2030 Committee
Texas Transportation Needs Report

January 9, 2009
DRAFT for Public Comment

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Table of Contents

List of Exhibits

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Introduction

About the 2030 Committee

In May 2008, Texas Transportation Commission Chair Deirdre Delisi, at the request of Texas Governor Rick Perry, appointed a volunteer committee of 12 experienced and respected business leaders designated as the 2030 Committee. The Committee's charge was to provide an independent, authoritative assessment of the state's transportation infrastructure and mobility needs from 2009 to 2030.

The Committee developed goals for the report, as follows:

- Preserve and enhance the value of the state's enormous investment in transportation infrastructure
- Preserve and enhance urban and rural mobility and their value to the economic competitiveness of Texas
- Enhance the safety of Texas' traveling public
- Initiate a discussion on strategic rebalancing of transportation investments among infrastructure, mobility and non-highway modes to anticipate future needs

The 2030 Committee provided guidance and direction to a nationally renowned research team of transportation experts at the Texas Transportation Institute (TTI) at The Texas A&M University System; the Center for Transportation Research at The University of Texas at Austin; and The University of Texas at San Antonio. Staff at the Texas Department of Transportation (TxDOT), and the state's metropolitan planning organizations provided input and support for the research team. More detailed information regarding the Committee's study is found in this complete *2030 Committee Texas Transportation Needs Report*.

The 2030 Committee's work was conducted in a short timeframe of six months. The Committee used several mechanisms to solicit public input to assist in making its recommendations.

2030 Report Context

According to the Texas State Demographer, Texas' population is projected to grow at close to twice the U.S. rate, adding between 7 million and 17 million people by 2030. This is the combined equivalent of the five largest metropolitan areas – another Dallas–Fort Worth, Houston-Galveston, San Antonio, Austin and El Paso – with enough left over to add another Corpus Christi.

With the population increase expected by 2030, transportation modes, costs and congestion are considered a possible roadblock to Texas' projected growth and prosperity. Absent a robust, vibrant transportation system, all sectors of the state's economy and the quality of life it offers will suffer. Inefficient transportation leads to escalated prices of goods, increased costs of labor and reduced quality of life. By comparison, an efficient system preserves mobility for workers, businesses, residents, emergency responders and tourists – a level of mobility that expands opportunities for commerce, reduces environmental impact and enhances freedom of movement for all citizens.

Historical Perspective

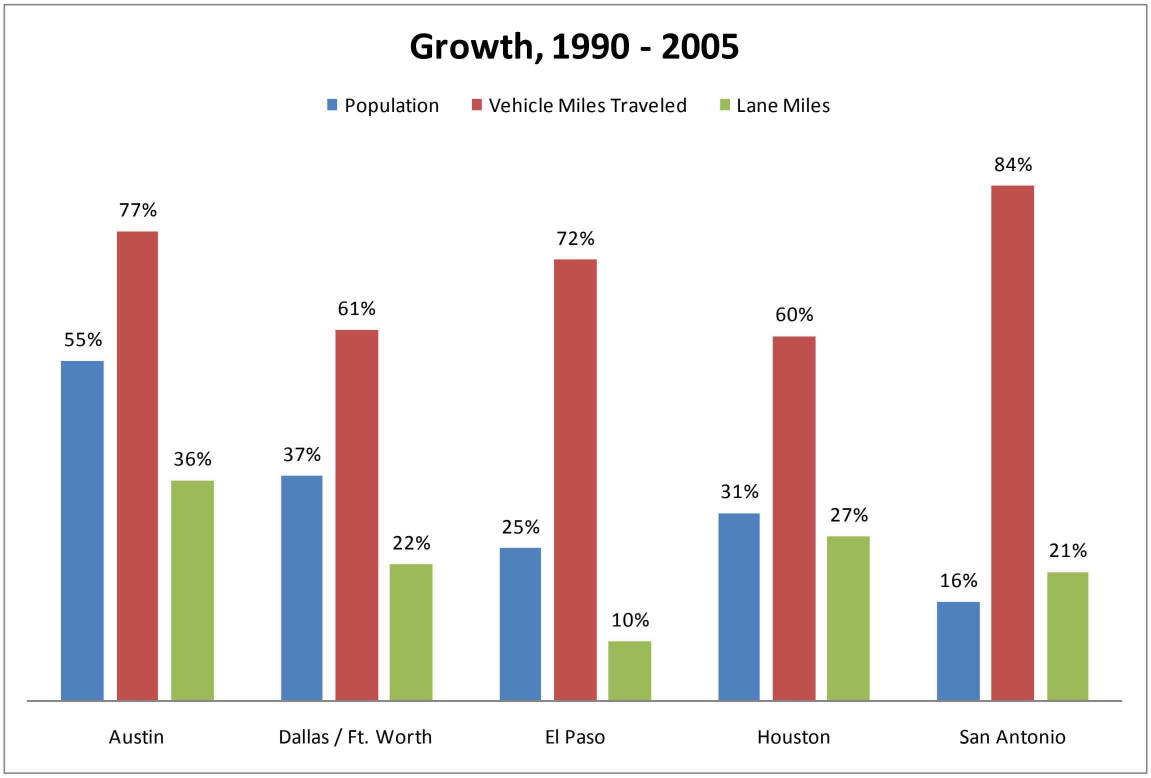
For many decades, Texas led the country in transportation infrastructure development. In the five years following World War II, one-quarter of all highway work in the U.S. occurred in Texas. The state's farsightedness in its 1950s and 1960s highway design allowed its trunk and U.S. highway system to readily upgrade to new federal interstate standards in the 1970s. The impact of this farsightedness is dramatic: The highway system alone has contributed $2.8 trillion to the Texas state economy over the past 50 years, and more than $100 billion each year since 2004, according to TTI.

Whereas the state initially anticipated growth in the development of its transportation system, the significant growth in both population and vehicle ownership has yielded even greater increases than expected in trips per household and vehicle miles traveled to common destinations, such as places of work. As jobs were increasingly found in the state's cities, the population migrated from rural and small urban areas to larger areas. This occurred concurrently with women entering the work force, increasing reliance on personal automobiles for commuting to places of employment, and the maturation of all segments of the baby boomer generation. Altogether, the demand for transportation infrastructure and services rapidly grew, and continues to grow today.

Texas Transportation Today

With its expanding population, Texas has experienced 30 years of increasing highway congestion, both in magnitude and geography. As shown in Exhibit I-1, construction of highway lane-miles in Texas has greatly lagged behind population and vehicle miles traveled in the state's five largest metropolitan areas for the past 15 years. Traffic delay in urban areas has increased more than 500 percent in the last two decades. Many of the quiet rural roads of the 1970s are now part of major urban highway networks. Not coincidentally, travel time delay has increased substantially within the same time period and bumper-to-bumper traffic can even be seen in the middle of the day in some cities. Mobility challenges in rural areas show up through not only increasing congestion, but also through inadequate connecting routes, safety concerns and during hurricane evacuations.

Exhibit I-1: Growth, 1990 – 2005



As a result of use and age, Texas' highway infrastructure is showing signs of deterioration. According to Federal Highway Administration data, passenger vehicle traffic in the United States is expected to increase by more than 30 percent by 2020, with large truck traffic estimated to increase by almost 40 percent. As indicated by the Texas Department of Transportation, a fully loaded tractor trailer truck damages the highway almost 10,000 times more than a passenger vehicle. Vehicle roadway damage affects smoothness of ride and causes ruts, potholes and cracks in the roadway. Driving on roads that are in disrepair accelerates vehicle deterioration, escalates roadway maintenance costs and increases fuel consumption.

Texas' vibrant and growing industrial- and consumer-friendly economy has led to a substantial growth in goods movement. Texas accommodates a rapidly growing number of trucks through its land ports. In 2007, almost 30 percent of all trade resulting from the North American Free Trade Agreement (NAFTA) and almost 70 percent of trade from Mexico entered the U.S. through Texas, according to the U.S. Department of Transportation.

Report Scope

The 2030 Committee research team provided a comprehensive analysis of estimated transportation needs, associated costs in 2008 dollars and resulting benefits from highway maintenance (pavements and bridges), urban mobility, and rural mobility and safety. The timeframe of the report did not permit an in-depth analysis of other transportation modes that could provide highway congestion relief, such as public transportation, freight and intercity passenger rail, ports and waterways, and airports. However, an overview of user demand for these modes, the state's role in funding them and their projected challenges between 2009 and 2030 was included in the report.

The report also identifies the need for more analysis to examine possible improvements in transportation efficiencies, the development of new technologies, travel options and innovations between 2009 and 2030. In addition, the Committee did not speculate on transportation improvements that could result from future legislation or policies that might be implemented.

Difficult Decisions Ahead

Texas is not unique. This story of upcoming growth is the same for all economically vibrant areas in the United States. As in Texas, other states and regions have responded to these travel demand pressures in a variety of ways, including new highway construction, bus and rail transit development and commuting alternative services such as vanpools, express buses and telecommuting options. Yet these options are unlikely to solely accommodate the anticipated population growth in Texas.

The challenge for policymakers is to efficiently manage the state's existing transportation investment and renew Texas' far-sighted approach to planning future transportation infrastructure, while maximizing mobility in an environment of increasing travel demand. Available funding will not be adequate to address all of the needs identified. State leaders must use limited resources wisely by optimizing the level of investment with the right mix of transportation strategies to protect Texas' economic competitiveness and preserve quality of life for Texans.

This *2030 Committee Texas Transportation Needs Report* provides the best available information on the nature, magnitude and impacts of transportation needs in Texas from 2009 to 2030. The report is designed to help policymakers answer two critical questions: Which transportation needs should we fund? How much do we need to spend?

Results of Public Input

The process of soliciting public input at the community level is vitally important to identifying transportation infrastructure and mobility solutions that are readily accepted by the public. Grassroots input on transportation alternatives from citizens and community and business leaders often results in new local, regional or statewide initiatives and policies to improve the state's overall transportation system.

The 2030 Committee held public hearings in six cities to receive citizen input on the state's most pressing transportation needs. More than 90 elected officials, community leaders and citizens presented testimony at the public hearings (Exhibit I-2 and Appendix A). The hearings were publicized through the media and the TxDOT and 2030 Committee websites.

Exhibit I-2: 2030 Committee Public Hearings

Hearing Date	Location	Participants	Testimonies
7/24/08	Austin	30	9
8/07/08	El Paso	94	22
8/14/08	Houston	61	11
8/21/08	Dallas	42	11
9/18/08	Amarillo	99	23
10/30/08	Corpus Christi	45	15

Of the individuals providing testimony at the 2030 Committee public hearings, most expressed concerns about the important role that transportation plays in economic development, the need to improve intracity and intercity public transit options, and roadway safety issues. Public comments covered a wide variety of transportation issues including:

- Timely, efficient and affordable movement of people and goods
- Improved maintenance of roadways and bridges
- Increased passenger and freight rail development
- Interconnectivity between transportation modes, such as public transit, intercity rail and airports
- Inclusion of pedestrian and bicycle paths into transportation plans
- Non-congested emergency evacuation routes
- Connectivity from rural areas to urban markets
- Expansion of general aviation airports

The Committee received approximately 175 suggestions and comments through its website, by regular mail and by facsimile. Comments expressed in a few of the letters received by the Committee include:

> *Our number one priority is to safely drive on well-maintained roads with adequate access to our facilities.*
> — ***Mike Hansen****, Director of Transportation Services – Texas, Wal-Mart Stores, Inc.*

> *Many businesses are finding other places to put down roots or expand because of Texas' inability to guarantee the swift movement of manufacturing goods and workers.*
> — ***Will Newton****, Texas Executive Director. National Federation of Independent Business*

> *Texas must recognize the dire consequences that could take hold should our state resist making comprehensive changes to our transportation system.*
> — ***Bill Hammond****, President and CEO, Texas Association of Business*

Sources

Looming Boom: Texas Through 2030, by James P. Gaines, *Tierra Grande* magazine, Real Estate Center, Texas A&M University, January 2008.

The Economic Impact of the Interstate Highway System, National Cooperative Highway Research Program 20-24 (52), Transportation Research Board, June 2006.

The Interstate and National Highway System – A Brief History and Lessons Learned, NCHRP 20-24 (52), Transportation Research Board, June 2006.

Schrank D. and Lomax T. *2007 Annual Urban Mobility Report*, Texas Transportation Institute, Texas A&M University, September 2007.

Pavement Maintenance

Introduction

The Texas transportation system has enabled the state to prosper in an increasingly competitive global economy, though the infrastructure is now aging and showing signs of deterioration at a time when freight movement continues strong growth. The role of Texas as the primary U.S. state exporter, the continued growth of trade generated by the North American Free Trade Agreement (NAFTA) through state gateways, the stewardship of major highway corridors critical to regional freight flows, and the reconstruction of the Panama Canal to raise container volumes in the Gulf of Mexico all combine to produce a future "tidal wave" of freight on Texas highways.

The result of increased freight movement in Texas will naturally accelerate deterioration of the aging highway system. Although the state maintains the largest paved highway system, analysis shows that Texas is spending substantially less on maintenance and rehabilitation activities per lane-mile than most of its peer states. It is critically important that sufficient funds are provided to reconstruct pavements that are nearing the end of their useful lives. It is equally critical to provide sufficient funds to preserve and extend pavement life by applying routine maintenance (RM) and preventive maintenance and rehabilitation (M&R) treatments at the right times. Projections of future RM and M&R funding needs must also be determined for added capacity anticipated as part of mobility improvement programs.

This chapter describes a network-level analysis of the TxDOT pavement system to determine RM and M&R funding needs from 2009 to 2030. These needs are expressed in terms of 2008 dollars, with no increase applied for inflation. This analysis provides a defensible and thorough assessment of future funding needs for existing TxDOT mileage and also examines the impacts of three different pavement-condition goals identified by the 2030 Committee for the existing network. In addition, funding needs are determined for added capacity mileage for

Q: What is a network-level analysis?

A: A network-level analysis is broad in nature and considers all pavements on the entire state system or within a geographic region of the state. A network-level analysis provides Administration, Managers and Planners with information about the district or statewide condition trends and funding needs.

A project-level analysis is much more detailed and is performed on a short section of roadway (a few miles in length) to determine the specific type of work that will be needed to correct ride, safety or structural problems.

four mobility scenarios (see the Urban Mobility Needs Assessment chapter of this report for descriptions of the scenarios referenced in this chapter).

This analysis was conducted in two parts:
- assessing funding needs of current existing on-system highway mileage, and
- assessing funding needs of proposed added capacity lane-miles to address mobility.

The TxDOT Pavement Management Information System (PMIS) database provided information for analyzing the existing state highway system. The Texas Transportation Institute (TTI) Mobility Study Team provided statistics to assess the necessary added capacity lane-miles to address mobility. For more information, see Appendix B.

Q: What is the difference between routine maintenance and preventive maintenance?

A: Routine Maintenance includes small localized pavement repairs such as patching a pot hole or sealing cracks with liquefied asphalt.

Preventive Maintenance includes more extensive and expensive, planned treatments such as a seal coat or micro-surfacing. Preventive Maintenance treatments typically cover the entire road surface and improve the Pavement condition score.

Current Conditions

As part of the assessment of needs and current conditions, public comments were solicited through multiple means of collection. Comments from citizens, business groups, councils of government and community organizations came in through email, U.S. Mail and fax. Public meetings and public hearings held across the state were scheduled and publicized through each local TxDOT public information office or through the TxDOT Office of Government and Public Affairs. In addition to comments from the public, more than 90 elected officials, community leaders and citizens presented testimony at the scheduled public hearings. For more information regarding public comments obtained during the assessment process, see Appendix A.

Analysis of Existing On-System Mileage

PMIS data and other sources were used to develop deterioration curves and other analysis procedures for characterizing the decline in pavement condition over time. Deterioration curves were developed to describe mathematically the decrease in pavement condition for different pavement types used on various state-maintained highway systems. These curves were used in conjunction with trigger points that specify different M&R treatment levels depending on the existing pavement condition and rate in change of condition.

The M&R treatment levels used in this study include Preventive Maintenance (PM), Light Rehabilitation (LRhb), Medium Rehabilitation (MRhb) and Heavy Rehabilitation (HRhb). Information about M&R treatment costs and other aspects of each of these four treatment levels has been obtained from sources including TxDOT, the Associated General Contractors (AGC) and an independent group of pavement experts. In addition, routine maintenance costs for the past eight years were obtained from the TxDOT Maintenance Division for use in developing future RM costs for the existing highway network and added capacity lane-miles.

Analysis of Added Capacity Mileage

For new added-capacity pavement lane-miles needed to address mobility, an inventory approach determined M&R funding needs instead of the analytical approach used for the existing on-system lane-miles. This is because less detailed information is available about highway miles that will be built in the future. More information will be provided in later sections of this chapter about M&R and RM funding analysis procedures for existing and added capacity new highway pavement lane-miles. The mobility needs are presented for four scenarios developed by TTI that include the mileage and associated treatment funding needs necessary to:

1. reduce congestion;
2. prevent worsening congestion;
3. achieve mobility competitiveness, and
4. current funding trend.

Scope of This Study

This analysis will address M&R and RM needs for on-system mileage managed by TxDOT. Highway mileage is defined as either on-system or off-system. On-system mileage comprises highway mileage that is TxDOT's responsibility to maintain. This mileage includes interstate highways (IH), U.S. highways (US), state highways (SH) and farm-to-market (FM) roads as well as other state highway system types such as loops, spurs, business routes and state park roads.

Off-system mileage includes residential and city streets, county roads and other highway pavements that were built and are maintained by a city, county or other local governmental authority. Off-system mileage is not addressed in this Pavement Needs study, primarily because data are not consistently collected for pavement management or planning purposes. The following assumptions were made in developing the needs estimates:

- Only on-system highway pavement miles are included in this study.
- The Texas Transportation Commission's 90% 'Good' or better goal is maintained over the analysis period for the existing highway mileage (TxDOT 2007).
- Toll roads are considered self-sustainable.
- Project delivery costs – which include pavement materials, mobility, traffic control and similar costs necessary to actually construct the project – determine treatment category costs.
- Truck size and weight remain unchanged over the analysis period.
- Additional mileage from the mobility study is evaluated separately using an inventory approach to determine treatment costs.
- The capital costs to build added capacity highway lane-miles for mobility are addressed in separate chapters of this report and are therefore not included in this Pavement Needs chapter.

The TxDOT On-System Highway Network

The Texas state on-system highway network comprises approximately 192,150 lane-miles (80,000 center-line miles) of paved roadway. For purposes of this report, a lane-mile is defined as a section of pavement one lane wide (generally 12 feet) and one mile long. A center-line mile is defined as a section of roadway one mile in length, regardless of the number of lanes, measured along the center of the roadway. Exhibit P-1 lists the number of existing lane-miles, by highway system classification, that are managed by TxDOT.

Exhibit P-1 Number of Lane-Miles by Highway System

Highway System Classification	Number of Lane-Miles	Percentage of Total Lane-Miles
Interstate Highway	15,090	8%
U.S. Highway	38,552	20%
State Highway	40,628	21%
Farm-to-Market Road	84,788	44%
Other Types	13,092	7%
Total Lane-Miles	**192,150**	**100%**

Note that the FM road system, which primarily consists of surface-treated pavements, constitutes the largest percentage of lane-miles (44%). By contrast, the IH system consists of 15,090 lane-miles (8%) and includes both asphalt concrete pavement (ACP) and Portland cement concrete (PCC) pavements. Selection of a specific M&R strategy for a certain section of roadway must be based on a thorough pavement engineering analysis (project-level) that addresses local conditions, costs, traffic and other factors.

The TxDOT highway system includes different types and thicknesses of pavements constructed based on engineering and economic factors. These factors include available funds, climate, materials, location (urban or rural), drainage, subgrade soil type, traffic volumes, loads and many other factors. For this reason, there is no single pavement type or thickness that is the best choice under all conditions. Exhibit P-2 lists the number of lane-miles by pavement type (TxDOT 2007).

Exhibit P-2 Number of On-System Lane-Miles by PMIS Pavement Type – FY 2006

Pavement type (PMIS)	Number of Lane-Miles	Percentage of Total Lane-Miles
Surface Treated	78,278	41%
Thin ACP (<2.5" surface)	27,681	14%
Intermediate ACP (2.5" to 5.5")	53,922	28%
Thick ACP (>5.5" surface)	5,147	3%
Continuously Reinforced Concrete Pavement	10,270	5%
Jointed Concrete Pavement	4,445	2%
Other Types	12,407	7%
Total Lane-Miles	**192,150**	**100%**

The detailed project-level analysis involves selecting and designing the correct pavement type and, eventually, the correct M&R strategy. However, the focus of this study is a network-level analysis that does not select specific treatment types for a given section of pavement, but rather determines district or statewide treatment funding needs based on treatment categories.

Treatment Costs

The five M&R treatment categories used for both the existing on-system mileage and added capacity mileage include:

1. Needs Nothing,
2. Preventive Maintenance,
3. Light Rehabilitation,
4. Medium Rehabilitation, and
5. Heavy Rehabilitation.

Q: What is a pavement treatment?

A: 'Pavement treatment' is a general term that applies to a range of resurfacing or rehabilitation activities designed to improve the ride, surface friction and/or structural strength of the pavement. There are many different types of treatments available depending on the pavement type, condition and available funds. Treatments are summarized into PM, Light, Medium or Heavy Rehab depending on the treatment cost and level of effort involved.

Even though each M&R category can potentially include several different specific treatments (such as a seal coat, thin overlay or microsurfacing), because of the nature of a network-level needs assessment, the analysis identifies the M&R treatment category for each section needing treatment, not a specific treatment type. For this reason, an average cost and a cost range were used for each M&R category other than "Needs Nothing" (categories 2 to 5), where the average project delivery treatment costs and high/low treatment cost ranges were determined based on information obtained from the following sources:

- TxDOT Construction Division – Administration, Construction Section and Materials & Pavements Section;
- TxDOT Maintenance Division – Maintenance Section;
- Associated General Contractors;
- expert panel meeting held August 29, 2008, at the Center for Transportation Research (CTR); and
- TxDOT website – Average Low Bid Unit Price List http://www.dot.state.tx.us/business/avgd.htm.

For the existing system mileage, the type of pavement (PCC, ACP or surface-treated pavement) is known based on PMIS data. For this reason, average project delivery treatment costs for these specific pavement types could be calculated for use in the analysis. However, for added capacity lane-miles, it is not possible to know the type of pavement that will be constructed at some future date. For this reason, the analysis used a weighted average treatment cost for each of the four treatment categories (2 to 5) based on treatment costs for both PCC and ACP pavements.

Comparison with Peer States

A number of factors affect the determination of which states to consider as peer states of Texas. For this study, peer states are identified by comparing critical factors that can affect highway expenditures. Some of these factors included emphasis given to pavement management and design practices, total highway expenditures, pavement M&R expenditures, population, daily vehicle-miles traveled (DVMT), highway network size and population location. Based on information provided by the Federal Highway Administration (FHWA), Exhibit P-3 provides a list of the peer states and some of the key factors used to identify them.

Exhibit P-3 Texas and Peer State 2006 M&R Expenditure per Lane-Mile (FHWA 2006)

State	2006 M&R Expenditures ($ Billions)	State Center-Line Miles	State Lane-Miles	Average Annual M&R Expenditure per Lane-Mile	M&R Expenditure National Rank
Texas	$1.82	79,489	191,530	$9,523	22
Pennsylvania	$1.32	39,843	88,293	$15,044	11
New York	$1.10	15,549	39,267	$27,907	3
Florida	$1.09	12,069	41,914	$25,999	5
Virginia	$1.06	57,481	124,383	$8,548	26
California	$0.82	15,234	50,594	$15,834	10
North Carolina*	$0.69	79,067	168,930	$4,096	45
Illinois	$0.52	16,083	41,990	$11,976	18
Ohio	$0.41	19,266	48,888	$8,484	27
Georgia	$0.21	17,910	47,192	$4,481	43

* Includes both paved and unpaved mileage

Note that Texas state lane-miles shown in Exhibit P-3 are based on an FHWA calendar year 2006 publication. The Texas state lane-miles in Exhibit P-2 are based on TxDOT figures published in calendar year 2007. The difference in numbers in these two exhibits is due to lane-miles added to the Texas system between calendar years 2006 and 2007.

Texas ranks 22nd nationally in lane-mile M&R expenditures. If the average cost per lane-mile for the peer states was used to calculate the annual M&R budget for Texas, the amount would be $2.53 billion. This is over <u>twice</u> Texas' FY 2009 M&R budget of $1.2 billion.

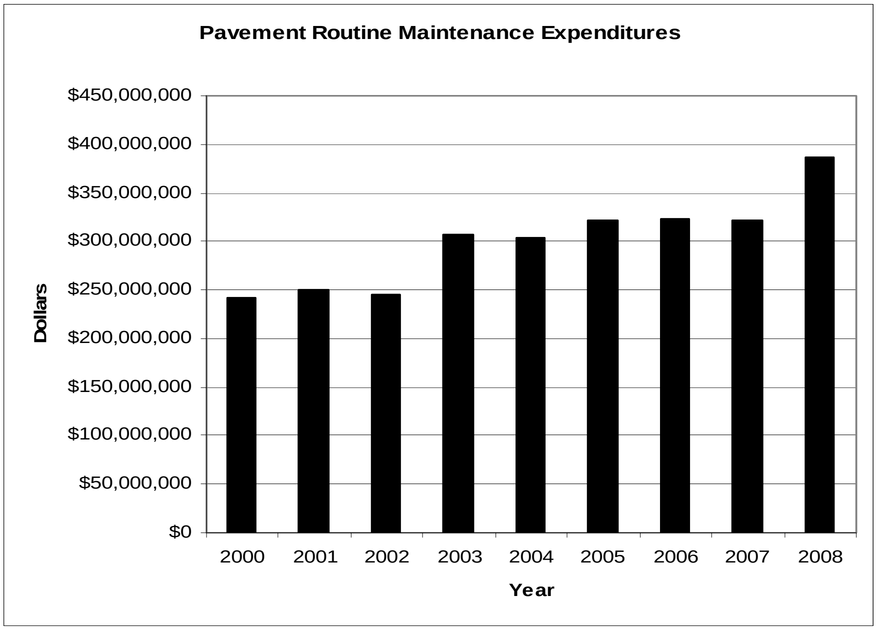
Routine Maintenance Expenditures

Routine maintenance is conducted to address safety issues and repair localized failures to prevent further deterioration of roadways. Routine maintenance includes activities such as pothole repair of a base failure or a short strip seal to improve friction at a specific location. Routine maintenance is not included in the four PMIS treatment categories and is managed by the Maintenance Division. Following is a list of RM activities:

- crack sealing;
- pothole, base layer and other pavement repairs;
- level-ups and short overlays;
- spot or strip surface seals;
- pavement lane or shoulder widening;
- pavement edge repairs; and
- miscellaneous pavement work to address deficiencies

Exhibit P-4 shows annual RM expenditures from 2000 to 2008. The average expenditure over the last three years is $325.13 million (TxDOT 2008).

Exhibit P-4 Pavement Routine Maintenance Annual Expenditures FY 2000 - FY 2008



If RM activities were not conducted, preventive maintenance and rehabilitation costs would increase due to the need for more extensive and costly repairs. Routine maintenance "holds the line" until a planned project can be funded. Continued expenditure of RM funds along the same length of roadway may be an indication of a problem that needs to be addressed with preventive maintenance or rehabilitation. Changes in pavement condition can be positive or negative after a routine maintenance treatment. Pothole patches, crack sealing and other localized repairs can increase pavement roughness or may affect the pavement distress score for the treated section. RM treatments preserve and extend the life of the pavement, and their impacts on pavement condition are inherent in the pavement deterioration curves.

For the existing system, the average expenditure for the last three years was multiplied by 22 years to obtain the total pavement routine maintenance needs for the existing pavement system from 2008 to 2030. The resulting estimate for pavement routine maintenance for the existing on-system mileage is $7.2 billion.

For the added capacity mileage to address mobility, the $325.13 million three-year average annual pavement routine maintenance expenditure was pro-rated based on the number of lane-miles added for each of the four scenarios. Exhibit P-5 provides the estimated pavement routine maintenance expenditures for each of the four mobility scenarios:

Exhibit P-5 Pavement Routine Maintenance Needs for Four Mobility Scenarios

Mobility Scenario	Total Lane-Miles Treated	Estimated RM Needs ($ Billions)
Reduce Congestion	48,300	$1.8
Prevent Worsening Congestion	41,700	$1.5
Maintain Economic Competitiveness	32,700	$1.2
Current Funding Trend	22,500	$0.8

Estimated Preventive Maintenance & Rehabilitation (M&R) Needs

Exhibits P-6 through P-8 show the calculated annual M&R expenditures for the existing on-system mileage required to reach 90%, 87% and 80% 'Good' or better condition respectively. The M&R needs for each of these percentages respectively are $77 billion, $73 billion and $64 billion for the 22-year analysis period. For this analysis, the respective goals are reached in the fourth year, or 2012, being consistent with the Texas Transportation Commission's goal to reach 90% 'Good' or better pavement conditions statewide by the year 2012.

Q: What does % 'Good' or Better mean?

A: Each year distress and ride is measured on Texas pavements to determine distress, ride and condition scores. Low levels of distress such as rutting, cracking and a good ride quality result in a high score. High levels of distress and/or poor ride quality result in a low score. Pavement Condition Scores that are from 100 – 90 are categorized as 'Very Good'; 89 – 70 are 'Good'; 69 – 50 are 'Fair'; 49 – 35 are 'Poor' and 34 and below are 'Very Poor.'

The % of pavements in 'Good' or Better Condition consists of the percentage of pavement in Texas with a Pavement Condition Score of 70 or above.

Exhibit P-6 Annual M&R Needs to Attain and Maintain 90% 'Good' or Better Condition

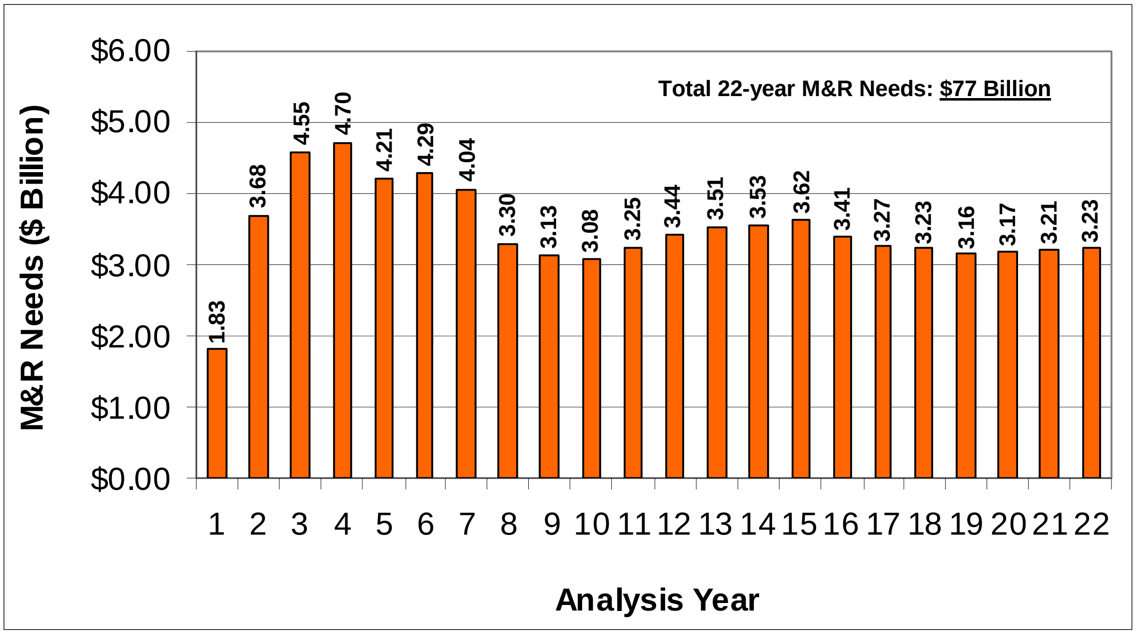


Exhibit P-7 Annual M&R Needs to Attain and Maintain 87% 'Good' or Better Condition

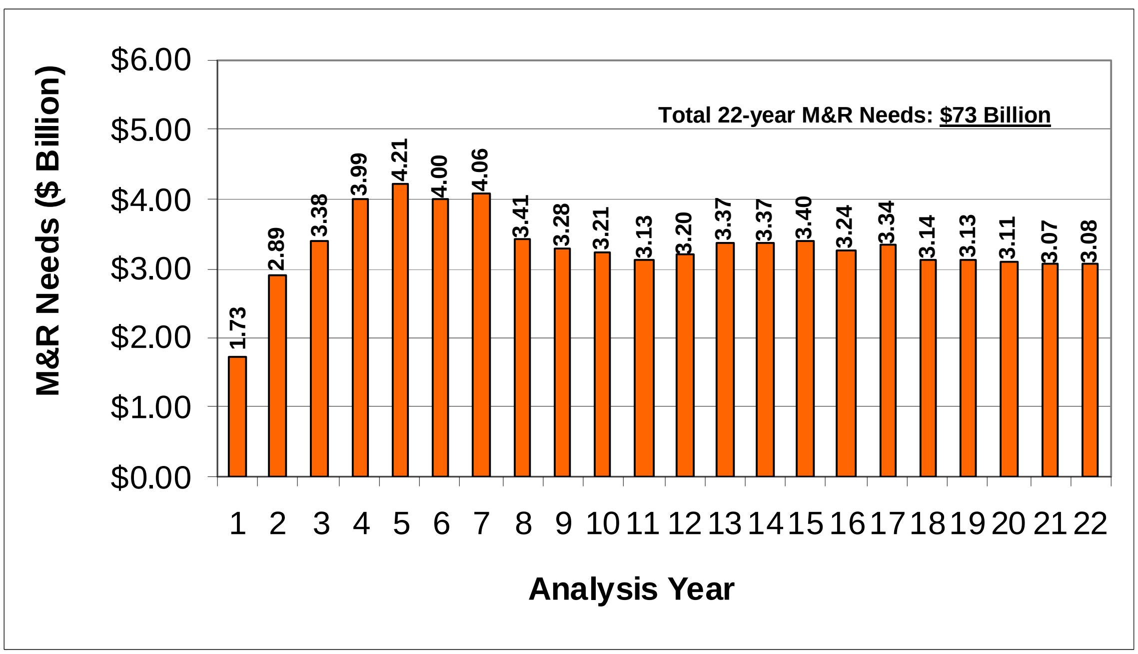
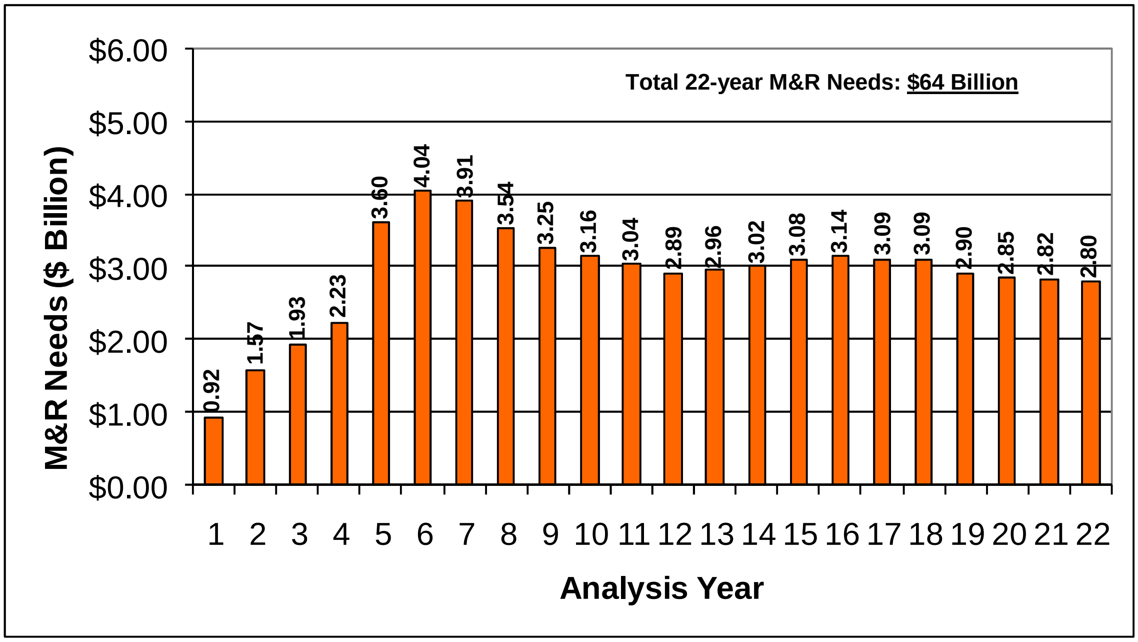


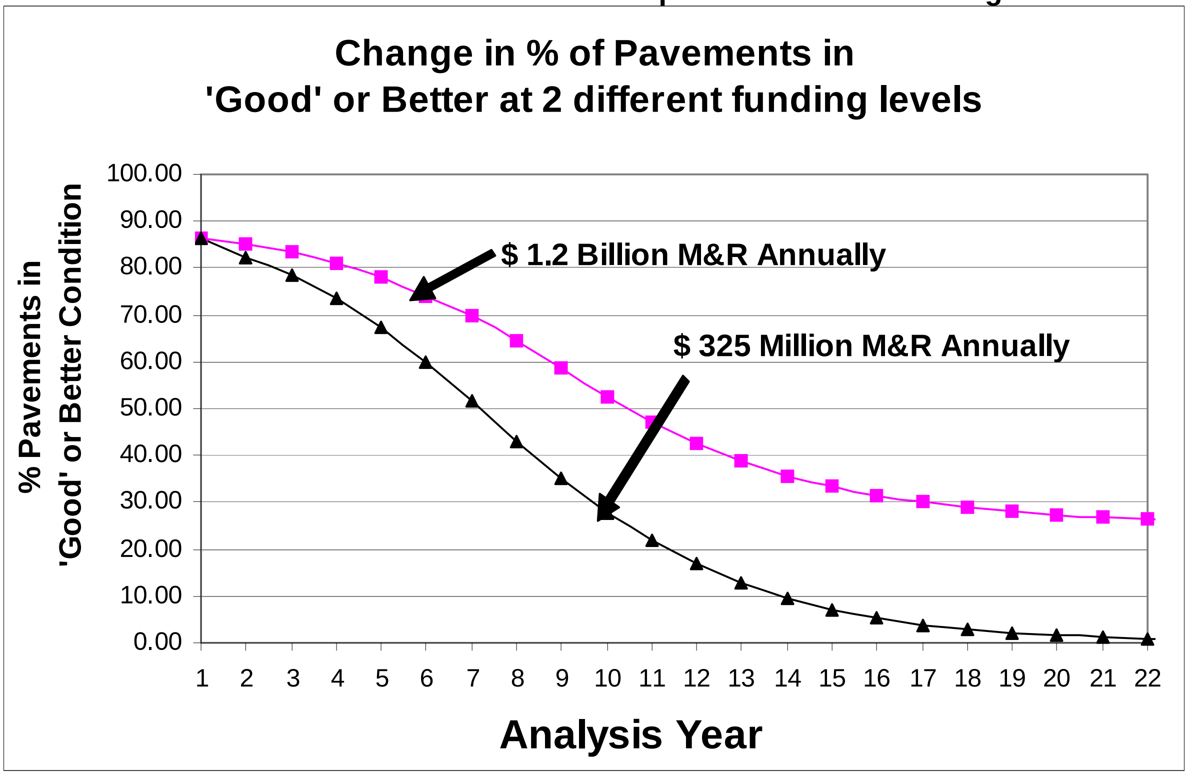
Exhibit P-8 Annual M&R Needs to Attain and Maintain 80% 'Good' or Better Condition



Note that the difference in funding needs between the 90% 'Good' or better goal and the 80% 'Good' or better goal is $13 billion. Approximately 50% of the need difference occurs within the first 7 years of the analysis period and the remaining 50% within the last 15 years. Note also that the difference in need between these high and low goals range from about $300 million to $500 million a year beyond year 11.

