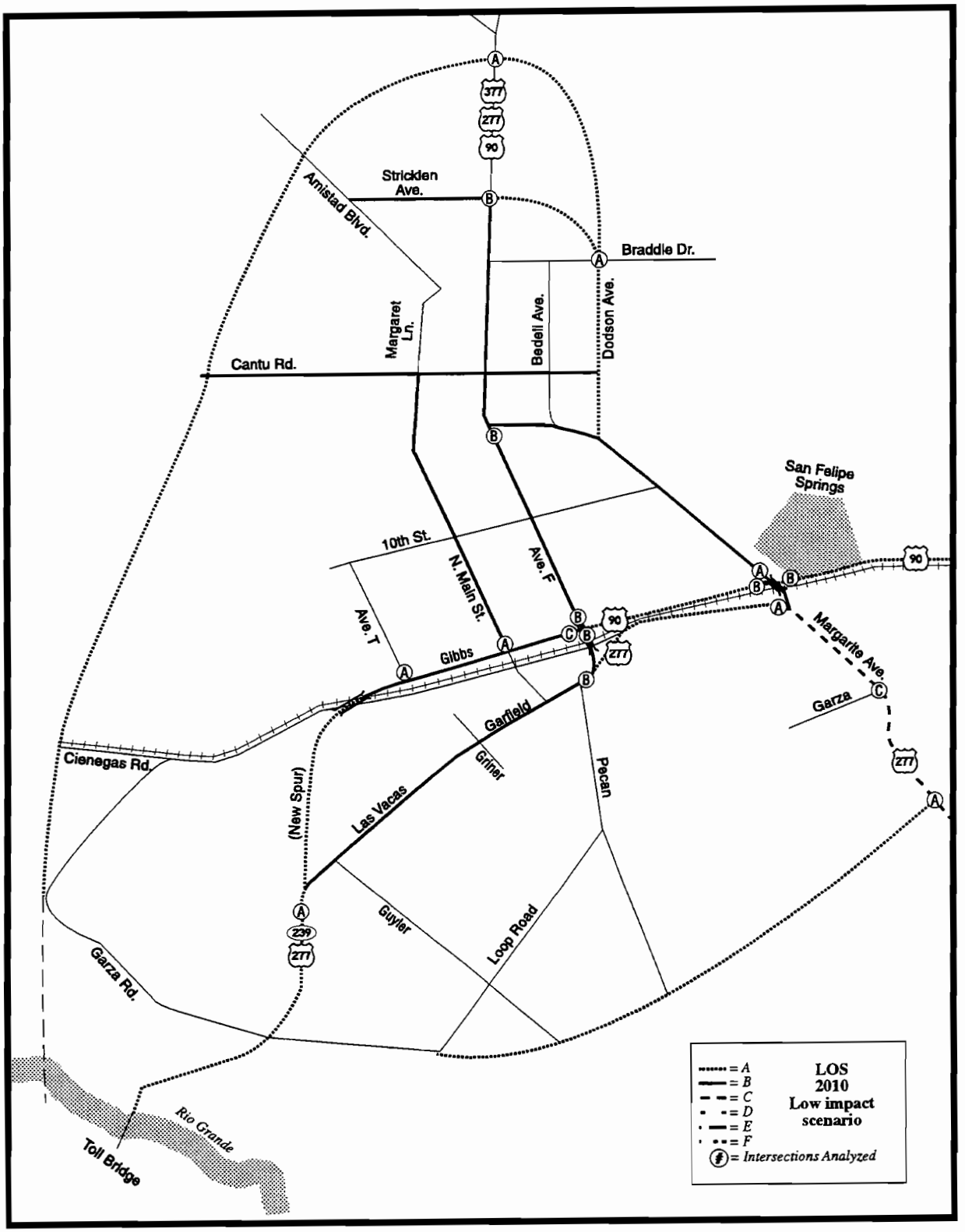

Figure 4.9 2010 Levels of Service — Low Impact Scenario

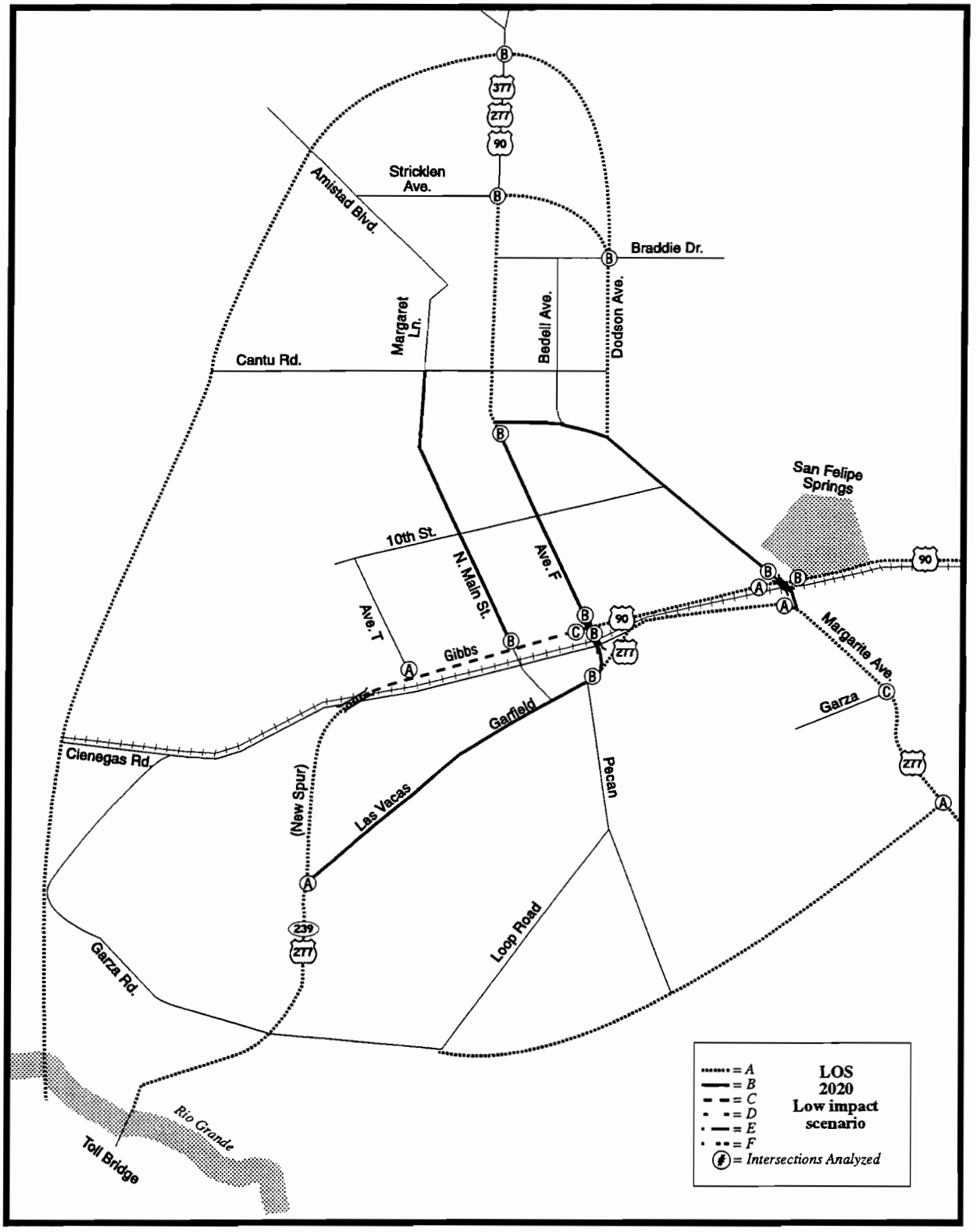

Figure 4.10 2020 Levels of Service — Low Impact Scenario

Table 4.3 High-Impact Scenario—Intersection LOS

Int. No.	Arterial Segment	Reference Scenario				High-Impact Scenario			
		1995	2000	2010	2020	1995	2000	2010	2020
1	US 239 (NB), Int. bridge to Spur	B	B	D	E	B	B	B	B
2	Garfield St. (WB), Spur to Ave. F	B	D	D	F	B	B	B	C
3	Garfield St., Ave. F to US 277	B	B	B	C	B	A	A	B
4	US 90, Ave. F to US 277	B	B	B	C	B	B	B	C
5	Ave. F (NB), Gibbs St. to 17th St.	C	D	F	F	C	B	B	B
6	Ave. F (SB), 17th St. to Gibbs St.	D	E	F	F	D	C	B	B
7	Ave. F, US 90 to Garfield	C	C	C	D	C	B	B	B
8	US 90, 17th St. to Stricklen	B	B	B	E	B	B	B	C
9	US 90, US 277 to Hwy. 2523	B	B	B	F	B	B	C	C
10	US 277, US 90 to Bowie	B	B	C	C	B	B	C	C
11	Gibbs Street	B	B	C	C	B	A	B	C
12	Bedell Avenue	A	A	B	F	A	A	B	B
13	Main Street	A	B	C	E	A	A	B	B
14	New Spur 239[2]						A	A	A
15	Bedell Extension[2]						B	B	B
16	North-South thoroughfare[2]							A	B
17	Loop Road extension[2]						A	A	B
18	Outer Loop[2]								B

[1]See Figure 3.4 (Chapter 3) for intersections 1 through 12.

[2]Proposed or new facilities. See bottom of Table 4.1 for intersections 13 through 18.

Table 4.4 High-Impact Scenario—Arterial LOS

Int. No[1]	Arterial Segment	Reference Scenario				High-Impact Scenario			
		1995	2000	2010	2020	1995	2000	2010	2020
1	US 239 (NB), Int. bridge to Spur	A	A	B	C	A	A	C	A
2	Garfield St. (WB), Spur to Ave. F	B	C	F	F	B	B	B	B
3	Garfield St., Ave. F to US 277	A	A	B	C	A	A	A	B
4	US 90, Ave. F to US 277	A	A	B	C	A	B	B	B
5	Ave. F (NB), Gibbs St. to 17th St.	C	C	C	E	C	B	B	B
6	Ave. F (SB), 17th St. to Gibbs St.	C	D	D	F	C	C	B	B
7	Ave. F, US 90 to Garfield	C	C	C	D	C	C	B	B
8	US 90, 17th St. to Stricklen	A	A	B	E	A	A	B	A
9	US 90, US 277 to Hwy. 2523	A	A	A	C	A	A	B	B
10	US 277, US 90 to Bowie	B	B	D	F	B	B	C	A
11	Gibbs Street	B	B	D	F	B	B	B	C
12	Bedell Avenue	B	C	E	F	B	B	B	C
13	Main Street	B	C	E	F	B	B	B	C
14	New Spur 239[2]						A	B	B
15	Bedell Extension[2]						A	B	B
16	North-South thoroughfare[2]							A	B
17	Loop Road extension[2]						A	B	A
18	Outer Loop[2]								A

[1]See Figure 3.4 (Chapter 3) for intersections 1 through 12.
[2]Proposed or new facilities. See bottom of Table 4.1 for intersections 13 through 18.

Conclusion

Currently, Del Rio's traffic circulation quality is average-to-good, with most important intersections and thoroughfares performing at either an A or B LOS. The exception is Avenue F, an important commercial artery that is subject to such hindrances as too many turning movements, exits and entrances to facilities, and delivery trucks, which cause a LOS C. This situation will not last long, however, without additional infrastructure, as shown in the reference scenario. By year 2000, Avenue F LOS would be between D and E, and Garfield Street, a major collector for international traffic and a major downtown route, would be at LOS F. Implementation of New Spur 239 and the proposed Bedell extension, in conjunction with other recommendations outlined in this chapter, will improve the LOS, as shown in Tables 4.1 and 4.2.