Analyses were also performed to determine the impact of different constrained budget levels on the network condition. Exhibit P-9 shows how the % 'Good' or better condition will change based on two different funding scenarios. The first funding scenario shows how conditions will change if the current FY 2009 funding level of $1.2 billion is maintained annually until 2030. The second funding scenario shows how conditions will change if the M&R budget is funded at $325 million annually, which is equivalent to the current average Routine Maintenance budget. The percentage of 'Good' or better pavements is projected to fall to 50% in just over seven years. Exhibit P-9 also shows how the network condition declines if the current $1.2 billion M&R budget is maintained over the entire 22-year analysis period. The percentage of 'Good' or better pavements is projected to fall to 50% in just over 10 years.

Exhibit P-9 Pavement Condition Comparison for Two Funding Levels



Based on the annual expenditures shown in Exhibit P-6, the estimated total M&R cost to provide for treatment of the existing on-system 192,150 lane-miles is $77 billion. Adding the existing on-system RM needs of $7.2 billion to the M&R needs results in a total need for the existing network of slightly over $84 billion. The M&R funding needed to treat added capacity lane-miles for the four mobility scenarios is summarized in Exhibit P-10. Exhibit P-11 shows the summation of RM and M&R needs for the analysis period.

Exhibit P-10 Estimated M&R Costs for Four Mobility Scenarios

Mobility Scenario	Added On-System Lane-Miles	Estimated M&R Cost ($ Billions)
Reduce Congestion	48,300	$4.5
Prevent Worsening Congestion	41,700	$3.9
Maintain Economic Competitiveness	32,700	$3.1
Current Funding Trend	22,500	$2.1

Exhibit P-11 Estimated Routine Maintenance and M&R Needs for Four Mobility Scenarios

Mobility Scenario	Added On-System Lane-Miles Treated	Estimated RM and M&R Needs ($ Billions)
Reduce Congestion	48,300	$6.3
Prevent Worsening Congestion	41,700	$5.5
Maintain Economic Competitiveness	32,700	$4.3
Current Funding Trend	22,500	$2.9

The total estimated RM and M&R needs are summarized in Exhibit P-10 based on a sum of the existing on-system and added capacity lane-mile needs.

Exhibit P-12 90% 'Good' or Better – Total Estimated M&R and Routine Maintenance Costs for the Four Mobility Scenarios plus the Existing 192,150 On-System Lane-Miles

Analysis Scenario	Total Lane-Miles Treated	Estimated M&R plus RM ($ Billions)
Existing System plus Reduce Congestion	240,450	$91
Existing System plus Prevent Worsening Congestion	233,850	$89
Existing System plus Maintain Economic Competitiveness	224,850	$88
Existing System plus Current Funding Trend	214,650	$87

Exhibit P-13 87% 'Good' or Better – Total Estimated M&R and Routine Maintenance Costs for the Four Mobility Scenarios plus the Existing 192,150 On-System Lane-Miles

Analysis Scenario	Total Lane-Miles Treated	Estimated M&R plus RM ($ Billions)
Existing System plus Reduce Congestion	240,450	$87
Existing System plus Prevent Worsening Congestion	233,850	$85
Existing System plus Achieve Mobility Competitiveness	224,850	$84
Existing System plus Current Funding Trend	214,650	$83

Exhibit P-14 80% 'Good' or Better – Total Estimated M&R and Routine Maintenance Costs for the Four Mobility Scenarios plus the Existing 192,150 On-System Lane-Miles

Analysis Scenario	Total Lane-Miles Treated	Estimated M&R plus RM ($ Billions)
Existing System plus Reduce Congestion	240,450	$78
Existing System plus Prevent Worsening Congestion	233,850	$76
Existing System plus Achieve Mobility Competitiveness	224,850	$75
Existing System plus Current Funding Trend	214,650	$74

The analysis also showed that if the percentage of the pavement system in 'Good' or better condition drops from 90% to 87%, a total of 5,700 lane-miles of pavement will fall to the 'Fair', 'Poor', or 'Very Poor' condition categories. If the pavement system drops from 90% to 80%, a total of over 19,000 lane-miles of pavement will fall to the 'Fair', 'Poor', or 'Very Poor' condition categories. In addition, as pavement conditions deteriorate, the traveling public will experience an increase in vehicle operating costs due to rougher pavement conditions.

Conclusions

As shown in Exhibits P-12 through P-14, the total estimated cost to provide maintenance and rehabilitation for the existing TxDOT pavement system at three different goal levels, including projected mileage based on the four mobility scenarios, ranges from a low of $74 billion to a high of $91 billion.

Based on a review of the variation in treatment costs for each of the treatment levels (PM, LRhb, MRhb and HRhb), the estimated M&R costs for the on-system lane-miles could vary +/- 5%. The variation due to treatment costs could therefore result in a range in total M&R treatment costs from a low of approximately $70 billion to a high of approximately $95 billion.

Committee Recommendations:

- Preserve the asset value of all pavements by maintaining a 90% 'good' or better pavement condition goal.
- Establish a statewide system to forecast and prioritize pavement maintenance needs.
- Pavement preservation needs = $89 billion total; $4 billion per year (average). (This figure includes maintenance needs for the existing 192,150 lane-mile pavement system and added pavement lane-miles for mobility scenario: 'prevent worsening congestion.')

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Bridge Maintenance

Introduction and Bridge Data Sources

The recent collapse of the I-35W bridge in Minneapolis has refocused attention on the need to inspect and maintain the U.S. highway bridge system and replace those bridges found to be deficient. Bridges require continuous maintenance and inspection to ensure their ability to support increasing traffic volumes and heavier truck loads. Public pressure following the 1967 collapse of Silver Bridge on the Ohio River prompted Congress to pass legislation requiring increased oversight and regulation of U.S. bridges. The legislation mandated the establishment of a National Bridge Inspection Standard and an accompanying National Bridge Inventory (NBI) database, which contains the inspection data on all publicly owned bridges and culverts with lengths greater than 20 feet.[1] Information on each record is updated by undertaking biannual standardized field inspections; the 2007 U.S. edition has over 600,000 records.

Each NBI bridge record lists 116 items, including such specific characteristics as age, location, functional class and structure type.[2] The NBI database in Texas is termed the Bridge Inspection and Appraisal Program (BRINSAP). The BRINSAP database reports on structures identified as on-system—for which the state, through the Texas Department of Transportation (TxDOT), maintains responsibility—and off-system—for which responsibility usually lies with counties and cities. It is the most comprehensive set of current Texas bridge data and is used as the primary data source for the analyses reported in this chapter. Bridge maintenance needs are expressed in 2008 dollars with no increase applied for inflation.

Current Conditions

As part of the assessment of needs and current conditions, public comments were solicited through multiple means of collection. Comments from citizens, business groups, councils of government and community organizations came in through email, U.S. Mail and fax. Public meetings and public hearings held across the state were scheduled and publicized through each local TxDOT public information office or through the TxDOT Office of Government and Public Affairs. In addition to comments from the public, more than 90 elected officials, community leaders and citizens presented testimony at the scheduled public hearings. For more information regarding public comments obtained during the assessment process, see Appendix A.

[1, 2] The Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges Report No. FHWA-PD-96-001, December 1995. Information on each record is updated by undertaking bi-annual standardized field inspections; the 2007 U.S. edition has over 600,000 records.

Texas and Nationwide Bridge Statistics

Summaries generated using Federal Highway Administration (FHWA) data[3] allow comparisons to be made between Texas and other peer states. Texas has almost twice as many bridges as the next state, with 8.4 percent (over 50,000) of the nation's bridges as shown in Exhibit B-1. Texas has 11.3 percent of the bridge deck area nationwide, which equates to more than 414 million square feet of deck area, as shown in Exhibit B-2.

Exhibit B-1: Peer State Comparisons: Percentage of National Bridges

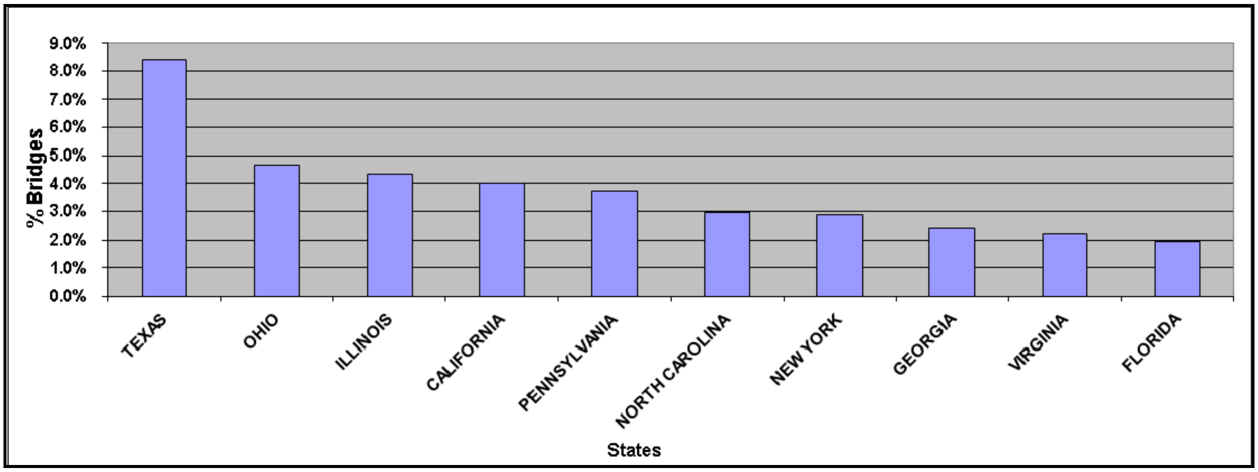
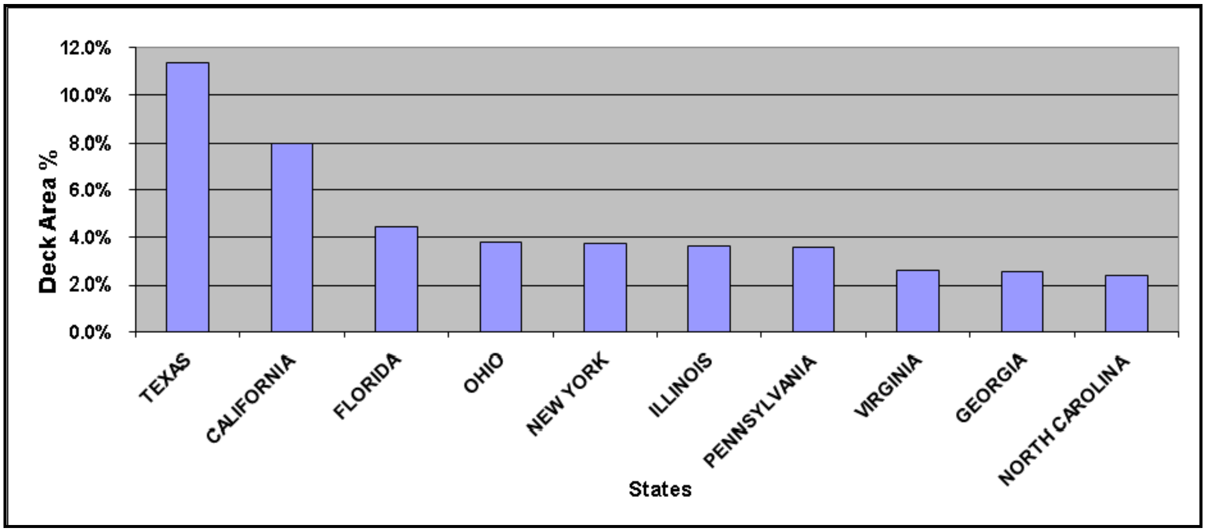


Exhibit B-2: Peer State Comparisons: Percentage of National Bridge Deck Area

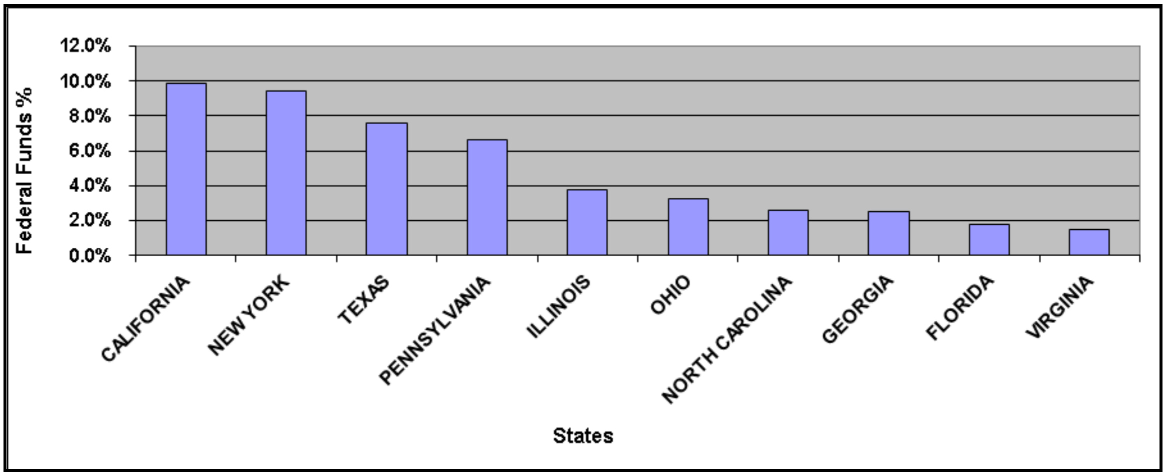


Texas received only 7.6 percent of the funds allocated to the states by the FHWA for bridge rehabilitation and replacement in FY 2007. These funds are clearly disproportionate to the Texas inventory of 11.3 percent of the deck area nationwide. In FY 2006, Texas received $362 million of the $4.8 billion distributed to the states, and Exhibit B-3 shows a peer state comparison of

[3] http://www.fhwa.dot.gov/bridge/hbrrp.htm

these distributed funds. Funding has declined since that date. In FY 2008 TxDOT received an additional $32 million of federal funds for the bridge program from the Consolidated Appropriations Act which passed following the collapse of the IH 35W bridge over the Mississippi River in Minneapolis. In FY 2009, despite these additional federal funds, the total available for bridges in the Highway Bridge Program (HBP) was $270 million.

Exhibit B-3: Peer State Comparisons: Percentage of Federal Funds for Bridges



Status of Texas Bridges

TxDOT established a goal of achieving 80 percent of the bridges rated in good or better condition by 2011. Exhibit B-4 summarizes the progress of TxDOT in achieving this goal and adds another goal of eliminating all on-system structurally deficient bridges. The goals established by TxDOT for the Texas bridges and related definitions of terms are provided in Appendix C.

Exhibit B-4: Increase in Condition Rating and Reduction in Deficient Rating

Fiscal Year	Condition Rating Good or Better	Structurally Deficient On-System Bridges
2001	70%	763
2002	71%	693
2003	75%	645
2004	76%	565
2006	77%	483
Goal 2011	80%	0

The September 2007 BRINSAP data show there are 33,500 on-system bridges, which encompass 352 million square feet of deck area and carry 584 million vehicles per day. There are 17,567 off-system bridges, which encompass 64.8 million square feet of deck area and carry 57 million vehicles per day.

Average bridge service life expectancy is approximately 50 years. The on-system bridge construction increased in the late 1950s and was approximately constant about from 1964 to 1974. These bridges will be reaching their expected 50-year life spans and will need replacement by 2030.

Exhibit B-5 shows the distribution of deck area by age for on-system bridges. A fairly high proportion exceeds the 50-year life expectancy, pointing to a growing replacement need. The peak in the off-system bridges occurred much later, starting about 1980 (Exhibit B-6). The peak of the replacement costs of the off-system bridges will not occur during the time frame covered by this study. However, a significant number of structurally deficient off-system bridges are currently in the inventory and these are candidates for replacement.

Exhibit B-5: Distribution of Deck Area by Year Built—On-System

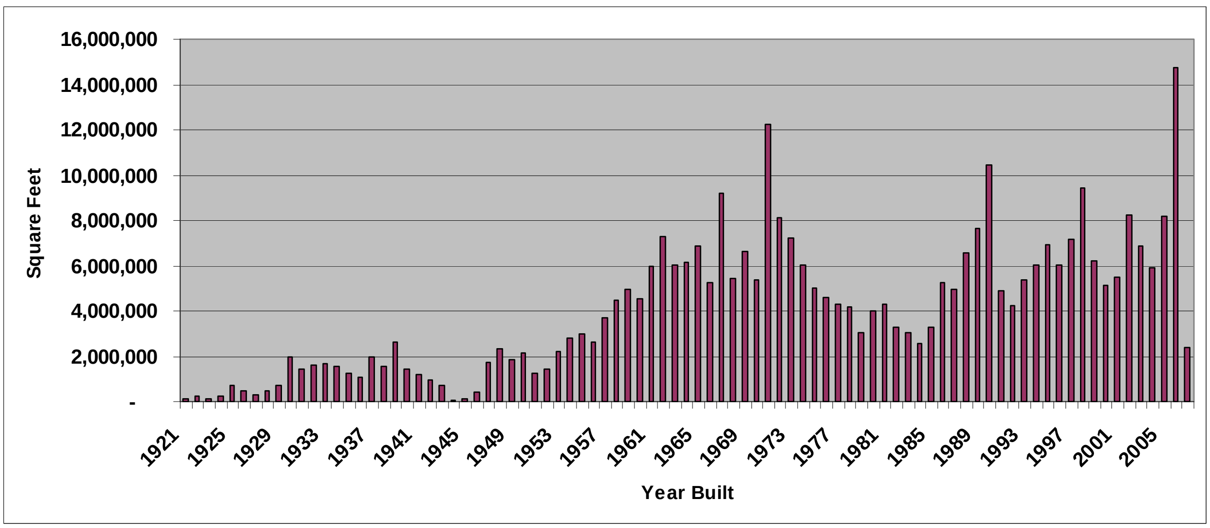


Exhibit B-6: Distribution of Deck Area by Year Built—Off-System

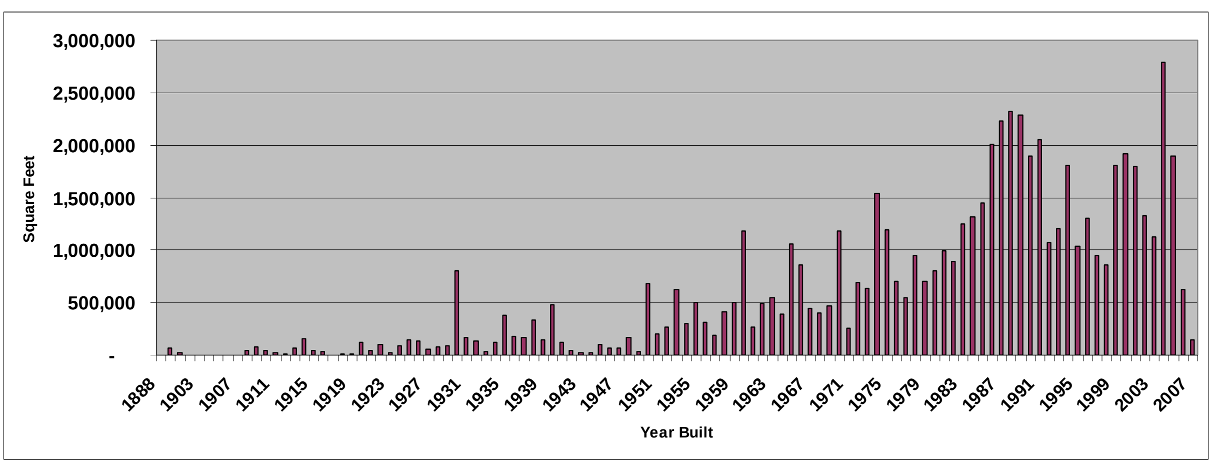


Exhibit B-7 summarizes the current conditions of on- and off-system bridges, respectively, using the federal eligibility criteria, and is based on the September 2007 BRINSAP data for both on- and off-system structure.

Exhibit B-7: Condition of Texas Bridges (September 2007)

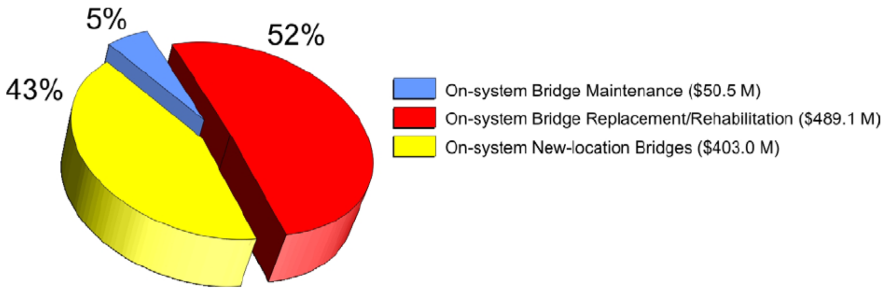
On-system (33,504 bridges)		
Rating	Bridges	Percent
Substandard for Load Only	106	0.32
Structurally Deficient	421	1.26
Functionally Obsolete	3,987	11.9
Off-system (17,568 bridges)		
Rating	Bridges	Percent
Substandard for Load Only	1,245	7.09
Structurally Deficient	1,552	8.83
Functionally Obsolete	3,918	22.3

As part of the assessment of needs and current conditions, public comments were solicited through multiple means of collection. Comments from citizens, business groups, councils of government and community organizations came in through email, U.S. Mail and fax. Public meetings and public hearings held across the state were scheduled and publicized through each local TxDOT public information office or through the TxDOT Office of Government and Public Affairs. In addition to comments from the public, more than 90 elected officials, community leaders and citizens presented testimony at the scheduled public hearings. For more information regarding public comments obtained during the assessment process, see Appendix A.

Texas Bridge Expenditures

Information from TxDOT's latest report regarding expenditures for Texas on-system bridges (September 2006) is summarized in Exhibit B-8. A total of about $943 million was spent on the on-system bridges to provide replacement/rehabilitation, maintenance, and inspection, together with the construction of new bridges for added capacity. The corresponding total for off-system bridges was $82.3 million.

Exhibit B-8: Expenditures for the On-System Bridges, FY 2006



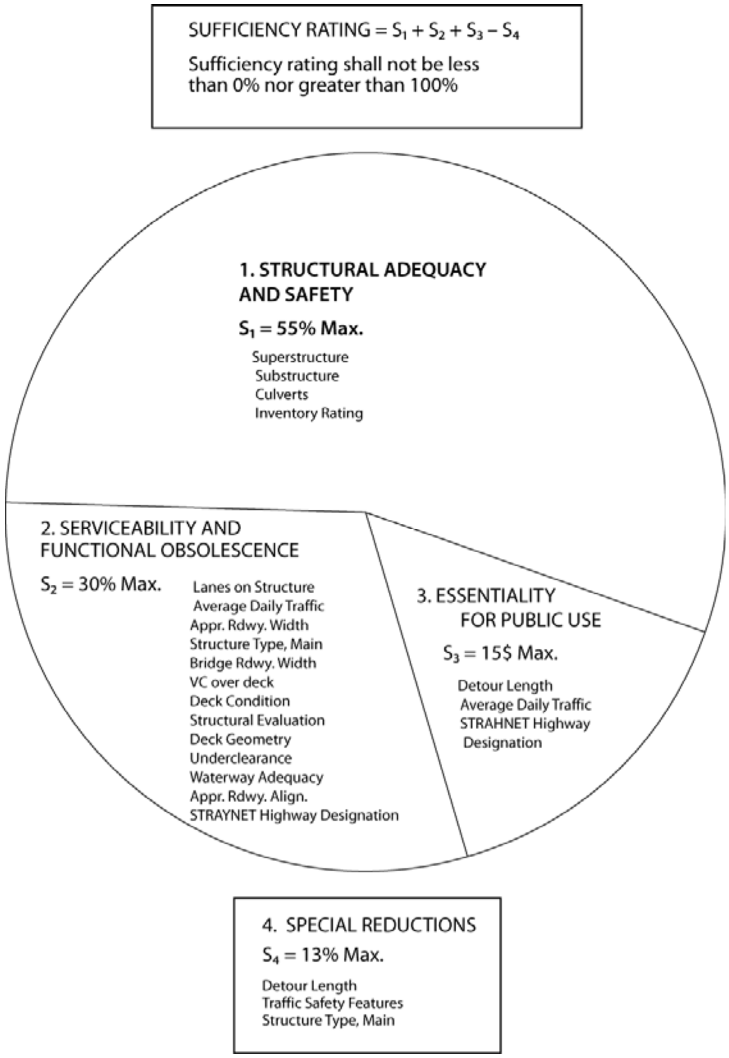
Eligibility for Federal Funds

Bridge projects nominated for federal funding require a 20 percent match from the State of Texas. Eligibility requires that each state first submit annual NBI data to the FHWA where staff determines which bridges meet the program's criteria and are eligible for HBP funding. Each state is allocated a total funding figure based on several criteria – including deck area and reported cost – and a budget is allocated that is typically constrained.

No specific bridges are identified by FHWA, and each state must decide on appropriate candidates for the program. The federal government will fund 80 percent of rehabilitation or replacement projects for eligible bridges, both on- and off-system, although organizations responsible for off-system structures frequently encounter difficulty funding their 20 percent of the cost. In the latter case, TxDOT has decided to share the cost and, in some cases, cover the entire amount so the off-system funding can comprise either 80 percent federal, 10 percent local and 10 percent state, or 80 percent federal and 20 percent state.

The FHWA eligibility process is as follows. A bridge must have a sufficiency rating (SR) of 80 or less to be eligible for federal HBP rehabilitation funds. Bridges with a sufficiency rating less than 50 are eligible for bridge replacement funding. Exhibit B-9 shows the main components of the SR formula, which combines attributes that measure the ability of a bridge to remain in service and produces a number on a 0-to-100 scale. A bridge may be classified as structurally deficient, functionally obsolete or both. Structural deficiency refers to the condition of the bridge deck, superstructure, and substructure, and reflects the integrity of the structure. The measure of functional obsolescence is based upon the deck geometry, underclearance, and approach roadway alignment of the bridge, and reflects the impact of the structure on highway capacity and safety, among other factors.

Exhibit B-9: Sufficiency Rating Formula and Its Components



Forecasting Texas Bridge Needs

Current Rehabilitation and Replacement Unit Costs

The 2030 Report bridges research team performed an evaluation of 2008 bridge rehabilitation and replacement costs to estimate the present and future costs needed to maintain the Texas bridge network at acceptable levels of service. For this purpose, bridge construction costs, as required for reporting by the FHWA, need to be enhanced by including what is defined in the transportation community as project delivery costs. Project delivery costs represent total project costs including engineering, mobilization and approach roadway costs, as well as the bridge cost. This is important since the federal contribution, though substantial, is "abutment to abutment" and does not cover several categories of cost needed to complete typical bridge engineering.

Exhibit B-10 presents the tabulation of some recent bridge bid data used to generate unit costs for bridge rehabilitation and replacement. These results encompass all cost items that contribute to project delivery costs. Only projects begun in 2008 were taken into consideration, as construction costs have been increasing at a high rate in the past four years, adding uncertainty to bid data for projects that were built several years ago. A meeting with bridge experts[4] provided information to evaluate various aspects of bridge analysis, including these costs. The consensus of the panel of experts was that a unit price of $200 per square foot was a reasonable estimate of current bridge replacement costs. Based on the tabulation of bids reported in Exhibit B-10, and the deliberations of the panel using further data from work being currently undertaken, an estimated average rehabilitation cost of $120/per square foot and a bridge replacement cost of $194/per square foot were used to estimate future bridge replacement costs.

Exhibit B-10: Replacement and Rehabilitation Unit Costs

Project Type	Highway	Feature Crossed	CSJ	Deck Area (square foot)	Bids	$/square foot
Bridge Rehab - Rural - On	US90	Pecos River	0022-06-046	42,260	$5,050,180	120
Bridge Replace - Rural - Off	Cooks Rd.	Channel	0920-03-067	2,210	$394,771	179
Bridge Replace - Rural - On	FM1776	Pecos River	2262-01-013	12,880	$2,693,126	209

Technical Analysis

Current Bridge Replacement Costs

The 2030 bridge analysis assumes that all bridges, either on-system or off-system, that are structurally deficient or substandard for load only are replaced immediately. Functionally obsolete bridges are replaced based upon the following criteria:

- Bridges that have a sufficiency rating of less than 50 will be replaced.
- Bridge replacement will be capped at 5 percent of the existing number of bridges (there are 33,508 on-system and 17,568 off-system existing bridges in the 2007 inventory).
- Bridges with higher average daily traffic (ADT) will receive priority.
- Unit costs for replacement will be $194 per square foot.
- No expansion factor is included for the replacement of the on-system deck area because additional capacity bridge costs are being incorporated in the Urban Mobility chapter of this report.
- An expansion factor of two is assumed for off-system bridges. Bridges screened for replacement are replaced with twice the deck area.
- Special large bridges were not included in this analysis and are treated separately.

[4] The 2030 team was guided by several experts who donated their time to providing insight and guidance on several key issues. This panel was comprised of Ralph K. Banks, P.E., Pete Chang, P.E., Dr. Manuel Diaz, P.E., Tom Stephenson, P.E.. TxDOT personnel provided data and insight into TxDOT procedures and are here acknowledged: Tom Rummel, P.E., Keith Ramsey, P.E., Michael O'Toole, P.E., and Tom Yarborough, P.E. Affiliations are provided in Appendix C.

The analysis, using these criteria, estimates that 674 on-system bridges will need to be replaced in the first year of the study period, and that these bridges account for 6,191,127 square feet of deck area to be replaced at a cost of $1.2 billion. Similar calculations for off-system bridges result in 879 bridges that need to be replaced in the first year of the analysis, and these bridges account for 2,615,321 square feet of deck area replaced at a cost of $507 million.

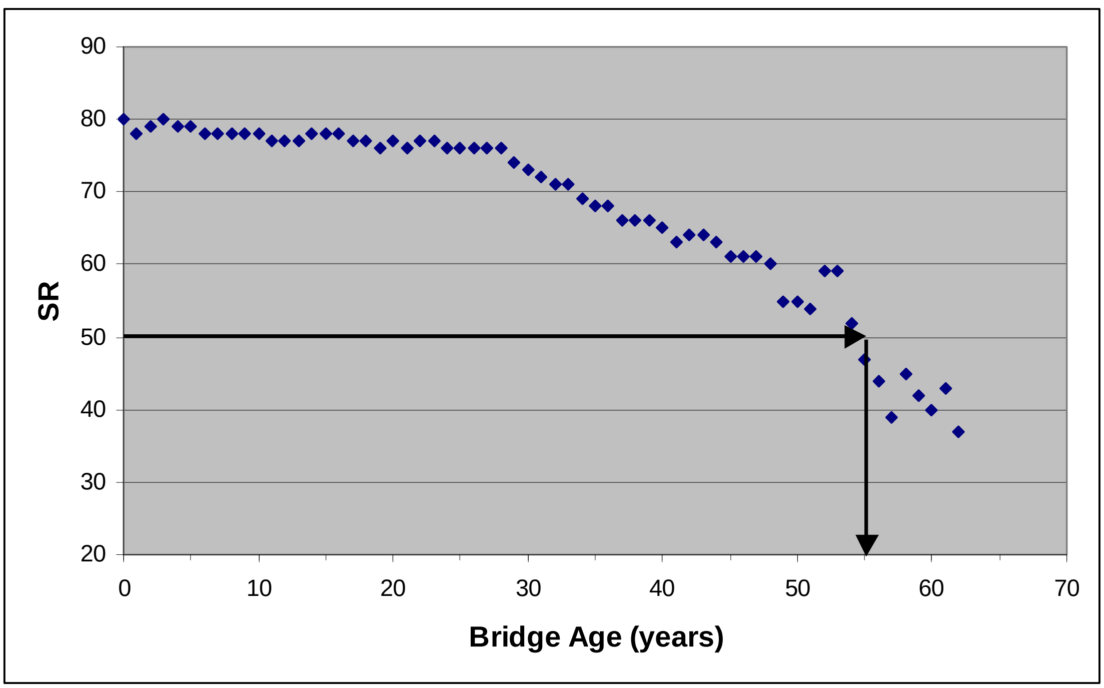
Detailed tables summarizing these results for needs in the first year of the analysis on a county-by-county basis may be found in Appendix C.

Bridge Replacement Costs through 2030

Extensive statistical analysis of the BRINSAP database from 1995 through 2007 shows that based on a sufficiency rating threshold of 50—the federal criterion for bridge replacement—on-system bridges reach this threshold at an age of 55 years. Similar analysis using the sufficiency rating for off-system bridges leads to a replacement criteria at an age of 50 years. These values were calculated so that there is a 10 percent probability that the age of replacement is less than the calculated value.

This analysis was performed based on highway functional class and age. Results appeared almost insensitive to functional class. One of the charts generated by this statistical analysis is shown in Exhibit B-11 to illustrate the procedure and shows that the eligibility criterion (SR 50) is reached at 55 years.

Exhibit B-11: Sufficiency Rating (SR) by Age for Functional Class 41 (Interstate Urban)



First-year analysis follows the procedure outlined earlier in this chapter. Subsequent years use the sufficiency rating and age thresholds determined by the statistical analysis reported previously to screen bridges that are candidates for replacement. In addition, some of the assumptions listed previously for the current bridge replacement costs paragraph, such as expansion factors, priority by average daily traffic, and the limit on the number of bridges to be replaced in a given year, are also used in the analysis.

Exhibits B-12 and B-13 show the calculated costs for needs regarding on- and off-system bridges, respectively. Tables tabulating the annual costs are provided in Appendix C. Bridge replacement costs are forecasted to be $19.9 billion for the on-system bridges and $7.8 billion for the off-system bridges through the period ending in 2030.

Exhibit B-12: Bridge Replacement Needs for On-System Bridges through 2030

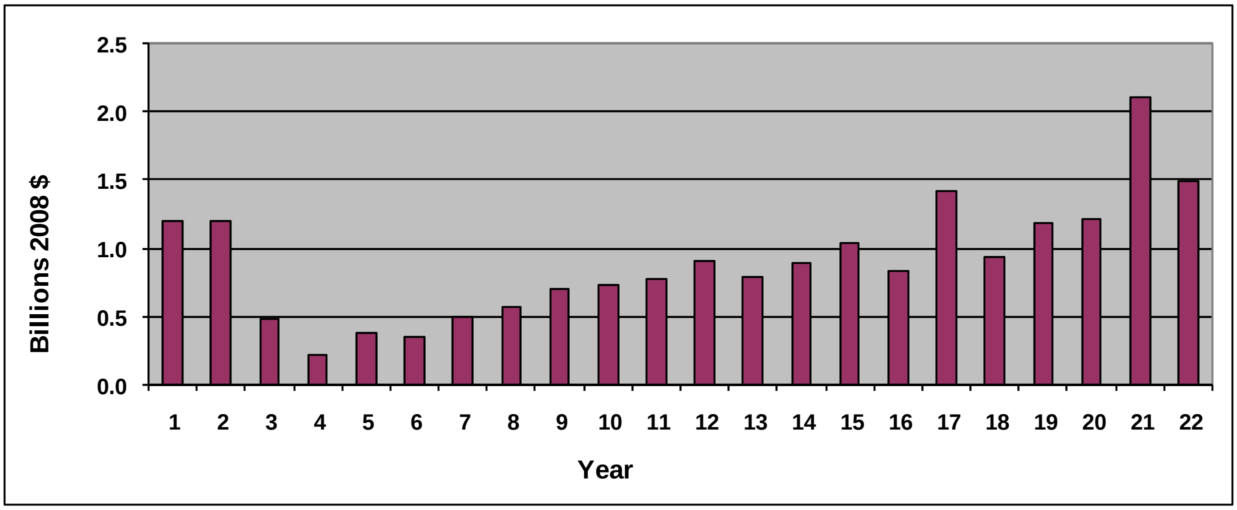
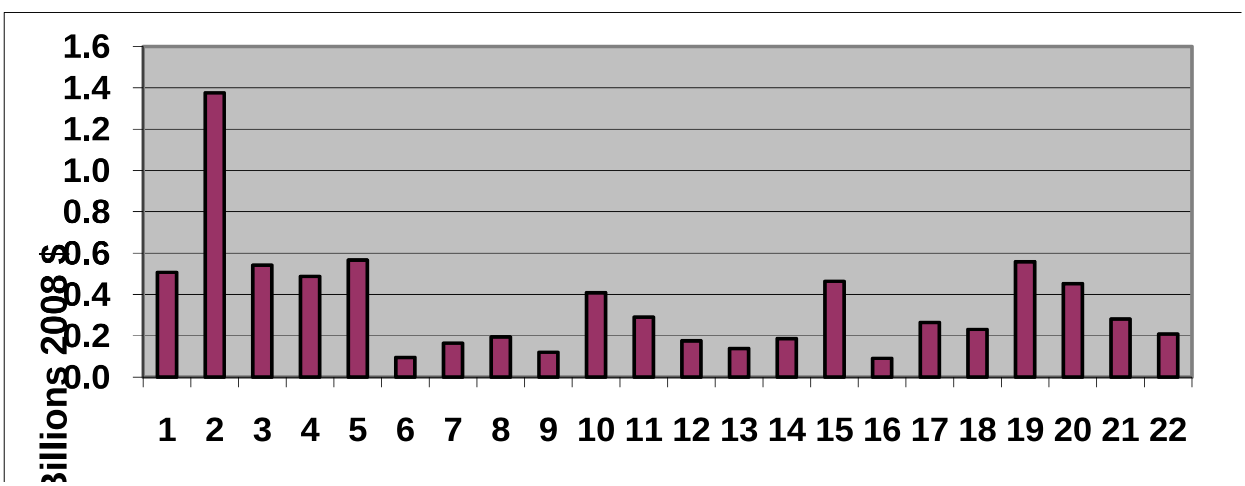


Exhibit B-13: Bridge Replacement Needs for Off-System Bridges through 2030



Mobility-Generated Bridges

The Texas Transportation Institute (TTI) supplied calculations for lane-miles to be added to the Texas roadway system to satisfy future mobility needs through the year 2030. These mobility miles were supplied to satisfy the three scenarios given at the start of the bridge analysis:

- Scenario 1: Current Funding Trend
- Scenario 2: Maintain Economic Competitiveness
- Scenario 3: Reduce Congestion

The lane-miles were reported on a TxDOT district basis and also by roadway functional class. Ratios of bridges per lane-mile by district and functional class were developed to convert the mobility lane-miles supplied by TTI to an applicable number of new bridges (called "mobility bridges" in this analysis). These bridge-per-mile ratios were calculated using the 2007 BRINSAP and RHINO files. The RHINO database has all the geometric data and traffic volume for most of the Texas roadways and is maintained by TxDOT's Transportation Planning and Programming Division (TP&P). BRINSAP bridge statistics by district and roadway functional class were matched with RHINO lane-miles by district and functional class to calculate these ratios. The ratios calculated for the Fort Worth District are presented in Exhibit B-14 to illustrate this process. A similar table summarizing the results for all districts is included in Appendix C.