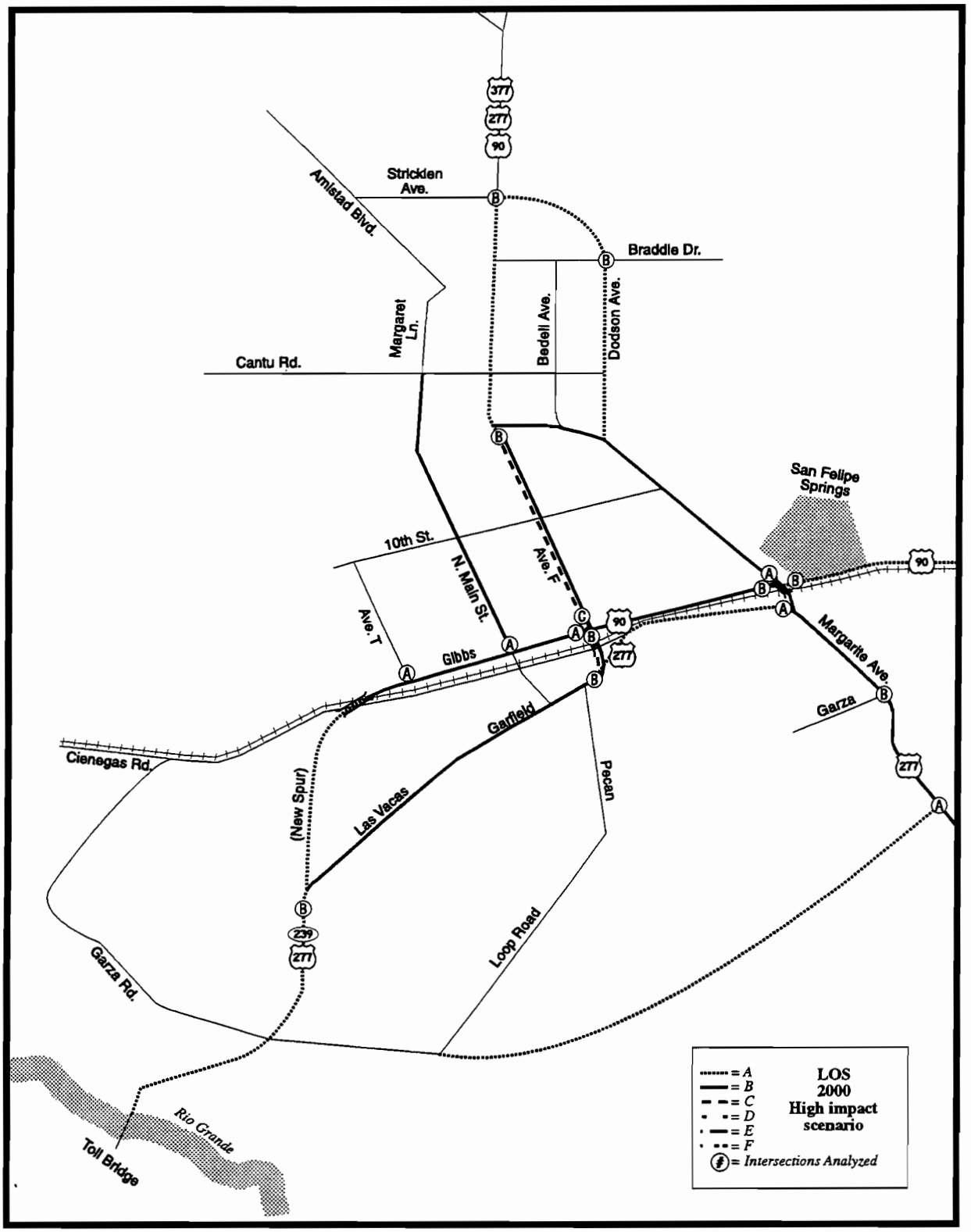

Figure 4.11 2000 Levels of Service — High Impact Scenario

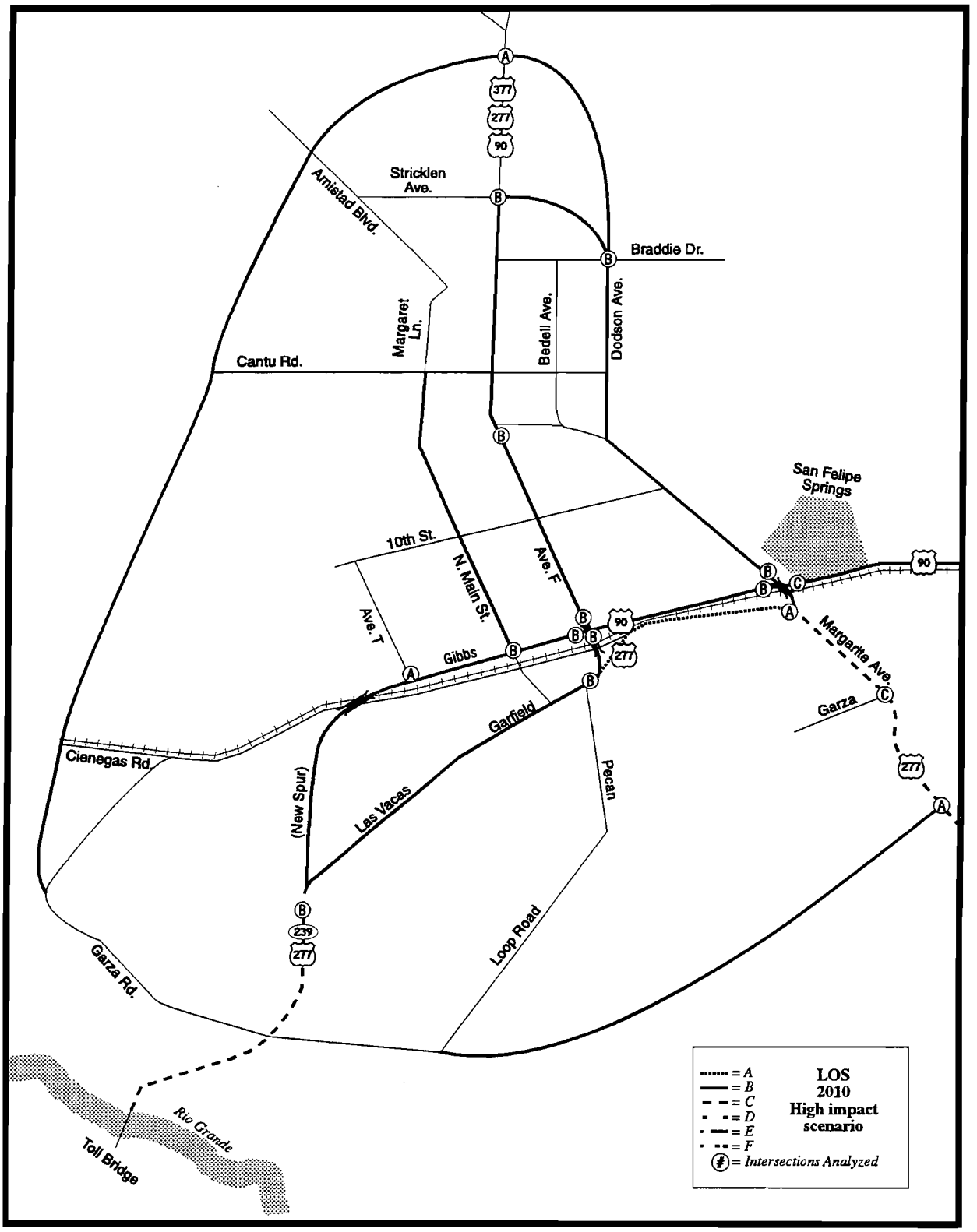

Figure 4.12 2010 Levels of Service — High Impact Scenario

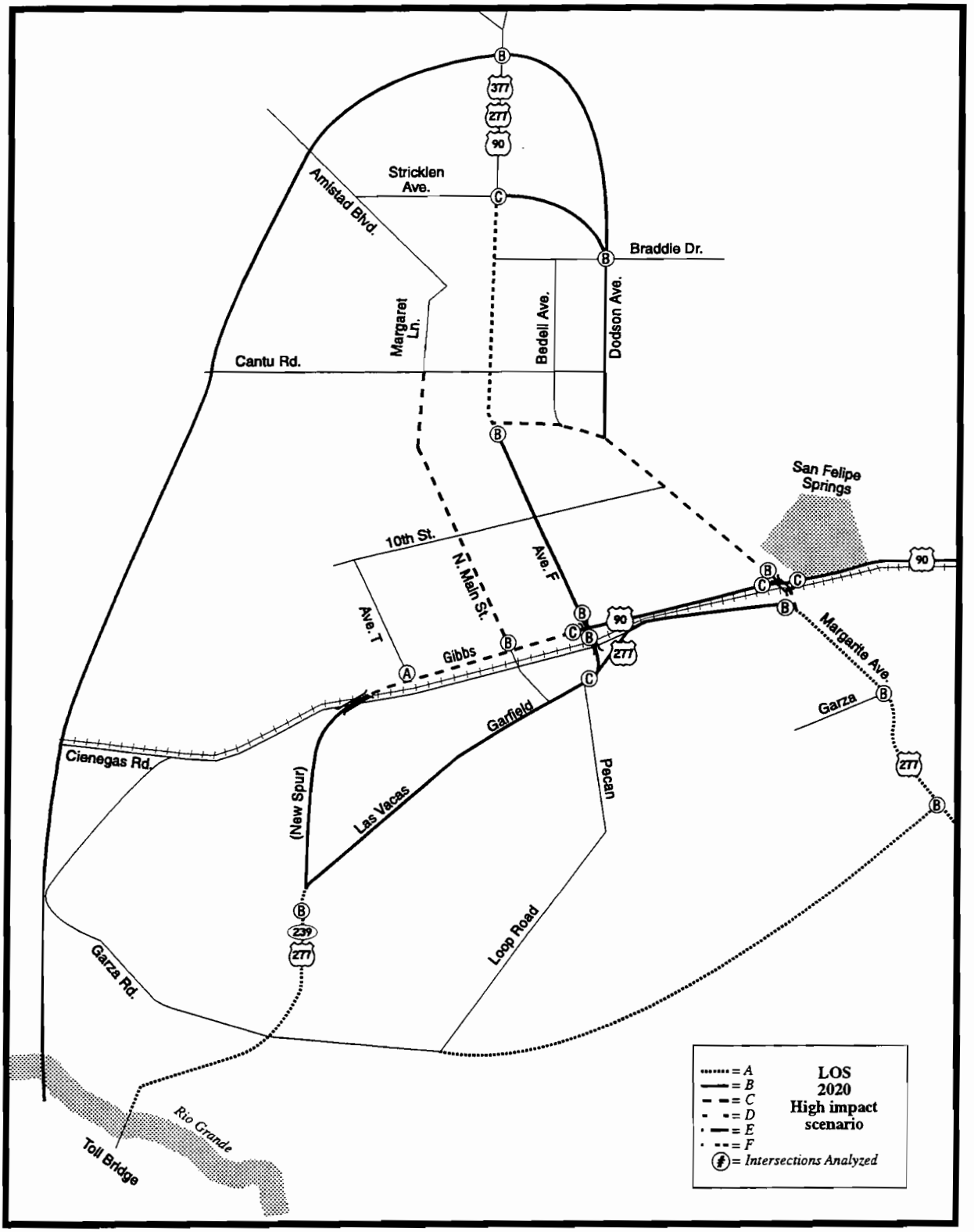

Figure 4.13 2020 Levels of Service — High Impact Scenario

The year 2010 will be more critical. In the reference scenario, only US90 and US239 near the international bridge will be at LOS A or B. The rest of the study network would have considerable congestion. By 2020, the best LOS observed in the reference scenario is C, and most important arterials and intersections would be at either D, E, or F. For Avenue F, Gibbs, and Main Street, the traffic would sustain an F LOS throughout the day, rather than just during the peak hours. The proposed traffic circulation plan has the potential to improve this outlook, keeping the LOS at either A or B everywhere except on Gibbs.

DISCUSSION

Many of the economic predictions based on Mexico joining GATT (1986) and on NAFTA (1993) have proved wrong. And, most recently, the peso devaluation (late 1994) has further invalidated all economic forecasts developed before 1994 for the border. All these uncertainties make traffic forecasts for the border area rather less reliable than those elsewhere, especially for the long-term. The traffic circulation plan presented in this report reflects these uncertainties. Moreover, it relies heavily on assumptions regarding future city development, air force base permanence and expansions, traffic demand, international and local traffic behavior, and continued agreement between Del Rio and Ciudad Acuña regarding the location of a second bridge. These assumptions may or may not materialize, and the recommendations for 2010 and beyond should be verified before implementation. These recommendations — as well as the issues that may affect their implementation — are discussed below.

Outer Loop Location and Environmental Considerations

The need for protecting San Felipe Aquifer has resulted in heterogeneous land development. Developments are located primarily south of US90 East and west of Bedell Avenue. The area east of Bedell and north of US90 is protected and has about 3 percent of its area used as right-of-way (typical urban developments have at least 20 percent of the land used as right-of-way). An environmentally friendly thoroughfare linking the east/west leg of US90 to US90/US277/US377 (north-south leg) would be located too far north to represent an effective route. An estimate of traffic demand for the year 2000 for an environmentally sensitive new thoroughfare resulted in auto ADT of less than 400, and truck ADT less than 1500 car equivalents. A thoroughfare could potentially contaminate the aquifer — during construction, during operations, and especially as a result of new development in the area that would doubtless be attracted by a new thoroughfare. A compromise solution is to use the newly extended Bedell to the fullest extent possible; traffic should also be monitored, and alternatives should be identified for circulating traffic within the busy areas of Del Rio currently served by Avenue F and Main Street.

International Traffic Issues and New Vehicular Bridge

A considerable portion of Texas-Mexico truck traffic still reflects pre-NAFTA regulations prohibiting foreign trucks beyond the commercial zone of both the U.S. and Mexico. Nevertheless, there is anecdotal evidence regarding an increasing tendency to take advantage of the more efficient new rules. If this tendency continues, the harmonization of truck weight limits throughout NAFTA territory will become more urgent than it already is. Before implementing new

infrastructure that serves international traffic, we recommend that the status of NAFTA truck size and weight harmonization be verified, and that an appropriate radius for Mexican and Canadian 18-wheelers be provided (or at least additional right-of-way secured for future upgrades).

Back-ups resulting from inspection procedures are a major cause of international traffic congestion at Texas international bridges, their access, and their egress. 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 this is expected to cause additional traffic problems for border cities in Texas (Refs. 4.2, 4.8, 4.8). Moreover, NAFTA is expected to increase and complicate, rather than decrease and simplify, the number of customs inspections, as a result of its requirement to verify the origin of product components for taxation purposes (Refs. 4.2, 4.8, 4.9 and interviews with Customs officials). If these new procedures cause congestion in Del Rio, a new international bridge would be indicated only if it is adequately staffed. The potential effects of additional staffing on the existing infrastructure should be evaluated before implementing a new bridge. If this evaluation indicates that additional staffing would not postpone the need for a new bridge, it is strongly recommended that this new bridge be planned in concert with inspection agencies on both sides of the border, to ensure full utilization of the physical facilities by providing full staffing.

International Rail Bridge

Both Del Rio and Ciudad Acuña have railroads terminating at the border, but no international rail bridge. Southern Pacific is not interested in a rail bridge, and Union Pacific is satisfied with its bridge in Eagle Pass. Mexican officials, however, continue to express interest in a rail bridge in Del Rio (Ref. 4.10). However, the feasibility of diverting part of Del Rio's international truck traffic to rail is uncertain and can only be determined through a specific study. While TxDOT Study 2932 investigated the most recent Mexican and U.S. data on commodity origin and destination (Refs. 4.5, 4.6, 4.7), further studies are needed to determine the potential for diverting Del Rio's freight demand to rail. A considerable portion of truck traffic is maquiladora oriented, but data on destinations of maquiladora exports and origin of maquiladora imports are conflicting and not very recent in some cases. It is also important to note that an international rail bridge capable of successfully attracting most of the freight traffic may postpone the need for a second vehicular bridge at least until 2025. Furthermore, if transit becomes a more viable option in the future, this rail bridge and line may also be used for passengers, decreasing international auto traffic and further postponing the need for a second vehicular bridge.

Downtown Traffic Congestion

The downtown congestion mitigation measures recommended by a consultant retained by the City of Del Rio (Ref. 4.4) are sound and should be implemented. However, it is important to note that any measures meant to improve downtown traffic circulation will necessarily be temporary, given that traffic demand grows continuously and that the infrastructure cannot be expanded within that area. As elsewhere in the state and country, the only permanent solution for congestion in highly developed areas is higher vehicular occupancy and/or transit. Accordingly,

TxDOT should consider a borderwide feasibility study for mass transit implementation. Such a study should also assess mass transit impacts on Clean Air Act compliance and on energy consumption.

Rail Intersections

The proposed outer loop intersects the Southern Pacific railroad, which could be left at-grade until there is sufficient demand to justify a grade separation. This will depend on the results of a specific study to be initiated no later than 2010. However, according to state law, any new at-grade intersection with a railroad requires closing or grade-separating two others. If the recommendation to grade-separate the intersection of Garza Road and the railroad is implemented, a good candidate for closing is the rail intersection of Farley Lane. In this case, Garza and Farley Lane must be linked in order to provide easy access across the railroad.

REFERENCES

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4.10 *XVII Binational Meeting on Bridges and Border Crossings*, Piedras Negras, Mexico, 5/23/1995.

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APPENDIX 1

SUMMARY OF MEXICAN DATA

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

During the data collection process, Ingeniería Gario contacted city planners, local authorities, representatives of the Coahuila transportation department, and other relevant officials, and obtained qualitative information to support and complement the quantitative data. Ingeniería Gario also sent information on traffic management plans, urban development, peak-hour conditions, 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. The objective of this Appendix is to summarize the available data, which include:

1. Socioeconomic Data, Urban Planning, and Maps of Ciudad Acuña
   - Plan of Actualized Urban Development 1992. State of Coahuila Government
   - Notebook with basic information for Municipal Planning (INEGI)
   - Photograph of Infrastructure Plan. State of Coahuila Government
   - Infrastructure Plan for Rail and Highways
   - General Plan of Nomenclature
   - Plan of Total Population by A.G.E.B.
   - Plan of Population Economically Active by A.G.E.B.
   - Plan of Population with Income from 2 to 5 minimum salaries by A.G.E.B.

2. Socioeconomic Statistics and Maps of the North Region of Coahuila
   - Statistical Yearbook for the State of Coahuila, 1994 edition (INEGI)
   - Directory of the Maquiladoras of the States of Tamaulipas, Nuevo Leon and Coahuila
   - Tourist map of Coahuila border area; map of the northern part of the state of Coahuila containing traffic volumes

3. Specific Statistics for Ciudad Acuña

- Historic description of the population — 1950, 1993, 2012
- Population economically active by activity
- Development of the maquiladora industry 1970-1979
- Vehicle Capacity, International Bridge
- Total load in rail station by type of product received
- Total load in rail station by type of product delivered

Numerical data and graphs were submitted to expand this information. The following graphs and tables are available from CTR:

1. Population 1950, 1993, and 2012 for Ciudad Acuña
2. Population of men and women ages 12 or older for activity condition for Ciudad Acuña
3. Manufacturers in Ciudad Acuña
4. Traffic for International bridge (Ciudad Acuña-Del Rio)
5. Rail data for Ciudad Acuña Railroad

APPENDIX 2

PHOTO ALBUM OF DEL RIO AND CIUDAD ACUÑA

This section contains photographs of strategic locations within Del Rio and Ciudad Acuña that have been essential for the development of Project 2940, *Traffic Circulation Study and Long-Range Plan for Del Rio and Eagle Pass.* These photographs provide a better understanding and a view of specific intersections or traffic characteristics that are discussed in this report. The description at the bottom of each photograph indicates the view being shown (not the point where the picture was taken).

LIST OF DEL RIO PHOTOGRAPHS

1. Intersection of US90 and Cantu
2. Intersection of US90 and Cantu
3. Intersection of US90 and Cantu
4. Avenue F South at 15th Street
5. Avenue F North at 15th Street
6. Avenue F North at Gibbs
7. Gibbs East at Avenue F
8. Avenue F South at Gibbs
9. Gibbs West at Avenue F
10. Turning Problem at US90 and Avenue F
11. Turning Problem at US90 and Avenue F
12. Intersection of Avenue F and US90 (noon)
13. Intersection of Avenue F and US90 (noon)
14. Garfield Street
15. Garfield Street at downtown
16. Garfield Street
17. Garfield Street east at Pecan
18. Pecan at Garfield
19. Intersection of Avenue F and Garfield
20. Avenue F

21. Avenue F
22. US90
23. US90 (electric poles)
24. Construction of New Spur 239
25. Overpass of New Spur 239
26. Construction of New Spur 239
27. Garfield Street east at Main Street
28. Garfield Street west at Main Street
29. Main Street at Garfield
30. Bedell at US90 and US277
31. US277 at US90 and Bedell
32. US90 East at Bedell and US277
33. Bedell Avenue
34. Industrial Park
35. Industrial Park
36. Industrial Park
37. International Bridge
38. International Bridge

LIST OF CIUDAD ACUÑA PHOTOGRAPHS

1. Toll booths at international bridge
2. Toll booths at international bridge
3. Access to international bridge
4. Entrance to Mexico
5. Mexican Customs
6. Railroad station