Exhibit B-14: Calculation of Ratios of Bridges per Mile for the Forth Worth District

Functional Class	Lane-Miles	# Bridges	Ratio Bridges/Mile
Urban Arterial	1,073	256	0.2385
Urban Freeway	827	580	0.7015
Rural Principal Arterial	919	199	0.2166
Rural Interstate	307	168	0.5473

The bridges added for mobility will require inspection and maintenance through the year 2030. These costs are included in the inspection and maintenance cost estimates. However, due to the long replacement life-cycle of bridges—around 50 years—the mobility bridges were not included in the future replacement analysis discussed previously.

Similar calculations were carried out using statistics for lane-miles and bridge counts to calculate appropriate ratios for all TxDOT districts. Ratios were used to convert mobility lane-miles to bridge counts that were, in turn, used to calculate maintenance and inspection costs for the mobility bridges. Exhibit B-15 summarizes the number of lane-miles and associated number of bridges for the three scenarios.

Exhibit B-15: Lane-Miles and Bridges for the Mobility Scenarios

Scenario	Current Funding Trend	Maintain Economic Competitiveness	Reduce Congestion
Number of Bridges Added	13,734	18,809	23,041
Lane-miles for Scenario	41,355	58,700	70,237

Costs of Inspection for Existing and Mobility-Generated Bridges

Federal law requires that all bridges be inspected every two years plus or minus six months. The purpose of the inspection is to evaluate deterioration of the bridge and to ensure the ability of the bridge to safely carry the legal or posted loads. Data from the bridge inspection are coded into a computerized database, BRINSAP in Texas. This database is used to set priorities for bridge repair and replacement. It is also the main database for the analyses conducted in the 2030 bridge study.

Two types of inspection are performed. Multiple-girder bridges such as the one shown in Appendix C are inspected visually. These types of bridges possess multiple load paths; consequently, loss of a single member will not cause a collapse. The condition of the bridge deck (the riding surface), the bridge railing, the expansion joints, girders, the bearings supporting the girders, and the substructure are examined visually for signs of deterioration. These inspections are typically performed by outside engineering firms. TxDOT requires that bridges be load-rated during subsequent in-office evaluations. The load-rating requirement is a new practice in Texas that should enhance bridge safety but will also increase the cost of the inspection and inspection reports.

Bridges that may collapse if a single element fractures are termed by engineers as “fracture critical,” and federal law requires that a hands-on inspection of the critical areas of such bridges be undertaken. In Texas, a specially trained team of TxDOT bridge inspectors do most of these bridge inspections. As an example, the inspectors look for fatigue cracking at critical weld and connection details. These inspections require much more time and the use of man lifts or specialized bridge snoopers to provide the access to the critical areas. Twin box girder bridges used for ramp structures in interchanges and the straddle bent caps used to support girders above traffic lanes are the most prevalent type of fracture critical structures. Inspection of a fracture straddle bent cap is shown in Appendix C. The cost to perform the inspection is dependent upon the number of fracture critical elements and details in a structure. As the number of areas required for inspection increases, the time and cost of the inspection also increases. The number of inspection locations varies from 1 for simple structures to 74 on longer, more complex structures.

The substructure supporting a bridge may require an underwater inspection. Corrosion inspection in brackish water and scour inspection around the pilings can be done only through underwater inspection by a certified diver. These underwater inspections are performed by TxDOT inspection personnel.

The annual cost of these inspections was estimated based on cost data from the FHWA, TxDOT and bridge inspection engineers. An additional increment was added to the inspection cost estimates to cover the cost of the bridge load-rating as part of the routine inspection requirement. The annual cost figures are shown in Exhibit B-16. The annual cost was developed assuming half of the bridges in the inventory are inspected each year to comply with federal requirements. The inspection costs are broken down between on- and off-system bridges. These costs are recurring annual costs. Over the 22-year planning horizon, inspection costs will add up to $942 million, calculated using the annual inspection costs summarized in Exhibit B-16 over the 22-year study horizon.

Exhibit B-16: Annual Inspection Costs for Existing On-System and Off-System Bridges Millions (2008 $)

System	Fracture Critical		Non Fracture Critical		Underwater Diver Inspection		Total Annual Bridge Inspection Costs
	Number of Bridges	Annual Costs	Number of Bridges	Annual Costs	Number of Bridges	Annual Costs	
On	378	$1,470,863	33,126	$24,844,500	603	$1,658,250	$27,973,613
Off	357	$1,412,888	17,211	$12,908,250	193	$530,750	$14,851,888
					Total All Bridges/year		$42,825,500

Detailed annual estimates for the additional bridges added for mobility and their inspection costs are summarized in Appendix C. Total Inspection costs for new bridges added during the study period (2009-2030) are estimated as follows:

- Current Funding Trend scenario - $132 million
- Maintain Economic Competitiveness scenario - $180 million
- Reduce Congestion scenario - $221 million

Costs of Maintenance for Existing and Mobility-Generated Bridges

Bridge maintenance maintains the integrity of bridge structural elements, repairs the bridge deck and deck joints, paints the bridge, and repairs guardrail damage. Maintenance of the river channel underneath the bridge is included in bridge maintenance costs. TxDOT maintenance costs over the last eight years were analyzed to develop cost estimates for both on- and off-system bridges. No data were available for off-system bridges. The maintenance cost for off-system bridges was estimated using the on-system cost as a basis. However, maintenance costs for off-system structures are not the responsibility of TxDOT, as off-system bridges are owned by cities and counties.

The pie chart in Exhibit B-17 shows the average amount spent in the last eight years on bridge maintenance activities. The bulk of the funds are spent on maintaining and clearing the water channel under the bridge and for emergency repairs. Repairs of the bridge deck, expansion joints and the railing are the largest of the remaining maintenance costs.

The total maintenance cost and total less emergency repair costs are shown in the exhibit. The emergency repair cost varies greatly from year to year and was removed from the other costs to extract the true maintenance costs. The average emergency repair cost for the eight years was $5.6 million. This figure will be added in to the estimated maintenance cost as a constant to develop the future costs. It is not expected to change with bridge age or bridge usage and therefore will not be incremented in the maintenance cost projections.

Exhibit B-17: Distribution of Average Annual On-System Bridge Maintenance Costs

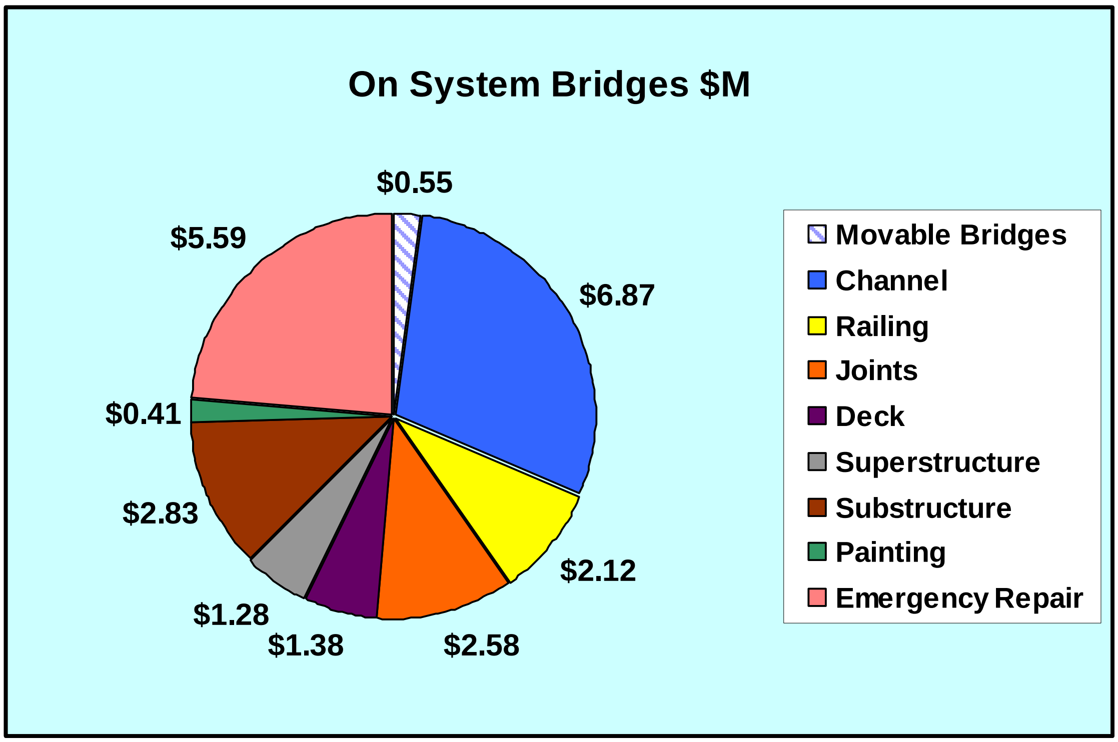
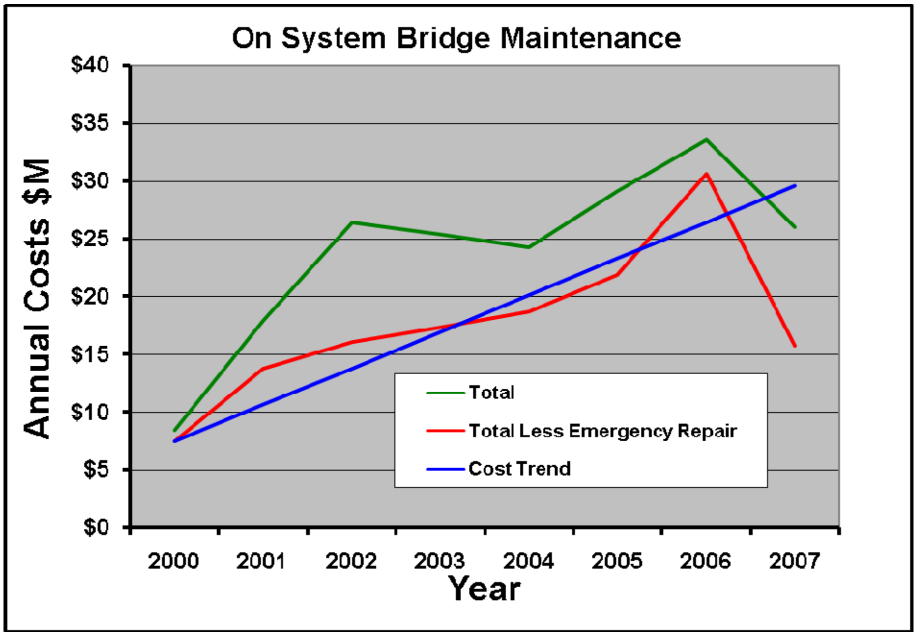


Exhibit B-18 shows the trend in the total bridge maintenance cost over the last eight years. Costs have steadily increased except for the last year, 2007, when budget constraints caused a reduction in maintenance funding.

Exhibit B-18: On-System Bridge Maintenance Cost Trends



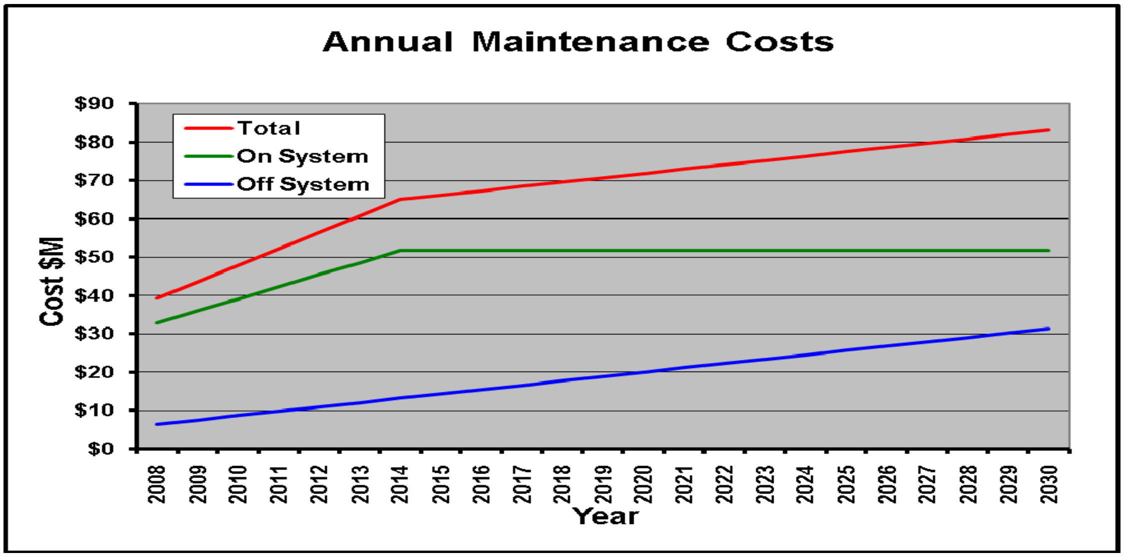
The red line in Exhibit B-18 is a linear fit to maintenance cost minus emergency repair cost. The data from 2007, which show a sharp drop-off in funding, were not included in the fitting of the trend line. The increase in bridge maintenance appears to be correlated with the aging of the bridge structures. As mentioned earlier, Exhibits B-5 and B-6 show the square footage of bridge deck plotted against the construction date for on- and off-system bridges. Bridge construction ramped up in the late 1950s and early 1960s. These bridges are reaching their nominal design life of 50 years. It would be expected for these bridges to have increasing maintenance costs, which are reflected in the cost increase shown in Exhibit B-18.

The volume of bridge deck constructed between approximately 1964 and 1976 is relatively constant. A leveling off of maintenance costs should occur as these bridges reach their design life in 2014 and are replaced or retrofitted. If the bridges are not replaced, the maintenance costs will increase at a greater rate. A maintenance model was developed that used the straight trend line shown in Exhibit B-18 to estimate the maintenance cost to 2014. The estimated cost was then kept as a constant after 2014 to reflect the plateau in bridge construction that occurred 50 years before.

The estimated costs for maintenance of the off-system bridges were estimated using data from the on-system bridges. The maintenance costs for movable bridges and emergency repairs were not used in developing the off-system costs. No movable bridges are off-system, and emergency repairs were left out because vehicular collision with an off-system bridge is unlikely. The loss of a bridge by a flood was not considered in the costs as this type of loss would be covered under bridge replacement costs. The growth in construction of off-system bridges occurred later than for on-system bridges. Consequently, no cap on maintenance cost was included in the off-system bridges and, therefore, the estimated bridge maintenance costs increase each year.

Exhibit B-19 shows the estimated maintenance costs for existing bridges through the year 2030. Maintenance costs over the 22-year planning horizon total $954 million for on-system bridges. The 2007 funding of $26 million is far short of the requirements for next year and less than one-third of what will be required in 2030.

Exhibit B-19: Estimated Annual Bridge Maintenance Costs – Existing Bridges



The number of bridges required for mobility was summarized in Exhibit B-15 for each of the three scenarios. The maintenance costs for the mobility bridges through the year 2030 were estimated using bridge maintenance unit costs developed earlier. Maintenance costs for the mobility bridges through the year 2030 are $82,148,211 for Scenario 1, $66,865,993 for Scenario 2, and $49,340,068 for Scenario 3.

Special and Large Bridges

Large bridges were identified in conjunction with TxDOT and were treated separately for estimation of replacement costs. These bridges are listed in Appendix C. Total replacement costs for these bridges are estimated to be $6.1 billion through the year 2030. Calculations assume an expansion factor of 2.3 for the deck area and a replacement cost of $194/per square foot (in 2008 dollars).

Cost Summaries for Texas Bridge Needs through 2030

The previously calculated costs are combined in Exhibit B-20 to provide an estimate of Texas bridge cost needs through the year 2030. Values summarized in the table recognize that TxDOT is responsible for inspection, maintenance and replacement of on-system bridges and inspection and replacement for off-system bridges. The total project is substantially higher than the abutment-to-abutment cost: $194 versus $64 per square foot of bridge deck.

New bridges generated as a result of mobility needs are also TxDOT's cost responsibility when it comes to inspection, maintenance and replacement. However, the capital costs of building the mobility bridges are captured in the mobility analysis of this study and not covered this chapter. In addition, mobility bridges will be added to the system on a yearly basis through the 22-year planning horizon and it is assumed that they will not meet criteria for replacement due to their relatively low ages throughout the planning horizon.

The maintenance and inspection costs of all bridges must be funded out of state and local funds. Only the on-system maintenance costs are included in the state costs, as local agencies are responsible for maintenance of the off-system bridges. Total costs resulting from this analysis total $36.2 billion over the period to 2030. The results are rather insensitive to mobility scenario choice due to the order of magnitude difference between the additional inspection and maintenance costs when compared to replacement costs.

Exhibit B-20: Bridge Cost Summary

Cost Category	Total to 2030 ($ millions)	Average Gross Annual Cost ($millions)
Replacement Costs On-system	$19,918	$905
Replacement Costs Off-system	$7,804	$355
Costs to Replace Special and Large Bridges	$6,107	$278
Inspection Costs Existing Bridges On-system	$615	$28
Inspection Costs Existing Bridges Off-system	$327	$15
Maintenance Costs Existing Bridges On-system	$1,123	$51
Inspection Costs Mobility Bridges	$222	$10
Maintenance Costs Mobility Bridges	$82	$4
Total- Full Funding	$36,198	$1,646

Conclusions

The total costs, as shown in Exhibit B-20, represent a substantial increase from current funding. The latest available annual bridge rehabilitation and replacement expenditure provided by TxDOT and comprising similar cost elements to those used in the 2030 calculations was $490 million for FY 2007. The estimated annual replacement costs shown in Exhibit B-20 are $1,538 million, an increase of $1,048 million over the annual figure provided by TxDOT. The annual bridge maintenance cost reported by TxDOT for FY 2006 (Exhibit B-8) was slightly over $50 million. The estimated annual cost estimated in this study is $55 million.

The first-year costs of replacing on-system structurally deficient, substandard for load only bridges and special and large bridges is $1.5 billion. A four-year program to replace on-system structurally deficient, substandard for load only and functionally obsolete bridges by 2012 would encompass 4,022 bridges at a cost of $3.1 billion.

Committee Recommendations

- Replace on-system structurally deficient and substandard for load only bridges by 2012.
- Replace remaining structurally deficient substandard for load only and functionally obsolete bridges by 2030.
- Increase inspection and maintenance activities to maintain safety and extend life.
- Investment needed: $36 billion total; $1.6 billion per year.

Urban Mobility

Introduction

For more than two decades, our state's largest cities have experienced increasing congestion. Texas Transportation Institute's (TTI's) *2007 Urban Mobility Report*[5] found that the cost of annual travel delay and extra fuel consumed in stop-and-go traffic by Texans was $6.7 billion. And this is not just a 'big city' problem; congestion is getting worse in medium and small cities, as well. The cost, difficulty, frustration and inability to plan a trip affects everyone whether they are traveling to work, school, doctor's appointments or leisure activities.

Translated into terms all Texans can understand, $6.7 billion per year in travel delay and fuel expense is equal to a 'congestion tax' averaging $570 per commuter per year. And the cost in the large metropolitan regions is two or three times more. With the Texas population expected to grow by 7 million to 17 million people over the next 20 years, congestion will affect even more trips, cities, regions and times of day.

Mobility challenges affect everyone – people who live and work in big cities, small towns and rural areas between them. Our state's favorable business, economic and social climate will bring significant growth in Texas. The questions are: How will Texans address the transportation challenges presented by this growth? Will we develop a set of policies, programs, projects, plans and partnerships in a conscious, planned, cooperative decision-making process? Or will we pay for our lack of attention to the growth issues with more time and wasted fuel, but less time with our families, at our jobs, with social and civic groups, and at parks and schools? Will the challenges overwhelm our ability to craft a meaningful plan to deal with travel mobility? What actions will be taken by transportation agencies, private businesses, the public and decision-makers? This chapter describes the mobility choices facing Texans and offers a basis to craft solutions that will meet the travel challenges we face.

Q. What cities make up urban Texas?

Abilene
Amarillo
Austin
Beaumont-Port Arthur-Orange
Brownsville
College Station-Bryan
Corpus Christi
Dallas-Fort Worth
El Paso
Harlingen-San Benito
Hidalgo County
Houston-Galveston
Killeen-Temple
Laredo
Longview
Lubbock
Midland-Odessa
San Angelo
San Antonio
Sherman-Denison
Texarkana
Tyler
Victoria
Waco
Wichita Falls

[5] http://tti.tamu.edu/publications/catalog/record_detail.htm?id=32636

Organization of This Chapter

This chapter explains the state's current situation concerning travel mobility in urban areas and examines possible ways that policy makers, decision makers and the public can view the future of mobility to prevent or respond to the challenges Texas faces. The 2030 Committee established several potential 'scenarios' for handling growing mobility issues and identified ways to specify desired mobility outcomes. This chapter explains those scenarios and presents possible outcomes and recommendations. Topics include:

- Current and future mobility conditions in Texas
- Scenarios developed by the 2030 Committee
- Benefits from investments in mobility
- Cost estimates
- Investments and benefits per person
- Potential cost savings

Current Conditions

The congestion levels for the Texas cities included in the study are compared to regions of similar size from around the U.S. in Exhibit M-1. The extra travel time spent by Texas travelers during commute hours is displayed in region population groups. Dallas-Fort Worth, Houston, San Antonio, El Paso and most of the smaller regions have congestion levels near the midpoint of all U.S. regions their size. Laredo, however, has among the highest congestion levels in its size group. The average urban Texas commuter spends an extra 32 hours in traffic each year, 60 percent more than a decade ago.

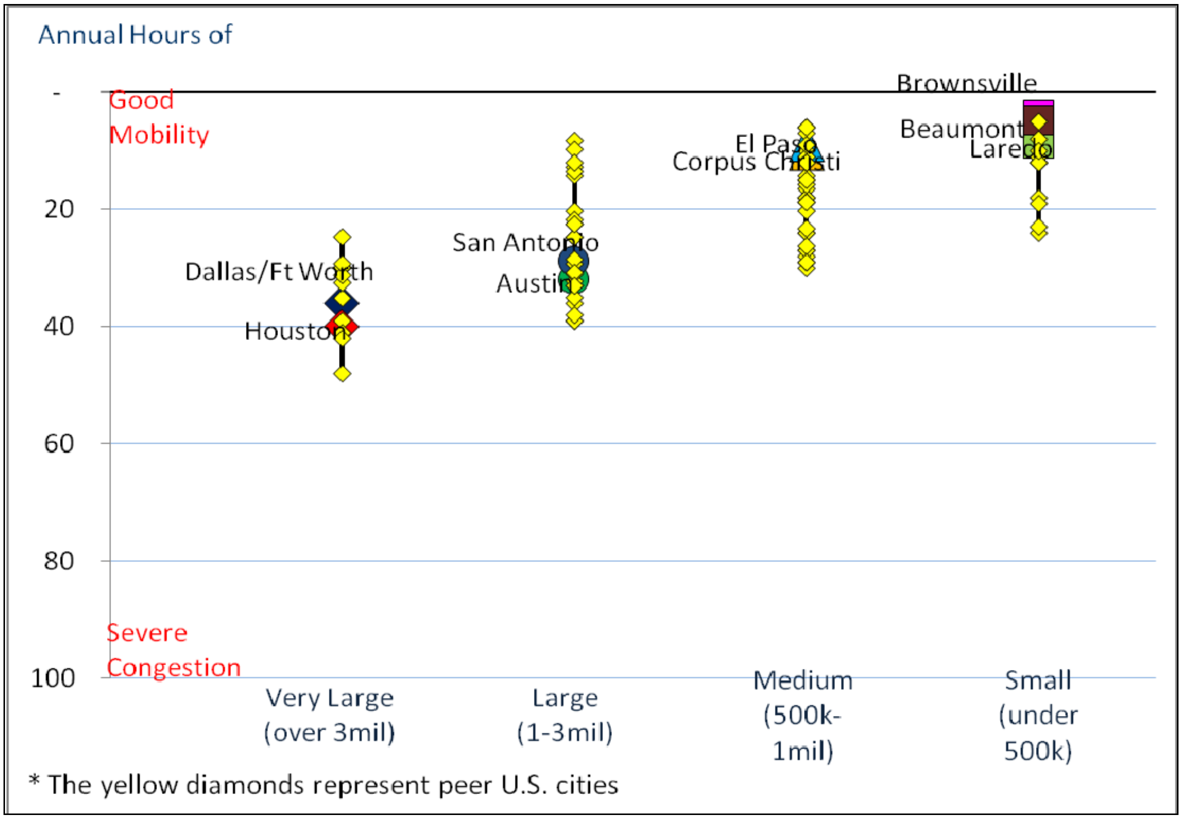
Mobility challenges are manifest in two ways: 1) increasing congestion and 2) inadequacy of travel options. Both of these problems result in additional hours spent traveling, more fuel purchased, interference with work, loss of leisure time with family and friends and increased cost of goods. Mobility is reduced when travel demand is greater than the available capacity of the transportation system or when crashes, vehicle breakdowns, weather or other events combine to increase congestion.

As part of the assessment of needs and current conditions, public comments were solicited through multiple means of collection. Comments from citizens, business groups, councils of government and community organizations came in through email, U.S. Mail and fax. Public meetings and public hearings held across the state were scheduled and publicized through each local TxDOT public information office or through the TxDOT Office of Government and Public Affairs. In addition to comments from the public, more than 90 elected officials, community leaders and citizens presented testimony at the scheduled public hearings. For more information regarding public comments obtained during the assessment process, see Appendix A.

Q: What projects are included in the scenario costs?

A: Each scenario is different, but the only specific projects identified are those in the metropolitan transportation plans. These long-range programs have been reviewed by the public and policy makers in each region and contain projects that can be funded by estimated future revenue. A statewide needs study does not contain enough detail or public input to make specific project decisions.

Exhibit M-1. Current Congestion Levels in Major Texas and Other U.S. Cities*



The Mobility Scenarios

The 2030 Committee developed a range of scenarios to achieve goals that reflect both the aspirations of Texans and prudent long-term investment strategies. Those scenarios represent trade-offs between investment levels, economic benefits and personal user costs. They provide a range of mobility levels by focusing on eliminating the worst bottlenecks. The goals that improve mobility the most will put Texas in a more competitive position compared to peer regions and cities around the nation.

The development of regional needs estimates were facilitated by the ongoing planning activity of the state's 25 metropolitan planning organizations (MPOs) – all of the Committee's recommendations draw heavily on the local knowledge captured in those MPO plans. These areas of need have been the subject of substantial analysis by local experts for many years. Exhibits M-2 to M-5 illustrate congestion levels in Texas regions in relation to their peers for the range of scenarios. Congestion levels in other U.S. regions were estimated assuming they follow a continuation of recent trends. Texas' Current Funding scenario, when combined with the rapid population and job growth, results in many Texas cities being among the most congested U.S. regions. Maintaining Economic Competitiveness improves the outcomes to the point where Texas regions would have congestion levels better than half of their peers in 2030. The remaining two scenarios show true progress by meeting and exceeding *current* mobility levels (Exhibit M-1). For more information on the estimation approach, see Appendix D.

Scenario Descriptions

Four mobility scenarios were examined by the 2030 Committee; current trends provided the baseline for comparison with three improvement options. The comprehensive studies of urban mobility funding and long-range projects and programs in Texas prepared by each of the Texas MPOs were used as the analytical basis for the scenarios.

- *Current Funding Trend* – This scenario represents the continuation of currently expected state and federal funding. Exhibit M-2 presents the most likely mobility levels if no changes occur in revenue sources or funding share by 2030. This scenario is less funding than expected in recent long-range plans and will result in significantly worse mobility. This scenario is the baseline for comparison with other scenarios to illustrate the effects of additional investment.
- *Maintain Economic Competitiveness* – Providing the funding necessary to allow each Texas urban region to have a mobility level better than or equal to similar U.S. regions was the goal of the lowest acceptable mobility scenario. Implementing this scenario improves mobility outcomes so Texas regions would likely be economically competitive with their peers.
- *Prevent Worsening Congestion* – Under this scenario, congestion levels in 2030 would be no worse than today's conditions. This scenario will cost considerably more than the previous two scenarios because the transportation system must accommodate another 7 million to 17 million people. But, congestion levels would also be much lower.
- *Reduce Congestion* – The most ambitious scenario goal eliminated all points of serious congestion in 2030. This goal was used in previous statewide mobility plans and represents a substantially better level of mobility than today.

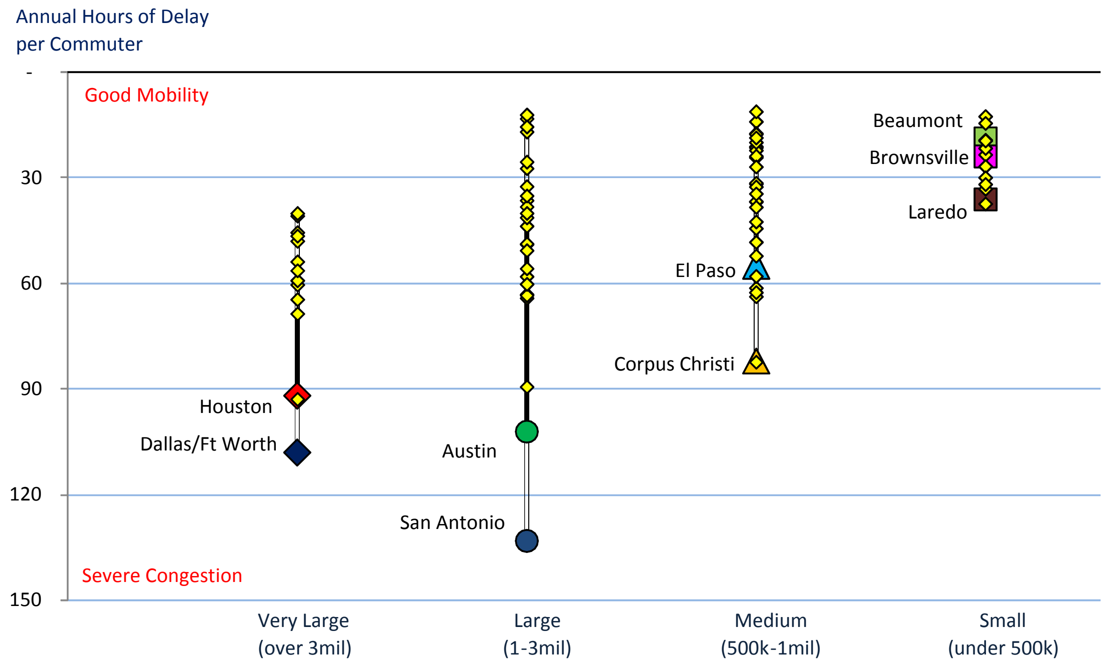
How Are Solutions Implemented Over the Next 22 Years?

Whatever "scenario" is pursued, it should be noted that the long-range transportation plans are evolutionary processes – changes are made to elements every few years when the plans are updated. The analysis in the *2030 Committee Texas Transportation Needs Report* should be a part of the process – identifying the need for improvements and the general costs and benefits from any large-scale transportation investment program. Community leaders and the public will be responsible for developing specific plans, projects and programs; the important element at this time is to define the size of the problem and the goals, and mobilize the resources needed to address the long-term solutions. The 2030 Needs Report can be used by decision-makers and the public to assess progress toward long-range goals.

Q: How are needs defined?

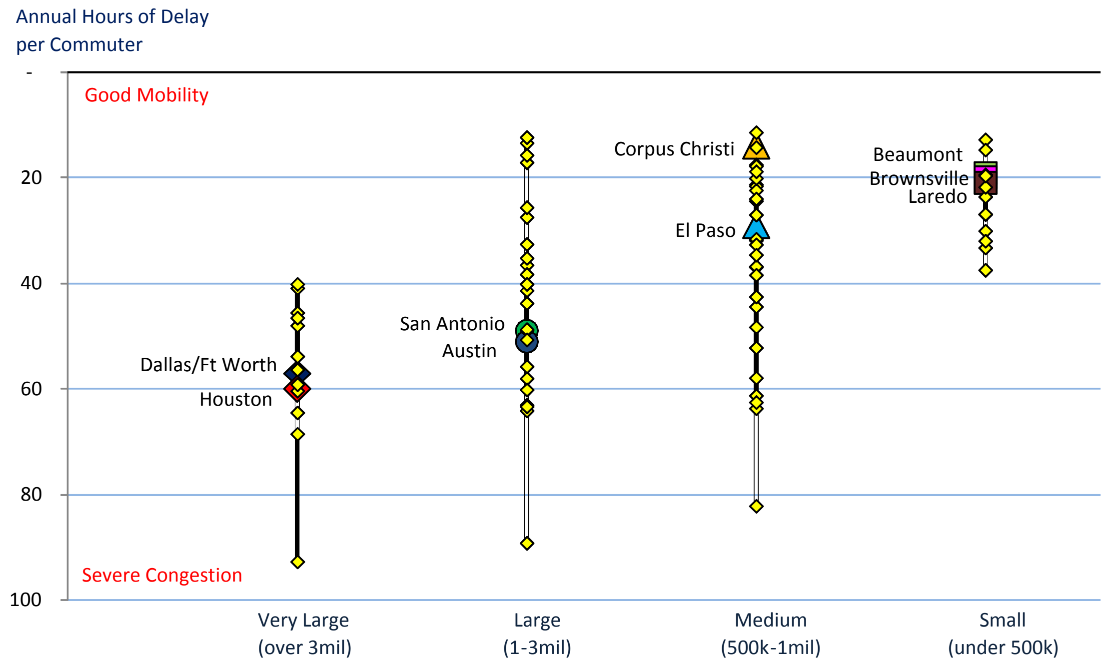
A: Needs are defined by the amount of investment required between 2009 and 2030. This estimate includes many projects for which funding has already been identified.

Exhibit M-2. Current Funding Trend National Comparisons*



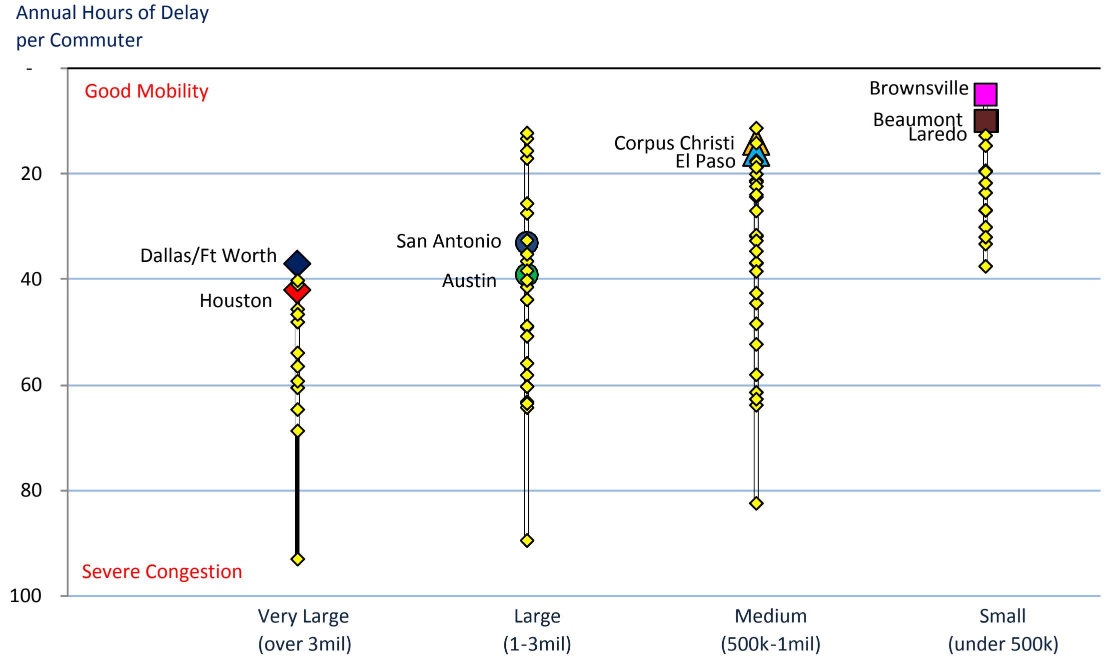
* The yellow diamonds represent peer U.S. cities

Exhibit M-3. Maintain Economic Competitiveness – National Comparisons*



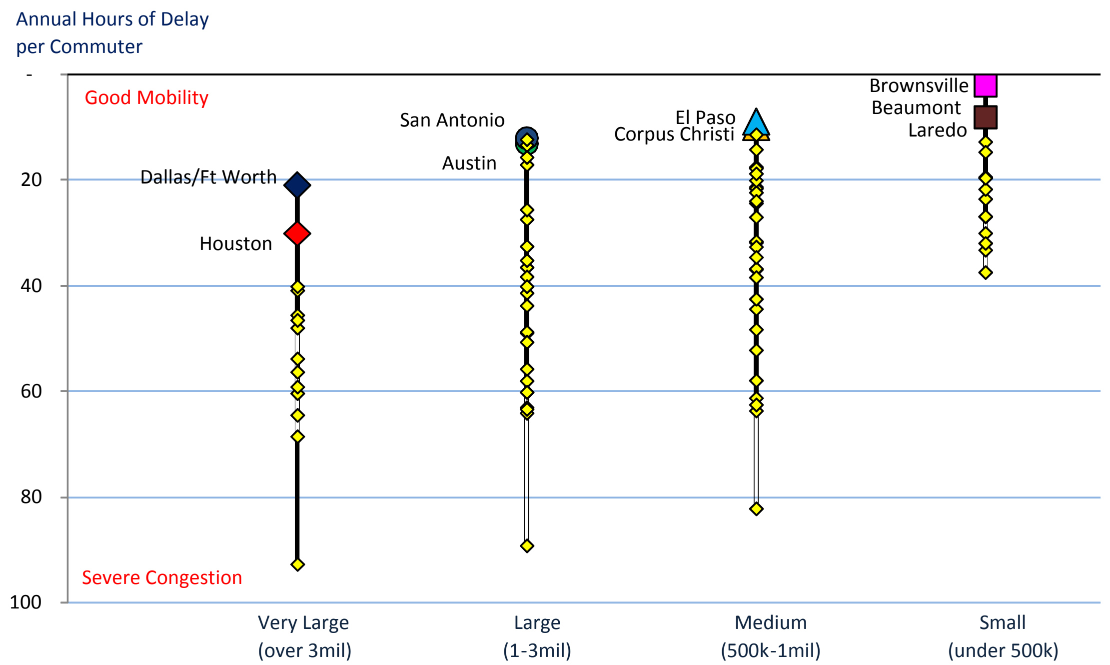
* The yellow diamonds represent peer U.S. cities

Exhibit M-4. Prevent Worsening Congestion – National Comparisons*



* The yellow diamonds represent peer U.S. cities

Exhibit M-5. Reduce Congestion – National Comparisons*



* The yellow diamonds represent peer U.S. cities

Benefits Resulting from Mobility Improvements

Several types of benefits were estimated based on the improved transportation service in the scenarios. For example, direct effects on motorists will be less time and fuel consumed if systems provide more mobility. Effects on Texas businesses will be even more apparent, and companies can serve more customers with the same equipment and personnel in regions with less congestion. Local governments will receive more tax revenue from the transportation expenditures. Construction of expanded systems provides jobs and payroll to the affected communities.

Direct Benefits to Texans

Fuel Savings – Improving the speed of travel and eliminating stop-and-go traffic results in fuel savings due to a more efficient fuel burn, which means cost savings for both personal and commercial travel.
Time Savings – Improving the speed of travel in the peak period means less time stuck in traffic for both individual and business travelers.

Indirect Personal Benefits to Texans

Reduced Costs of Goods and Services – Time and fuel savings lead to greater business efficiencies and productivity because more finished goods can be delivered at lower cost within the same time period. The anticipated result would be lower costs to consumers, the reverse of the effect seen in the increase of costs of goods and services and fuel prices during 2007 and 2008.

Economic Value of Mobility Investments to Texas Businesses

Increased Business Profitability and Job Creation – Lower business costs lead to increased profit. Increased business profitability generates economic growth and creates jobs. The creation of jobs translates into population growth and more economic activity.
Increased Local Government Tax Revenues – More economic activity and population growth means greater tax revenues for local governments from property and sales taxes.
Economic Benefits of Construction Activity – The act of constructing improvements has positive economic benefits. Those benefits come from the income that is paid to workers who are employed as well as the purchase of materials and supplies used to build the project. Additional economic benefits result from the multiplier effect that occurs when those workers spend their salaries on food, clothing, housing, entertainment or other activities. That spending, called an indirect benefit, also has a positive economic effect, as does the personal spending of those employed by companies providing the materials for the project.

Q: How were the problem locations determined?

A: The planning organizations from Texas' larger regions (above 50,000) developed an approach using long-range planning models. If a road link was projected to have more traffic volume than the scenario goal (for example, "reduce congestion"), enough road lanes were added to reduce congestion to acceptable levels.

What Will The Improvements Cost?

> **Q: What is a lane-mile?**
>
> A: A measure of roadway space. A 10-mile-long, four-lane road has 40 lane-miles. The measure of equivalent lane-miles used throughout this chapter is simply a consistent way of estimating the cost of the full range of strategies that will be deployed to improve mobility over the next 22 years, regardless of transportation mode.

The cost of each scenario was estimated using the same process used by metropolitan planning organizations in the Texas Mobility Plans. The long-range planning models from each region were configured for the 2030 population and job forecasts. The locations of transportation network problems or investment opportunities were identified according to the goals of each scenario. The main principle was to add transportation capacity only where there were problems, resulting in an efficient use of financial resources. Project or program cost estimates from the MPOs were used whenever possible (and updated to 2008), but where more capacity was needed, the scenario cost was estimated as the funding required to add roadway lane-miles. This does not mean that all the projects required to address mobility problems will be roadways. This process recognizes that the specific project decisions are made at the region or local level. Costs of 'big ticket' items such as freeways, major streets, freeway-to-freeway interchanges, as well as additional right-of-way for transportation corridors were also included. Exhibit M-6 presents the size of the existing and possible future Texas urban networks.

The investment levels described in Exhibit M-6 represent the additional amount necessary to meet the scenarios by 2030 in 2008 dollars. Costs for achieving the scenarios range from $70 billion to $213 billion. The large amount of additional roadway might be surprising, but many road sections have heavy traffic volumes now, and the growth in population, employment and trade will place great strain on the network. The cost of urban projects reflects the higher cost of construction in large, congested metropolitan regions.

Exhibit M-6. Investment Required for Each Mobility Scenario

Mobility Scenario	Estimated Equivalent Lane-Miles Needed	Investment Required (Billions of 2008 $)
Urban Network Size		
Completed by 2009	78,400	NA
Urban Scenarios		
Current Funding Trend	17,600	$70
Mobility Competitiveness	32,500	$124
Prevent Worsening Congestion	41,700	$171
Reduce Congestion	48,100	$213

Note: Costs are the median value of a range of cost estimates.

Mobility Results from Investment Scenarios

Texans will realize many benefits from any mobility improvements pursued. Current trends, however, are not good if no improvements are undertaken. Average trip times, as estimated by long-range planning models, will increase substantially from today's conditions in the absence of additional funding sources and new policies. The cost of congestion will rise from $570 per urban Texas commuter today to as much as $2,100 per commuter in 2030. And these are expressed in today's dollars – when future inflation is included, the actual values will be much higher.

Mobility improvements described in the scenarios produce significant time, fuel and financial savings. Exhibit M-7 summarizes mobility outcomes of each scenario. In addition to the scenario costs introduced in Exhibit M-6, Annual Hours of Delay is an estimate of the time spent in congestion per commuter, and congestion cost is the combination of wasted fuel and time per commuter, as a result of congestion.

Q: How are the needs identified in the 2030 Report different from a "wish list"?

A: Through computer models, traffic volume indicators identify the pieces of the transportation network that will be more congested than the scenario goal. Scenario costs are related to the amount of lanes needed to treat the problem locations.

Exhibit M-7. Summary of Urban Mobility Scenario Outcomes

Current Congestion Level	Texas Congestion Index 1.30**		Annual Delay per Commuter 32 hours	
	2030 Mobility Scenarios			
2030 Mobility Outcomes	**Current Funding Trend**	**Economic Competitiveness**	**Prevent Worsening Congestion**	**Reduce Congestion**
Scenario Cost ($ Billion)	$70	$124	$171	$213
Texas Congestion Index**	1.91	1.41	1.30	1.16
Annual Delay per Commuter (hours)	90	48	32	19
Congestion Cost per Commuter	$2,100	$1,080	$740	$430

**Urban area travelers during the peak period*
***Ratio of peak travel time to free-flow travel time. A TCI of 1.30 indicates that a 20-minute midday trip takes 26 minutes in the peak period.*

Exhibit M-8 summarizes the benefits associated with each scenario. As noted previously there are significant economics benefits associated with each mobility scenario. (See page 6 for a detailed explanation of each type of benefit).

Exhibit M-8. Summary of Benefits for Each Urban Mobility Scenario

2009 to 2030 Benefits (Billions of 2008 $)	Current Funding Trend	Economic Competitiveness	Prevent Worsening Congestion	Reduce Congestion
Fuel Savings	NA	$17	$22	$27
Time Savings	NA	$200	$266	$325
Reduced Costs of Goods and Services	NA	$169	$230	$285
Increased Business Profitability and Job Creation	NA	$18	$26	$32
Increased Local Government Tax Revenues	$5	$9	$12	$15
Economic Benefits of Construction Activity	$232	$410	$558	$688
Total	$237	$823	$1,114	$1,372

NA – Not applicable; this is the baseline scenario.

Key Findings for Each Scenario

Current Funding Trend – By definition the baseline mobility scenario has no associated congestion benefits, although congestion will be much worse if no capacity were added at all. There will be investments between now and 2030 that will provide a significant construction effect as well as additional local government tax revenues. The mobility picture, however, is not good. Exhibit M-2 shows that many of the Texas regions will be among the most congested in the country, with the average trip taking almost twice as much time as in light traffic conditions. The average urban commuter will spend the equivalent of more than two extra work weeks of time in congestion and pay a "tax" of $2,100 in time and fuel each year. The data indicate that the average commuter delay will be almost 60 hours more in 2030 than today.

Maintain Economic Competitiveness – Congestion levels will improve from the "Current Trend" conditions if each region achieves a mobility level equal to or better than urban areas of similar size. All of the metropolitan regions would be expected to have congestion levels on par with peer U.S. regions (Exhibit M-3). Extra travel time will "only" consume the equivalent of six work days and cost more than $1,000 per commuter each year. "Only" is used because this would save more than $215 billion of time and fuel between now and 2030, and create a total of more than $820 billion in economic benefits.

Prevent Worsening Congestion – Using current congestion levels as a target for 2030 mobility, while not desirable, would put Texas cities in a favorable competitive position with regions of similar size. Most areas would be near the best of their peer group (Exhibit M-4) and even the relatively congested Texas regions would be better than average. The average trip would require 30 percent extra time to complete and delay will be about 32 hours per commuter in 2030. The congestion cost would be slightly more than $700 per person and the benefits would be in excess of $1.1 trillion between now and 2030.

Reduce Congestion – With Texans clamoring for congestion relief, it seems inappropriate for a needs study to not include at least one scenario that estimates the effort needed to improve current mobility levels. Adding enough capacity to eliminate all of the road sections with serious congestion problems in 2030 will not eliminate congestion, but the average Texas commuter will spend only 19 hours per year in extra travel time. The benefits by 2030 will approach $1.4 trillion and all the Texas urban areas will have congestion levels among the best in their population size group (Exhibit M-5).

Comparing the Benefits and Costs

All of the investments provide returns that are far greater than the additional costs. The Current Funding Trend scenario, the estimate of what is likely to occur if revenues decline (Exhibit M-9), has a benefit/cost ratio of 3.4 ($3.40 in benefits for every $1.00 spent) due to the inclusion of only a few benefit categories. The other three options all provide benefit/cost ratios of 6.0 or above. The improvement gained by additional investment is further illustrated in the 'incremental' benefit/cost ratio. For each additional dollar invested in the next scenario, there is between $6 and $11 per year returned to taxpayers and businesses. This suggests an economic case could be made to adopt any of the scenarios other than the Current Funding Trend scenario because at each level of investment, more benefits are returned than the program costs required to fund that scenario.

Exhibit M-9. Investment and Return for Urban Mobility Scenarios

Urban Mobility Scenario	Investment Required (Billions 2008 $)	Benefits From Investments (Billions 2008 $)	Benefit / Cost Ratio (B/C)	Incremental B/C Ratio
Current Funding Trend	$70	$240	3.4	
				10.9
Economic Competitiveness	$124	$820	6.6	
				6.2
Prevent Worsening Congestion	$171	$1,110	6.5	
				6.1
Reduce Congestion	$213	$1,370	6.4	

Note: Values shown are the median of a range.

Potential Reductions in Both Total Implementation Costs and the State's Share of Those Costs

The cost estimates used in this report are a representation of the total cost of addressing mobility needs through a variety of projects, programs, policies and plans which will be developed and implemented by multiple agencies or partners over the next 20 years. The 2030 Committee did not presume to identify the appropriate mix of strategies or methods that regions will choose to solve their mobility challenges.

As the 2030 Committee is charged with assessing the statewide need, the total need identified above must be adjusted to more closely reflect the approximate financial responsibility of the State of Texas under each scenario. There are three ways that investment costs to the State can be reduced – sharing mobility costs with local entities ("more system"), making more efficient use of the system capacity ("more efficiency"), and reducing total travel demand through alternatives and incentives ("more options"). Together they represent ways to complement the traditional expenditure of state funds on roadway construction.

- *More System* - freeways, streets and public transportation service provided by other funding sources – Cities and counties traditionally construct 30 percent to 40 percent of the roadway capacity in urban regions. The larger metropolitan regions have a significant amount of toll highways in their current committed plans. And new public transportation system capacity is funded largely by a combination of local and federal funding. All of these funding alternatives reduce the total funds needed from the state. For analysis purposes, this section of the report assumes a baseline local share of 33 percent and examines the effects of local funding up to 50 percent of total needs.
- *More Efficiency* - 'smart' technology – Computerized systems (also called "intelligent transportation systems") can improve traffic light timing, crash and stalled vehicle removal, traveler information about alternative travel modes and routes and a variety of other methods to 'squeeze out the last bit of capacity' from the transportation network at relatively low cost (often at only 15 percent of roadway expansion costs). For analysis purposes, this section of the report assumes a baseline efficiency improvement of 5 percent and examines the effects of efficiency improvements up to 15 percent of total needs.
- *More Options* - commute options – Programs such as telecommuting, carpooling, flexible work hours, working at home, parking incentives and other methods can encourage travel without a peak-period, driver-only car trip. These are most productive when focused on major activity centers. There are costs for incentives to encourage travelers and employers to change their behavior, but these are much less than the cost of road construction (typically about 10 percent of roadway construction). For analysis purposes, this section of the report assumes a baseline reduction in travel demand of 2 percent and examines the effects of travel demand reductions up to 10 percent of total needs.

These strategies were combined to illustrate how the level of mobility identified in each scenario could be provided at a lesser cost. Exhibit M-10 shows the potential cost reduction that could be provided by these mobility deployment strategies. The column "Baseline State Costs" is the result of deducting the estimated cost (Exhibit M-7) that would be borne by local entities, including local governments, public transportation agencies and toll authorities, as well as the capacity gains from advanced technologies and commute options. As noted, this varies considerably among the urban areas, but regardless of area, this suggests very large funding needs exist for those other systems and government entities as well. The final column, "Potential Reduced State Cost through

Q: What is "funding gap"?

A: The term "funding gap" defines the difference between the funded projects and needed investment.

Efficiencies and Travel Options," shows the *potential reductions*, if even larger contributions are made by local and toll sources, efficiency measures and travel options.

These major reductions in cost are speculative. To achieve them will require substantial implementation expense (though less than actual road construction), unprecedented levels of public acceptance for non-traditional options, as well as difficult state and local policy decisions, such as charging travelers for roadways that provide fast and reliable travel times.

Exhibit M-10. Cost Range for Urban Capacity Replacement Options (State Share of Scenario Cost – 2008 Dollars)

Mobility Scenario	Annual Delay per Commuter (Hours)	Total Investment Required ($ Billions)	Baseline* State Cost ($ Billions)	Potential State Cost Through Efficiencies and Travel Options ($ Billions)
Current Funding Trend	90	$70	$43	$36 to $24
Maintain Economic Competitiveness	48	$124	$77	$64 to $43
Prevent Worsening Congestion	32	$171	$106	$89 to $60
Reduce Congestion	19	$213	$132	$110 to $74

** Note: Reducing the state's share of costs does not reduce total implementation costs.*

What Mobility Goal is the Right One?

Identifying the appropriate target scenario involves considering the improvement costs and the benefits that can be derived from the projects, programs, policies and plans. The scenarios studied provide a range of congestion reduction in exchange for additional investment in transportation facilities and services. Texans bear two burdens under all scenarios. So, one way to compare the scenarios may be to consider the total of the two methods of paying for transportation – the cost of providing the system and the costs of suffering the burden of under-investing.

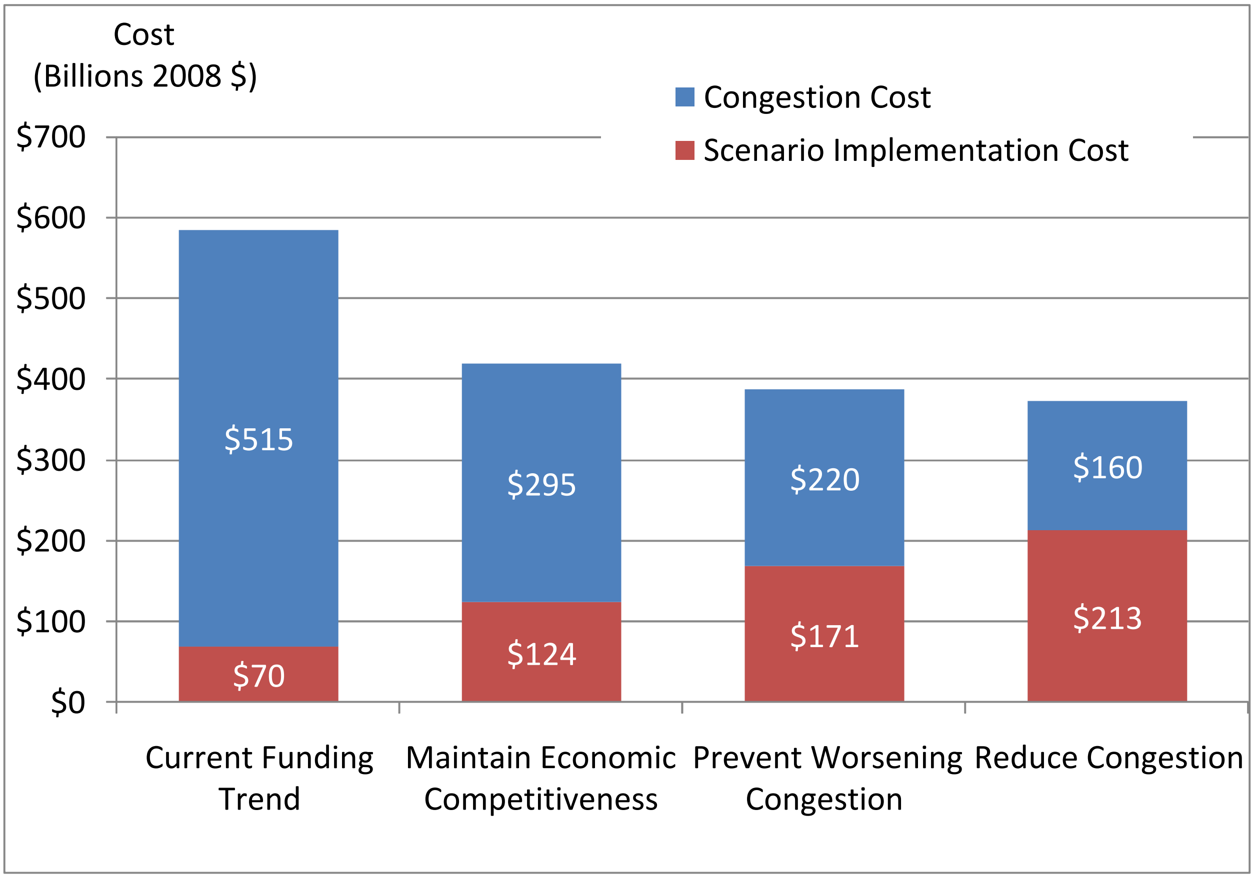
Q: How does this report relate to other studies?

A: The same procedures and principles used in the Texas Mobility Plans were used in the 2030 Report. These plans were developed by the metropolitan planning organizations to identify mobility problems and estimate the cost of solutions. In addition, the 2030 Report presents other investment scenarios to identify the trade-offs between additional funding and mobility levels.

Exhibit M-11 illustrates the total cost of the four scenarios, which is made up of the actual implementation costs of that scenario (in red) and the costs of congestion (wasted fuel and time) borne by the commuter. The Current Funding Trend scenario is the most costly at a combined cost of almost $585 billion. For the next alternative (Maintain Economic Competitiveness), the implementation costs are $54 billion higher, but the cost of wasted fuel and time is reduced by $220 billion, so that the total cost to travelers/taxpayers is about $165 billion less than the Current Funding Trend Scenario.

The Prevent Worsening Congestion and Reduce Congestion scenarios are approximately $20 billion to $45 billion cheaper than the Maintain Economic Competitiveness scenario, with higher construction costs more than outweighed by substantial congestion cost reductions. This analysis suggests that investing with a goal of reducing congestion levels would provide the lowest total cost, although with substantially higher implementation costs than if the goal was to prevent worse congestion levels than currently experienced in urban regions of Texas.

Exhibit M-11. Scenario Implementation and Congestion Costs ($ Millions)



What's Next?

The range of mobility scenarios provides a good sense of the choices facing Texas residents, businesses and decision makers. This report describes the general cost of these solutions as a first step toward a conversation about addressing the urban congestion problem. The exact nature of the solutions will not be known until projects, programs, policies, plans and partnerships are determined by the public and agencies working together to achieve a community consensus. As shown in Exhibit M-11, the range of scenario costs are accompanied by a "sliding scale" of congestion – more investment equals less congestion.

Q: What's the connection between mobility and the economy? A: A qualified workforce, reasonable tax and regulatory environment and access to markets are key elements in business location and expansion decisions. Access to markets is provided by a reliable and well-maintained transportation network. Without an adequate network, Texas businesses are at a competitive disadvantage – costing Texas jobs and economic opportunity.

Committee Recommendations

- Support Texas' economic strength and quality of life by preventing worsening congestion; as an absolute minimum, do not allow Texas' urban mobility to decline below the average of peer cities.
- Broaden the ability of urban regions to raise revenue to increase mobility if locally desired without reducing state funding for mobility.
- Investment needed: Prevent Worsening Congestion" $171 billion; $7.6 billion per year.

Rural Mobility and Safety

Introduction

Texas' rural transportation network is very large and serves a diverse set of personal trips and freight shipments. Transportation needs in rural areas fall into four basic categories – infrastructure preservation, mobility, connectivity and safety. Infrastructure preservation needs (maintenance and rehabilitation of pavements and bridges) for Texas are addressed in an earlier chapter. This chapter focuses on estimating the investment associated with addressing congestion, connectivity and safety in rural Texas.

The Rural Transportation Challenge

Rural areas face transportation needs that differ from those of urban areas. While the same categories of transportation needs – infrastructure preservation, mobility, connectivity and safety – exist in rural areas as in urban areas, they do not occur in the same mix. Overwhelming congestion in Texas' urban areas by 2030 will demand attention, and higher levels of urban connectivity with corresponding changes in infrastructure are an inherent element of the urban planning process.

In rural areas, mobility challenges show up through increasing congestion and inadequate connecting routes. Both of these problems result in more hours spent on the road, which translates into more expensive travel in terms of fuel cost, interference with work, and loss of leisure time with family and friends, plus increased cost of goods. Crash rates in urban areas are high, but crash severity is much higher in rural areas. In rural areas, improved safety and enhanced connectivity of routes often surface as more urgent needs than managing congestion.

Current Conditions

There are more than 60,000 miles of rural highway in Texas, with the Texas Trunk System forming the core of the rural network. This 10,175-mile network (adopted by the Texas Transportation Commission in 1990) will provide connectivity between communities of 20,000 population or more, as well as linking rural communities to markets in urban areas. This network is the rural equivalent of the metropolitan transportation plans produced by each urban area in Texas. Using the Trunk System as the base network provides consistency between urban and rural estimation methodologies. The Trunk System includes those sections of major intercity corridors that will experience congestion, such as the rural segments of I-35, I-45 and I-20.

As part of the assessment of needs and current conditions, public comments were solicited through multiple means of collection. Comments from citizens, business groups, councils of government and community organizations came in through email, U.S. Mail and fax. Public meetings and public hearings held across the state were scheduled and publicized through each local TxDOT public information office or through the TxDOT Office of Government and Public Affairs. In addition to comments from the public, more than 90 elected officials, community leaders and citizens presented testimony at the scheduled public hearings. For more information regarding public comments obtained during the assessment process, see Appendix A.

Technical Analysis

Rural Needs Scenarios

The 2030 Committee developed a range of scenarios to achieve goals that reflect both the aspirations of Texans and prudent long-term investment strategies. Like the scenarios presented in the Urban Mobility chapter of this report, scenarios for rural areas represent trade-offs between investment levels, economic benefits and personal user costs. The three rural scenarios identified are:

- Improve Congestion/Safety
- Improve Congestion/Safety + Partial Connectivity
- Improve Congestion/Safety + Full Connectivity

Improve Congestion/Safety – By 2030, congestion in Texas will not be limited to urban areas. This scenario estimates the amount of congestion that can be expected on rural highways, typically in the vicinity of growing urban areas, and identifies the investment needed to address that congestion. This scenario addresses rural roads that will be congested by 2030, which includes some roads that are not on the Texas Trunk System.

Improve Congestion/Safety + Partial Connectivity – This scenario builds on the previous one and addresses connectivity that fosters economic development and opportunity in rural areas. The basis for estimating the magnitude of need is the addition of lanes to Texas Trunk System highways that have traffic volumes approaching the congestion level. Industrial location practices give heavy weight to communities that are accessible via divided four-lane highways. Therefore, selecting the highest-priority Trunk System elements is a logical step toward addressing connectivity, and thus economic opportunity.

Improve Congestion/Safety + Full Connectivity – This scenario accomplishes all of the goals of the first two, plus completes the Texas Trunk System to four-lane divided roadways. This scenario maximizes the accessibility of all of Texas' larger but non-urban communities, further enhancing the connectivity and economic opportunity.

This report does not suggest that only Texas Trunk System roadways should be considered for either mobility or connectivity purposes. Those determinations should be made during the planning processes and in response to opportunities that arise. As in the urban mobility scenarios, the rural needs analysis uses roadway improvement costs as a proxy for estimating overall investment needs in rural Texas. For more information on the methodology approach, see Appendix E.

Mobility Benefits

As with the urban scenarios described in the urban mobility chapter of this report, the estimated cost of each rural scenario was based on the amount of equivalent roadway lane-miles needed. The actual mix of strategies, modes, operating systems and programs that will be developed will be different from region-to-region and from decade-to-decade. Time and fuel savings are not substantial (Exhibit R-1) because the mobility-related capacity additions and the traffic volumes are lower than those in the urban scenarios, but the benefits of connectivity represent an important component of the mobility picture.

As seen in Exhibit R-1, time and fuel savings benefits accrue to a community by improving mobility and reducing delay. Savings to businesses also occur and those savings, in turn, help lower business costs and increase profit. As improved mobility helps the economy grow, governments also benefit from increased tax revenue. These benefits can be reasonably estimated based on well-established relationships between fuel and time savings as well as transport costs to businesses and the economy.

Exhibit R-1. Summary of Rural Scenario Benefits ($ millions)

Rural Scenario	Fuel and Time Savings	Reduced Cost of Doing Business (Direct Savings)	Economic Impact of Business Savings (Indirect Savings)	Local Government Tax Revenues	Economic Impact of Construction Activity
Congestion/Safety	$ 260	$ 9,670	$1,090	$ 360	$ 31,100
Congestion/Safety + Partial Connectivity	$ 770	$ 19,200	$ 2,160	$ 660	$ 56,200
Congestion/Safety + Full Connectivity	$ 1,000	$ 23,700	$ 2,660	$ 810	$ 69,400

Note: Rounded to nearest $100 million

Hilmar Cheese Company: A Case Study in the Importance of Market Access

The Hilmar Cheese Company, a privately owned company established in 1984 by 11 dairy families, is the largest single-site cheese and whey product manufacturer in the world, with a 13 percent share of the natural American cheese market. The company had reached production capacity and sought to find a site to expand its California-based business. The City of Dalhart, Dallam County, the Amarillo Economic Development Corporation, and the State of Texas put together a $45 million incentive package to entice Hilmar to relocate to the Dalhart area. The State's combined share of the incentive package was $20 million, and a key component of that commitment was to spend $7 million to build a farm-to-market road spur to facilitate the movement of trucks to and from the facility.

In total, the economic impact of the cheese plant and the associated dairy industry will exceed $500 million annually at maturity. Total employment, both direct and indirect, will exceed 4,300 permanent jobs in the Panhandle region. The increase in local government tax revenues will exceed $12 million annually. This case study illustrates that an integrated, strategically aligned roadway network connecting Texas' smaller urban and rural areas to economic centers can be an economic catalyst for development. The transportation investment did not *cause* the economic development, but *enabled* it. The economic return on relatively modest roadway investments like this one can be significant to a region and to the state as a whole.

Sources: *Richard "Buzz" David, President and CEO, Amarillo Economic Development Corporation.*
The Perryman Group
Christine Knowlton, Dalhart Chamber of Commerce
Judge David D. Field, County Judge, Dallam County

Connectivity Benefits

As in urban areas, adequate mobility is a necessary component, but not the only factor, to cause economic growth in rural regions. Other factors, including an adequate and well-trained labor force, good schools at all levels and a competitive tax and regulatory environment, must be present as well. In any one rural area, however, the positive economic effect of a single connectivity improvement can be quite significant to the local economy.

For example, a short $10 million loop road segment connecting two highways in a rural Texas town could result in a total economic impact of more than $30 million per year by serving as a major catalyst for development. If it prompted a small manufacturing company employing 100 people to locate in the town, the original 100 jobs would likely create an additional 110 support jobs. Total annual income in the area would increase by more than $8 million per year. The additional income would increase consumer spending. Sales tax collections would likely increase by $400,000 per year and property tax revenues for the city, county and school district would rise, as well. Similar employment and income effects of that decision would likely go unnoticed in a large urban area, but would impact rural areas significantly.

Connectivity benefits tend to be more difficult to estimate than some other benefits in terms of when or where they will occur because it is hard to know, with specificity, when or where a business will locate or expand its operations once connectivity improvements are made. But connectivity nonetheless plays an important role in business expansion decisions. And, as illustrated by the case study of Dalhart, Texas, the economic impact can be quite significant.

Safety Benefits

There are relatively straightforward approaches to identifying the goals of reducing congestion and improving connectivity in the description of each of the rural scenarios, but ways to identify the achievement of improved safety are not as evident. The following analyses show that improved safety results as a by-product of widening and grade-separating highways to accomplish the congestion reduction and connectivity improvements in each scenario.

The Center for Transportation Safety at the Texas Transportation Institute estimated safety benefits that would accrue simply as a result of implementing the mobility and connectivity improvements identified in the three rural needs scenarios. Using historical crash reduction factors, year 2030 traffic volumes anticipated, and miles of roadway affected, analysts estimated the annual reductions in deaths and injuries for the year 2030, as described in Exhibit R-2.

Exhibit R-2. Estimated Safety Improvements Resulting from Each Scenario

	Deaths and Injuries Avoided in Year 2030			
Rural Scenarios	**Fatalities**	**Incapacitating Injuries**	**Non-Incapacitating Injuries**	**Possible Injuries**
Congestion/Safety	53	219	714	1364
Congestion/Safety + Partial Connectivity	113	406	1259	2062
Congestion/Safety + Full Connectivity	137	473	1415	2212

The National Safety Council estimates and publishes "average comprehensive costs" associated with these four injury severity categories:

Category	Cost per Injury
Fatal	$4,000,000
Incapacitating Injuries	$201,100
Non-incapacitating Injuries	$50,400
Possible Injuries	$24,400

Using these values, the year 2030 annual safety benefits for the three rural scenarios are estimated as shown in Exhibit R-3.

Exhibit R-3. Estimated Safety Improvements Resulting from Each Scenario

Rural Scenarios	Estimated Year 2030 Annual Safety Benefits (2008 $)
Congestion/Safety	$320 million
Congestion/Safety + Partial Connectivity	$650 million
Congestion/Safety + Full Connectivity	$770 million

All of the improvements associated with the rural scenarios are assumed to be implemented in equal annual increments from 2009 to 2030, so the safety benefits would accrue in a similar fashion. The resulting 22-year safety benefits added to the previous mobility and connectivity benefits are shown in Exhibit R-4.

Exhibit R-4. Summary of Estimated Benefits for Rural Scenarios ($ millions) (2009 to 2030, 2008 $)

Rural Scenario	Fuel and Time Savings	Economic Benefits and Tax Revenues (Direct & Indirect Savings)	Safety	TOTAL*
Congestion/Safety	$ 260	$42,200	$ 3,600	$ 46,100
Congestion/Safety + Partial Connectivity	$ 770	$78,200	$ 7,100	$ 86,100
Congestion/Safety + Full Connectivity	$ 1,000	$96,600	$ 8,400	$ 106,000

**Rounded to nearest $100 million*

What Will Improvements Cost?

The cost of each rural scenario was estimated using the same process used by the metropolitan planning organizations and described in the Urban Mobility chapter. The locations of transportation network problems were identified according to the goals of each scenario. The main principle was to make capacity additions to only those sections of the network where there were problems; this resulted in an efficient use of financial resources. Rural capacity requirements were indicated by lower traffic volume than in urban regions. This reflects the different operating characteristics and the difference in expectations between cities and rural areas.

The amount of roadway capacity that will be constructed by the end of 2008 is used as the base amount for the rural transportation improvement scenarios. The investment levels described in Exhibit R-5 represent the additional cost (in 2008 dollars) necessary to meet the needs of the rural scenarios by 2030. Costs for the rural scenarios are estimated between $6.5 billion and $17 billion. The large amount of congested rural roadway might be surprising, but many road sections have large traffic volumes, and growth in trade and travel will place great strain on the network. As noted previously, the equivalent lane-miles are simply a consistent way of estimating the cost of the full range of strategies that will be deployed to improve mobility and connectivity over the next 22 years.

Exhibit R-5. Investment Required for Each Rural Scenario

Mobility Scenario	Estimated Equivalent Lane-Miles Needed	Investment Required (Millions of 2008 $)
Rural Network Size		
Completed by 2009	162,990	NA
Rural Scenarios		
Congestion/Safety	7,970	$ 8,400
Congestion/Safety + Partial Connectivity	13,750	$15,200
Congestion/Safety + Full Connectivity	17,200	$18,800

Note: Costs are the median value of a range of cost estimates.
2008 dollars used in the calculations.

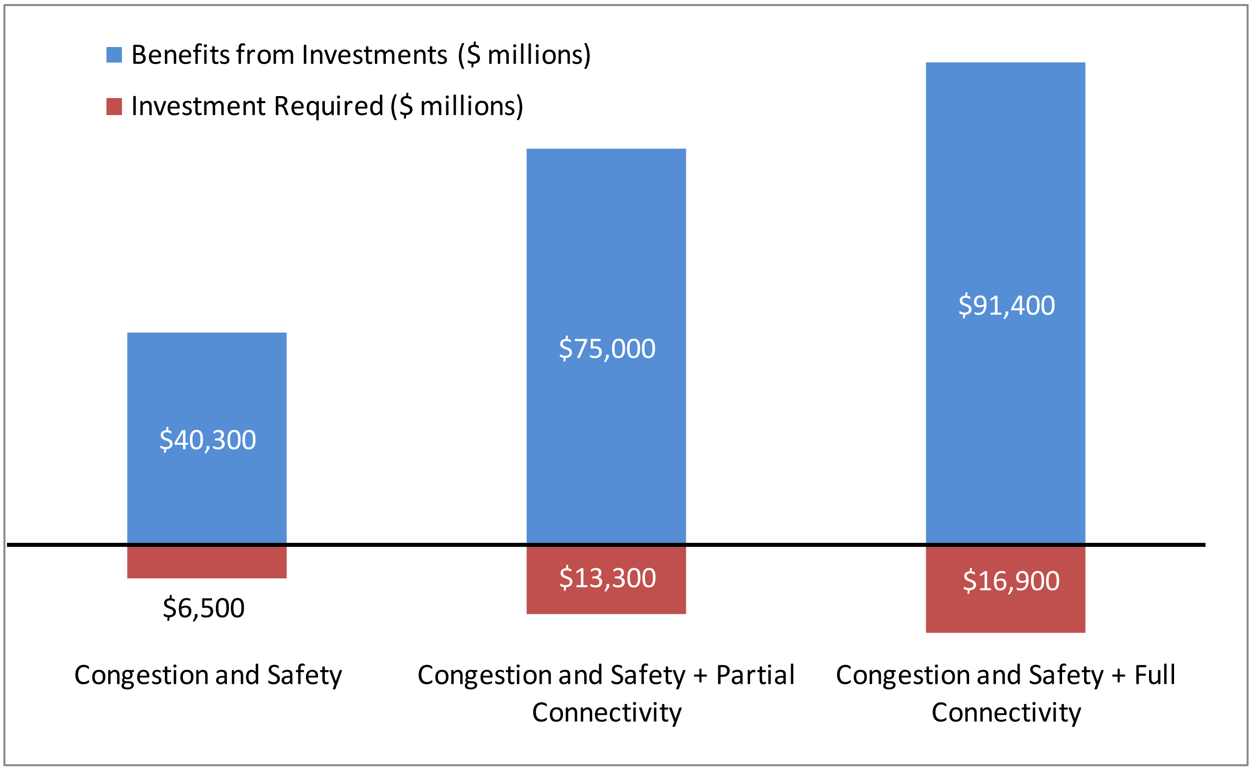
Comparison of Rural Scenarios

Following the approach used for the urban needs assessment, the benefits and costs for each of the scenarios is presented in Exhibit R-6. This table indicates that all of the scenarios have benefit/cost ratios of 5.0 or higher, suggesting a substantial return on investment. Exhibit R-7 shows these costs and benefits in graphical form.

Exhibit R-6. Benefits and Costs of Rural Scenario Investments

Rural Scenario	Investment Required ($ Millions)	Benefits from Investments ($ Millions)	Benefit / Cost Ratio (B/C)	Incremental B/C Ratio
Congestion/Safety	$ 8,400	$ 46,100	5.5	
Congestion/Safety + Partial Connectivity	$15,200	$ 86,100	5.7	5.9
Congestion/Safety + Full Connectivity	$18,800	$ 106,000	5.6	5.7

Exhibit R-7. Graphical Depiction of Rural Costs and Benefits



Much of the benefit is derived from the economic impact of the construction activity itself. Arguably, any program that invests heavily in construction of any kind, including parks or dams, would produce similar benefits in this one category. As shown in Exhibit R-8, even without the high benefit factor associated with the economic impact of construction activity, all three scenarios would have benefit/cost ratios greater than 1.0, generally considered as the minimum threshold to justify a project.

Exhibit R-8. Benefits and Costs of Rural Scenarios (Exclusive of "Economic Impact of Construction Activity")

Rural Scenario	Investment Required ($ millions)	Benefits from Investments ($ millions)	Benefit / Cost Ratio (B/C)	Incremental B/C Ratio
Congestion/Safety	$ 8,400	$ 11,100	1.3	
Congestion/Safety + Partial Connectivity	$15,200	$ 22,000	1.4	1.6
Congestion/Safety + Full Connectivity	$18,800	$ 27,200	1.4	1.4

Conclusions

The benefits included in this chapter do not include economic development potential. As noted earlier in the Dalhart example, relatively small investments in connectivity improvements in rural areas can produce significant benefits, especially in comparison to the size of the local economy in which that project is implemented. Though the locations of future congestion can be reasonably forecast, the locations for future economic opportunity are far more difficult to estimate. The authors are not aware of a more reliable technique to forecast the magnitude of such future need and opportunity. Therefore, congestion and completion of some or all of the Texas Trunk System remains a solid basis for estimating transportation needs in rural Texas.

Exhibit R-6 describes the benefit of each successive scenario. The benefit/cost ratios of the three scenarios are all near 5.5:1, but it should be remembered that this benefit estimation methodology is better suited to urban transportation analysis. The incremental benefit/cost ratio between the first and second scenarios and second and third scenarios is approximately the same, suggesting that the Improve Congestion/Safety + Full Connectivity scenario is the optimum choice.

Because of the limitations of benefit estimation methodology, the benefits derived from investment in rural transportation improvements are probably understated. Yet, even understated, there is more than adequate evidence of the value of the investment in rural improvements.

Committee Recommendations

- Complete Texas Trunk System to facilitate rural competitiveness and improve safety.
- Prioritize additional road capacity for highest immediate economic impact.
- Investment needed = $17 billion total; $0.8 billion per year.

Public Transportation

Introduction

Public transportation in Texas is a responsibility of local government. There are nine transit authorities or municipal transit departments approved by voter referendum and funded with a dedicated local sales tax. Transit authorities and transit departments are generally in the largest metropolitan areas of the state. In addition, there are 32 small urban transit systems and 39 rural transit districts in the state. Funding for public transportation comes from federal, state and local resources. Federal funds are available to transit agencies in all urban and rural areas. In Texas, state transit funds are distributed to small urban and rural transit providers – the state does not fund transit programs in large metropolitan areas where most of the state's population resides. With the exception of the nine metropolitan areas that have approved a local sales tax dedicated to transit, the source of local government funds is the general revenues of cities and counties served by small urban or rural transit providers.