Del Rio

Photo 1. Intersection of US 90 and Cantu

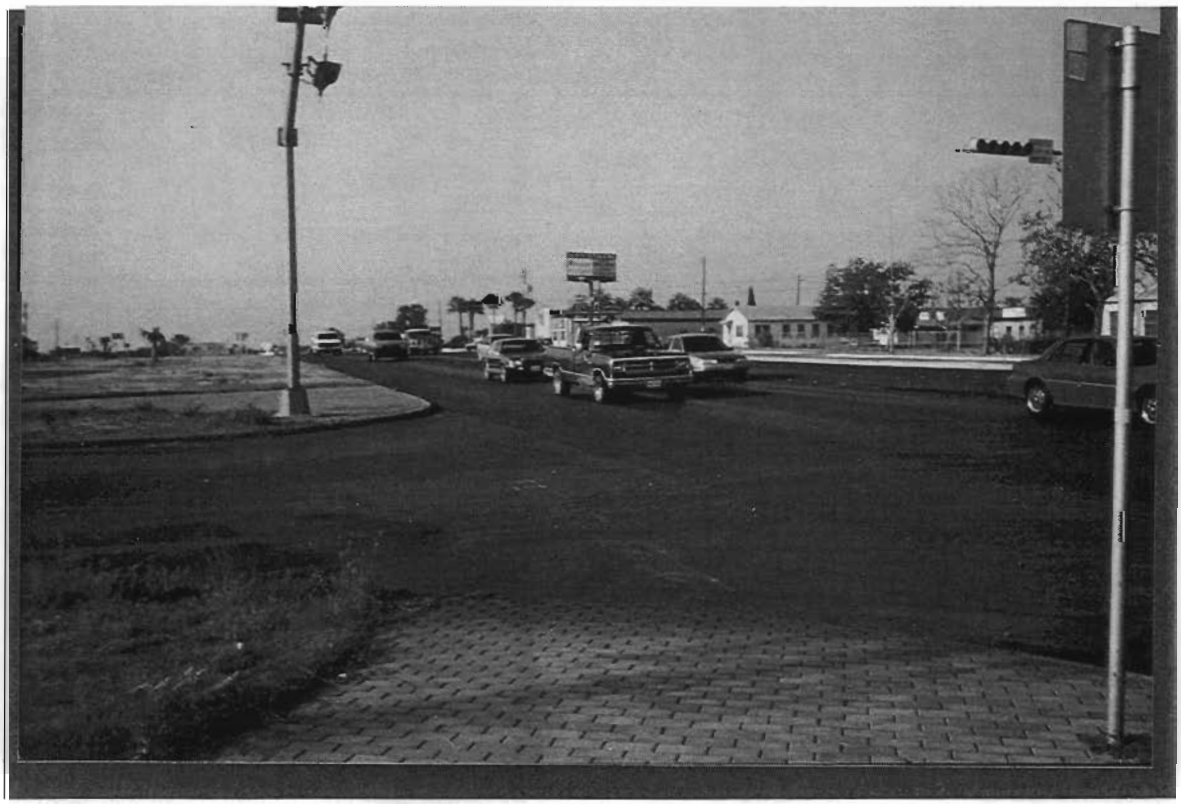

Photo 2. Intersection of US 90 and Cantu

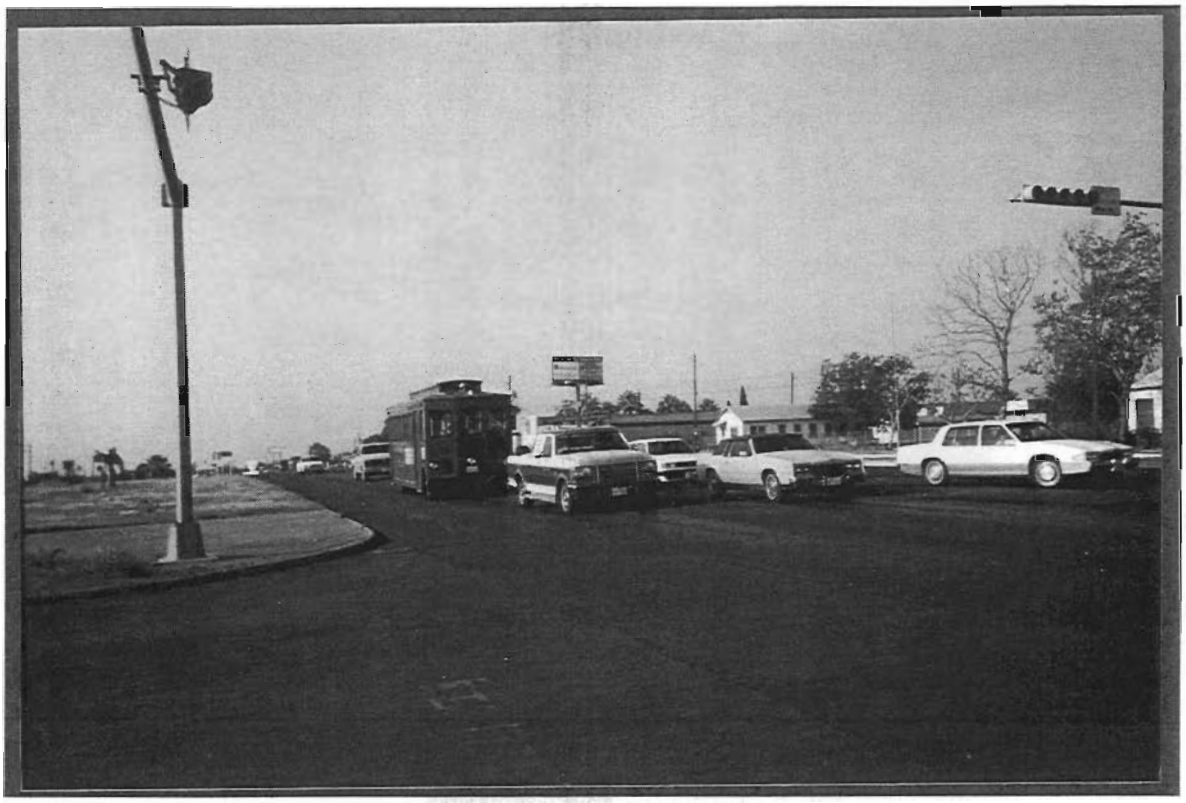

Photo 3. Intersection of US 90 and Cantu

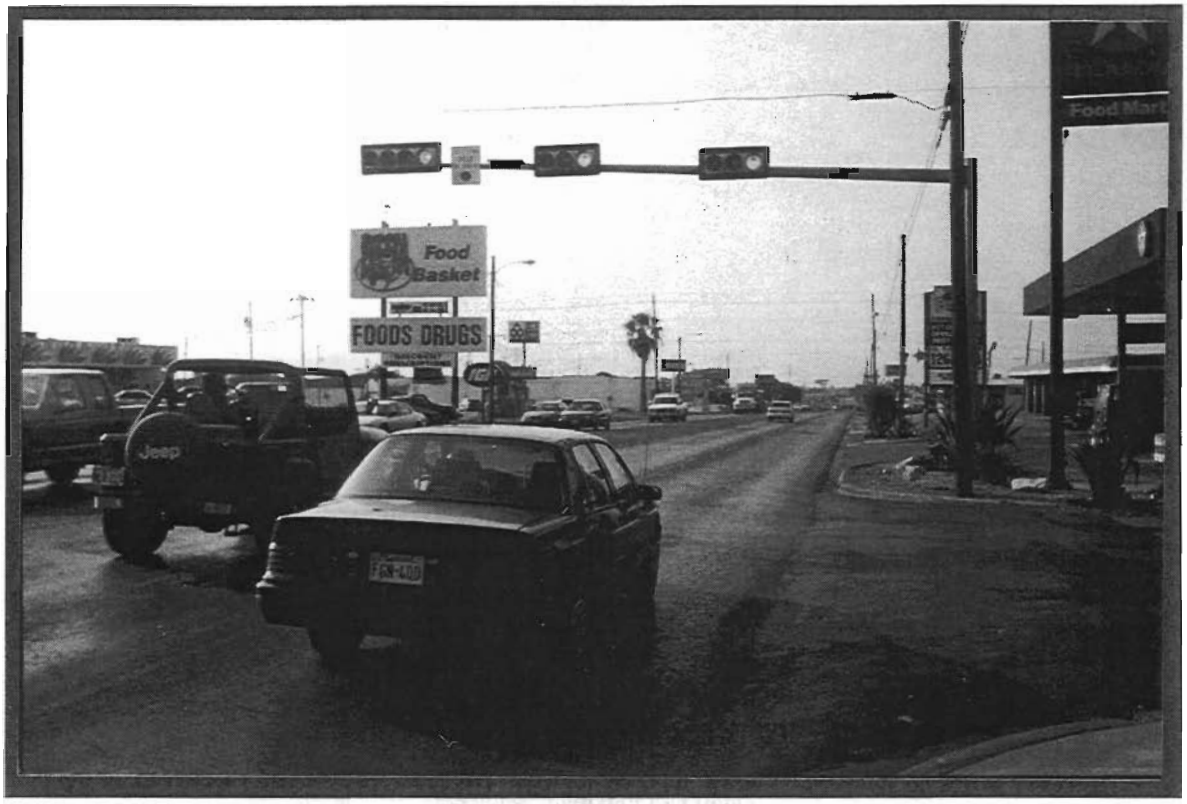

Photo 4. Avenue F south at 15th Street

Photo 5. Avenue F north at 15th Street

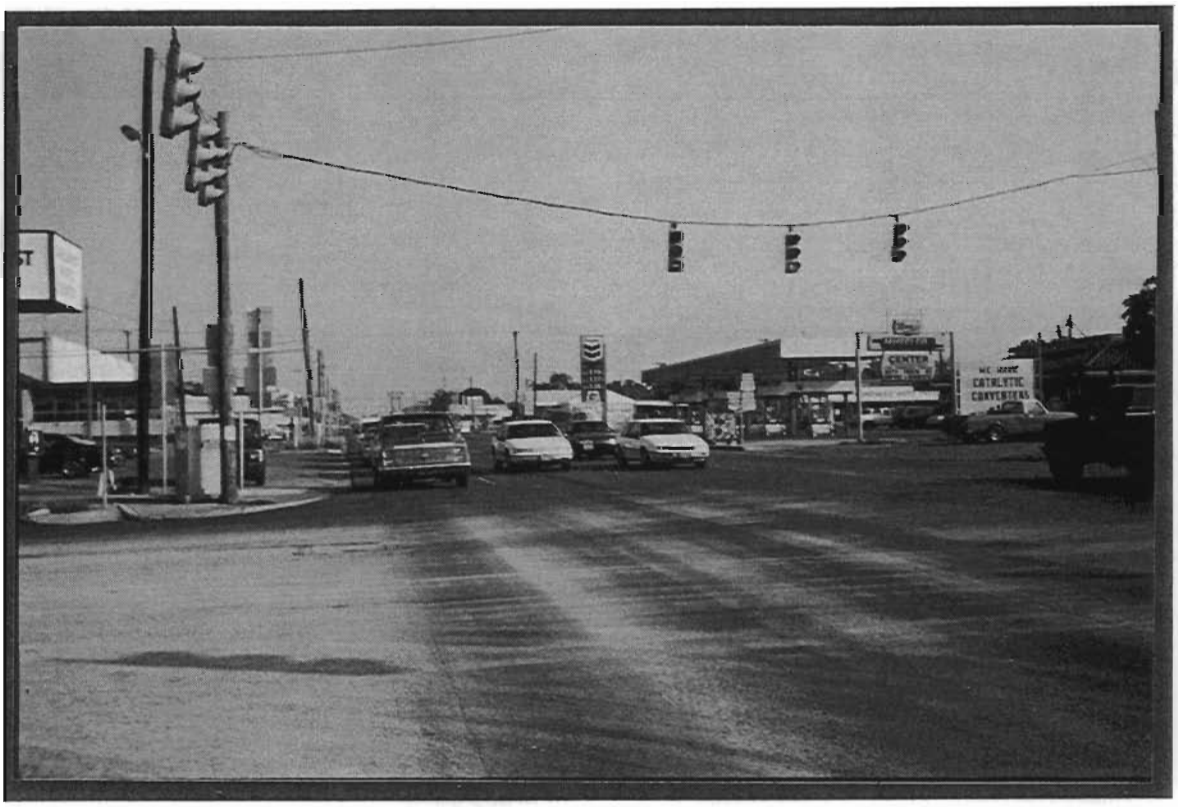

Photo 6. Avenue F at Gibbs

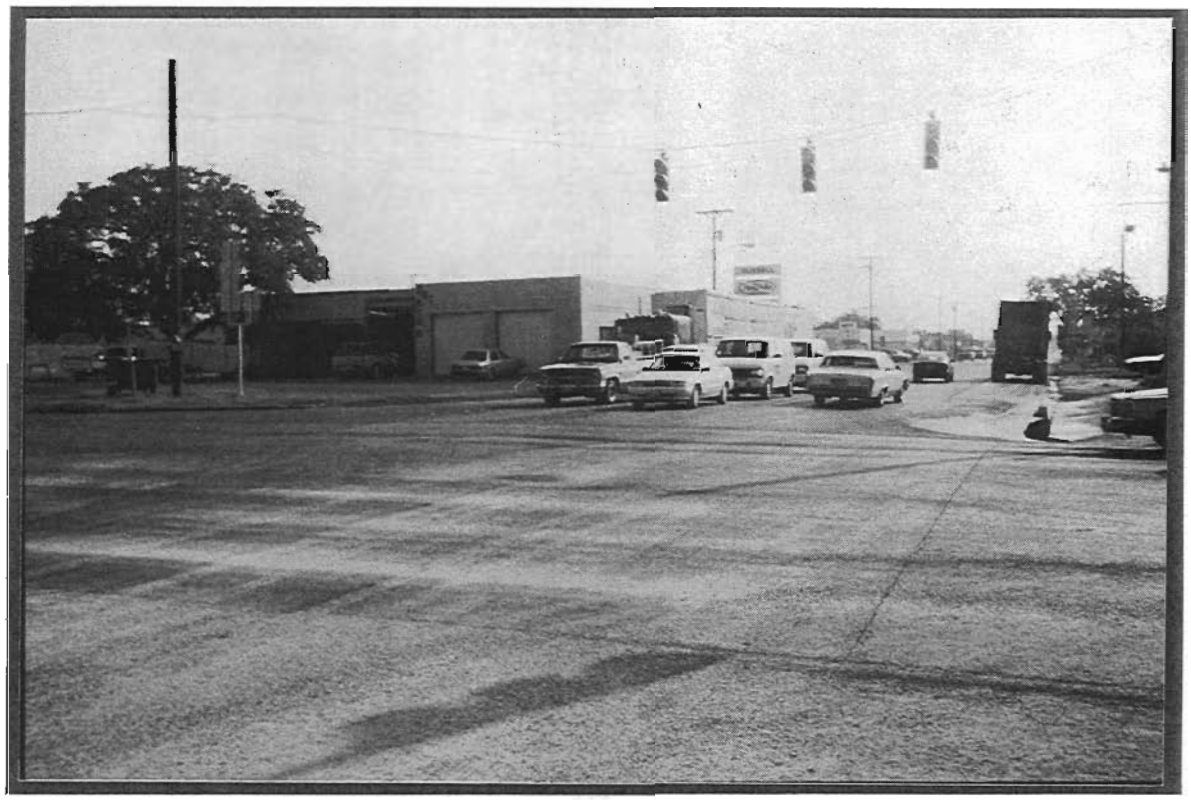

Photo 7. Gibbs east at Avenue F

Photo 8. Avenue F south at Gibbs

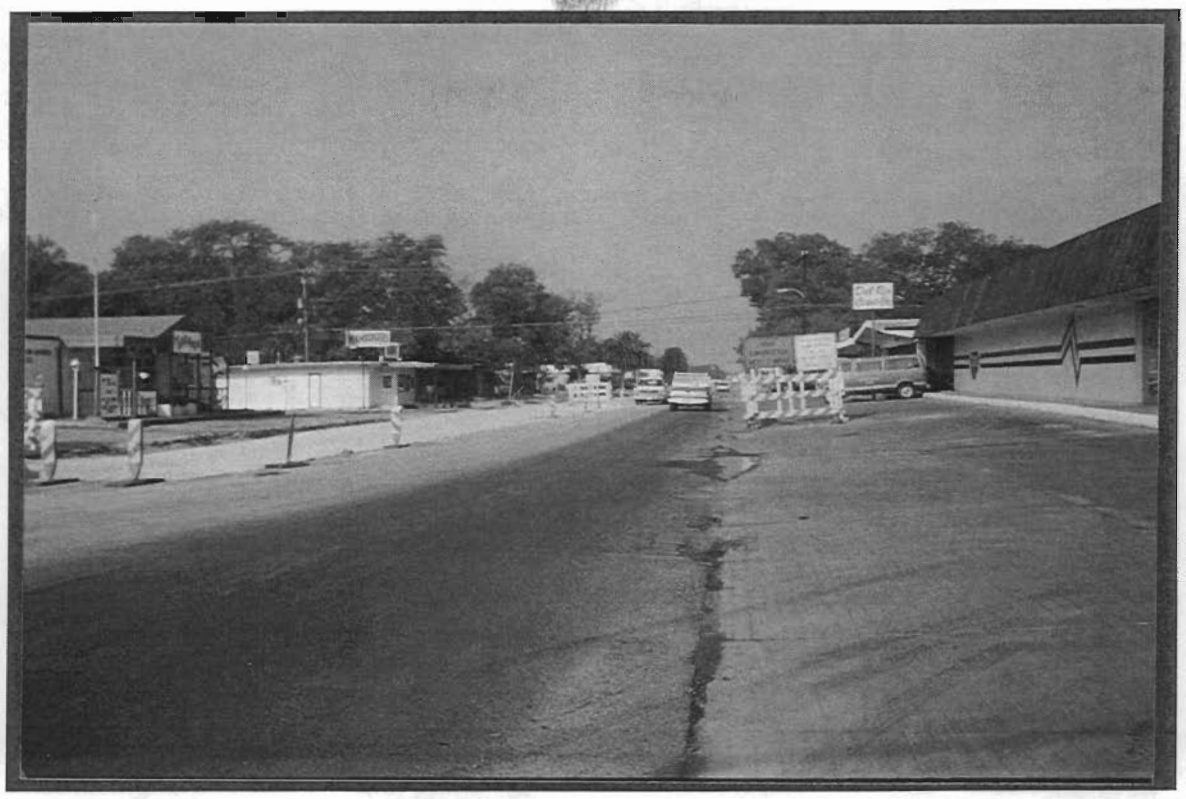

Photo 9. Gibbs west at Avenue F

Photo 10. Turning problem at US 90 and Avenue F