Public Transportation Challenges in Texas

The following items represent significant public transportation challenges that Texas faces:

- *Increasing demand.* The rising cost of fuel has led to a nationwide increased demand for alternative options to driving a personal vehicle. The American Public Transportation Association (APTA) reported that after record ridership in 2007, transit ridership in the U.S. has continued to grow in 2008. Comparing the second quarter of 2008 to the same quarter in 2007, total transit ridership increased 5.2 percent. San Antonio VIA (the city's public transit system) reported a 14 percent increase in bus ridership during this period, the second largest among large bus operators in the United States. Economic and demographic projections indicate that demand for transit services will grow even stronger in the future. Aging baby boomers are entering the period of life when they are more likely to need mobility assistance. Further, the Texas State Demographer's Office projects that retirees will settle in sparsely populated rural areas, which will increase the demand for rural transit systems.

- *Urban area boundaries.* The boundaries of urban areas do not always coincide with the boundaries of urban transit providers. This circumstance is particularly true in metropolitan areas where urban growth is significant outside the limits of the transit authority. The regional transit authority or the municipal transit provider may decline to deliver service outside jurisdictional boundaries. However, agencies are beginning to develop policies for providing service in these excluded areas. Both Capital Metro in

Austin and METRO in Houston are willing to provide services outside the authority's jurisdictional boundaries at full cost recovery. But the cities in these urban fringes may not have access to federal funds, are not eligible for state funds, and may not be able to access sales tax revenue.

- *Limited funding options.* In Texas, the traditional source of local funding for transit is the local option sales tax. However, it is constitutionally limited to not more than 2 percent (in addition to the 6.25 percent state sales tax). The local sales tax can be used for a variety of purposes in addition to transit. In most cities and counties that are not part of a transit authority or municipal transit department, the local sales tax is already committed to other purposes, leaving little or no room to authorize funding for transit.

- *Impacts of 2010 census.* Federal and state funds are allocated to areas based on formulas according to the classification of an area as rural or urban. Changes to the current urban areas and additions of new urban areas will occur following the 2010 Census as a result of population change and growth. The changes in urban/rural area designation will redefine the sources and eligible uses of funds for public transportation for each existing program. This may, in some cases, cause small urban and rural transit providers to be allocated less funding.

- *Regional perspective.* There is a clear need for regions to coordinate the use of financial and operational resources to find new ways to plan and deliver services throughout the region. Rural operators, in particular, are challenged to move beyond the traditional demand response model and examine ways to integrate the services with both intercity bus providers and nearby urban systems. Such coordinated service planning was a central concept behind H.B. 3588[6] that mandated regional service coordination.

- *Integration with health and human services.* H.B. 3588 envisioned both client-based and system-based transportation providers sitting at the table to develop coordinated service plans. Health and human service organizations participated to highly varying degrees across the state. Public transportation system-based operations focus on optimizing service efficiency, while human services organizations focus on client flexibility. Coordinating services requires integration of those perspectives into a joint transportation program.

Current Conditions

As part of the assessment of needs and current conditions, public comments were solicited through multiple means of collection. Comments from citizens, business groups, councils of government and community organizations came in through email, U.S. Mail and fax. Public meetings and public hearings held across the state were scheduled and publicized through each TxDOT public information office or through the TxDOT Office of Government and Public

[6] H.B. 3588, passed by the Texas Legislature in 2003, addressed a wide range of transportation issues. Article 13 of the act focused on improving coordination of public transportation to eliminate waste, generating efficiencies to increase service levels and furthering the state's efforts to reduce air pollution.

Affairs. In addition to comments from the public, more than 90 elected officials, community leaders and citizens presented testimony at the scheduled public hearings. For more information regarding public comments obtained during the assessment process, see Appendix A.

Funding History

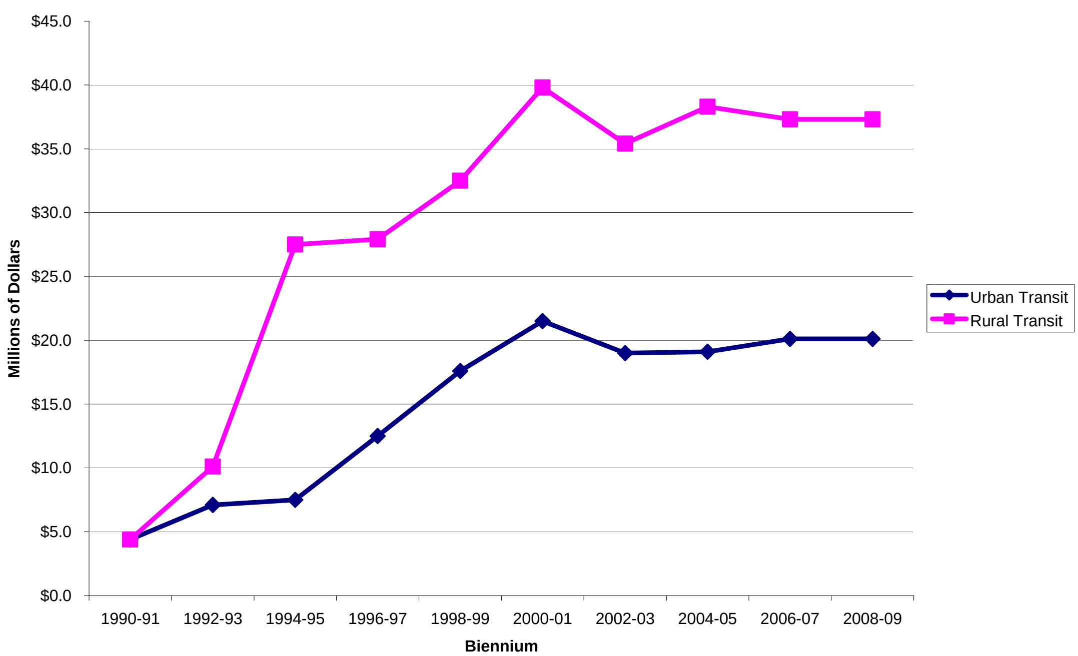
The State's Role in Funding Public Transportation

States vary significantly in their levels of funding for public transportation and in the methods of allocating those funds. According to data reported by the U.S. Department of Transportation, Bureau of Transportation Statistics (BTS) *Survey of State Funding for Public Transportation,* 47 states provided funding for public transportation in 2006. Of those states, the average state funding for transit in 2006 was $37.40 per person; transit funding in Texas was $1.23 per person.

Texas provides financial support to transit providers in rural and eligible small urban areas. The state does not provide funding assistance to urbanized areas with more than 200,000 in population that are legislatively authorized to ask voter approval to create a transit authority with a dedicated sales tax.

State funding levels are established biennially by the Texas Legislature. Exhibit T-1 displays the Texas state funding levels for transit since 1991.

Exhibit T-1 Texas State Appropriations for Public Transportation per Biennium



State funding for public transportation is split into 35 percent for small urban areas and 65 percent for rural areas. Funds are allocated to agencies based upon a formula that considers both needs and performance. The portion of the formula attributed to needs is allocated to small urban transit systems based on population in each urbanized area. Rural systems receive the needs allocation based upon population and land area. Several measures are used to allocate funding based upon transit performance, as shown in Exhibit T-2.

Exhibit T-2 Texas Transit Funding Allocation Factors

Funding Category	Needs Factors (Weights)	Performance Factors (Weights)
Small Urban: Federal 5307 Funds	Federal funds for small urban areas are allocated to the designated recipient in each area in the amount apportioned by FTA formula	
Small Urban: State Funds	Population (100%)	Revenue miles/operating cost (20%) Passengers/revenue miles (30%) Local investment/total revenue (30%) Passenger trips per capita (20%)
Rural: Federal 5311 Funds State Funds	Population (75%) Land Area (25%)	Revenue miles/operating cost (33%) Passengers/revenue miles (33%) Local investment/total revenue (33%)

Total Public Transportation Funding in Texas

Overall, state funding for transit represents just less than 1 percent of the funding for operating urban public transportation in Texas. The mix of funding varies by the size of the urban area. Urban areas with populations of 1 million and more receive virtually no state support. Small urban systems with populations between 50,000 and 199,999 receive about 14 percent of operating costs from state funds.

Exhibit T-3 displays the sources of funding for operating public transportation in the urban areas of Texas in 2006 as reported in the National Transit Database (NTD).

Exhibit T-3 Operating Funds Applied in Urbanized Areas for Transit in Texas, 2006

Size of Urbanized Area	Operating Funds Applied ($ thousands)					
	Fares	Directly Generated Revenues	Local Other	State	Federal	Total
50,000 to 199,999 Population (a)	$8,269	$2,174	$12,220	$8,040	$24,813	$55,502
200,000 to 999,999 Population (b)	$18,807	$160,606	$1,483	$1,165	$27,434	$209,495
1 Million or More Population (a,c,d,e)	$123,132	$684,886	$880	$514	$123,392	$932,818
State of Texas Total	$150,208	$847,666	$14,583	$9,719	$175,639	$1,197,815
Percent of Total by Source	12.5%	70.8%	1.2%	0.8%	14.7%	100.0%

Source: National Transit Database for 2006
(a0 Longview, NETS, Texarkana, Tyler and Wichita Falls did not report to NTD in 2006; data for these systems from TxDOT PTN-128 report
(b) State funds applied in Lubbock, McAllen, and Lower Rio Grande Valley Rio Metro
(c) State funds applied in Arlington, Grand Prairie, Mesquite and NETS
(d) Dallas DART reported dedicated local sales tax as State Dedicated in NTD; value included as directly generated here
(e) San Antonio reported dedicated local sales tax as Local Dedicated in NTD; value included as directly generated here

Exhibit T-4 displays the same information for capital expenses. The state contributes 2.1 percent of capital costs statewide, with small urban systems receiving state funding support for 12 percent of capital expense. The total expenses for capital are roughly 37 percent of operating expenses for transit in urban areas in Texas in 2006. In 2006, Texas transit systems reported total expenditures of $442 million for capital and $1,198 million for operating expenses.

Exhibit T-4 Source of Capital Funds Applied by Size of Urbanized Area in Texas, 2006

Size of Urbanized Area	Capital Funds Applied ($ thousands)				
	Directly Generated	Local Other	State	Federal	Total
50,000 to 199,999 Population	$89	$1,791	$1,661	$11,394	$14,934
200,000 to 999,999 Population	$44,608	$701	$107	$15,190	$60,607
1 Million or More Population	$236,708	$6864	$36	$122,361	$365,969
State of Texas Totals	$281,405	$9,356	$1,803	$148,946	$441,510
Percent of Total by Source	63.7%	2.1%	0.4%	33.7%	100.0%*

Notes:
** Rounding error*
Longview, NETS, Texarkana, Tyler and Wichita Falls did not report to NTD in 2006; data for these systems from TxDOT PTN-128 report did not indicate any capital spending in 2006.

Transit investment in Texas is highest in the largest urbanized areas (UZAs) with populations over 1 million. Exhibit T-5 displays funding information on the nation's 38 UZAs with populations of over 1 million. The average per capita investment in public transportation among this group is $216.94 and the median per capita investment is about $180. Among the three Texas urbanized areas with over 1 million population, the average per capita investment in public transportation is $120.51. All three of these urbanized areas are below the average and the median.

Exhibit T-5. Funding Information on the 38 UZAs with Populations Over 1 million

Sorted by Rank for Total Expense Per Capita				PER CAPITA STATISTICS Total Operating and Capital Expense for Transit 2006					
UZA (Rank 2000)	**Urbanized Area**	**Additional UZA served by Local Transit**	**Population 2006 incl Addn UZA**	**Per Capita Operating**	**Rank for Operating**	**Per Capita Capital**	**Rank for Capital**	**Total Per Capita**	**Rank for TOTAL**
UZA over 1 Million Population									
1	New York-Newark, NY-NJ-CT		18,213,825	$537.54	1	$229.67	3	$767.21	1
12	San Francisco-Oakland, CA	382	3,257,006	$490.26	2	$102.23	10	$592.49	2
14	Seattle, WA	231	3,000,049	$265.05	5	$268.45	1	$533.50	3
8	Washington, DC-VA-MD		4,180,139	$357.33	3	$141.41	5	$498.75	4
7	Boston, MA-NH-RI		4,058,570	$296.46	4	$129.17	7	$425.63	5
15	San Diego, CA		2,721,722	$97.83	22	$233.77	2	$331.60	6
3	Chicago, IL-IN	133	8,742,041	$211.53	7	$105.30	9	$316.84	7
18	Baltimore, MD		2,125,963	$204.39	10	$93.03	11	$297.42	8
24	San Jose, CA	300	1,666,305	$206.60	8	$79.51	14	$286.11	9
4	Philadelphia, PA-NJ-DE-MD	360	5,274,764	$195.77	11	$70.50	15	$266.27	10
22	Pittsburgh, PA	416	1,743,509	$218.62	6	$36.82	23	$255.44	11
23	Portland, OR-WA		1,742,904	$206.57	9	$38.98	21	$245.54	12
20	Denver-Aurora, CO	239,330,379	2,315,633	$151.14	13	$89.77	13	$240.91	13
42	Salt Lake City, UT	79, 102	1,759,463	$87.78	24	$141.15	6	$228.93	14
47	Charlotte, NC-SC	199,229,338	1,240,679	$70.50	29	$151.66	4	$222.15	15
2	Los Angeles-Long Beach-Santa Ana, CA	68	12,812,346	$155.68	12	$40.46	20	$196.15	16
21	Cleveland, OH		1,728,459	$138.05	14	$53.92	17	$191.97	17
13	Phoenix-Mesa, AZ	347	3,311,878	$69.94	30	$113.12	8	$183.05	18
17	St. Louis, MO-IL	299	2,196,505	$88.92	23	$92.67	12	$181.60	19
5	Miami, FL		5,298,058	$130.94	16	$48.32	18	$179.26	20
16	Minneapolis-St. Paul, MN		2,421,590	$127.64	17	$38.55	22	$166.20	21
11	Atlanta, GA		4,051,019	$104.98	21	$60.27	16	$165.25	22
31	Las Vegas, NV		1,474,747	$137.24	15	$24.01	26	$161.25	23
6	**Dallas-Fort Worth-Arlington, TX**		**4,508,929**	**$107.37**	**20**	**$43.07**	**19**	**$150.45**	**24**
28	Sacramento, CA		1,505,660	$111.59	19	$27.28	25	$138.87	25
32	Milwaukee, WI		1,296,037	$124.80	18	$1.52	38	$126.32	26
10	**Houston, TX**		**4,353,053**	**$75.22**	**28**	**$33.88**	**24**	**$109.10**	**27**
30	**San Antonio, TX**		**1,423,313**	**$84.94**	**25**	**$17.05**	**28**	**$101.99**	**28**
34	Providence, RI-MA		1,178,911	$81.96	26	$11.46	31	$93.42	29
9	Detroit, MI	427	3,903,041	$78.51	27	$6.12	35	$84.63	30
26	Cincinnati, OH-KY-IN		1,539,660	$66.84	31	$14.84	29	$81.68	31
35	Orlando, FL	165	1,495,520	$58.77	33	$20.14	27	$78.90	32
25	Riverside-San Bernardino, CA		1,812,081	$61.17	32	$7.38	33	$68.55	33
36	Columbus, OH		1,155,839	$58.59	34	$5.80	36	$64.39	34
29	Kansas City, MO-KS	412	1,458,913	$52.18	35	$10.17	32	$62.35	35
19	Tampa-St. Petersburg, FL	418	2,260,558	$44.95	36	$14.18	30	$59.13	36
27	Virginia Beach, VA		1,438,982	$43.19	37	$6.93	34	$50.11	37
33	Indianapolis, IN		1,271,745	$34.73	38	$5.60	37	$40.33	38
	Avg of 38 UZA			$148.30		$68.64		$216.94	
	Avg for 3 UZA in Texas			**$89.18**		**$31.33**		**$120.51**	

Rural transit providers did not report to the NTD in 2006, but these providers report financial and operating information to TxDOT annually. Exhibit T-6 displays sources of funds applied to operating costs in 2007 by all rural transit systems.

Exhibit T-6 Source of Operating Funds Applied by Rural Transit Districts in 2007

	Operating Funds Applied (dollars in thousands)					
Rural Transit	**Fares**	**Directly Generated Revenues**	**Local Other**	**State**	**Federal**	**Total**
Rural Transit Systems	$3,810	$3,335	$15,189	$19,721	$19,366	$61,422
Percent of Total by Source	6.2%	5.4%	24.7%	32.1%	31.5%	100%*

Source: TxDOT PTN-128 Reports
** Rounding error*
Note: Rural systems did not consistently report capital expenditures in 2007. Therefore, TTI cannot document sources of funds for rural capital expenditures.

Technical Analysis

Public Transportation Capital Requirements

The estimated comprehensive capital investment for metropolitan area public transportation from 2008 to 2030 is $31,924 million. To arrive at this estimate, Texas Transportation Institute (TTI) developed a costing model for fleet replacement with the assistance of TxDOT's Public Transportation Division (see Appendix F). TTI requested input from each transit agency and from the corresponding metropolitan planning organizations (MPOs) regarding planned operating and passenger facilities. These data were added to vehicle replacement data to calculate the total capital requirements of small urban and rural providers. The total combined cost of fleet replacement and expansion for small urban and rural providers is $904.5 million.

Appendix F contains a listing of major capital projects included in the Metropolitan Transportation Plan (MTP) for each region. The methodology used to determine vehicle fleet replacement and expansion is included in Appendix F. TTI requested from MPOs, small urban transit agencies and rural transit districts specific information regarding plans for investment in transit operating and maintenance facilities or passenger facilities. Agencies submitting responses and the facilities included in the long-range plans are included in Appendix F.

Public Transportation Demand by 2030

As shown in Exhibit T-7, Texas metropolitan areas account for 96 percent of the total anticipated transit investment needed between 2006 and 2030 in the state of Texas. The remaining 4 percent of the funding covers all capital for small urban and rural operators. The funding required to support operation of transit systems is not included.

Exhibit T-7 Estimated Capital Requirements to Support Public Transportation in Texas (2006-2030)

Category of Capital Expense	Total Funds Required 2006-2030 (dollars in millions)
Metropolitan Urban Capital Requirements [a]	$34,735.8
Small Urban Fleet Replacement/Expansion	$288.9
Rural Fleet Replacement/Expansion	$615.6
Small Urban/Rural Major Capital Facilities	$667.6
Small Urban Passenger Facilities	$23.1
Rural Passenger Facilities	$30.8
TOTAL [a]	**$36,361.8**

(a) $11.338 million is already included in the system transportation costs contained in the Urban Mobility chapter.

Committee Recommendation

- Perform a comprehensive examination of federal, state and local partnerships to meet regional needs through coordination of funding and services.

Freight Rail

The Freight Rail Challenge

State freight rail needs identified in this chapter show that while substantial funding is needed for a wide range of projects within Texas throughout the period to 2030, the magnitude of the funding and the level of state participation cannot currently be estimated with precision. Strategic investment by the state in the freight rail transportation has not been significant in the past, but could play an important role in future years. Railroad companies have successfully grown their networks through significant reinvestment of capital which has allowed them to remain a competitive alternative to trucking. This source of funding, however, is inadequate to grow the systems to the point where significant freight volumes can be diverted from state highways. If public participation is offered or sought, the financial and policy terms would have to be determined through future legislation which is unknown at this time. Rail is a critical mode in Texas, first developing the state and more recently playing a major role in growing the economy. Texas is also critical to the railroad industry since the trans-continental systems of both western railroads pass through the state. There should therefore be mutual advantages to systemic improvements. The future success of Texas transportation depends on an efficient and encompassing multimodal system in which rail must play a vital part. While freight rail needs cannot, at this time, be aggregated, the chapter includes several key rail projects in the state which would raise efficiency and continue to competitively serve Texas freight rail users.

Current Conditions

The Freight Rail System in Texas

The freight rail system in Texas is expansive, as can be seen in Exhibit FR-1, a map of the Texas rail system. Exhibit FR-2 shows that approximately 44 railroads operated in the state at the end of 2006, the most current data year. The vast majority of system mileage, both on a track-mileage[7] basis and a track-miles-operated[8] basis, is operated by the state's three Class I railroads: Union Pacific Railroad (UP), BNSF Railway (BNSF) (formerly the Burlington Northern Santa Fe Railway), and Kansas City Southern Railway (KCS). These major railroads connect Texas with the larger North American railroad system. Texas is a rail crossroads with both east-west and north-south national freight routes crossing the state in addition to regional rail service.

[7] Track mileage is the actual number of miles of track owned and maintained by a rail company.

[8] Track miles operated includes the additional miles that a rail company operates over tracks owned and maintained by another rail company, with which a financial and/or operational "trackage rights" agreement has been negotiated.

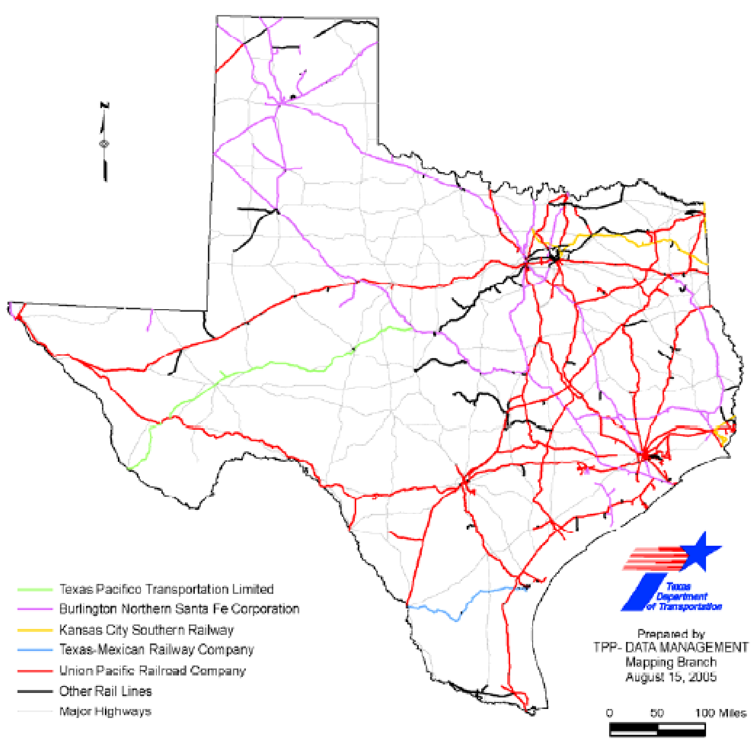
Developing policies and funding programs that maintain or increase the percentage of goods moving by rail benefit the people of Texas. Rail companies can move freight using less fuel and producing less pollution per ton-mile of freight[9] moved than other land-based surface transportation modes and can create economic opportunities for businesses located on the rail network. The traveling public would generally benefit from improving the capacity of existing freight corridors in Texas in several ways. Among these are an increased ability to grow rail market share from truck freight for longer movements, reduce train delays within communities, reduce highway congestion and pavement damage, and improve environmental and energy impacts of freight movements for Texas shippers, distributors, and manufacturers.

The importance of the freight rail system to the Texas economy can be seen by the several categories in which Texas ranks in the top five nationally. Among these are:

Total Rail Miles	Rail Tons Terminated	Freight Rail Employment
Freight Rail Wages	Rail Carloads Carried	Rail Tons Originated
Number of Railroads	Rail Carloads Terminated	Rail Carloads Originated
Rail Tons Carried		

Additional statistics associated with rail movement in Texas are included in Appendix G of this report.

Exhibit FR-1: Map of Texas Railroad System from the 2005 Texas Rail System Plan



9 A ton-mile of freight is the movement of one ton of freight the distance of one mile.

Exhibit FR-2: Miles of Railroad Track in Texas by Railroad Class[10]

Texas Totals	Number of Freight Railroads	Miles Operated: Excluding Trackage Rights	Miles Operated: Including Trackage Rights
Class I	3	8,226	12,219
Regional	2	813	1,058
Local	19	669	697
Switching & Terminal	20	900	991
Total	44	10,608	14,965

Class I Railroad - As defined by the Surface Transportation Board, a railroad with 2006 operating revenues of at least $346.7 million.
Regional Railroad - A non-Class I line-haul railroad operating 350 or more miles of road and/or with revenues of at least $40 million.
Local Railroad - A railroad which is neither a Class I nor a Regional Railroad and is engaged primarily in line-haul service.
Switching & Terminal Railroad - A non-Class I railroad engaged primarily in switching and/or terminal services for other railroads.
Note: Railroads operating are as of December 31, 2006. Some mileage figures may be estimated.

As part of the assessment of needs and current conditions, public comments were solicited through multiple means of collection. Comments from citizens, business groups, councils of government and community organizations came in through email, U.S. Mail and fax. Public meetings and public hearings held across the state were scheduled and publicized through each local TxDOT public information office or through the TxDOT Office of Government and Public Affairs. In addition to comments from the public, more than 90 elected officials, community leaders and citizens presented testimony at the scheduled public hearings. For more information regarding public comments obtained during the assessment process, see Appendix A.

Current State DOT Freight Rail Planning Activities

TxDOT has become increasingly involved in freight rail planning activities over the past decade, but has only recently been given some of the necessary tools to begin actively pursuing railroad projects as a strategy to address both current and future transportation needs. Historically, TxDOT's Multimodal Section has funded several research and engineering studies regarding freight rail to assess freight rail system impacts on highways and other modes of transportation in the state. A list of these studies is included in Appendix G.

In 2001, TxDOT purchased the 381-mile South Orient Railroad to preserve the corridor for future needs. TxDOT has subsequently contracted for operations and infrastructure improvements to preserve the line intact. In 2005, several events further increased TxDOT's responsibilities and contacts with freight rail companies—the Legislature transferred responsibility for rail safety oversight to TxDOT from the Railroad Commission of Texas; the creation of the Texas Rail Relocation and Improvement Fund (TRRIF) was authorized; and TxDOT published the Texas Rail System Plan (TRSP), a comprehensive review of rail projects and plans throughout the state. The TRSP set a baseline from which TxDOT has begun to

[10] Association of American Railroads (AAR), *AAR Railroads and States: Texas Summary, 2006*. Available at: http://www.aar.org. Accessed: September 26, 2008

further develop its ability to account for the freight rail mode in meeting its goals of moving people and goods statewide; however, project implementation has been limited as the TRRIF has not been capitalized at the state level.

Funding History

Private railroad companies almost exclusively provide both the capital and operational funds necessary for continued growth and expansion of the state and the national rail system. Freight rail is the most capital-intensive industry in the United States. In any given year, private railroad companies' capital investments roughly equal 17% of their revenues as compared to an average of 3% for most other industries.[11] Unfortunately, the demand for freight rail forecast by the U.S. Department of Transportation along with forecasts produced by the rail industry itself indicate that the rate of growth in freight demand may exceed the rate at which the industry can internally fund rail infrastructure growth.

The State of Texas is very limited in the amount of funding that it makes available to support strategic projects to increase freight movement by rail. In the coming decades, the public sector (federal, state and local) can play a crucial role by providing strategic capital investment to augment the ability of the rail industry to maintain or grow its current freight market share and keep additional trucks off of state-funded highways. Defining the role that government can, and should, reasonably play in the provision of freight rail infrastructure and operations is yet to be determined. Most likely, it will be in funding projects with high public benefit that are necessary to ensure efficient movement of goods and to decrease traffic conflicts with other modes. Partnering with private freight railroad companies is likely the best way for both public sector and private sector interests to achieve common goals.

Technical Analysis

Freight Rail System Capacity Needs

Though no Texas-specific studies have been completed to estimate overall freight rail capacity needs and related costs, several national and regional capacity studies are ongoing or recently completed. These studies allow some gross estimates to be made of the minimum costs that can be expected related to rail system needs during the study period to 2030. All of the studies project that freight traffic will increase and that freight rail network capacity will need to expand to retain its current freight percentage in relation to truck freight.

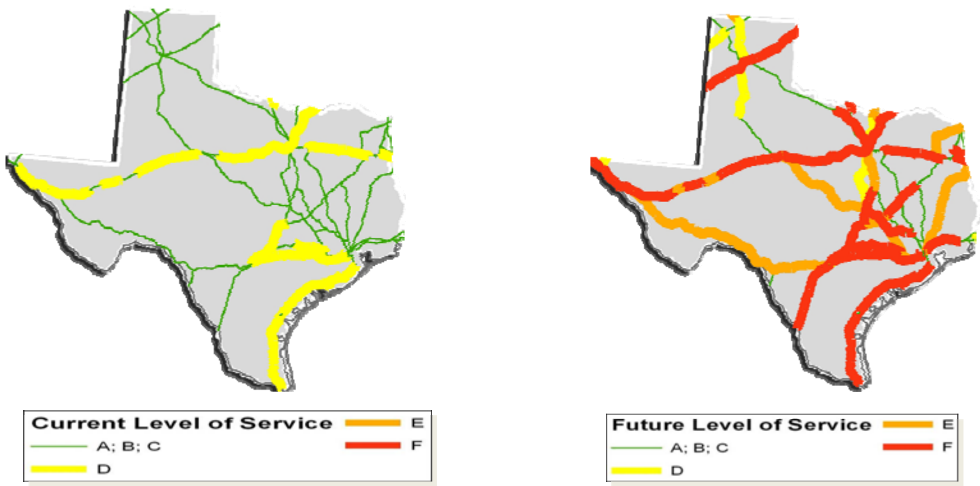
The scope of expected freight rail infrastructure capacity improvements required over the next two decades is shown by a recently completed study funded by the Association of American Railroads (AAR). In September 2007, at the request of the National Surface Transportation Policy and Revenue Study Commission, the AAR produced its National Rail Freight Infrastructure Capacity and Investment Study. This report estimated the impacts of projected freight rail traffic growth on the national rail system using conservative freight forecasts that had been incorporated into the Federal Highway Administration's (FHWA's) Freight Analysis

[11] U.S. Bureau of the Census

Framework Version 2.2 for the period between 2005 and 2035.[12] Exhibit FR-3 shows the study's 2035 projection for many of the major freight rail corridors in Texas without funding of capacity improvements, indicating the majority of Texas' major freight corridors would be operating above theoretical capacity within the Texas 2030 study's time horizon.

To report its findings, the AAR's consulting team devised an A through F classification system for rail system capacity that is similar to the one used by highway planners to describe the Level of Service (LOS) for highway congestion. LOS A, B or C means that the rail is generally free of congestion and below its theoretical capacity with existing infrastructure. At volume-to-capacity ratios[13] significantly greater than 0.8 (e.g., at LOS E or F), train flow rates and schedule reliability deteriorate and it takes longer to recover from disruptions. To provide acceptable and competitive service to shippers and receivers, railroads typically aim to operate rail corridors at LOS C/D or better.

Exhibit FR-3: Current and Estimated Future Major Rail Line Levels of Service in 2005 and 2035 without Capacity Expansion



As can be seen from the exhibit above, substantial investment will be required to ensure continued mobility on the Texas freight rail system. Determining the necessary funding levels and the split between private and public funding to address these needs is much more problematic.

[12] AAR, *National Rail Freight Infrastructure Capacity and Investment Study*, Performed by Cambridge Systematics, Washington, DC, September 2007. Available at: www.aar.org. Accessed: October 16, 2008.

[13] The ratio of the number of trains using a corridor compared to the theoretical maximum capacity (number of trains) of the line as it is configured (i.e. one track vs. two tracks, advanced signals vs. no signals, etc.).

Freight Rail Capital Requirements

The comprehensive freight rail capital investment needed within the state of Texas to 2030 is indeterminate at this time. Further detailed studies and discussions with the freight railroads are needed to determine the slate of projects that will be necessary to accommodate freight demand and to determine the level of involvement that the public sector would take in carrying out those projects. The primary difficulty in developing such an estimate is that freight rail projects in which the public sector is involved are most likely to be carried out as public-private partnerships with varying levels of public sector investment depending on the public benefits associated with each specific project. The cost estimates included in the following sections, based upon the AAR capacity needs study and projects of interest identified by the private railroad companies, are reported to aid the state in estimating a preliminary range within which freight rail funding needs may fall.

Needs Estimate Based on AAR National Study

The first estimate of capacity improvement funding needs to 2030 is based upon the AAR's National Rail Freight Infrastructure Capacity and Investment Study that was discussed earlier in this chapter. Cambridge Systematics, AAR's consultant for this study, recently used the findings of the national study to estimate what Texas would need if the same growth assumptions that it made in that study were made to 2030. The study estimated that $637 million per year in investment would be needed for the 22-year period between 2008 and 2030, totaling approximately $14.2 billion to cover the Texas projects assumed by the national study.

If the same capital shortfall percentage (percentage of total capital funding needs that could not be generated by the private railroads) used in the national study is applied to the total Texas estimated costs, it suggests that the Texas shortfall could be around $3.6 billion for the entire period or approximately $165 million per year. This amount would need to be funded by the public sector or other non-railroad sources to enable freight rail capacity to accommodate forecast growth and to preserve the current truck/rail modal split. It should be noted that the study's growth rate of slightly above 2 percent is quite conservative, and even higher funding levels might be needed to keep up with stronger growth in freight traffic.

This $3.6 billion public sector estimate in Texas over the study period should most likely be viewed as a minimum level of investment to maintain the status quo in regard to freight rail movement in and through Texas. This figure could increase if the individual projects undertaken have a higher percentage of public rather than private benefit ratios resulting in higher public investment on a project-by-project basis. The estimate is based upon a national throughput capacity expansion study and does not:

- fully take into account detailed cost estimates of specific urban rail congestion relief projects,
- plan for additional public sector investment to seek truck diversion to rail to relieve highway congestion or minimize pavement damage in intercity corridors,
- provide for additional state investment in high public-benefit projects such as grade separations or potential relocations within urban areas to improve highway traffic flow in areas where the number of trains is projected to at least double, or

- include any capital investments required to increase intercity passenger or commuter rail service.

This estimate calculates costs for track and signal upgrades required to meet national freight forecasts by route, including those that pass through Texas. Many desired grade separation or relocation projects, which are often the primary interest of the public sector but do not address private sector freight capacity needs, would be excluded from this calculation.

Needs Estimate Based on Identified Railroad Projects

As a second method of determining the magnitude of potential needs of the freight rail system in the state to 2030, researchers from the Center for Transportation Research (CTR) and Texas Transportation Institute (TTI) worked with BNSF Railway to create a list of currently identified major projects that the rail industry would like to see developed within the state during the study period. BNSF worked with representatives of UP and KCS to list 13 freight rail projects or regional rail infrastructure improvement programs that were considered potential public-private partnership candidates, the desired/needed time period for implementation, and preliminary estimates of project costs. Exhibits FR-4 and FR-5 show the results of this effort. The list includes both site-specific capacity improvements (such as double tracking certain bridges in an urban area that could help railroad operations) and regional projects (such as an urban rail bypass or relocation that could have greater benefit in reducing highway traffic conflicts). The list is not meant to be comprehensive. Rather it should be viewed as exemplary of the types of projects that could be undertaken jointly by the public and private sectors and their estimated costs.

In addition to the projects represented in Exhibit FR-5, BNSF, KCS and UP each have several future projects to improve fluidity within their freight corridors (such as siding extensions, new sidings, and double track) that will be required as freight traffic levels increase. While two of the projects listed in the exhibit are included both as individual projects and as part of a regional project total, the magnitude of the estimate based upon individual projects points to larger investment levels than the $14.2 billion estimated by calculating the Texas portion of the national AAR study.

Exhibit FR-4: Estimated Project Implementation Timeframe Tier Definitions

Estimated Time Frame	Tier
2009-2015	I
2015-2020	II
2020-2030	III

Exhibit FR-5: Texas Freight Rail Major Infrastructure Projects Identified for Potential Public-Private Cooperation by the Class I Railroads Operating in Texas

Location	Project (Operating Carrier)	Tier	Description	Key Benefits	Project Cost Estimates
Fort Worth (DFW Metroplex)	Tower 55: At-Grade Improvements (BNSF/UP)	I	Joint BNSF – UP project to improve at-grade intersection at Tower 55.	Remedy immediate urgency of Tower 55 reaching capacity from today's traffic exceeding 120 trains/day Assure robust freight rail network for the region/state Improve freight and Amtrak service Reduce emissions and crossing delays	$70 million (North Central Texas Council of Governments study, 2008)
Beaumont	Neches River Bridge Replacement (KCS)	I	Improve single track KCS Bridge over Neches River (upgrade or 2nd bridge)	Convert existing single track bridge chokepoint to double track on critical East-West rail corridor	$45 million (2004 Zeta-Tech Study for Port of Beaumont)
South Texas	Garcitas Creek and Colorado River Bridge Replacement (UP)	I	Replace two low-tonnage bridges over Garcitas Creek and Colorado River	Allow Port of Corpus Christi to receive fully- laden trains and improve rail capacity for future La Quinta development	TBD
South Texas	Rosenberg to Victoria Line Restoration (KCS)	I	Reconstruction of the former SP line between Rosenberg and Victoria, Texas / (KCS)	Improve connectivity for US-Mexico trade Reduce freight rail congestion within local communities	TBD
El Paso	Ciudad Juarez Grade Separations Santa Teresa, NM Rail Bypass Project (BNSF/UP/FXE)	I-II	Construct five grade separations in Ciudad Juárez/ expand operating hours (FXE) Establish new freight rail border crossing at Santa Teresa, NM (BNSF/UP)	Improve trans-border freight rail capacity and velocity Reduce congestion within border communities	Estimated $70 million (Mexico SCT) Estimated $445 million (2003 Study)
Houston	Houston Region Freight Rail Study / (UP, HBT, PTRA, BNSF)	I-III	Freight rail capacity enhancements within Houston Region	Improve freight rail capacity and velocity. Reduced congestion in urban area	Identified up to $3.4 Billion in projects (2007 TxDOT Study)

2030 COMMITTEE

Location	Project (Operating Carrier)	Tier	Description	Key Benefits	Project Cost Estimates
UP corridors with / projected capacity gaps noted in AAR Study (Exhibit FR-3)	El Paso-Shreveport Fort Worth-Laredo San Antonio-Houston Shreveport-Brownsville (UP)	I-III	Multi Track/Signal/Siding Capacity Additions	Increase Freight Rail Capacity and Velocity Increase Commerce and Trade Improve Domestic and Mexico interchange Reduce congestion within metro and border communities	Varies over time (Subset of AAR TX projects of $14 billion, cited on page 76 of this report)
BNSF corridors with / projected capacity gaps noted in AAR Study (Exhibit FR-3)	Gainesville-Houston Denison-Houston Amarillo-Ft Worth Silsbee-Somerville Lubbock-Houston (BNSF)	I-III	Multi Track/Signal/Siding Capacity Additions	Increase Freight Rail Capacity and Velocity Increase Commerce and Trade Reduce congestion within metro and border communities	Varies over time (Subset of AAR TX projects of $14 billion, cited on page 76 of this report)
Southeast Texas	Cleveland – Dayton Rail Bypass (Liberty County Rural Rail District)	II	Freight Rail bypass as identified in the Houston Freight Rail Study	Establish freight by-pass around Houston for Eastern Gulf originating/terminating freight	Estimated $267.4 million (2007 TxDOT Regional Study)
Fort Worth (DFW Metroplex)	Tower 55: Grade Separation (BNSF/UP)	III	Grade Separation Project being led by NCTCOG	Long-term grade separation at Tower 55 Private funding would be based on incremental benefits vs. at-grade crossing	Various options being considered, estimated cost to exceed $300M (2007, NCTCOG)
Central Texas	Central Texas Rail Relocation Study (UP)	TBD	New freight rail bypass through central Texas	Improve freight rail capacity and velocity. Reduce congestion in urban area	Identified range of relocation projects between $1.4 and $2.4 Billion (2007 TxDOT Study)
Laredo	Rail Bypass (KCS)	TBD	Proposed rail bypass around Laredo, Texas the "East Loop Bypass" (KCS)	Improve trans-border freight rail capacity and velocity Reduce congestion within border communities	TBD

Interaction with Passenger Rail Service

None of the cost estimates take into account additional capacity needs that would be required if intercity passenger rail service were added within existing freight rail corridors of the state. Such operations would increase costs greatly by introducing the need for additional track capacity, new signaling upgrades, and increased dispatching complexity. Passenger rail services would need to be carefully planned in conjunction with freight railroad companies in order to avoid negatively affecting freight rail movement or the ability to expand freight rail capacity in the future. Freight railroads also have outlined policies regarding the operation of passenger rail over their freight tracks. An example of such principles from BNSF Railway is included in Appendix G.