Photo 11. Turning problem at US 90 and Avenue F

Photo 12. Intersection of Avenue F and US 90 (noon traffic)

Photo 13. Intersection of Avenue F and US 90 (noon traffic)

Photo 14. Garfield Street

Photo 15. Garfield at downtown

Photo 16. Garfield Street

Photo 17. Garfield east at Pecan

Photo 18. Pecan at Garfield

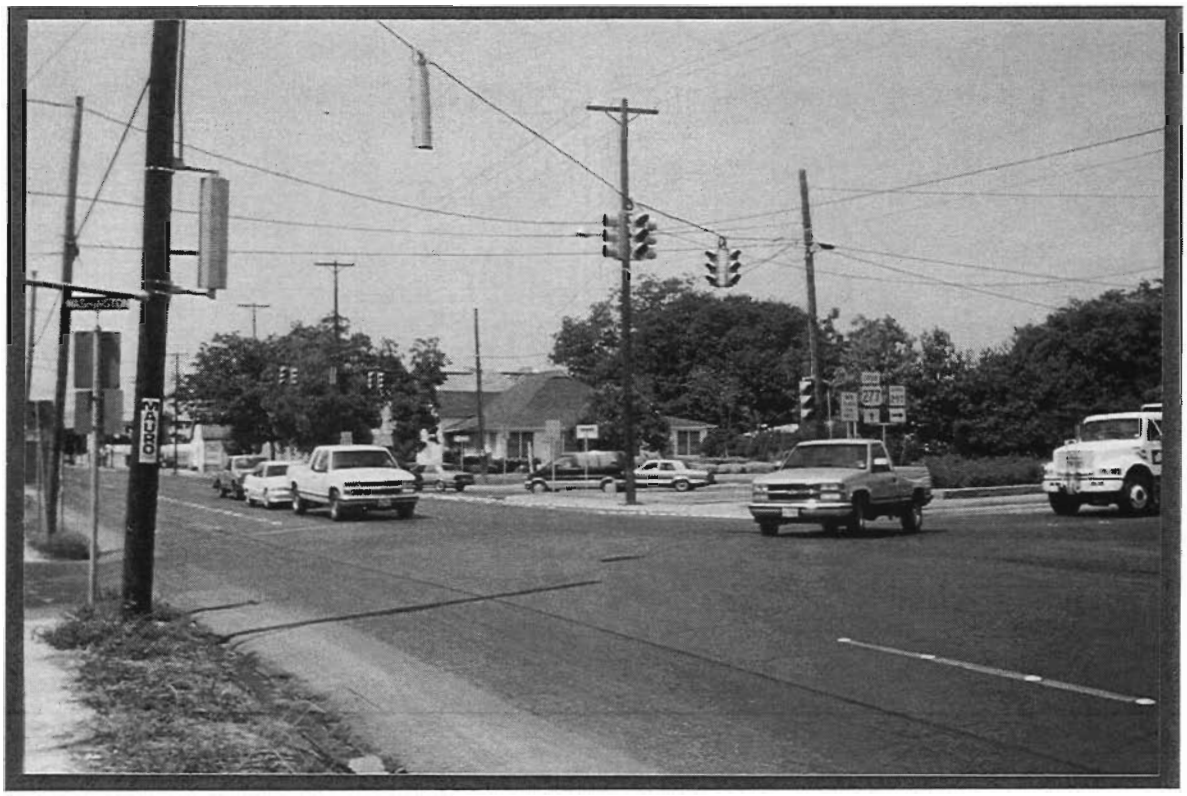

Photo 19. Intersection of Avenue F and Garfield

Photo 20. Avenue F

Del Rio

Photo 21. Avenue F

Photo 22. US 90

Del Rio

Photo 23. US 90 (Electric Poles)

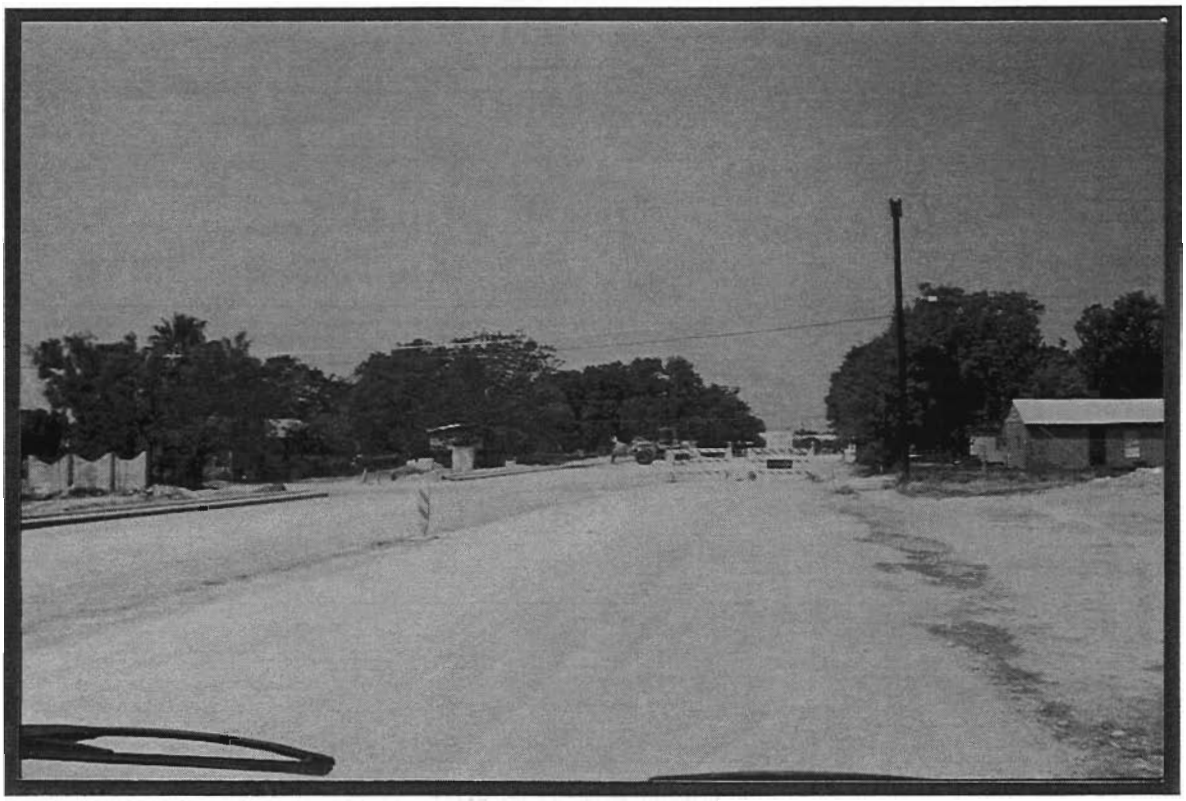

Photo 24. Construction of new spur

Del Rio

Photo 25. Overpass (new spur)