Potential State Agency Roles in Freight Rail

Several state entities currently have roles and/or powers related to freight rail and provision of freight rail projects. Among these are TxDOT, Regional Mobility Authorities, Rural Rail Transportation Districts, Freight Rail Districts, Commuter Rail Districts, and several other state land use or historical preservation agencies. Metropolitan planning organizations also affect freight rail development, mostly through rail transit planning efforts that are often based on use of existing freight rail lines or rights-of-way. These entities and their roles are discussed in more detail in Appendix G.

TxDOT, as the state's rail planning agency, has several potential roles that it could play in creating an improved freight rail system between now and 2030. If given authorization and properly funded, TxDOT could more effectively partner with the private railroad industry to pursue the public interest in making the freight rail system more efficient and effective by removing bottlenecks and addressing capacity constraints as population and freight demand grow within the state. Exhibit FR-6 shows some potential roles that TxDOT could perform based upon recent studies conducted by CTR and TTI and the research team's experience in examining the programs of other states.

Exhibit FR-6: Potential TxDOT Roles in Supporting Freight Rail Improvements

Potential Role	Description
Advocate for/act as a conduit for federal freight rail funding programs.	• TxDOT could act as the implementing and oversight agency for federal freight rail funding programs for all projects within Texas and support federal policies that encourage infrastructure investments by freight railroads.
Create state-level freight rail funding programs.	• Several states have instituted freight rail funding programs which benefit low-density shortline railroads to help them more effectively collect railcars for movement on the Class I rail system. Other states fund the building of industrial tracks to facilitate economic development, provide rail service to industrial parks, improve port mobility, provide capacity for more highway traffic to be moved via rail, or to attract new business.
Public-private funding partnerships on specific projects.	• Direct funding and partnership could be focused on projects that have a public benefit but that have limited private benefits. An example of such a project might be a grade separation structure.
Tax incentives for freight rail infrastructure development.	• Rather than directly funding a rail project, the state or local agency could allow the railroad company a tax-break incentive to encourage completion of a rail infrastructure project. This option is not unlike granting a tax abatement to attract investment by new businesses.
Set statewide standards for rail project development.	• TxDOT, on behalf of the state, could set standard practices to be associated with rail improvement projects so that railroad companies and each municipality would not have to negotiate basic contractual items for each project. Specific needs of certain projects would require negotiation; however, basic principles would be standardized.
Cooperative planning for major corridor improvements.	• TxDOT and other state entities could cooperate directly with the railroad companies to focus public investment on high-priority corridors that would enhance statewide movement of freight leaving lower priority (lower public benefit) improvements to internal railroad funding or, possibly, local or regional funding partnerships with the railroads.
Highway-rail grade crossing safety.	• Currently federal funds provide for most grade crossing safety improvements. State funding could be applied to grade crossing improvements that would reduce crashes that occur at these locations.

Intercity Passenger Rail

Introduction

Railroads that revolutionized passenger travel and business practices from the 1850s to the 1950s have for Texas become relics of a bygone era with only marginal passenger transportation utility when compared to cars, trucks and planes. That is not the case in most developed countries or even in some of the more concentrated population centers of the U.S. The question before the 2030 Committee was whether there is any material role for intercity passenger rail that would require additional transportation funding between now and 2030. Although the answer to that question is beyond the scope of the Committee's charge, a number of factors seem to be converging in a way that suggests the answer might well be "yes."

Intercity Passenger Rail: Context and Technology

For a wide variety of reasons, transportation systems and infrastructure in many developed countries have evolved differently from those in the United States. The concentration of government investment in highway and aviation systems elsewhere has not approached that of the U.S. As a result, the U.S. has developed uniquely efficient and valuable highway and aviation systems that continue to serve the nation and its economy very effectively. Although not quite a case of total abandonment, the concentration of public investment in the expansion of highway and aviation infrastructure in the U. S. has left intercity passenger rail developmentally stranded and financially starved in much of the country.

That is not the case in most other developed countries—particularly during the last two decades—where new passenger rail technologies have emerged to connect major population centers with increasing speed, safety, comfort, capacity and efficiency.

Current Conditions

To oversimplify, today's passenger rail technology falls into three general categories:

- *Conventional rail.* Refers to diesel-powered trains operating on tracks shared with freight trains and operating at speeds generally up to 79 mph but as high as 120 mph in some corridors.
- *High-speed rail.* Refers usually to electric-powered trains, operating on shared or dedicated tracks and at speeds regularly over 125 mph, usually between 150 mph and 225 mph.

- *Mag-Lev or magnetic levitation trains.* Refers to a highly advanced power system technology that moves trains with magnetic force at speeds well above 300 mph (currently operating commercially only on a short line in Shanghai, and operating as experimental trains in Germany and Japan).

Currently, high-speed rail is the passenger rail technology of choice for most new rail development, with projects either planned or under development in Africa, Asia, the Middle East, Europe, North America, Australia and South America. The cost of Mag-Lev is generally viewed as a significant barrier to its feasibility; nonetheless, Mag-Lev technology is under consideration as a possible alternative for regional rail projects in three areas of the United States: the Baltimore-Washington, D.C.; Los Angeles-Las Vegas; and Chattanooga-Atlanta corridors.

As part of the assessment of needs and current conditions, public comments were solicited through multiple means of collection. Comments from citizens, business groups, councils of government and community organizations came in through email, U.S. Mail and fax. Public meetings and public hearings held across the state were scheduled and publicized through each local TxDOT public information office or through the TxDOT Office of Government and Public Affairs. In addition to comments from the public, more than 90 elected officials, community leaders and citizens presented testimony at the scheduled public hearings. For more information regarding public comments obtained during the assessment process, see Appendix A.

Intercity Passenger Rail in Texas

In Texas, all intercity passenger rail is conventional—diesel-powered locomotives, with trains operating on tracks owned and controlled by private freight rail operators limited to a top speed of 79 mph. Amtrak currently operates the only three intercity passenger rail routes in Texas, supplementing its rail operations with connecting bus services. Amtrak's operations are described in Exhibit ICPR-1. Exhibit ICPR-2 presents a map of the train and bus routes currently operated by Amtrak. Amtrak provides both capital and operating funds for its Sunset Limited and Texas Eagle routes. Texas (through TxDOT), Oklahoma (through ODOT) and Amtrak share the operating cost of the Heartland Flyer. As freight rail traffic and congestion have increased, the on-time-performance of all of Texas' Amtrak trains has become increasingly less reliable.

In addition to Amtrak operations, there are ongoing efforts to develop intercity passenger rail routes in the Austin-San Antonio corridor and in east Texas along the I-20 corridor. The Texas High Speed Rail and Transportation Corporation hopes to develop a high-speed rail system connecting the major urban areas of the state. Any such service would represent added capacity in existing corridors or within new rights-of-way. In light of the transportation capacity and funding challenges facing Texas, any additional capacity that can be provided on a cost-effective basis, especially in the Central Texas Triangle (shown in Exhibit ICPR-3) , is valuable capacity. The Committee applauds such efforts and encourages their continuation, with any support TxDOT or the Texas Legislature might lend.

Exhibit ICPR-1: Current Amtrak Intercity Passenger Rail and Thruway Motorcoach Routes Serving Texas Cities

Route Name	Description
Heartland Flyer	Operates between Fort Worth and Oklahoma City once daily in each direction, southbound in the morning, returning northbound in the evening.
Sunset Limited	Operates three days per week in each direction between New Orleans and Los Angeles. Westbound stops: Beaumont and Houston on Mon.; Wed.; Fri. San Antonio, Del Rio, Sanderson, Alpine, and El Paso on Tues; Thurs; and Sat. Eastbound stops: El Paso, Alpine, Sanderson, Del Rio, and San Antonio on Mon.; Thurs.; and Sat. Houston and Beaumont on Tues.; Fri.; and Sun. Thruway Motorcoach connections are provided to Galveston via Houston, Brownsville and Laredo via San Antonio, and Albuquerque via El Paso.
Texas Eagle	Operates between Chicago and San Antonio daily and between Chicago and Los Angeles three days per week in conjunction with the Sunset Limited. Stations west of San Antonio are served on the same schedule as the Sunset Limited. Thruway Motorcoach connections are provided to Shreveport and Houston via Longview, Ft. Hood and Killeen via Temple, Brownsville and Laredo via San Antonio, and Albuquerque via El Paso.

Exhibit ICPR-2: Texas Amtrak Passenger Rail and Thruway Motorcoach Connecting Service

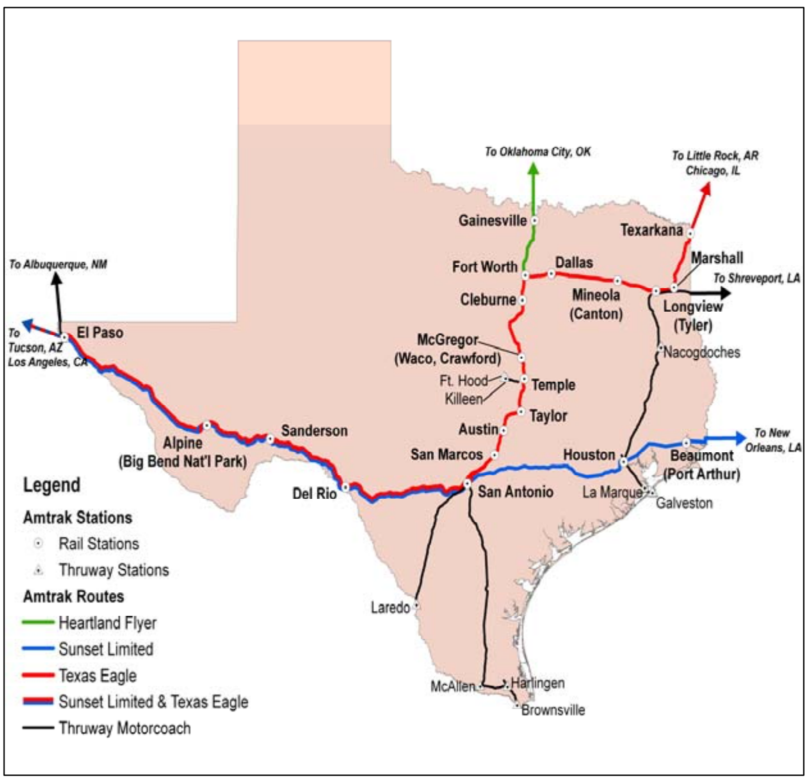


Exhibit ICPR-3: Central Texas Triangle

Current Trends in U.S. Intercity Passenger Rail

Nationally, intercity passenger rail has been experiencing historic growth in ridership over the last several years, especially during the gasoline peak-price period of 2007-08. The greatest ridership growth has been seen in the middle-distance, regional corridor routes that connect urban areas approximately 200-300 miles apart. These Amtrak trains include its premier high-speed electric-powered trains on its Northeast Corridor (between Washington D.C. and Boston), as well as its conventional diesel-powered trains operating on standard freight tracks (principally operating in Illinois out of the Chicago area, in California, and in the Northwest). Ridership trends on selected Amtrak routes are shown in Exhibit ICPR-4.

Exhibit ICPR-4: Example Corridor Route Ridership Percent Growth Trends

AMTRAK Route	FY04-FY05 (% growth)	FY05-FY06 (% growth)	FY06-FY07 (% growth)	FY07-FY08 (% growth)	FY04-FY08 Period (% growth)
Acela	(30.99)*	45.67	23.28	6.75	32.30
Northeast Regionals	5.64	(19.14)**	(0.05)	9.35	(6.65)***
Cascades	4.37	0.71	7.41	12.78	27.33
Heartland Flyer	23.10	(4.32)	6.50	18.53	48.69
Hiawathas	14.08	10.49	2.59	25.92	62.82
Pacific Surfliner	7.50	5.45	1.86	7.08	23.64
San Joaquins	2.34	5.82	0.61	18.00	28.58
Capitols	8.14	0.26	14.77	16.79	45.33

*Source: Ridership numbers provided by Amtrak. Analysis by TTI. * Decrease due to decreased service following mechanical outage on Acela trainsets during FY05. ** Decrease in ridership attributable to increased Acela service and ridership following Acela trainset outage in previous year. ***Overall decrease is due to increased Acela service ridership and reconfiguration of certain Northeast Corridor Regional Routes to commuter service.*

The Texas market has long been attractive to Amtrak and federal rail planners due to the relatively close proximity of several major population centers along corridors of comparable length. In its 1997 report to Congress entitled High Speed Ground Transportation for America, the Federal Railroad Administration (FRA) ranked viable existing and potential U.S. passenger rail routes as candidates for high-speed rail service with the "Central Texas Triangle" of Interstates 35, 10 and 45 ranked among the highest. Although a number of attempts have been made since the 1970s to link these areas by passenger rail, no actual development has occurred.

Funding and Oversight History

Historically, TxDOT has been a passive observer of other entities in the oversight, evaluation, development, funding or provision of intercity passenger rail service in Texas. This is understandable because of the historically insignificant role of passenger rail in Texas and the fact that much of that responsibility and initiative is statutorily assigned to the U.S. Department of Transportation (USDOT), the Federal Railroad Administration, Amtrak and private freight rail operators.

Nonetheless, in 2005, TxDOT published the Texas Rail System Plan – a comprehensive review of all rail projects and plans throughout the state, covering freight rail/intermodal, current intercity passenger rail service, rail safety, rail service to port areas, and rail funding programs. This document established a baseline from which TxDOT has begun to improve its understanding of the overall role of rail in Texas' mobility.

Any further development of passenger rail in Texas will require that TxDOT assume a more active and assertive role on behalf of the state at the federal government level, with Amtrak, the FRA, USDOT, and the U.S. Congress. TxDOT currently has no meaningful presence or capability for contributing to the shape or substance of the relationship between either freight or intercity passenger rail and Texas' growing transportation needs between now and 2030. It is a capability that will become increasingly important in the future.

Technical Analysis

Convergence of Factors: A Role for Passenger Rail?

- *Population trends: Texas and the Texas Triangle.* The report of the 2030 Committee began with a discussion of the growth and demographic trends of the state: a population today of roughly [19 million], with about 75 percent of that population, or [14 million residing in the area of the so-called Texas Triangle. Projecting forward to 2030, assuming a virtual doubling of the state's population and further concentration of the state's population in its major urban centers of the Interstate 35-10-45 triangle, the population of the major urban centers within the Triangle might well approach [30 million]. Currently, the two highest volume-to-capacity (V/C) highway corridors—the I-35 corridor between DFW and San Antonio and I-10 from San Antonio to Houston—had V/C ratios at or approaching 0.80. Preliminary analysis currently being conducted by the Texas Transportation Institute (TTI) for TxDOT has shown that, using 2030 forecast traffic, 13 of 18 intercity study corridors would have a V/C ratio well above 1.0 with several well over 1.5 and average projected speeds of 15 to 20 miles per hour in some parts of each corridor assuming current infrastructure.
- *Additional highway capacity, diminishing cost-effectiveness.* With rising costs of right-of-way and construction, resolving mobility needs with additional highway capacity will become less and less cost-effective.
- *Aviation capacity: terminals, runways, traffic control systems, security.* The same capacity constraints that adversely affect Texas' highway system are likely to affect the state's airport infrastructure and operating systems just as severely as highways.
- *Trends in aviation route efficiencies.* In the context of airline operating efficiencies, the trend may well be toward longer-haul routes and away from short-haul flights such as those between cities in the Texas Triangle, further limiting capacity relative to population growth and intrastate travel demand.
- *Environmental issues: intercity rail vs. cars and planes.* Passenger trains, especially electric trains, are generally viewed as more eco-friendly than cars, trucks and planes by the public and elected officials. That perception and modal preferences stemming from it are likely to grow. For example, rail operators in Europe have developed websites

enabling travelers to compare the environmental impact of rail versus that of other modes from designated points along passenger rail routes.

- *Continuing advances in high-speed rail technology.* The evolution of high-speed rail technology seems to be advancing rapidly, almost annually. There is a significant likelihood that further advances in passenger rail technology will become available by the time any U.S. system becomes operative (probably 15 to 20 years from project inception), making high-speed rail travel even more cost-effective, efficient and feasible.
- *Public receptivity.* As reflected in Europe, East Asia and even the U.S. Northeast Corridor, the traveling public is quick to accept advanced passenger rail technology, moving quickly from considering it something special to something that is expected. (Amtrak's Acela controls a market share of 50-60 percent of the air/rail market between Washington, D.C., and New York City).
- *Need to protect competitive level of Texas mobility.* Ultimately, as stated throughout the 2030 Committee report, the central challenge is to protect Texas' historically competitive level of transportation mobility. The idea that intercity passenger rail might have a role in that effort sometime in the future is a proposition worthy of examination.

Conclusions

The 2030 Committee is not in a position to draw any conclusions regarding the importance or viability of developing additional conventional intercity passenger rail capacity or a more advanced high-speed rail system within the state. However, the Committee projects that it would be an expensive proposition requiring a lead time of probably no less than 15 years. The cost-effectiveness to the state of such an investment is central to any evaluation of such significant, multi-year commitment, and might well lead others to conclude that the cost is simply prohibitive.

On the other hand, at least three areas of the country have initiated comprehensive studies of the viability of Mag-Lev rail in their areas, and California voters recently approved the first installment of project cost ($9.5 billion in state bonds) for what will likely become the first new high-speed rail operation in the country (San Francisco to Los Angeles). Texas has been and should remain a leader among the states in transportation efficiency. Whether through conventional or advanced passenger rail technology, or both, whether intercity passenger rail would be a cost effective strategy in addressing Texas transportation challenges in the future is a question that deserves careful examination.

Committee Recommendation

- The 2030 Committee recommends that TxDOT or the Legislature authorize a comprehensive evaluation of the viability and value to the state of the development of a high-speed rail system linking the major urban areas of the Texas Triangle, leading to a final recommendation in 2010 to TxDOT and the Legislature as to whether to proceed with such a project.

Ports and Waterways

Introduction

There is wide variation among states in terms of the structure and operation of ports. In Texas, port authorities are primarily political subdivisions of the State of Texas, with control and responsibility at the local level. Ten port complexes handle virtually all of the state's oceangoing cargo. Eight of these ports are navigation districts, one is a municipal agency (Galveston), and one is a private facility (Texas City). In addition to these 10 ports, several port complexes handle barge traffic only.

Texas already handles more than 20 percent of the nation's oceangoing tonnage. Using the conservative estimates that have been produced for container traffic at the Port of Houston, volume at the Port of Houston in 2030 is projected to be greater than the current volume handled at any other U.S. port in 2008, with the exception of the Los Angeles/Long Beach port complex. This will almost certainly give rise to increased public concern about environmental and congestion issues. For more information, see Appendix H.

Ports and Waterways Challenges in Texas

The areas described in the following sections represent significant transportation challenges that Texas ports and waterways face.

Lack of Dredging

The level of federal funding over the last 10 years has not been sufficient to maintain all ship channels at their authorized dimensions. Up to an additional 20 percent in funding could be required to maintain all projects at their authorized dimensions—the dimensions which Congress has instructed the U.S. Army Corps of Engineers to maintain (typically described in terms of width and depth). If the severity and/or frequency of major storms increase, budget requirements will increase. A continual escalation in fuel prices will also cause significant increases in the cost of dredging.

Given these factors, either the cost of dredging will increase or dredging activity will be reduced. At a minimum, at least $71 million will be needed each year to maintain channels. It is conceivable that the number could be as high as $90 million.

Container Capacity

Almost all oceangoing containerized cargo arriving directly in Texas is handled by the Port of Houston, although a small number of containers is handled at nearby Port Freeport. Barbours Cut, which is currently Texas' largest container facility, has reached virtual capacity. The Port of Houston is planning technological enhancements to speed the rate of container processing, including the acquisition of next-generation container cranes and handling equipment. The new Bayport container terminal, located near Barbours Cut and operated by the Port of Houston Authority, will more than double its capacity when build-out is complete. The effects of Hurricane Ike have not affected the plans of the Port of Houston to develop the Bayport facility. It is too early to determine how the hurricane may impact the plans for the development of a terminal on Pelican Island. The Pelican Island project will only be initiated once the Bayport facility is completely built out.

The proposed development of a container terminal in Corpus Christi to serve South Texas and northern Mexico, a region where the population and economy are growing rapidly, would involve substantial private sector involvement through a concession arrangement—specifically, a one-year Memorandum of Understanding with Zachry American Infrastructure, Inc. Under the terms of the MOU, the Port of Corpus Christi and Zachry American will engage in discussions with shipping lines, port operators, financial institutions and other private sector companies interested in investing or participating in the project. The goal is to enter into a long-term agreement for the design, financing, construction and operation of the La Quinta Trade Gateway Terminal. Such an agreement in the port environment usually calls for the concessionaire to make a significant investment in infrastructure in exchange for a long-term lease. Although the plan is not finalized, the Port of Corpus Christi plans to arrange for $83 million of the total cost. Other financing arrangements for capital expansions, such as private financing arrangements, have been proposed.

Environmental and Congestion Issues

As freight traffic at ports and waterways in Texas grows, so will the need to address the environmental and congestion impacts of port activity. Rapid growth at several of the container ports along the West Coast, has resulted in public pressures to perform significant mitigation to ensure that port activity does not disproportionately impact quality of life in the surrounding areas.

Security Requirements

The security measures required by the federal government have created a significant increase in operating expenses for port authorities. While the federal government has provided grant money for security assets, it does not provide money for on-going maintenance or for the personnel expenses incurred because of the required measures. In 2005, the Texas Transportation Institute (TTI) performed an analysis that showed security expenses were absorbing an average of 7 percent of operating revenues across all Texas ports, with a range of anywhere from 5 percent to 17 percent. New requirements have been implemented since then (one of the most notable being the Transportation Workers Identification Credential). The effect is that operating expenses are certainly higher today than in the past.

Intermodal Connectivity

Ports and the federal government are investing billions of dollars in maritime infrastructure. However, the value of that investment is directly dependent on the landside connections of ports. It is very important to have safe and efficient highway and rail connections for Texas ports to be competitive.

Current Conditions

As part of the assessment of needs and current conditions, public comments were solicited through multiple means of collection. Comments from citizens, business groups, councils of government and community organizations came in through email, U.S. Mail and fax. Public meetings and public hearings held across the state were scheduled and publicized through each local TxDOT public information office or through the TxDOT Office of Government and Public Affairs. In addition to comments from the public, more than 90 elected officials, community leaders and citizens presented testimony at the scheduled public hearings. For more information regarding public comments obtained during the assessment process, see Appendix A.

Funding History

The State's Role in Funding Ports and Waterways

Almost 89 percent of port asset financing comes from the port authorities, approximately 7 percent comes from the federal government, and just less than 5 percent comes from other sources. The State of Texas has historically appropriated $1.35 million each biennium to cover its expenses as non-federal sponsor of the Gulf Intracoastal Waterway (GIWW). This money funds acquisition and maintenance of dredged disposal sites and beneficial-use projects for the GIWW. Additionally, in 2001 the Texas Legislature created a funding program called the Port Access Account Fund for port security, projects and studies. At this time the fund is not capitalized and is unavailable for funding port projects.

Ship channels and the GIWW are federal waters. The federal government, through the U.S. Army Corps of Engineers, is responsible for maintaining all navigation channels and pays anywhere from 50 percent to 65 percent of the cost of any channel deepening or widening projects.

Total Ports and Waterways Funding in Texas

During fiscal years 1994-2004, public port authorities in Texas added almost $1 billion in assets to their books, which were primarily infrastructure components such as docks, roads and warehouses. This does not include amounts contributed by the federal government to construct deeper or wider channels.

Ports (both deep sea and barge) typically finance their asset growth via general obligation bonds, revenue bonds, ad valorem taxes and operating revenues. Exhibit PW-1 shows the proportional use of these financing vehicles by deep sea ports.

Exhibit PW-1: Asset Financing of Deep Sea Ports by Source of Funds

Source	Dollar Amount	% of Total
Public Financing:		
General Obligation Bonds	$431,375,920	43.7
Grants – Non-Security	$32,939,793	3.3
Grants – Security	$14,406,754	1.5
Capital Contribution from Government	$19,173,985	1.9
User Financing:		
Revenue Bonds	$73,097,052	7.4
Loans	$43,008,051	4.4
Reimbursements	$17,536,834	1.8
Other Contributions	$3,721,344	0.4
Cash and Miscellaneous	$351,103,761	35.6
Total	$986,363,494	100.0

There are no data available on private investments in port complexes. Infrastructure items typically funded by the private sector generally consist of docks and related items. Private operators located on port authority property may either rent warehouses and equipment or make other arrangements to finance them.

Dredging

Without constant maintenance, silt, mud, and sand will accumulate in ship channels and waterways, making it impossible for a fully loaded vessel to pass through. Dredging, the process of removing that accumulation, is mandatory so that vessels and barges can operate efficiently and safely. Exhibit PW-2 shows the value of dredging contracts issued by the U.S. Army Corps of Engineers for calendar years 2001-06. The dollar amounts are adjusted to 2007 price levels in order to show constant dollars.

Column (1) shows that the Corps typically spends $62 million a year in maintenance work, of which it pays 100 percent, discounting minor contributions by other federal agencies.
Column (4) shows what state and local entities must pay in order to maintain dredge material disposal areas, relocate utilities and cover other expenses related to the Corps' maintenance dredging. Columns (2) and (5) show what was spent to widen and/or deepen existing channels.

Exhibit PW-2: History of Dredging Expense in Texas (in 2007 $)

Year	(1) Corps Maint	(2) Corps New Work	(3) Other Fed Maint	(4) Local/ State Maint	(5) Local/State New Work
1998	55,931,983	5,795,885	112,721	1,236,425	2,046,416
1999	74,556,785	32,970,236	0	1,415,495	13,517,838
2000	63,851,802	83,411,499	0	650,259	30,522,157
2001	81,239,511	31,353,510	0	1,907,656	9,981,994
2002	63,847,211	41,033,511	158,764	769,504	10,994,811
2003	71,897,821	60,350,532	6,336,253[14]	3,659,616	22,847,110
2004	52,976,920	60,555,013	0	343,707	20,265,254
2005	37,903,994	21,266,962	0	654,658	11,606,791
2006	58,360,425	6,626,975	0	559,274	1,984,279
Average	62,285,161	38,151,569	734,193	1,244,066	13,751,850

Committee Goals

- Enhance the competitive position of the Texas port system by ensuring the timely completion of channel improvement projects
- Maintain the competitive position of all Texas ports by ensuring their channels are maintained at authorized dimensions
- Enable the state to realize the maximum benefit of its port system by constructing and maintaining adequate highway and rail connections
- Enhance port security without sacrificing competitiveness and efficiency

Committee Recommendations

- Monitor adequacy of federal and state funding, and elevate port connectivity needs in the surface transportation planning process to ensure a significant contribution to Texas' economic competitiveness.
- Incorporate ports into the state's homeland defense planning structure in such a manner that freight transportation needs are addressed as a priority.

Technical Analysis

Ports and Waterways Capital Requirements by 2030

According to the Federal Highway Administration's (FHWA's) Freight Analysis Framework, total waterborne tonnage will almost double to 2.2 billion tons in the period of 2002 to 2035, due mostly to growth in international trade. The rate of growth for the containerized portion of total tonnage is expected to be significantly higher, although such projections have not been well substantiated.

[14] $4 million of this amount was contributed by the Coast Guard for work performed in Galveston. The remainder comes from Maintenance Operations of Dams and Improvements of Navigable Waters.

The completion of the project being undertaken by the Panama Canal Authority to expand the capacity of the Panama Canal will result in further growth. This expansion will make it economically more feasible for ships – primarily container ships – to sail directly from Asia to ports in the Gulf of Mexico. In a study commissioned by TxDOT in 2006, the authors stated that the proposed expansion of the Panama Canal will have significant impacts on Texas ports, their surrounding communities, and the highways and rail lines that serve them. Texas ports are still evaluating their needs for additional port infrastructure resulting from the Panama Canal project. It could be argued that the projected Bayport Terminal expansion in Houston and the proposed La Quinta Gateway in Corpus Christi are affected by the potential increased demand from the Panama Canal widening, but both port authorities expect these terminals to be built by 2030 based on the demand from other sources. The main effect of the Panama Canal will be to accelerate the growth curve.

Basic Infrastructure and Channel Improvement Needs

The Texas Ports 2008-2009 Capital Program provides a basis for analysis of basic infrastructure. Unfortunately, little information is available for forecasting purposes. Therefore, several assumptions were made by the research team members based on their best judgment.

Infrastructure in the port context focuses on basic facilities such as docks, roads, rail lines and berthing areas/channels. Additionally, channel widening/deepening projects are being pursued by various Texas ports with the hope of accomplishing them by 2030. In several cases, it is too early to predict what the cost will be because the new channel dimensions have not been defined. For analysis purposes the research team selected a number that it deemed reasonable in comparison to historical activity. A summary of the projected port needs is shown in Exhibit PW-3. To the degree that the available information allowed, items such as buildings, security equipment, etc., were eliminated from the figures shown in Exhibit PW-3.

Exhibit PW-3: Projected Non-Channel Infrastructure Improvements

	Total Requirement	Expected Port Funds	Expected Federal Funds	State Funding Requirement
Basic Infrastructure	$1,406,931,900	$240,109,155	$894,616,690	$272,206,055
Channel Improvements	$2,202,730,000	$851,550,000	$1,351,180,000	-0-
Total	$3,609,661,900	$1,091,659,155	$2,245,796,690	$272,206,055

Note: Currently, the Port of Houston does not envision the need to deepen its channel in order to support new container operations at Barbours Cut. It is possible that a deeper channel will be required at Bayport; however, the timing and cost are uncertain.

The number shown in Exhibit PW-3 as the State Funding Requirement assumes that the Texas Legislature will sufficiently capitalize the Port Access Account Fund and that ports will apply to the account for $272 million from the fund. Barring that capitalization by the State of Texas, other sources of funds must be secured or the amount of infrastructure development will most likely be curtailed.

Given the history of port infrastructure development in the last 10 to 15 years, these numbers are probably conservative. However, freight volumes will continue to increase significantly. Therefore, cost-benefit analyses of terminal improvements designed to serve the largest ships—those requiring a 50-foot channel—are needed to justify the investments. Over the last 10 years, the growth in freight has far exceeded the growth in general economic activity, both in the United States and around the world. This is primarily because of the globalization of the manufacturing process.

Airports

Introduction

The Texas Airport System is comprised of 300 airports, including 27 primary commercial service airports, 25 general aviation (GA) reliever airports and 248 general aviation airports (non-reliever). Reliever airports are general aviation airports located in larger urban areas and designated by the FAA to serve as alternative locations for smaller aircraft instead of utilizing the larger commercial airports. This essentially frees up capacity at the larger airports for additional passenger aircraft. In Texas, there are 213 airports in the National Plan of Integrated Airport Systems (NPIAS), with five-year development costs totaling more than $4 billion. This includes both commercial service and general aviation airports. For more information, see Appendix I.

Challenges Facing Texas Airports

The following areas represent significant challenges that Texas airports face:

- *Revenue Generation.* Airports are limited in their ability to generate the revenues needed to sustain operations, provide for maintenance and make necessary capital improvements. Airports are continuously looking for new ways to increase revenue in the wake of increasing construction costs and economic turmoil in the airline industry. Larger airports with passenger service have more tools at their disposal, such as parking, rental car and terminal concession revenues. Smaller airports, especially general aviation airports, rely mostly on revenue from hangar rentals and fuel flowage fees. They will continue to require support, as their role in the overall economy is significant but their direct revenue potential is limited.
- *Airport Development Funding Sources.* Compounding the funding issue is the fact that Texas is among a small number of states that do not have a dedicated source of airport development funding. According to the National Association of State Aviation Officials[15], 19 states fund airport development from the general fund, 30 have aviation fuel taxes that support airport development, 10 have aircraft sales and use taxes and 27 use other sources. Texas is in the "other" category, with TxDOTas the sole source of state airport development funds. Twenty-two states utilize two sources of funding, while four states utilize three sources and three states have four sources of revenue. In addition to the sources already mentioned, other funding streams that have been discussed and/or implemented in other states to fund airport development include: redistributing existing

[15] State Aviation Funding and Organizational Data Annual Report, Fiscal Years 2002 and 2003. National Association of State Aviation Officials, 2003.

aviation-related sales tax revenues to airport development, aircraft registration fees, property tax on aircraft and pilot registration fees.

- *Security Issues*. In recent years, issues associated with security – including fencing, gates, cameras and other technologies – have put airports in the difficult position of securing their facilities without additional levels of funding. For example, Laredo International Airport spends approximately $1 million per year on security alone. Its passenger and cargo entitlement funds total approximately $1.5 million, which impacts funding for other airport improvements.
- *Infrastructure Needs*. Infrastructure issues may require significant investment, including protecting airports by ensuring compatible surrounding land uses and developing hangars at general aviation airports. The same can be said about larger airports where major capacity/infrastructure upgrades, intermodal facilities and other expensive project needs may emerge due to changing economic and/or demographic conditions. The development needs in the next 20 years will be different in size and scope for commercial service airports and general aviation airports, as will be their ability to pay for them. Large commercial service airports will have some ability to meet those needs on their own, while smaller commercial service airports and general aviation airports will have to rely on additional public investment and innovative methods.

Current Conditions

As part of the assessment of needs and current conditions, public comments were solicited through multiple means of collection. Comments from citizens, business groups, councils of government and community organizations came in through email, U.S. Mail and fax. Public meetings and public hearings held across the state were scheduled and publicized through each local TxDOT public information office or through the TxDOT Office of Government and Public Affairs. In addition to comments from the public, more than 90 elected officials, community leaders and citizens presented testimony at the scheduled public hearings. For more information regarding public comments obtained during the assessment process, see Appendix A.

Funding History

Overview of Airport Funding in Texas

The State of Texas is involved primarily in funding general aviation airports through both state and federally funded programs, while funding for commercial service airports is handled directly by the Federal Aviation Administration (FAA). Commercial service airports are defined as airports scheduling passenger service of at least 2,500 enplanements (number of passengers boarding an airplane) per year. Any activity that is not scheduled passenger service or military activity is considered to be general aviation.

The primary source of airport development and improvement funds is the FAA, through its Airport Improvement Program (AIP). Additionally, states typically have a grant program of their own but on a much smaller scale. Individual airports provide a match to the grant that can range from 10 percent to 50 percent. Larger AIP grants are typically for 90 percent of a project. The grant and matching amounts can vary depending on the airport, the specific grant program and whether or not they receive funds from passenger facility charges. The FAA, through its NPIAS, identifies airports nationwide that are significant to the national air transportation system and consequently eligible to receive federal grant money for capital improvements[16].

Capacity Needs/Issues

Growth in the air transportation system has prompted federal officials to examine future capacity needs across the country. This effort was accomplished and published in the report entitled, *Capacity Needs in the National Airspace System 2007-2025: An Analysis of Airports and Metropolitan Area Demand and Operational Capacity in the Future*.

The methodology used in this analysis, which measures the 2007 capacity level against 2025 demand, revealed three airports and one metropolitan area in Texas that will be in need of additional capacity. The three airports are George Bush Houston Intercontinental Airport, Houston Hobby Airport and San Antonio International Airport. The metropolitan area in need of additional capacity[17] is the Houston area. At the time the analysis was published, all three airports were in the environmental phase of projects to increase airfield capacity. By 2025, if the planned improvements at these airports are completed, they are not expected to have capacity limitations. The same is true for the Houston metropolitan area.

NextGen Air Transportation System

For several years, a multi-agency effort has been under way to ensure that the national air transportation system will be able to accommodate the demand required to meet the safety, operational, economic, mobility and security needs of its many users. This effort, dubbed the Next Generation Air Transportation System, or NextGen, is expected to transform the industry by utilizing new technologies that will be safer, more secure and capable of accommodating the new demand imposed on the system created by the growth of both the domestic and global economy.

It is anticipated that much of the new technology will be available and implemented across our system by the year 2030. According to the multi-agency Joint Planning and Development Office, which oversees the NextGen work effort, the goals include retaining U.S. leadership in global aviation, expanding capacity, ensuring safety, protecting the environment, ensuring our national defense and securing the nation. According to the established timeline, the NextGen Air Transportation System is expected to become operational by 2025.

Funding Texas General Aviation Airports

As with all states, the funding for airport capital improvement projects in Texas comes from a variety of sources. The single largest source is the FAA's Airport Improvement Program. This

[16] The FAA has established criteria for federal grant money through FAA Order 5090.3C, *Field Formulation of the NPIAS* (Chapter 2. Entry Criteria and Procedures). The criteria is largely based on an airport's activity, number of based aircraft, and proximity to other NPIAS airports.

[17] This is determined based on existing infrastructure, planned improvements to the facility and the airspace system, among other factors, compared to the airport/region's forecasted demand.

federal program provides funding for both commercial service and general aviation airports but, in Texas, funding is administered differently than states not in the block grant program. The amount of local matching funds required varies and depends on the funding source (state or federal) and the type of airport (commercial service or general aviation).

Federal Funding

The TxDOT Aviation Division is a participant in the FAA's State Block Grant Program that gives TxDOT the lead responsibility in carrying out the AIP for the FAA for general aviation airports. Texas is one of nine states that participates in this program. Commercial service airports still work directly with the FAA in planning, programming and implementing airport projects using federal funds. For general aviation airports, the AIP funding is a 90/10 split, meaning the FAA share for the project is 90 percent of the project costs, with the airport sponsor (owner) paying the remaining 10 percent.

For commercial service airports, the federal share may range from 75 percent to 90 percent depending on the size of the airport. Larger airports pay a greater share, as they have a greater ability to generate revenue from sources not available to smaller airports. These include revenues from their bonding ability and fees from concessions/advertising, parking and facility rental. Additionally, airports receive funds according to their activity levels such as number of enplaned passengers and amount of cargo.

State Funding

The State of Texas has a state airport grant program that increases eligibility to airports not in the National Plan of Integrated Airport Systems (NPIAS). These are airports that the state has determined to be important to population and economic centers that meet the state airport system's goals and objectives, and thus are eligible to receive state funding. The state program also operates on a 90/10 cost-sharing basis for most projects, with the state covering 90 percent of the costs and the airport sponsor (owner) paying the remaining 10 percent.

Other Funding Programs

The TxDOT Aviation Division administers state funding programs for a variety of specific purposes in which matching requirements differ from those noted above. This includes the Routine Airport Maintenance Program (RAMP), Terminal Building Program, Air Traffic Control Tower Program, and the Automated Weather Observing System (AWOS) Program. RAMP and the Terminal Building Program are 50/50 matching programs, while the AWOS program is a 75/25 matching program.

Historical general aviation funding levels from 2005 to 2007 are shown in Exhibit A-1. Exhibit A-2 shows the level of funding in the capital improvement program for 2008-2010. The local, state and federal share of the funding is also shown.

Exhibit A-1: General Aviation Airport Funding Levels in Texas, 2005-2007 (millions $)

Year	State Funding	Federal NPE/ Discretionary Funding	Total Federal Funding	TOTAL FUNDING
2005	$16,000,000	$34,696,294	$55,580,850	$71,580,850
2006	$16,000,000	$35,983,105	$57,423,649	$73,423,649
2007	$16,000,000	$34,915,993	$54,310,707	$70,310,707

Source: TxDOT-*Aviation Division*

Note: NPE= Non-Primary Entitlement funds given to individual airports according to an activity-based formula.

Exhibit A-2: Summary of 2008-2010 General Aviation Capital Improvement Program Costs

Fiscal Year	Airport Sponsor Share	TxDOT-Aviation Share	FAA Share	Total
2008	$7,678,000	$11,879,000	$53,028,000	$72,585,000
2009	$10,144,000	$20,211,000	$55,808,000	$86,163,000
2010	$8,420,000	$11,692,000	$55,947,000	$76,059,000
Total	$26,242,000 (11%)	$43,782,000 (19%)	$164,783,000 (70%)	$234,807,000

Source: TxDOT-Aviation Division

Technical Analysis

Texas Airport System Plan Development Needs

With responsibility for the planning, programming and project implementation for general aviation airports, the TxDOT Aviation Division closely monitors the development needs of the airports in the state system plan. This is largely accomplished through its continuous planning approach, which includes visits to the airports and periodic public meetings to ensure the airport serves the needs of the community, region and state. The needs of the commercial service airports are determined by the airports working in conjunction with planning officials from the FAA Southwest Regional Office in Fort Worth.

General Aviation Airports

Development needs for general aviation airports are viewed in terms of three distinct planning timeframes: short-term, mid-term and long-term. They are classified according to nine different categories: capacity, new access, new capacity, planning, preservation, reconstruction, safety, standards and upgrade. Exhibit A-3 shows the total development needs forecast for general aviation airports for the next 20 years. These costs are calculated in 2008 dollars.

Exhibit A-3: General Aviation Airport Development Needs Through 2028 (2008 $)

Airport Role	Total
Basic Service	$ 140,103,295
Community Service	$ 402,691,327
Business/Corporate	$ 534,456,446
Reliever	$708,167,181
Total	$ 1,785,418,249

Source: TxDOT-Aviation Division.

Commercial Service Airports

Development needs for commercial service airports are determined by the FAA and published in the NPIAS every two years. The most recent NPIAS report was released in October 2008 and shows development costs for 2009 to 2013. Longer-term development cost estimates were also obtained from the FAA's Southwest Region for commercial service airports in Texas. These estimates were developed by the FAA in conjunction with the administrators of the commercial airports. These needs, shown in Exhibit A-4, include projects eligible for funding through the federal AIP or through revenue produced from passenger facility charges.

Exhibit A-4: Texas Commercial Service Airport Development Needs, 2009-2028.

Development Time Period	Development Costs (in 2008 dollars)
2009-2013	$3,436,000,000
2014-2018	$1,737,000,000
2019-2028	$1,522,000,000
Total	$6,695,000,000

Source: Federal Aviation Administration, Southwest Region, Texas Airports Development Office.

Airport Demand

Systemwide enplanements at commercial service airports in Texas have rebounded since 2001 and are expected to continue to rise in the decades to come. The 26 commercial service airports in the state enplaned nearly 70 million passengers in 2006. This is expected to increase by nearly 73 percent in 2025 to approximately 120 million. Exhibit A-5 compares 2006 activity levels at commercial service airports in Texas with 2025 projections.

Exhibit A-5: Texas Commercial Service Airport Activity, 2006 and 2025.

Total Enplanements*		Airport Operations					
		Commercial		General Aviation		Total Airport Operations	
2006	2025	2006	2025	2006	2025	2006	2025
69,208,649	119,556,205	2,086,785	3,122,150	1,014,661	1,343,147	3,296,424	4,659,761

* *Enplanements are number of passengers boarding an airplane.*
Source: Federal Aviation Administration, Terminal Area Forecast

Committee Recommendations

- Monitor adequacy of federal and state funding to ensure a significant contribution to Texas' economic competiveness.

Summary of 2030 Committee Recommendations

INFRASTRUCTURE

Pavement Maintenance

- Preserve the asset value of all pavements by maintaining the 90 percent "good" or better pavement condition goal.
- Establish a statewide system to forecast and prioritize pavement maintenance needs.

Investment needed:
$89 billion total
$4 billion per year

Bridge Maintenance

- Replace on-system structurally deficient and substandard for load only bridges by 2012.
- Replace remaining structurally deficient, substandard for load only and functionally obsolete bridges by 2030.
- Increase inspection and maintenance activities to maintain safety and extend life.

Investment needed:
$36 billion total
$1.6 billion per year

TOTAL INVESTMENT NEEDED (2008 $)

	2009-2030	Per Year
Pavements	$ 89 Billion	$ 4.0 Billion
Bridges	$ 36 Billion	$ 1.6 Billion
Urban Mobility	$171 Billion*	$ 7.8 Billion*
Rural Mobility & Safety	$ 17 Billion	$ 0.8 Billion
TOTAL	**$313 Billion**	**$14.2 Billion**

MOBILITY

Urban Mobility

- Support Texas' economic strength and quality of life by preventing worsening congestion; as an absolute minimum, do not allow Texas' urban mobility to decline below the average of peer cities.
- Broaden the ability of urban regions to raise revenue to increase mobility if locally desired without reducing state funding for mobility.

Investment needed:
$171 billion total*
$7.8 billion per year*

Rural Mobility and Safety

- Complete the Texas Trunk System to facilitate rural competitiveness and safety.
- Prioritize additional road capacity for highest immediate economic impact.

Investment needed:
$17 billion total
$0.8 billion per year

Other Transportation Modes

Other transportation modes play a crucial and complementary role in the cost-effective movement of people and goods in Texas. To ensure the state's long-term economic well-being, the Committee believes that these modes warrant further study beyond the current scope of the 2030 Committee.

- Public Transportation – Perform a comprehensive examination of federal, state and local partnerships to meet regional needs through coordination of funding and services.
- Freight Rail – Maintain prudent regulatory policy and continue TxDOT initiatives and analysis of public-private potential.
- Intercity Passenger Rail – Convene a committee of representative stakeholders to evaluate conventional and high-speed rail alternatives and produce recommendations in 2010.
- Ports and Waterways – Monitor adequacy of federal and state funding for security and elevate port connectivity needs in the surface transportation planning process to ensure a significant contribution to Texas' economic competitiveness.
- Airports – Monitor adequacy of federal and state funding to ensure a significant contribution to Texas' economic competitiveness.

*Historically, about 2/3 of urban mobility has been state responsibility, 1/3 local responsibility.

Appendix A:
Public Comments Summary

The process of soliciting public input at the community level is vitally important in identifying transportation infrastructure and mobility solutions that will be readily accepted by the public. Grassroots input on transportation alternatives from citizens and community and business leaders often results in new local, regional or statewide initiatives and policies that improve the state's overall transportation system.

The following is a summary of public comments solicited and provided to the 2030 Committee through multiple means of collection. Over 50 comments from citizens, business groups, councils of government and community organizations came in through the 2030Committee@tamu.edu email set up for public input. Other means of providing comment were in place such as regular mail and facsimile, and the Committee received approximately 175 suggestions and comments through the combination of means. In addition to public comments received, over 90 elected officials, community leaders and citizens presented testimony at the scheduled public hearings.

Meetings held across the state were scheduled and made public through each local Texas Department of Transportation (TxDOT) public information office or through the TxDOT Office of Government and Public Affairs:

- Public Meetings
  - August 21, 2008, Dallas/Fort Worth – BNSF Headquarters
  - October 2, 2008, Austin – Center for Transportation Research, University of Texas
  - December 2, 2008, Austin – University of Texas Thompson Conference Center
- Public Hearings
  - July 24, 2008, Austin – J.J. Pickle Research Campus
    - 30 participants
    - 9 testimonies
  - August 7, 2008, El Paso – El Paso Public Library
    - 94 participants
    - 22 testimonies
  - August 14, 2008, Houston – Houston-Galveston Area Council
    - 114 participants (Please check this number)
    - 12 testimonies
  - August 21, 2008, Dallas – Dallas Area Rapid Transit
    - 42 participants
    - 11 testimonies
  - September 18, 2008, Amarillo – Texas A&M Agricultural Experiment Station Auditorium
    - 99 participants
    - 23 testimonies

- October 30, 2008, Corpus Christi – Congressman Solomon P. Ortiz International Center
  - 45 participants
  - 15 testimonies

Public comments covered a wide variety of transportation issues. Of the individuals providing testimony at the 2030 Committee hearings, most expressed concerns about the important role that transportation plays in economic development, the need to improve intracity and intercity public transit options, and roadway safety issues. The following are excerpts of public comments related to the context of the 2030 Committee's charge and submitted to the 2030 Committee by email, fax or mail:

- Texas' ability to create, grow and maintain profitability during trying times is inextricably linked to the ability to move people, services and products in a timely, efficient and affordable manner.

- On rural roads, mowing is a safety precaution. Wildlife of all sizes easily hide in the roadside grasses causing a hazard. Car crashes with wildlife on rural roads is a safety concern.

- With the passage of HR2095, The Railroad Safety Enhancement Act, signed into law on October 16, 2008 by President Bush, a new era for passenger and freight rail development has begun for Texas and we must be prepared for it. There are provisions in the act for an 80% federal / 20% state match for rail corridor development along with other federal funding possibilities. Texas Rail Advocates urges the commission to establish a Task Force to develop a Corridor Development Action and Implementation Plan.

- Need bridge widening on I-35, mix of heavy trucks and vehicle weave is a safety hazard.

- Need intra-city train linking Houston, San Antonio, Dallas, El Paso and Corpus.

- Invest in light rail system in Houston.

- Roadside maintenance, mowing, tree trimming.

- We need mass transit in Texas.

- Poor use of funds to invest in lavish roadside rest stops. Improvement of rail and pedestrian/bicycle options are needed.

- Interconnectedness between DART, DFW and Dallas Logistics Hub.

- Hopefully the Texas Legislature will designate that proceeds from the state gasoline taxes are only for highway construction and maintenance, will index the gasoline taxes to inflation, will revise and improve eminent domain and condemnation laws.

- Separate lanes needed for commercial vehicles.

- Transition to a vehicle miles traveled tax system with ability to pay at the pump.
- Increase trucking fees for maintenance purposes.
- Consideration for the need of public transportation for those with disabilities.
- The amount of money for mass transit is far less than is needed. If we put more money into an efficient method of mass transportation, we might be able to spend less on roads due to fewer vehicles on the road. Consider improving bus stops, routes, sidewalks, walking and biking trails, trail routes, short-time rental cars, commuter rail.
- Bicycles, there is little money budgeted for this efficient method of transportation. Every person who leaves their car at home and bikes to work does several things: reduces carbon footprint, gets exercise, and reduces costs for road maintenance and healthcare. This is an extremely beneficial form of transportation.
- Bicycles and pedestrians must always be considered in transportation plans. We produce the lowest carbon footprint and add the least to traffic congestion. Today, there are no bike paths available on I-10, Hwy 20 and Hwy 85 in El Paso, consequently travel by bicycle is very dangerous. Our climate lends itself to year 'round biking whether for recreation or transportation. Adding bike lanes to these highways you will be making this form of transportation a viable option for the many people in El Paso who would choose to ride if it was only safe.
- Retire the plan for La Entrada al Pacifico as a major trade route through far West Texas. Passenger trains from El Paso to the towns of Marfa, Alpine, Marathon and Presidio…A train route would connect their isolated and economically challenged community to the other towns in this spread out region. The benefit that came from the La Entrada hearings was that communities realized the support of rail transport in the region.
- The Texas Public Utility Commission has announced the maps for building more transmission lines and wind energy in this area…Oilfield traffic is at an all time high as well. Our highways and bridges are in fair shape now, but with this increased industry steps have to be taken to insure that infrastructure is maintained.
- Evacuation routes must be firmly established to ensure evacuations are orderly and unburden some encouraging our citizens to evacuate when ordered to do so. Looming natural disasters, evacuation routes will become even more important

Appendix B:
Processes and Procedures for Pavement Needs Analysis

The pavement maintenance and rehabilitation (M&R) needs consist of two parts that will be analyzed separately: 1) the needs to maintain the existing pavements of TxDOT highway network; and 2) the needs to maintain newly added highway pavements from the mobility analysis. Both parts of the needs will be established based on a specified goal for the overall condition of the pavement network set by the Texas Transportation Commission (TTC), which is to have 90% of the pavements with a condition of "good" or better. The needs will be expressed in term of 2008 costs. Because of the difference in the accuracy level of the information used for the two parts, the corresponding results will be reported as two separate line items.

1) Needs to Maintain the Existing Pavements of TxDOT Highway Network. The needs analysis of existing pavements will be based on historical data from the TxDOT Pavement Management Information System (PMIS). Using the PMIS data and calibrated pavement deterioration models developed at UT, the average condition of the pavement network for the base year (2008) will be first calculated. The base-year average condition will then be compared with the TTC goal, to determine the difference between them for each PMIS pavement section. This difference will be used to determine the M&R projects required for the base year. Finally, combining unit cost information with the required M&R projects will produce the base-year pavement needs in dollars by District. This process will continue as a loop for the whole analysis period from year 2009 to 2030, yielding the pavements needs for each individual year and the total pavement needs for the analysis period. The overall analysis procedure is illustrated in Figure 1.

2) Needs to Maintain Newly Added Highway Pavements from the Mobility Analysis. The M&R needs for newly added pavements will be based on the information produced from the TTI mobility analysis. The information on newly added pavement lane-miles is provided by the mobility research team for each district by functional class for both rural and urban facilities. Once the lane-miles are determined for each year of the analysis period, an inventory approach will be employed to determine the M&R needs, where M&R treatments are applied on a cyclic basis (for example, every 7 years for a seal coat, every 15 years for overlay).

Basic assumptions for the pavement need analysis include: 1) Only state-maintained highways are considered; 2) Toll-roads, such as the Trans-Texas Corridor, are self-sustainable; 3) Costs will include not only the pavement materials but also other costs that are required to deliver the pavement as a completed project; 4) Truck size and weight will remain unchanged over the analysis period.

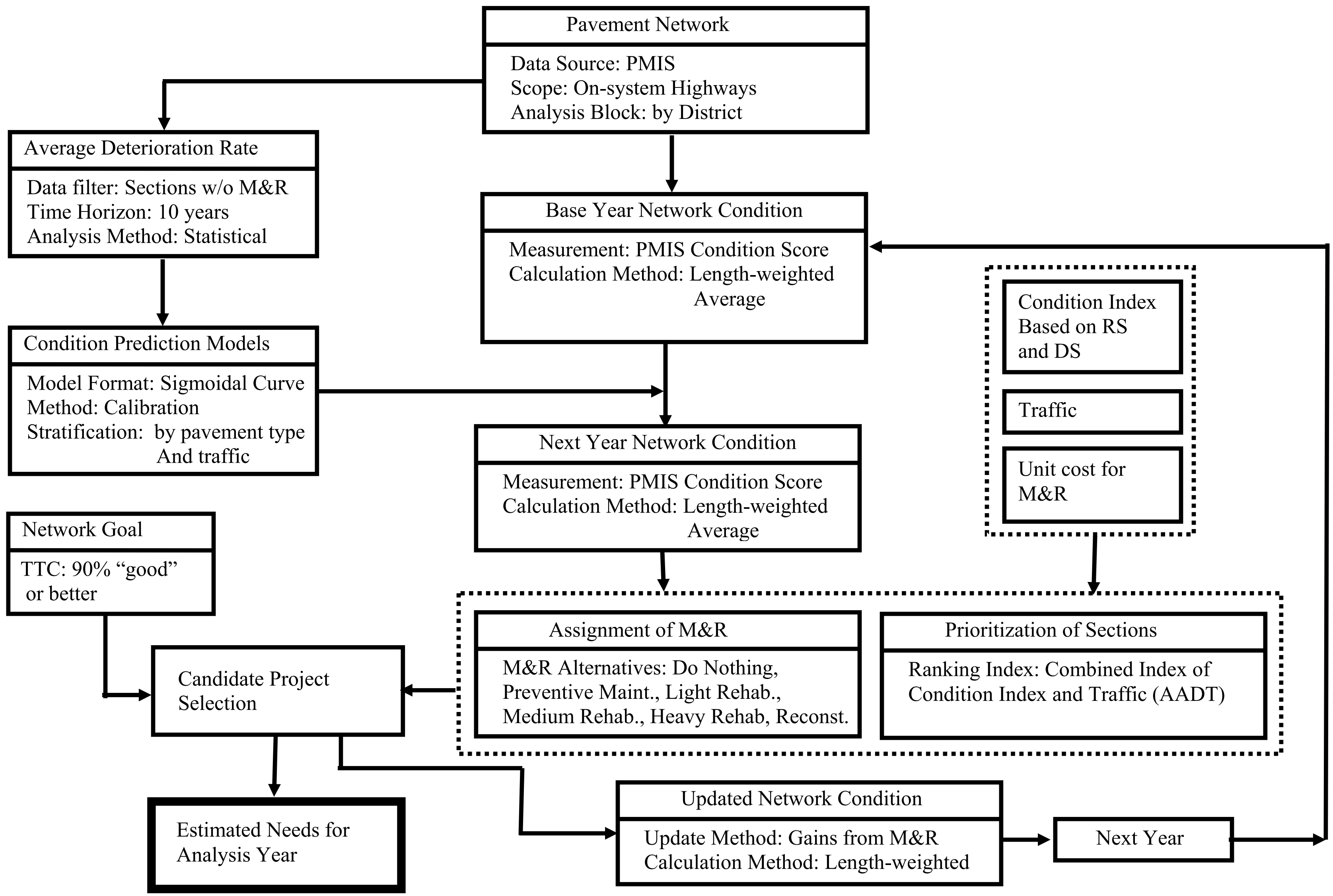


Figure 1. Methodological Framework for Needs Analysis of Existing Pavements

I. Needs Analysis for Existing Pavements

The Needs analysis of the existing pavements of TxDOT's highway network has been addressed with the development of a methodological framework by the Transportation Infrastructure and Information Systems (TIIS) Lab of the Center of Transportation Research (CTR). Major components of the methodological framework are shown schematically in Figure 1 and discussed As follows.

Pavement Network
The pavement network of the analysis concerned the existing pavements under TxDOT's jurisdiction and in particular the highway network whose sections are part of the existing PMIS database. The most current version of the PMIS database was used in the analysis, based on the 2008 data collection. The analysis blocks of the network were TxDOT's 25 districts.

Base Year Network Condition
The base year of the analysis was 2008. The condition of the entire state's pavement network was initially determined based on the individual scores of the pavement sections in the PMIS database. The Condition Score of these sections was used as the performance measurement index, and the state's network condition was determined by averaging the individual Condition Scores of all the sections in all 25 districts, weighted by their respective length and number of lanes (aggregated in one measure, i.e., section lane-miles).

Average Deterioration Modeling
Before planning for the Maintenance and Rehabilitation (M&R) actions for the road network, the deterioration process of the pavements was studied in order to understand when their condition would reach a critical level that would trigger intervention. The process that was followed in order to calculate the average yearly deterioration rate consisted of a number of steps as explained in the following.

Data filtering: A dataset was queried from the PMIS for a period of 10 years (1995 to 2005). The dataset contained the following information: section reference markers, pavement type, Annual Average Daily Traffic (AADT), Condition Score, Distress Score and Ride Score. The deterioration rate was defined as the difference in the pavement condition between consecutive years. Since any M&R action would result in an improvement of the condition, the dataset was filtered in order to exclude these effects. The filtering was carried out by removing the data entries that showed condition improvement between two consecutive years.

Pavement stratification: It is well known that rigid pavements and flexible pavements have different load distribution mechanisms. Moreover, for different Highway Functional Classes, the pavement structures, which are usually designed as a function of the traffic, are also different. In this study, a statistical analysis was carried out to analyze the deterioration rate distribution for the different structure types and pavement functional classifications. As a result, nine broad groups were defined:

Group 1: flexible interstate highways, flexible US highways,
Group 2: flexible state highways,
Group 3: flexible farm-to-market and flexible others,
Group 4: CRCP-interstate highways, CRCP US highways,
Group 5: CRCP state highways,
Group 6: CRCP farm-to-market and CRCP others,
Group 7: JCP interstate highways,
Group 8: JCP US highways,
Group 9: JCP farm-to-market.

These nine groups were found to have distinctive deterioration rates; and therefore a different set of models were developed for each group.

Climatic regions: It is also known that the daily temperature range and the precipitation play an important role in the pavement deterioration process. As a result, instead of developing pavement condition models for every district in Texas, these models were developed instead for the 4 climatic zones of Texas, as shown in Figure 2. For each zone, separate pavement condition models pertaining to the Distress Score and the Ride score were developed.

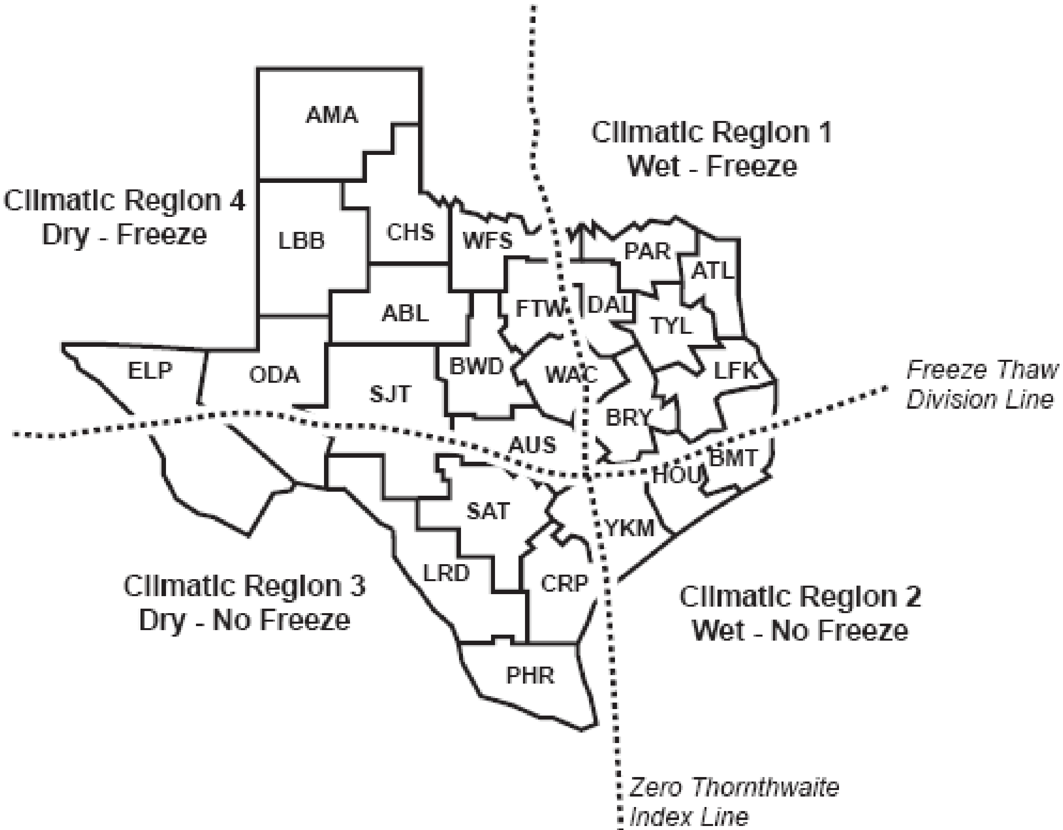


Figure 2. Climatic Regions in the State of Texas

Next Year Network Condition
The condition of the network for each subsequent year was based on the condition of the previous year with the addition of the effect of the natural deterioration, as predicted by the developed condition prediction models. The models were used in order to predict the deterioration of each individual section in terms of the Ride Score and their Distress Score. Once these new values were determined then they were combined together to calculate the new Condition Score of each section. The new Condition Scores of each sections were then averaged together weighted by their respective lane-miles to get the new state-wide Condition Score.

Network Goal
The criterion on which the needs analysis was based was the Texas Transportation Committee goal of having "90% of Texas pavements in "Good" or better condition". This goal translates into having 90% or more of all sections within the state with a Condition Score of 70 or more. The way the compliance with the goal was calculated for each year of the analysis period was by summing together all the lane-miles of the individual sections with a Condition Score greater or equal to 70 and dividing them with the overall number of lane-miles in the state, according to the following equation:

$$\%\text{ of sections within TTC goal} = \frac{\sum\left(\text{section lane-miles for sections with CS} \geq 70\right)}{\sum\left(\text{section lane-miles}\right)}$$

Candidate Project Selection
The selection of candidate projects was based on the assignment of Maintenance and Rehabilitation (M&R) actions to the various individual pavement sections, as well as on their subsequent prioritization.

Assignment of M&R actions: The assignment of M&R actions to the various individual pavement sections was performed by considering two criteria: 1) The section's current Ride Score; and 2) The drop of the Ride Score between the current year and the previous year. Based on these defined categories of Ride Score and Ride Score drop, the M&R actions were assigned to form a decision matrix. Using the decision matrix, the current Ride Score as well as the drop of the Ride Score between the current and the previous year were simultaneously considered for every section in order for a specific treatment to be assigned. Furthermore, a few restrictions were placed in the number of M&R actions of each type that any individual section could receive during the planning horizon. This was determined based on the minimum cycle length of each action/treatment type which was set according to past experience and current practice at TxDOT. Furthermore, each M&R action was assumed to have a specific effect on the section it was applied to, in terms of the section's Ride Score and Distress Score. The correspondence between the various M&R actions and their respective effect on the pavement sections are set also based on past experience and current practice at TxDOT. Finally, the implementation of each action corresponded to a specific cost for the agency, based on the unit cost of the action by lane-mile treated and the lane-miles of the treated section(s). The unit costs of each action were set to values that reflect the total delivery cost of a project.

Prioritization of Sections: Once the various M&R actions had been assigned the sections planned to receive them were prioritized in order to be selected for implementation based on three criteria:

The section's Ride Score;
The section's Distress Score; and
The section's traffic.

The final outcome of the prioritization algorithm was a ranking number ranging from 0 to 5 with the value of 5 denoting a very high priority for M&R actions and 0 denoting no need for any action.

Project Selection Algorithm: Once the M&R actions had been assigned and the sections ranked in terms of their priority for implementation, the project selection algorithm was implemented as follows: The algorithm would initially determine the current year's compliance with the TTC goal. If for the current year the TTC goal was accomplished then no section was selected and the corresponding results were reported. If, however, the percentage of sections with Condition Score of 70 or higher was less than 90% then the algorithm would start picking sections based on their ranking (starting from the top), "implement" the corresponding M&R action (by adding to the section the corresponding effect of the selected action), calculate the new Condition Score for the section and recalculate the percentage of sections that complied with the TTC goal. The algorithm would terminate only when the calculated percentage of sections was equal to or above of the specified TTC goal. While doing that, a cost algorithm kept track of the corresponding expenses incurred by undertaking the various M&R actions and summed them, separating the expenses for Preventive Maintenance from the expenses for all other types of Rehabilitation (light, medium and heavy).

Updated Network Condition
After the various projects were selected so that the TTC goal was accomplished for the current analysis year, the analysis for the following year would begin. The individual sections that had received a treatment would get their Condition Scores updated based on the improvement of the Ride and Distress Scores and the overall Condition Score of the entire network would be calculated. This would lead again to the prediction of the deterioration based on the prediction models and the whole process would again be repeated until all years in the planning horizon have been analyzed.

Estimated Needs for Analysis Year
Based on the number of sections treated during the analysis year in order to reach the TTC goal the overall state-wide needs were determined. There results were reported for each year of the analysis period.

II. Needs Analysis for Added Capacity Mobility Lane-miles

The added Capacity Mobility lane-miles were provided to the Pavement Needs Analysis Team based on the TTI Mobility Team's Mobility analysis. The added capacity lane miles used by the Pavement Needs Team included only on-system added lane-miles. Four added capacity lane mile scenarios were analyzed by the Mobility team including:

Mobility Scenario	Added Capacity Lane miles (on-system)
Reduce Congestion,	48,300
Prevent Worsening Congestion,	41,400
Maintain Mobility Competitiveness, and	30,500
Current Funding Trend	22,500

This analysis only considered the Maintenance & Rehabilitation costs for added capacity lane miles. The capital cost for constructing the pavement was captured in the Mobility Chapter.

The added lane-miles for each district were apportioned over the analysis period in equal amounts (e.g. 2,200 lane miles / 22 years = 100 lane miles added per year). In reality, the number of lane-miles constructed each year would vary, however information regarding how the number of lane-miles would be apportioned from year to year for each Mobility scenario was not available.

Added Capacity Lane-Mile Treatment Costs

The Maintenance & Rehabilitation treatment costs for the added capacity lane miles were calculated based on a weighted treatment cost for Asphalt Concrete (ACP) and Portland Cement Concrete (PCC) pavement. This was done because it is not possible to know how many miles of each type of pavement will be constructed over the next 22 years. Therefore it is not possible to know if a particular lane mile of pavement will need an ACP or PCC treatment.

The treatment costs were determined for four different treatment categories:

Preventive Maintenance
Light Rehabilitation
Medium Rehabilitation
Heavy Rehabilitation

Determining Treatment Needs for Each Mobility Scenario
An inventory approach was used to determine the type and timing of treatments for each mobility scenario. This approach was used because the pavement type was unknown and therefore the deterioration curves used for the on-system mileage could not be applied. This is because the deterioration curves are developed for specific pavement types (Continuously Reinforced Concrete Pavement, Jointed Concrete Pavement and Asphalt Concrete Pavement) and for specific highway systems (IH, US, SH and FM).

An inventory approach applies a given treatment level to the pavement inventory (newly added lane miles) on a given treatment cycle. For example, Preventative Maintenance treatments such as a seal coat were applied on a 7 year cycle, Light Rehabilitation treatments were placed on a 15 year cycle and Medium Rehabilitation treatments were placed on a 22 year cycle. Since Heavy Rehabilitation usually involves total reconstruction of the pavement from the subgrade up, it was assumed that none of the added capacity lane miles would receive a Heavy Rehabilitation within the analysis period.

Figure 3 shows an example section from a spreadsheet calculation for added capacity lane miles in a Metro district.

Arterial			Freeway		
Lane Miles Added	**Total M&R Cost Distributed over the analysis period**	**Treatment Application and Cost**	**Lane Miles Added**	**Total M&R Cost Distributed over the analysis period**	**Treatment Application and Cost**
2250		on- system mileage	**1464**		on- system mileage
46	Rural Scenario ss	**31**	0	Rural Scenario ss	0
0	Urban Region ss	0	0	Urban Region ss	0
3273		**2218**	2160	Dallas/Ft. Worth Metro ss (30%)	**1464**
102.25	$9,295,532		66.55	$6,050,358	
102.25	$9,295,532		66.55	$6,050,358	
102.25	$9,295,532		66.55	$6,050,358	
102.25	$9,295,532		66.55	$6,050,358	
102.25	$9,295,532		66.55	$6,050,358	
102.25	$9,295,532	**7 year cycle PM**	66.55	$6,050,358	**7 year cycle PM**
102.25	$9,295,532	$92,025,762	66.55	$6,050,358	$59,898,540
102.25	$9,295,532		66.55	$6,050,358	
102.25	$9,295,532		66.55	$6,050,358	
102.25	$9,295,532		66.55	$6,050,358	
102.25	$9,295,532		66.55	$6,050,358	
102.25	$9,295,532		66.55	$6,050,358	
102.25	$9,295,532		66.55	$6,050,358	
102.25	$9,295,532	**15 yr cycle LRhb**	66.55	$6,050,358	**15 yr cycle LRhb**
102.25	$9,295,532	$81,800,677	66.55	$6,050,358	$53,243,147
102.25	$9,295,532		66.55	$6,050,358	
102.25	$9,295,532		66.55	$6,050,358	
102.25	$9,295,532		66.55	$6,050,358	
102.25	$9,295,532		66.55	$6,050,358	
102.25	$9,295,532		66.55	$6,050,358	
102.25	$9,295,532	**22 yr cycle MRhb**	66.55	$6,050,358	**22 yr cycle MRhb**
102.25	$9,295,532	$30,675,254	66.55	$6,050,358	$19,966,180
2250			**1464**		
		$204,501,694			**$133,107,866**

Figure 3 Example Inventory Approach Calculation for Added Capacity Lane-miles

Note that the total number of lane miles determined by the TTI mobility analysis for the arterial routes, 3273 lane miles, and the Freeway routes, 2160 lane miles includes both on- and off-system mileage for this particular district. The number of on-system (on-system = mileage managed by TxDOT) arterial lane-miles (2250) and freeway lane-miles (1464) were calculated based on factors provided by the TTI Mobility Team and these numbers were used in calculating the treatment needs.

Note also, as previously stated, the number of lane miles added per year is equal to the total lane miles added over the 22 year period (e.g., 2250) divided by 22 which gives an average number of arterial lane miles added per year of 102.25.

The treatment costs were determined for the total number of lane-miles added for each scenario and summed to determine the total M&R costs. The analysis procedure was applied to each mobility scenario and the related M&R costs calculated as discussed.

It is noted that the cost of treating the added capacity Mobility lane miles is a small fraction of the cost to treat the existing 192,150 on-system lane miles. This is because the added capacity lane miles are being added over a 22 year period, rather than all at once, and are new lane miles that do not require as heavy treatments as does the older and much larger existing system.

III. Project Delivery Treatment Costs

Treatment costs used in the Pavement Needs analysis were based on total project delivery costs rather than just the cost to provide the paving materials in place. Total project delivery costs include additional costs such as contractor mobilization, traffic control, storm water pollution prevention procedures and other costs that are related to constructing a pavement Preventative Maintenance or Rehabilitation project.

These costs were determined through interviews with TxDOT Construction and Maintenance Division personnel, the Associated General Contractors, a pavement engineer expert task group that was convened and information provided through the TxDOT online average bid price system.

Appendix C: Bridge Information

Appendix items follow the sequence they are mentioned in the Bridges chapter. These items include:

C1. Goals Established by TxDOT for the Texas Bridges and Related Definitions of Terms

To understand the goals established by TxDOT for the Texas bridges, a definition of terms follows and is quoted from the *TxDOT September 2006 Report on Texas Bridges*:

- Sufficient structure (good or better): A sufficient structure meets current federal and Texas requirements and is in good or better condition. To be classified in good or better condition, a bridge is not structurally deficient, functionally obsolete, or substandard for load only.
- Non-sufficient structure: A non-sufficient structure is structurally deficient, functionally obsolete, or substandard for load only.
- Structurally deficient structure: A bridge is classified by the Federal Highway Administration (FHWA) as structurally deficient if it meets any of the following criteria:
  - It has an extreme restriction on its load-carrying capacity.
  - It has deterioration severe enough to reduce its load-carrying capacity.
  - It is closed.
  - It is frequently over-topped during flooding, creating traffic delays.
- Critically deficient structure: A bridge is classified by TxDOT as critically deficient if it is structurally deficient and in most need of attention.
- Functionally obsolete structure: A bridge is classified by the FHWA as functionally obsolete if it fails to meet its design criteria in any one of the following areas:
  - Deck geometry
  - Load-carrying capacity
  - Vertical or horizontal clearances
  - Approach roadway alignment

In this report, structures that are both functionally obsolete and structurally deficient are counted only as structurally deficient.

- Substandard for load only structure: A bridge is considered substandard for load only if it is not classified as structurally deficient or functionally obsolete but has a load capacity less than the maximum load permitted by state law. It has not deteriorated or has not deteriorated severely enough to reduce its load capacity beneath its original as-built capacity, but its original as-built capacity was not designed to carry current legal loads. A substandard for load only structure is load-posted or recommended for load posting.
- Load-posted bridge: A bridge that is load-posted has a safe load capacity less than the state legal load, and its load capacity is communicated by signs at the bridge site. (Note: Certain vehicles, identified in Chapter 622 of the Texas Transportation Code, that exceed posted load capacity can legally use load-posted bridges.)

- Land-locking bridges: This report classifies a bridge as land-locking if it restricts traffic into an area because of load limitations or closures. These bridges are load-posted.

TxDOT has established a goal of achieving 80 percent of the bridges—in terms of bridge counts—in good or better condition. Sufficient or Good or better condition was defined in the Bridges chapter.

C2. Technical Advisory Group

The construction figure for highway bridge construction in Texas—currently $66 per square foot—represents the average abutment-to-abutment cost for all bridges built in the state and omits a number of key costs that make the final cost significantly higher. The 2030 bridge team sought counsel on a range of issues related to both method and cost data. The following list recognizes those bridge specialists who provided the CTR/UTSA team with data and guidance throughout the work. Several team members were familiar with bridge inspection costs—another element to be estimated as part of the 2030 bridge needs.

The TxDOT members provided Departmental bridge data and advised the team on a wide range of procedures in the early stages of the work. The non-TxDOT members met at CTR on October 8, 2008, and provided additional material thereafter as questions arose. The advisory group played an important role in ensuring the bridge work reflected current practices and costs and their willingness to participate is recognized with much appreciation. The 2030 bridges research team is, of course, responsible for the actual estimates given in the report.