Photo 26. New spur (construction)

Photo 27. Garfield east at Main Street

Photo 28. Garfield west at Main Street

Del Rio

Photo 29. Main Street at Garfield

Photo 30. Bedell at US 90 and US 277

Photo 31. US 277 at US 90 and Bedell

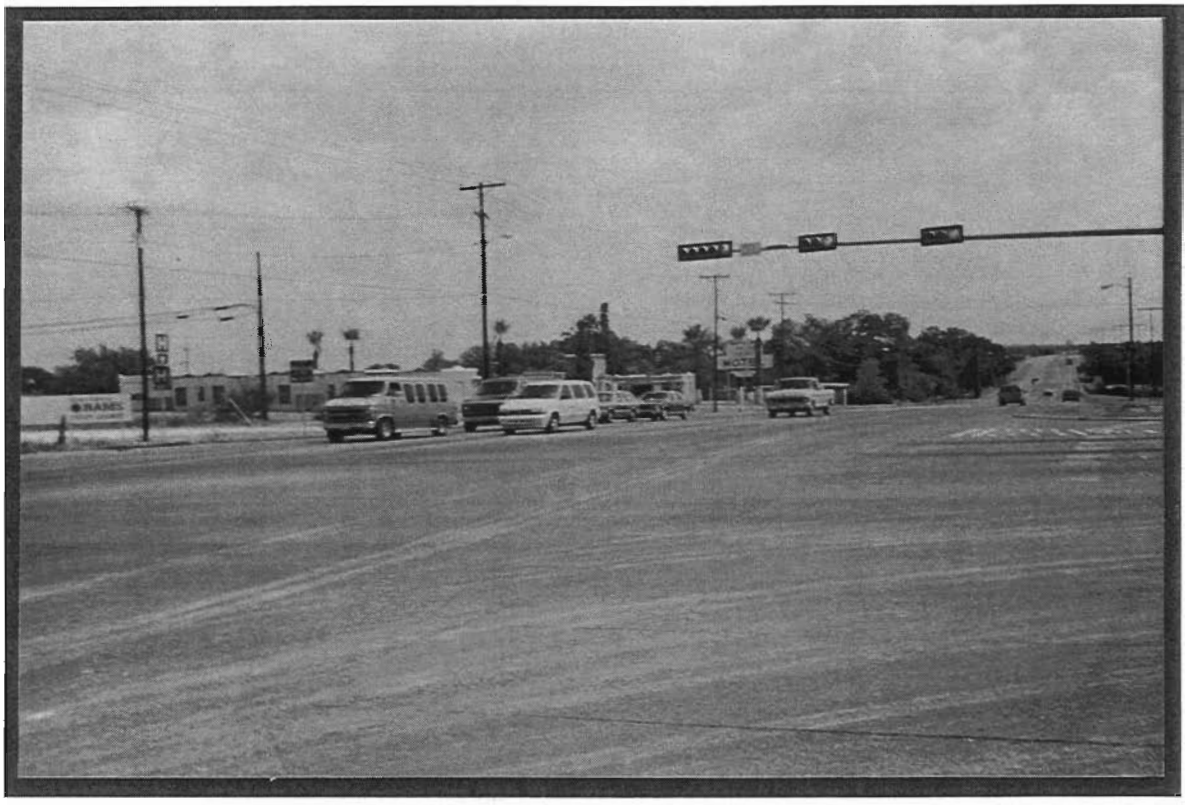

Photo 32. US 90 east at Bedell and US 277

Photo 33. Bedell Avenue

Photo 34. Industrial Park

Photo 35. Industrial Park

Photo 36. Industrial Park

Del Rio

Photo 37. International Bridge

Photo 38. International Bridge

Del Rio

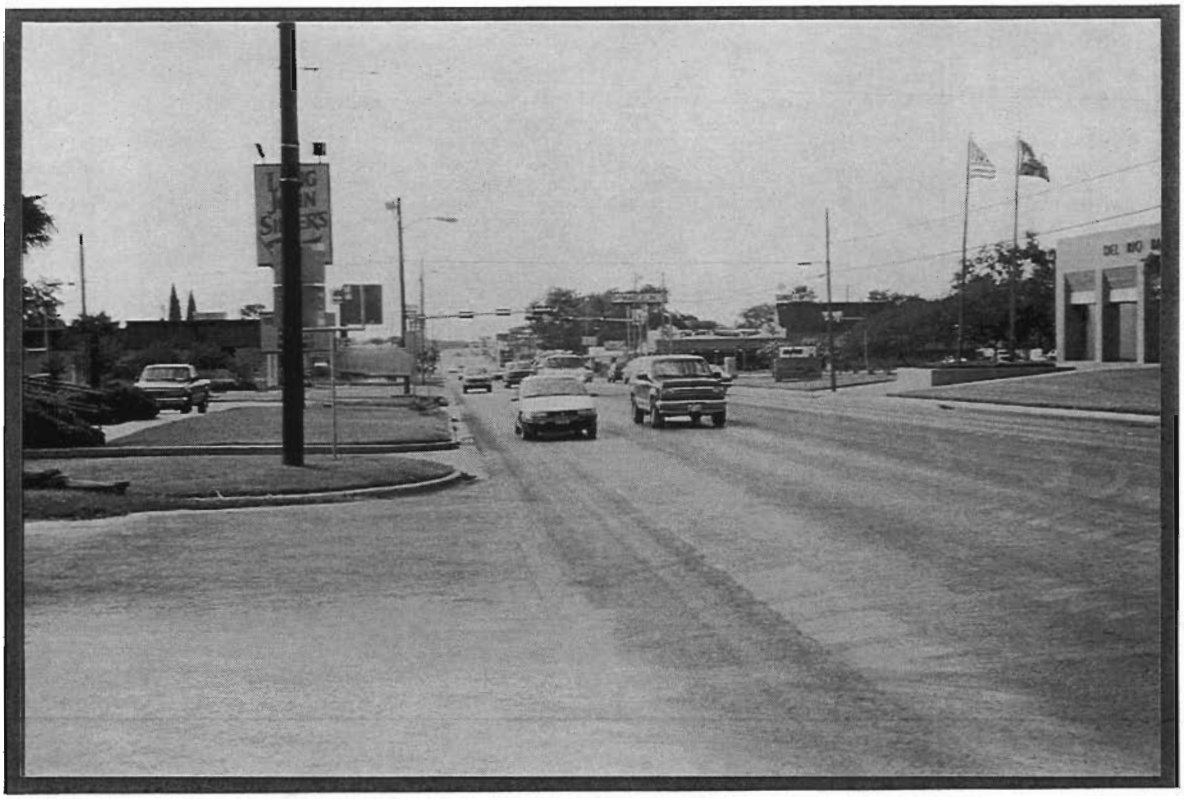

Photo 39. Avenue F at 10th Street

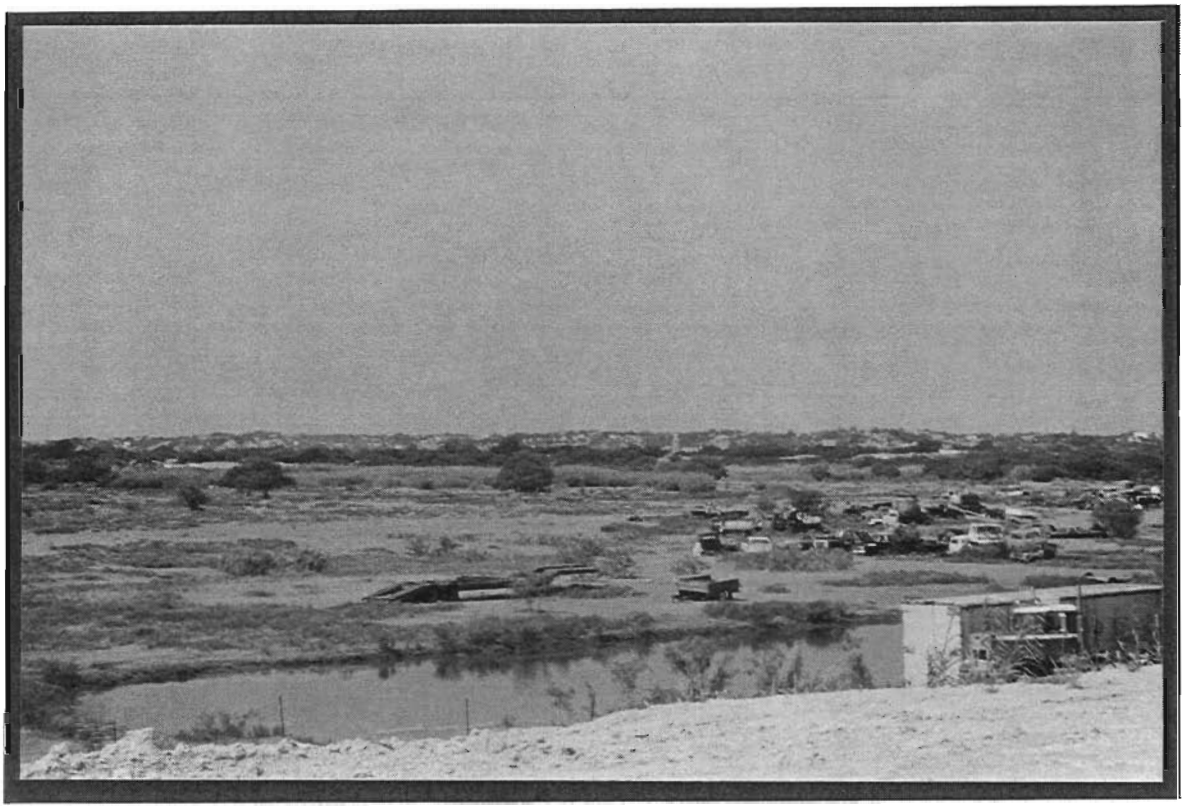

Photo 40. Ciudad Acuña

Photo 41. Proposed Bedell extension (along Dodson Avenue)

Photo 42. US 90 at Foster Drive

Ciudad Acuña

Photo 1. Toll Booths

Photo 2. Toll Booths

Ciudad Acuña

Photo 3. Access road leading to the international bridge

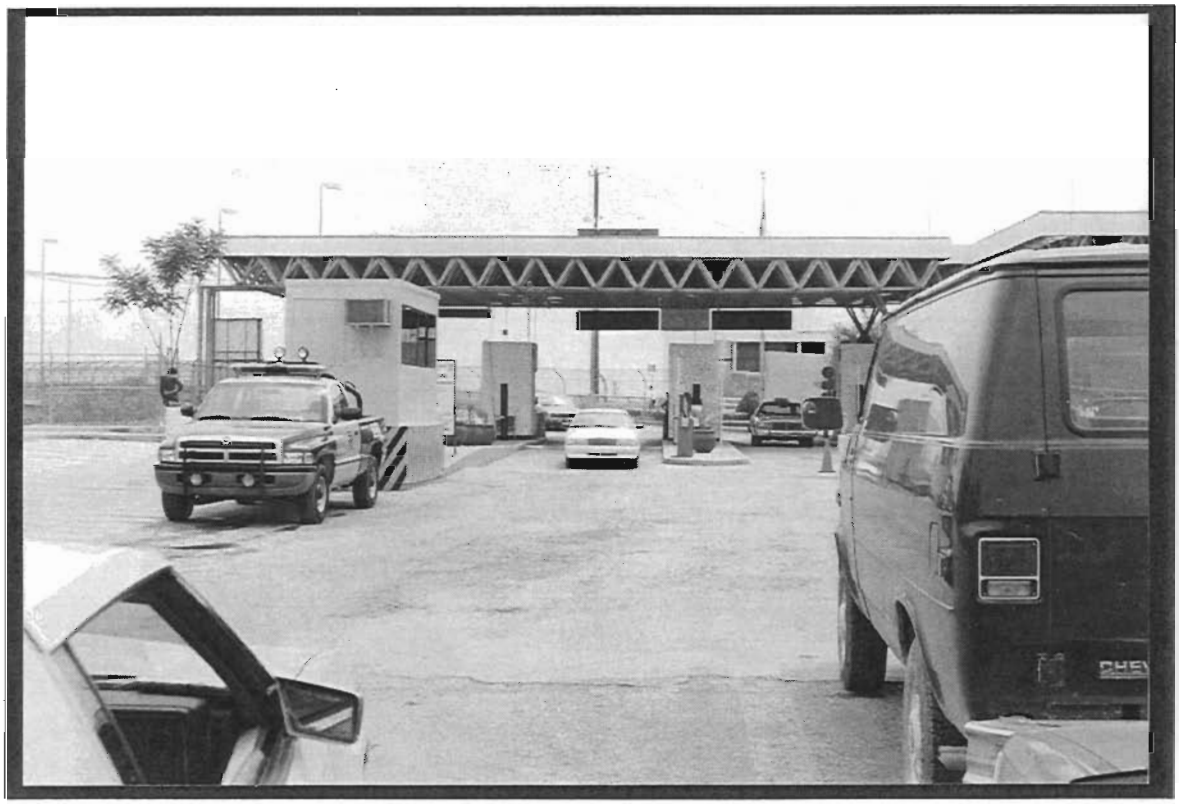

Photo 4. Entrance to Mexico

Ciudad Acuña

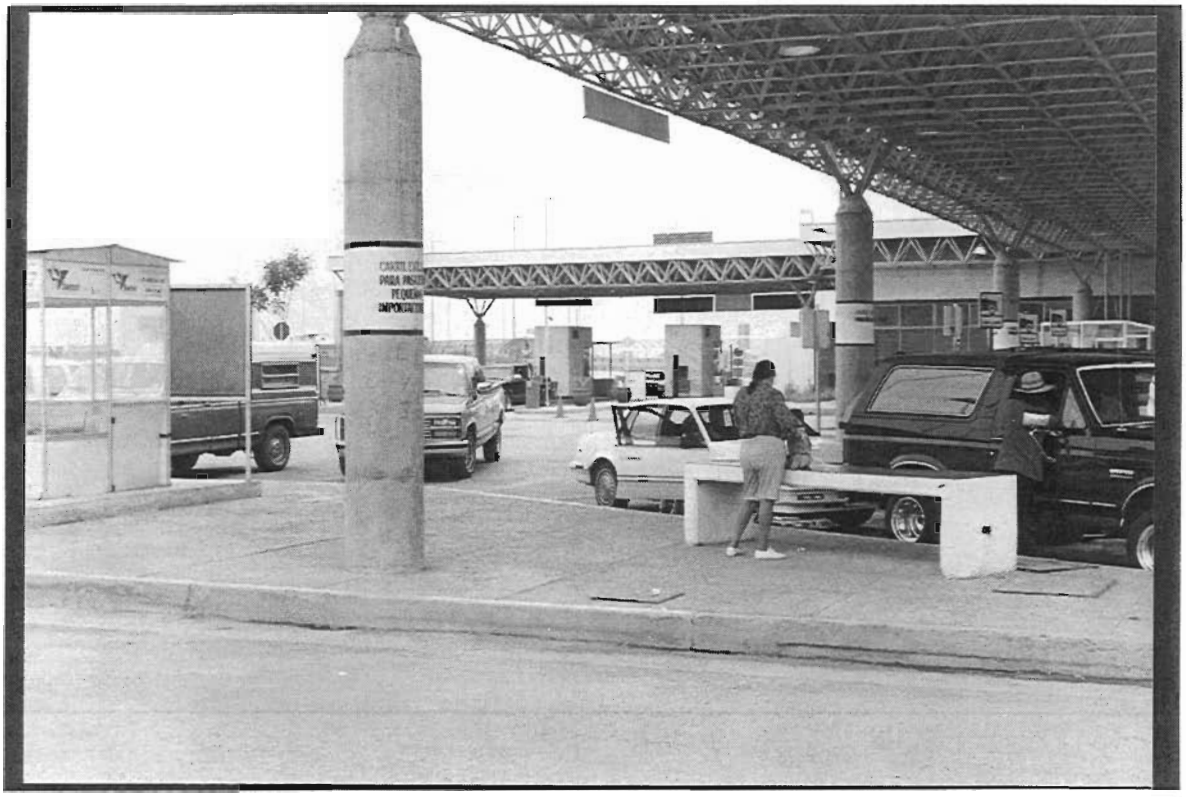

Photo 5. Mexican Customs

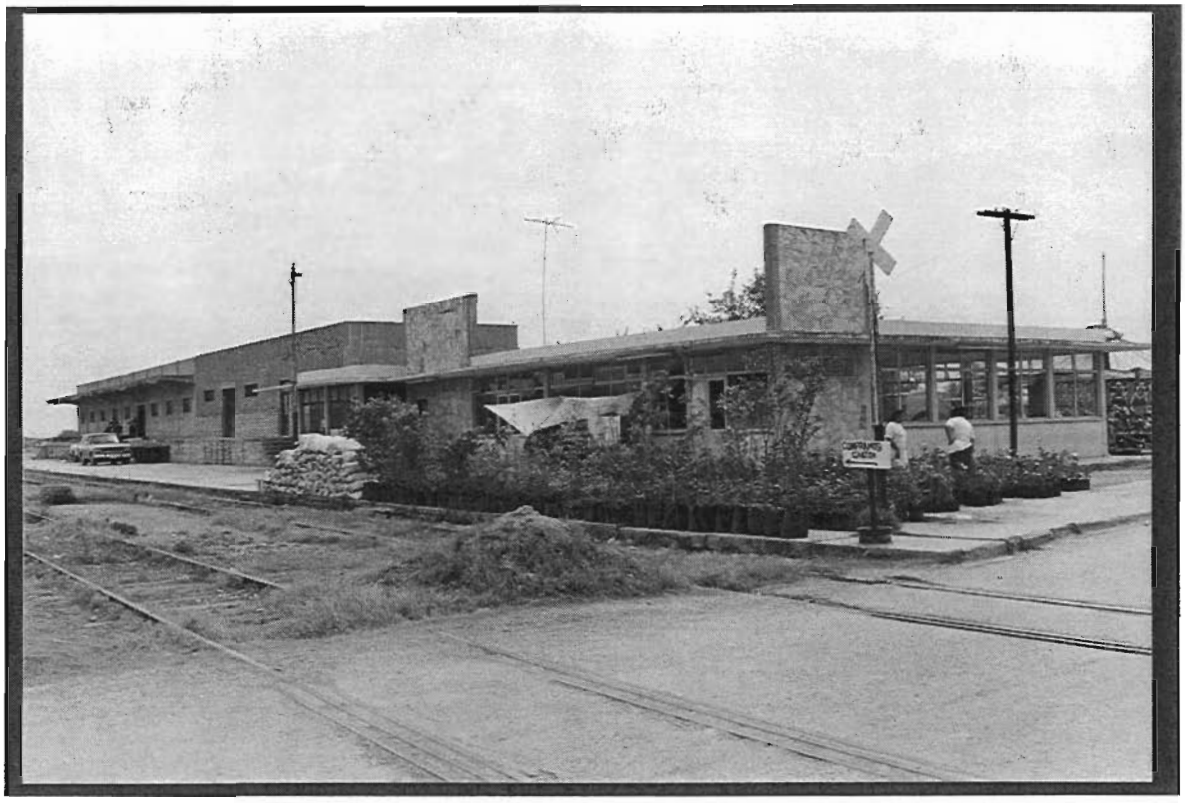

Photo 6. Rail terminal