Ralph K. Banks, P.E. Bridge Engineer
Peter Chang, P.E. FHWA, Austin
Manuel Diaz, Ph.D., P.E. Associate Professor, UTSA
Tom Rummel, P.E. TxDOT Bridge Division
Tom Stephenson, P.E. CP&Y – Chiang, Patel, and Yerby
Keith Ramsey, P.E. TxDOT Bridge Division
Michael O'Toole, P.E. TxDOT Bridge Division
Tom Yarborough, P.E. TxDOT Bridge Division

C3. 2008 Bridge Replacement Needs on a County Basis

On- and Off-System Bridges

Table C3.1: On-System Bridges

County	Count	Area (sqft)	Cost at $194.sqft
Angelina	3	15,615	3,029,310
Austin	1	18,550	3,598,642
Bastrop	1	2,130	413,220
Bee	4	14,776	2,866,447
Bell	1	2,315	449,110
Bexar	5	70,630	13,702,259
Blanco	5	13,344	2,588,775
Borden	1	1,065	206,610
Bosque	2	3,167	614,456
Bowie	8	143,024	27,746,734
Brazoria	1	28,887	5,604,039
Brazos	1	51,271	9,946,574
Burleson	1	30,240	5,866,560
Burnet	4	60,271	11,692,477
Caldwell	5	55,595	10,785,469
Calhoun	2	5,517	1,070,201
Callahan	2	1,649	319,945
Cameron	1	12,040	2,335,760
Camp	3	6,390	1,239,660
Cass	1	0	0
Chambers	3	202,092	39,205,848
Clay	5	84,214	16,337,497
Collin	18	41,155	7,984,070
Collingsworth	1	22,329	4,331,826
Colorado	4	17,657	3,425,419
Comal	2	57,833	11,219,602
Comanche	1	821	159,216
Concho	2	13,677	2,653,280
Cooke	5	20,473	3,971,665
Coryell	3	13,176	2,556,105
Cottle	7	34,749	6,741,209
Crockett	2	27,425	5,320,450
Culberson	1	9,200	1,784,800

County	Count	Area (sqft)	Cost at $194.sqft
Dallam	1	2,616	507,582
Dallas	8	433,241	84,048,793
Deaf Smith	3	31,902	6,188,969
Delta	3	22,747	4,412,918
Denton	9	63,224	12,265,437
DeWitt	1	2,130	413,220
Dickens	8	37,548	7,284,312
Donley	1	6,072	1,177,968
Duval	3	11,175	2,167,950
Eastland	2	1,891	366,854
Ector	2	34,145	6,624,091
El Paso	1	3,372	654,168
Ellis	9	53,017	10,285,279
Erath	3	51,855	10,059,870
Falls	7	30,787	5,972,756
Fannin	1	7,924	1,537,256
Fayette	2	5,816	1,128,362
Fisher	1	2,550	494,700
Foard	5	61,365	11,904,849
Fort Bend	4	17,459	3,387,046
Freestone	6	22,649	4,393,828
Galveston	2	4,640	900,160
Gillespie	1	30,180	5,854,920
Gonzales	9	21,386	4,148,787
Gray	4	40,045	7,768,633
Grayson	4	114,021	22,120,035
Gregg	1	8,507	1,650,300
Grimes	2	2,587	501,936
Guadalupe	2	58,120	11,275,280
Hall	3	15,746	3,054,724
Hamilton	1	1,598	309,915
Hardeman	3	17,237	3,343,939
Harris	14	318,932	61,872,769
Harrison	9	46,570	9,034,483
Hays	1	0	0
Henderson	2	2,625	509,328
Hill	9	59,279	11,500,184
Hopkins	3	8,812	1,709,509

County	Count	Area (sqft)	Cost at $194.sqft
Houston	5	14,047	2,725,137
Howard	1	1,324	256,798
Hunt	5	7,263	1,408,925
Hutchinson	3	38,659	7,499,768
Jack	7	15,902	3,084,988
Jackson	4	19,273	3,738,981
Jasper	2	56,993	11,056,700
Jeff Davis	2	5,725	1,110,650
Jefferson	11	346,184	67,159,774
Johnson	13	30,802	5,975,510
Jones	1	3,163	613,525
Karnes	2	3,228	626,154
Kaufman	13	103,894	20,155,475
Kerr	9	18,075	3,506,531
Kimble	1	33,550	6,508,700
King	4	17,610	3,416,359
Kinney	2	63,939	12,404,224
Kleberg	3	5,763	1,117,925
Knox	1	21,895	4,247,630
Lamar	5	17,655	3,425,089
Lampasas	1	4,973	964,665
Lavaca	2	13,115	2,544,310
Lee	4	47,018	9,121,492
Leon	5	7,522	1,459,268
Liberty	4	41,580	8,066,423
Limestone	5	42,375	8,220,750
Lipscomb	1	4,131	801,414
Live Oak	2	8,589	1,666,266
Llano	7	78,557	15,239,961
Marion	1	36,379	7,057,565
Mason	3	27,112	5,259,650
Maverick	3	11,630	2,256,123
McCulloch	1	3,195	619,830
McLennan	6	27,171	5,271,096
Menard	1	4,719	915,486
Milam	4	13,515	2,621,968
Mitchell	4	14,348	2,783,415
Montague	3	5,187	1,006,278

County	Count	Area (sqft)	Cost at $194.sqft
Montgomery	1	6,200	1,202,800
Moore	1	0	0
Motley	5	52,890	10,260,660
Nacogdoches	8	59,079	11,461,345
Navarro	9	17,400	3,375,503
Newton	4	57,580	11,170,559
Nolan	4	54,221	10,518,893
Nueces	7	76,486	14,838,303
Ochiltree	4	25,889	5,022,369
Orange	3	52,378	10,161,254
Palo Pinto	4	36,248	7,032,112
Panola	4	4,260	826,440
Parker	10	142,315	27,609,071
Pecos	1	18,360	3,561,743
Polk	8	41,995	8,146,952
Potter	4	53,427	10,364,780
Randall	4	31,410	6,093,598
Real	1	1,710	331,740
Red River	8	106,022	20,568,171
Reeves	3	14,988	2,907,730
Refugio	6	10,141	1,967,393
Robertson	5	63,044	12,230,536
Rockwall	5	9,765	1,894,410
Runnels	2	6,528	1,266,335
Rusk	1	6,100	1,183,322
San Augustine	3	19,494	3,781,817
San Patricio	3	12,142	2,355,548
San Saba	2	1,598	309,915
Scurry	1	20,520	3,980,880
Shackelford	5	22,482	4,361,411
Shelby	9	64,217	12,458,156
Smith	2	8,316	1,613,343
Somervell	3	53,408	10,361,074
Starr	1	1,467	284,676
Stephens	4	10,915	2,117,529
Stonewall	2	30,444	5,906,175
Tarrant	26	456,266	88,515,643
Taylor	5	19,823	3,845,662

County	Count	Area (sqft)	Cost at $194.sqft
Throckmorton	2	7,663	1,486,622
Titus	1	1,070	207,580
Travis	8	69,278	13,439,913
Trinity	4	22,397	4,344,940
Tyler	5	22,763	4,415,925
Upshur	7	57,085	11,074,509
Uvalde	2	4,123	799,823
Val Verde	1	42,313	8,208,722
Victoria	1	8,670	1,681,980
Walker	4	35,165	6,822,010
Ward	1	10,128	1,964,832
Washington	5	16,931	3,284,556
Wharton	1	4,350	843,900
Wheeler	3	36,332	7,048,466
Wichita	6	7,844	1,521,717
Wilbarger	6	18,575	3,603,453
Williamson	22	147,020	28,521,958
Wilson	1	3,188	618,375
Wise	7	48,144	9,339,975
Young	1	4,480	869,120
Zavala	1	2,985	579,168
Total	**674**	**6,191,127**	**1,201,078,541**

Table C3.2: Off-System Bridges

County	Count	Area (Sqft)	Cost At $194.Sqft
Anderson	9	11,277	2,187,699
Angelina	3	6,311	1,224,373
Armstrong	1	1,876	363,983
Austin	5	7,861	1,524,956
Bastrop	1	1,778	345,010
Bee	2	6,320	1,226,080
Bell	4	31,946	6,197,524
Bexar	8	97,745	18,962,530
Bosque	2	2,668	517,514
Brazoria	34	99,083	19,222,063
Brazos	1	1,984	384,974
Brewster	1	6,586	1,277,684
Brown	4	14,109	2,737,146
Burleson	9	14,872	2,885,207
Burnet	1	2,614	507,038
Caldwell	1	801	155,355
Calhoun	2	3,674	712,756
Callahan	1	1,520	294,880
Cameron	2	10,322	2,002,546
Chambers	4	15,106	2,930,564
Cherokee	14	20,223	3,923,184
Coke	2	8,401	1,629,872
Coleman	2	2,385	462,690
Collin	3	5,995	1,163,069
Colorado	5	10,015	1,942,988
Comanche	6	13,389	2,597,427
Cooke	9	16,066	3,116,726
Coryell	2	2,512	487,250
Dallas	9	33,009	6,403,785
Deaf Smith	4	9,420	1,827,480
Denton	1	1,092	211,848
Dewitt	2	3,298	639,734
El Paso	66	286,963	55,670,744
Ellis	8	19,042	3,694,109
Erath	5	8,594	1,667,158
Falls	31	63,237	12,267,939

County	Count	Area (Sqft)	Cost At $194.Sqft
Fannin	7	9,815	1,904,110
Fayette	2	4,140	803,160
Fisher	13	23,084	4,478,374
Floyd	1	911	176,695
Fort Bend	38	98,909	19,188,424
Freestone	5	9,596	1,861,546
Galveston	8	29,713	5,764,400
Gillespie	2	3,800	737,200
Goliad	1	890	172,738
Gonzales	1	1,280	248,320
Gray	2	3,735	724,629
Grayson	8	19,136	3,712,462
Gregg	2	13,365	2,592,810
Grimes	1	1,280	248,320
Guadalupe	3	6,251	1,212,733
Hale	1	1,340	259,921
Hamilton	2	10,098	1,959,012
Hansford	1	8,856	1,718,064
Hardin	1	1,470	285,180
Harris	29	246,714	47,862,477
Harrison	2	3,000	582,000
Henderson	4	7,817	1,516,459
Hidalgo	3	8,602	1,668,710
Hill	12	27,256	5,287,625
Hood	1	1,012	196,328
Hopkins	3	4,784	928,096
Houston	30	38,668	7,501,631
Howard	2	44,222	8,579,068
Hunt	2	3,580	694,442
Hutchinson	1	1,296	251,424
Jack	12	18,292	3,548,687
Jackson	1	1,463	283,783
Jasper	1	3,000	582,000
Jefferson	4	45,561	8,838,834
Jim Wells	5	11,508	2,232,513
Johnson	4	10,368	2,011,353
Jones	5	9,701	1,882,072
Kaufman	5	7,855	1,523,792

County	Count	Area (Sqft)	Cost At $194.Sqft
Kent	4	9,213	1,787,283
Kimble	1	1,402	271,910
La Salle	1	3,195	619,830
Lavaca	1	1,561	302,756
Lee	1	960	186,240
Leon	3	3,905	757,648
Liberty	5	9,630	1,868,298
Limestone	18	36,724	7,124,417
Live Oak	3	6,041	1,171,993
Madison	6	9,713	1,884,322
Matagorda	9	31,093	6,031,964
Maverick	2	6,257	1,213,819
McLennan	42	161,844	31,397,814
Medina	2	2,810	545,101
Milam	1	1,248	242,112
Mills	2	14,532	2,819,130
Mitchell	3	7,504	1,455,776
Montague	7	12,031	2,334,092
Montgomery	7	21,575	4,185,550
Moore	1	1,037	201,139
Nacogdoches	7	10,354	2,008,754
Navarro	5	6,406	1,242,725
Newton	1	1,199	232,567
Nolan	10	18,792	3,645,648
Nueces	3	6,247	1,211,918
Ochiltree	1	2,079	403,404
Orange	6	26,570	5,154,541
Palo Pinto	2	5,410	1,049,618
Parker	25	66,477	12,896,499
Polk	12	17,646	3,423,246
Red River	2	5,036	976,984
Reeves	1	790	153,260
Runnels	2	4,100	795,322
Rusk	13	16,255	3,153,431
Sabine	1	1,214	235,594
San Augustine	6	8,805	1,708,209
San Jacinto	2	3,403	660,104
San Patricio	3	5,187	1,006,356

County	Count	Area (Sqft)	Cost At $194.Sqft
Scurry	5	13,209	2,562,585
Shackelford	2	6,140	1,191,160
Shelby	12	22,283	4,322,941
Smith	29	54,985	10,667,012
Stephens	3	7,828	1,518,671
Stonewall	3	5,291	1,026,415
Tarrant	8	68,907	13,367,958
Taylor	3	18,016	3,495,104
Tom Green	4	73,582	14,274,869
Travis	2	4,183	811,424
Trinity	6	4,979	965,965
Tyler	7	12,959	2,514,085
Van Zandt	11	18,832	3,653,447
Victoria	5	10,539	2,044,605
Walker	3	4,242	822,948
Waller	9	21,266	4,125,526
Washington	1	1,264	245,216
Wharton	24	52,202	10,127,266
Wheeler	2	5,650	1,096,178
Wichita	5	8,206	1,591,925
Wilbarger	3	5,944	1,153,136
Willacy	1	2,076	402,822
Williams	4	15,012	2,912,406
Wilson	2	3,920	760,480
Wise	15	41,100	7,973,439
Total	**879**	**2,615,321**	**507,372,235**

C4. Data on Bridge Replacement Needs, On- and Off-System Bridges through 2030, Deck Area, and Cost (2008 dollars)

Table C4.1: Bridge Replacement Needs for On-System Bridges through 2030

Year	# Bridges	Deck Area	$ Million
1	674	6,191,127	1,201
2	1,676	6,195,926	1,202
3	1,193	2,493,009	484
4	479	1,143,708	222
5	603	1,928,542	374
6	585	1,780,829	345
7	711	2,528,359	491
8	816	2,961,299	574
9	900	3,615,496	701
10	822	3,769,795	731
11	849	3,969,392	770
12	845	4,674,365	907
13	716	4,097,910	795
14	766	4,591,799	891
15	893	5,379,309	1,044
16	790	4,316,603	837
17	776	7,280,741	1,412
18	683	4,854,346	942
19	847	6,096,901	1,183
20	815	6,269,106	1,216
21	982	10,847,047	2,104
22	614	7,683,548	1,491
Total	**18,035**	**102,669,157**	**19,918**

Table C4.2: Bridge Replacement Needs for Off-System Bridges through 2030

Year	# Bridges	Deck Area	$ Million
1	879	2,615,321	507
2	879	7,090,071	1,375
3	879	2,793,874	542
4	879	2,510,503	487
5	775	2,918,026	566
6	64	493,332	96
7	118	847,672	164
8	97	1,005,523	195
9	98	622,908	121
10	357	2,104,419	408
11	97	1,495,538	290
12	109	906,431	176
13	121	715,615	139
14	117	959,722	186
15	480	2,389,538	464
16	61	468,272	91
17	143	1,363,881	265
18	132	1,190,882	231
19	203	2,877,608	558
20	380	2,331,399	452
21	159	1,450,314	281
22	125	1,074,081	208
Total	**7,152**	**40,224,930**	**7,804**

C5. Ratios of # Bridges per Lane Mile by District and Functional Class

District	Functional Class	Lane Miles	# of Bridges	Ratio
Abilene	Rural Interstate	532.99	257	0.4822
Abilene	Rural Principal Art	671.52	103	0.1534
Abilene	Urban Freeway	110.09	97	0.8811
Abilene	Urban Arterial	227.06	52	0.2290
Amarillo	Rural Interstate	581.71	108	0.1857
Amarillo	Rural Principal Art	1412.08	98	0.0694
Amarillo	Urban Freeway	152.86	80	0.5234
Amarillo	Urban Arterial	365.93	77	0.2104
Atlanta	Rural Interstate	373.34	163	0.4366
Atlanta	Rural Principal Art	743.42	113	0.1520
Atlanta	Urban Freeway	65.06	34	0.5226
Atlanta	Urban Arterial	281.69	34	0.1207
Austin	Rural Interstate	173.3	51	0.2943
Austin	Rural Principal Art	1044.74	147	0.1407
Austin	Urban Freeway	331.2	194	0.5858
Austin	Urban Arterial	610.35	127	0.2081
Beaumont	Rural Interstate	264.33	80	0.3027
Beaumont	Rural Principal Art	616.9	148	0.2399
Beaumont	Urban Freeway	116.99	70	0.5983
Beaumont	Urban Arterial	508.73	99	0.1946
Brownwood	Rural Interstate	159.43	69	0.4328
Brownwood	Rural Principal Art	898.75	136	0.1513
Brownwood	Urban Arterial	178.1	26	0.1460
Bryan	Rural Interstate	403.78	149	0.3690
Bryan	Rural Principal Art	986.38	210	0.2129
Bryan	Urban Freeway	44.85	17	0.3791
Bryan	Urban Arterial	325.54	53	0.1628
Childress	Rural Interstate	146.26	27	0.1846
Childress	Rural Principal Art	791.58	108	0.1364
Childress	Urban Arterial	30.74	2	0.0651
Corpus Christi	Rural Interstate	269.37	102	0.3787
Corpus Christi	Rural Principal Art	1050.73	279	0.2655
Corpus Christi	Urban Freeway	98.21	54	0.5499
Corpus Christi	Urban Arterial	318.07	67	0.2107
Dallas	Rural Interstate	506.04	281	0.5553
Dallas	Rural Principal Art	638.02	261	0.4091
Dallas	Urban Freeway	1388.54	956	0.6885
Dallas	Urban Arterial	1390.87	386	0.2775
El Paso	Rural Interstate	596.99	250	0.4188
El Paso	Rural Principal Art	291.79	38	0.1302
El Paso	Urban Freeway	215.37	144	0.6686

District	Functional Class	Lane Miles	# of Bridges	Ratio
El Paso	Urban Arterial	563.78	108	0.1916
Fort Worth	Rural Interstate	306.97	168	0.5473
Fort Worth	Rural Principal Art	918.56	199	0.2166
Fort Worth	Urban Freeway	826.75	580	0.7015
Fort Worth	Urban Arterial	1073.27	256	0.2385
Houston	Rural Interstate	233.7	98	0.4194
Houston	Rural Principal Art	843.96	281	0.3330
Houston	Urban Freeway	1249.21	742	0.5940
Houston	Urban Arterial	2207.91	397	0.1798
Laredo	Rural Interstate	268.52	136	0.5065
Laredo	Rural Principal Art	926.01	181	0.1955
Laredo	Urban Freeway	72.88	29	0.3979
Laredo	Urban Arterial	374.78	55	0.1468
Lubbock	Rural Interstate	302.69	79	0.2610
Lubbock	Rural Principal Art	1590.99	68	0.0427
Lubbock	Urban Freeway	74.69	56	0.7498
Lubbock	Urban Arterial	543.6	51	0.0938
Lufkin	Rural Principal Art	1067.8	157	0.1470
Lufkin	Urban Arterial	262.33	60	0.2287
Odessa	Rural Interstate	1070.66	448	0.4184
Odessa	Rural Principal Art	418.99	61	0.1456
Odessa	Urban Freeway	149.73	81	0.5410
Odessa	Urban Arterial	386.96	53	0.1370
Paris	Rural Interstate	235.09	143	0.6083
Paris	Rural Principal Art	761.2	208	0.2733
Paris	Urban Freeway	61	27	0.4426
Paris	Urban Arterial	296.98	70	0.2357
Pharr	Rural Interstate		1	
Pharr	Rural Principal Art	980.54	123	0.1254
Pharr	Urban Arterial	756.94	69	0.0912
San Angelo	Rural Interstate	602.46	214	0.3552
San Angelo	Rural Principal Art	906.38	205	0.2262
San Angelo	Urban Arterial	53.64	25	0.4660
San Antonio	Rural Interstate	857.51	357	0.4163
San Antonio	Rural Principal Art	430.72	106	0.2461
San Antonio	Urban Freeway	858.51	649	0.7560
San Antonio	Urban Arterial	1058.12	183	0.1730
Tyler	Rural Interstate	328.27	159	0.4844
Tyler	Rural Principal Art	953.76	182	0.1908
Tyler	Urban Freeway	5.26	5	0.9513
Tyler	Urban Arterial	917.71	105	0.1144
Waco	Rural Interstate	287.27	125	0.4351
Waco	Rural Principal Art	330.85	95	0.2871
Waco	Urban Freeway	208.78	133	0.6370

District	Functional Class	Lane Miles	# of Bridges	Ratio
Waco	Urban Arterial	501.07	120	0.2395
Wichita Falls	Rural Interstate	64.53	21	0.3254
Wichita Falls	Rural Principal Art	995.87	226	0.2269
Wichita Falls	Urban Freeway	92.06	65	0.7061
Wichita Falls	Urban Arterial	312.57	78	0.2495
Yoakum	Rural Interstate	372.28	168	0.4513
Yoakum	Rural Principal Art	791.46	275	0.3475
Yoakum	Urban Arterial	291.94	67	0.2295

C6. Inspection of a Fracture Critical Bent Cap

C7: Inspection Costs for Mobility Bridges

	Business as Usual		Prevent Serious Congestion		Reduce Congestion	
Year	**# Bridges**	**Inspection Cost $**	**# Bridges**	**Inspection Cost $**	**# Bridges**	**Inspection Cost $**
2009	1,047	876,076	855	715,243	624	522,051
2010	2,095	1,752,153	1,710	1,430,486	1,249	1,044,101
2011	3,142	2,628,229	2,565	2,145,729	1,873	1,566,152
2012	4,189	3,504,305	3,420	2,860,972	2,497	2,088,203
2013	5,237	4,380,381	4,275	3,576,214	3,121	2,610,254
2014	6,284	5,256,458	5,130	4,291,457	3,746	3,132,304
2015	7,331	6,132,534	5,985	5,006,700	4,370	3,654,355
2016	8,379	7,008,610	6,840	5,721,943	4,994	4,176,406
2017	9,426	7,884,686	7,695	6,437,186	5,618	4,698,457
2018	10,473	8,760,763	8,550	7,152,429	6,243	5,220,507
2019	11,521	9,636,839	9,405	7,867,672	6,867	5,742,558
2020	12,568	10,512,915	10,259	8,582,915	7,491	6,264,609
2021	13,615	11,388,991	11,114	9,298,158	8,116	6,786,659
2022	14,662	12,265,068	11,969	10,013,400	8,740	7,308,710
2023	15,710	13,141,144	12,824	10,728,643	9,364	7,830,761
2024	16,757	14,017,220	13,679	11,443,886	9,988	8,352,812
2025	17,804	14,893,297	14,534	12,159,129	10,613	8,874,862
2026	18,852	15,769,373	15,389	12,874,372	11,237	9,396,913
2027	19,899	16,645,449	16,244	13,589,615	11,861	9,918,964
2028	20,946	17,521,525	17,099	14,304,858	12,485	10,441,014
2029	21,994	18,397,602	17,954	15,020,101	13,110	10,963,065
2030	23,041	19,273,678	18,809	15,735,344	13,734	11,485,116
Total		**221,647,295**		**180,956,451**		**132,078,833**

C8. Summary Characteristics for Special and Large Bridge Needs

District	County	Feature Crossed	Facility Carried	Age (yrs)	Replacement Cost
Paris	Hunt	LAKE TAWAKONI	SH276	48	$ 132,789,120
Houston	Harris	US 290	BW8 SB ML	17	$ 142,527,881
Houston	Harris	US 290	BW8 NB ML	17	$ 142,527,881
Houston	Harris	IH45 SB FR & BW8 WB FR	IH45 SB TO BW8 WB	10	$ 97,196,281
Houston	Harris	IH 45 NBFR & STREETS	SP 5 NB	22	$ 123,691,994
Houston	Harris	IH45SB OFF-RPS & STREETS	SP 5 SB	19	$ 110,768,258
Houston	Harris	US290	IH610 HOV	19	$ 94,337,478
Houston	Harris	US59 & MISC ST	IH45 NB PIERCE EL	11	$ 175,246,166
Houston	Harris	US59 & MISC ST	IH45 SB PIERCE EL	10	$ 175,650,378
Houston	Harris	IH10	ELYSIAN ST	53	$ 138,154,229
Houston	Harris	BNSF RR	SH249	14	$ 91,880,522
Yoakum	Calhoun	LAVACA BAY	SH 35	46	$ 335,103,428
Austin	Travis	IH 35 SB LOWER LEVEL	IH 35 SB OVERHEAD	31	$ 147,456,830
Austin	Travis	IH 35 NB LOWER LEVEL	IH 35 NB OVERHEAD	31	$ 145,317,077
Austin	Travis	IH 35 N & S BOUND	US 183 NB	9	$ 106,313,397
Austin	Travis	IH-35 N&S BOUND	US 183 SB	9	$ 106,494,554
San Antonio	Bexar	IH 35, ETC.	IH 37 SB/US 281 SB	35	$ 94,167,030
San Antonio	Bexar	N FLORES-N ST. MARY'S ST	IH 35 NB ELEV ML	18	$ 135,421,611
San Antonio	Bexar	SAN PEDRO TO BROOKLYN AV	IH 35 SB ELEV ML	14	$ 126,298,695
San Antonio	Bexar	W MAGNOLIA TO N FRIO ST	IH 10 EB ELEV ML	14	$ 227,802,948
San Antonio	Bexar	LOWER LEVEL	IH 10 WB UPPER L	18	$ 242,939,837
Corpus Christi	Nueces	C C SHIP CHANNEL	US 181	2	$ 212,871,311
Corpus Christi	Nueces	NUECES BAY	US 181 NB	17	$ 252,411,726
Dallas	Collin	US 75/DART RR/SPRING CRK	G BUSH TPKE EBML	9	$ 181,219,668
Dallas	Collin	US 75/DART RR/SPRING CRK	G BUSH TPKE WBML	9	$ 180,782,392
Dallas	Dallas	IH 30 & TRINITY RIVER	HOUSTON VIADUCT	96	$ 112,091,018
Dallas	Dallas	SH 352 & EXPOSITION ST	IH 30 WB	13	$ 146,027,428
Dallas	Dallas	IH 30 & TRINITY RIVER	JEFFERSON VIADUCT	32	$ 130,929,938
Dallas	Dallas	SH 352 & EXPOSITION ST	IH 30 EB	13	$ 146,027,428
Dallas	Dallas	IH 30, US 75 & DART RAIL	IH 345 SB	36	$ 340,815,056
Dallas	Dallas	IH 30, US 75 & DART RAIL	IH 345 NB	36	$ 338,799,928
Dallas	Dallas	OAK LAWN AVE	IH 35E	24	$ 96,427,390
Dallas	Dallas	IH 35E & DART RAILWAY	SPUR 366 EB	26	$ 101,549,944
Dallas	Dallas	IH 35E & DART RAILWAY	SPUR 366 WB	26	$ 100,892,156
Beaumont	Jefferson	NECHES RIVER	SH 73 WB	10	$ 91,531,906
Beaumont	Orange	NECHES RIVER	IH 10	28	$ 181,253,133
Pharr	Hidalgo	RIO GRANDE	PHARR/RENOSA INTL	13	$ 401,084,718
					$ 6,106,800,734

Appendix D:
Urban Mobility Estimation Approach

What procedures did we use to estimate the investment needed?

The computerized travel models developed by the metropolitan planning organizations (MPOs) were used as a way to leverage the considerable local knowledge and the significant amount of previous study. Population and travel volume were estimated for each region in 2030. The process described below was oriented at providing the 2030 Committee and the public with more information about the trade-offs between transportation capacity investment and the resulting congestion levels.

How were urban area needs estimated?
The technical team from TTI worked with the MPOs throughout Texas to gather data for estimating needs in the metropolitan areas. Each MPO has a computerized travel demand model that supports its long-range planning efforts. Using the results from individual MPO travel demand models and demographic data for each MPO, TTI ran its own congestion reduction utility model. This model enabled TTI to estimate additional capacity needed for each MPO to meet the mobility scenario. Once the forecasted amount of congestion in each metro and urban area was estimated, TTI calculated the cost of the additional capacity required for each scenario (in 2008 dollars). The capacity costs are based on project cost estimates when available or the cost per lane-mile of roadway constructed in recent TxDOT contracts, and are categorized by functional classification and geographic classification (urban, suburban, etc).

The most ambitious scenario calls for “reduced congestion,” which, in technical terms, means adding roadway to any location where serious congestion will exist in 2030. In traveler terms, serious congestion means traffic moving at 40 mph or less on freeways and 25 mph or less on arterial roadways. TTI calculated the additional capacity needed to address the forecasted demand, which would raise the travel speeds to about 50 to 60 mph. For each scenario, the total amount of additional roadway capacity required was multiplied by average construction costs by roadway type, area type and region to produce a total dollar estimate. Finally, those estimates were accumulated for all 25 MPOs to produce the urban portions of the mobility needs assessment.

For the “prevent worsening congestion” scenario, TTI reran the congestion reduction utility model described above, but this time to reflect congestion levels typical in current conditions. To prevent congestion from worsening, the additional capacity must match the forecasted growth in traffic for each MPO. This result was then converted to total investment using estimated project costs or current average costs of construction.

TTI used a similar methodology to develop the “maintain economic competitiveness,” scenario, which adds enough transportation capacity to ensure that average commuter delays in Texas do not exceed average commuter delays in peer cities (as determined by population).

For the "current funding trend" scenario, TTI estimated the amount of capacity that could be built for the funding expected under existing funding programs and then used the congestion utility model to compute the additional congestion that would result.

Table 1 shows the level of investment needed for each of the four urban mobility scenarios.

Table 1. Estimated Urban Investment Needed by Mobility Scenario

Mobility Scenario	Additional Travel Capacity Equivalent Needed Statewide (lane-miles)*	Investment Required to Maintain Mobility Goal by 2030
Reduce Congestion	48,100	$213 billion
Prevent Worsening Congestion	41,700	$171 billion
Maintain Economic Competitiveness	32,500	$124 billion
Current Funding Trend	17,600	$70 billion

** NOTE: Neither the 2030 Committee nor the technical team from TTI is suggesting that constructing additional highway lane-miles is the only solution in any part of the state. This approach is simply a tool for approximating the level of investment needed, regardless of the form of the solution. The actual mix of solutions will vary across all of the urban regions.*

Appendix – Urban Mobility Summary Statistics

Type of Measure	Table	
Regional Congestion	Table 5	Total Daily Delay (Person-Hours)
Regional Congestion	Table 6	Annual Congestion Cost (2008$ Millions)
Individual person	Table 8	Texas Congestion Index
Individual person	Table 7	Delay Per Commuter (Hours)
Individual person	Table 9	Congestion Cost Per Commuter (2008$ Millions)
Regional System Needs	Table 10	Lane Miles Added
Regional System Needs	Table 2	Implementation Cost For Mobility Scenarios 2009 Through 2030 (2008$ Millions)
Regional Congestion	Table 3	Congestion Cost (2009 Through 2030) (2008$ Million)
Regional System Needs & Congestion	Table 4	Total Cost - Implementation and Congestion - 2009 to 2030 (2008$ Millions)

The Appendix provides a summary of the Urban Mobility Scenario finding for each urban region. An explanation of each measure is included; an overview of the calculation procedures is also included in this Appendix.

Table 2. Implementation Cost For Mobility Scenarios (2009 through 2030) (2008$ Millions)

Region	Reduce Congestion	Prevent Worse Congestion	Economically Competitive	Current Funding Trend
Austin	$ 19,956	$ 15,099	$ 13,529	$ 6,704
Corpus Christi	$ 3,228	$ 3,038	$ 3,038	$ 1,053
Dal-FtWorth	$ 76,986	$ 63,029	$ 49,551	$ 29,731
El Paso	$ 9,567	$ 6,237	$ 2,964	$ 1,778
Hidalgo	$ 2,845	$ 2,359	$ 874	$ 874
Houston	$ 64,782	$ 54,265	$ 38,489	$ 23,093
Lubbock	$ 644	$ 593	$ 593	$ 299
San Antonio	$ 22,169	$ 15,577	$ 8,824	$ 1,980
Abilene	$ 196	$ 196	$ 104	$ 104
Amarillo	$ 603	$ 603	$ 313	$ 313
Beaumont	$ 664	$ 560	$ 274	$ 274
Brownsville	$ 812	$ 569	$ 333	$ 267
Bry-Coll Sta	$ 1,051	$ 804	$ 633	$ 227
Harlingen	$ 579	$ 579	$ 358	$ 215
Killeen-Temple	$ 1,190	$ 983	$ 901	$ 466
Laredo	$ 2,281	$ 2,139	$ 1,339	$ 804
Longview	$ 676	$ 676	$ 597	$ 247
Midland-Odessa	$ 409	$ 409	$ 167	$ 167
San Angelo	$ 140	$ 87	$ 20	$ 20
Sherman-Denison	$ 447	$ 447	$ 79	$ 79
Texarkana	$ 1,211	$ 649	$ 486	$ 389
Tyler	$ 771	$ 610	$ 610	$ 139
Victoria	$ 624	$ 290	$ 76	$ 76
Waco	$ 1,024	$ 729	$ 109	$ 109
Wichita Falls	$ 239	$ 239	$ 84	$ 84
Total	$ 213,095	$ 170,767	$ 124,348	$ 69,493

Cost for equivalent lane-miles, interchanges and rights-of-way estimated to be required to achieve each mobility scenario. Expressed in 2008 dollars.

Table 3. Congestion Cost (2009 through 2030) (2008$ Million)

Region	Reduce Congestion	Prevent Worse Congestion	Economically Competitive	Current Funding Trend
Austin	$ 11,470	$ 20,899	$ 23,942	$ 43,907
Corpus Christi	$ 2,014	$ 2,600	$ 2,600	$ 10,108
Dal-FtWorth	$ 57,816	$ 85,379	$ 102,909	$ 199,833
El Paso	$ 2,344	$ 2,845	$ 4,345	$ 7,360
Hidalgo	$ 823	$ 1,092	$ 3,267	$ 3,267
Houston	$ 66,802	$ 82,702	$ 118,125	$ 164,790
Lubbock	$ 1,005	$ 1,136	$ 1,136	$ 1,880
San Antonio	$ 11,148	$ 18,570	$ 24,174	$ 51,609
Abilene	$ 85	$ 85	$ 174	$ 174
Amarillo	$ 233	$ 233	$ 312	$ 312
Beaumont	$ 1,080	$ 1,185	$ 1,819	$ 1,819
Brownsville	$ 215	$ 367	$ 1,132	$ 1,351
Bry-Coll Sta	$ 368	$ 539	$ 776	$ 1,458
Harlingen	$ 282	$ 282	$ 621	$ 837
Killeen-Temple	$ 462	$ 690	$ 1,448	$ 1,837
Laredo	$ 792	$ 953	$ 1,866	$ 3,025
Longview	$ 378	$ 378	$ 649	$ 1,430
Midland-Odessa	$ 227	$ 227	$ 505	$ 505
San Angelo	$ 56	$ 56	$ 65	$ 65
Sherman-Denison	$ 95	$ 95	$ 319	$ 319
Texarkana	$ 230	$ 358	$ 561	$ 798
Tyler	$ 766	$ 983	$ 983	$ 1,788
Victoria	$ 194	$ 198	$ 242	$ 242
Waco	$ 112	$ 162	$ 437	$ 437
Wichita Falls	$ 122	$ 122	$ 172	$ 172
Total	$ 159,120	$ 222,133	$ 292,581	$ 499,324

Value of delay and fuel costs for 22-year period from 2009 to 2030.

Table 4. Total Cost - Implementation and Congestion - 2009 to 2030 (2008$ Millions)

Region	Reduce Congestion	Prevent Worse Congestion	Economically Competitive	Current Funding Trend
Austin	$ 31,427	$ 35,998	$ 37,471	$ 50,611
Corpus Christi	$ 5,242	$ 5,638	$ 5,638	$ 11,161
Dal-FtWorth	$ 134,802	$ 148,408	$ 152,461	$ 229,564
El Paso	$ 11,911	$ 9,081	$ 7,309	$ 9,139
Hidalgo	$ 3,668	$ 3,451	$ 4,141	$ 4,141
Houston	$ 131,583	$ 136,967	$ 156,614	$ 187,884
Lubbock	$ 1,649	$ 1,729	$ 1,729	$ 2,179
San Antonio	$ 33,318	$ 34,147	$ 32,999	$ 53,589
Abilene	$ 281	$ 281	$ 278	$ 278
Amarillo	$ 836	$ 836	$ 626	$ 626
Beaumont	$ 1,744	$ 1,745	$ 2,094	$ 2,094
Brownsville	$ 1,028	$ 935	$ 1,466	$ 1,618
Bry-Coll Sta	$ 1,419	$ 1,342	$ 1,409	$ 1,684
Harlingen	$ 861	$ 861	$ 978	$ 1,051
Killeen-Temple	$ 1,652	$ 1,674	$ 2,349	$ 2,303
Laredo	$ 3,072	$ 3,092	$ 3,205	$ 3,828
Longview	$ 1,055	$ 1,055	$ 1,246	$ 1,677
Midland-Odessa	$ 637	$ 637	$ 672	$ 672
San Angelo	$ 195	$ 142	$ 86	$ 86
Sherman-Denison	$ 542	$ 542	$ 398	$ 398
Texarkana	$ 1,441	$ 1,007	$ 1,048	$ 1,187
Tyler	$ 1,537	$ 1,593	$ 1,593	$ 1,927
Victoria	$ 818	$ 488	$ 318	$ 318
Waco	$ 1,136	$ 891	$ 546	$ 546
Wichita Falls	$ 360	$ 360	$ 256	$ 256
Total	$ 372,216	$ 392,900	$ 416,929	$ 568,817

Sum of 1) costs for implementation of each scenario and 2) the congestion cost over 22 years estimated for that scenario. The total represents the two costs that Texans will pay - one for projects, programs and policies and the other for the effects brought on by those choices.

Table 5. Total Daily Delay (Person-Hours)

		2030 Scenarios			
Region	Base Year - 2008	Reduce Congestion	Prevent Worse Congestion	Economically Competitive	Current Funding Trend
Austin	101,400	70,579	214,889	273,925	566,054
Corpus Christi	12,212	13,254	20,768	20,768	111,098
Dal-FtWorth	393,317	550,258	995,654	1,513,589	2,878,729
El Paso	17,693	20,915	39,460	68,680	129,022
Hidalgo	5,098	7,843	12,069	46,274	46,274
Houston	451,609	628,116	885,025	1,270,389	1,927,639
Lubbock	6,994	8,579	10,559	10,559	21,910
San Antonio	100,968	61,984	169,005	260,463	680,505
Abilene	274	658	658	1,684	1,684
Amarillo	706	1,518	1,518	2,277	2,277
Beaumont	6,765	7,950	9,392	18,057	18,057
Brownsville	1,599	1,778	4,145	16,136	19,558
Bry-Coll Sta	1,460	3,312	5,552	8,911	17,606
Harlingen	924	3,512	3,512	8,849	12,252
Killeen-Temple	3,311	3,499	7,060	20,425	24,510
Laredo	2,619	6,793	8,668	19,294	32,913
Longview	1,730	3,229	3,229	6,553	17,022
Midland-Odessa	1,149	2,018	2,018	5,902	5,902
San Angelo	317	361	361	481	481
Sherman-Denison	197	977	977	3,709	3,709
Texarkana	1,402	1,189	2,546	4,728	7,274
Tyler	4,554	6,664	9,808	9,808	21,430
Victoria	1,134	1,090	1,090	1,641	1,641
Waco	570	1,130	1,836	5,771	5,771
Wichita Falls	761	903	903	1,586	1,586
Total	1,118,764	1,408,110	2,410,702	3,600,460	6,554,907

The daily delay is expressed in person-hours. Delay is the difference in travel time between peak period conditions and free-flow (or light volume) periods.

Table 6. Congestion Cost in 2008 and 2030 (2008$ Millions)

			2030 Scenarios							
Region		Base Year - 2008	Reduce Congestion			Prevent Worse Congestion		Economically Competitive		Current Funding Trend
Austin	$	615	$ 428		$	1,285	$	1,561	$	3,376
Corpus Christi	$	89	$	94	$	147	$	147	$	830
Dal-FtWorth	$	2,205	$ 3,051		$	5,556	$	7,150	$	15,961
El Paso	$	98	$ 115		$	161	$	297	$	571
Hidalgo	$	30	$	45	$	70	$	267	$	267
Houston	$	2,539	$ 3,534		$	4,979	$	8,199	$	12,441
Lubbock	$	40	$	51	$	63	$	63	$	130
San Antonio	$	626	$ 388		$	1,062	$	1,572	$	4,066
Abilene	$	2	$	5	$	5	$	13	$	13
Amarillo	$	7	$	14	$	14	$	22	$	22
Beaumont	$	45	$	53	$	63	$	121	$	121
Brownsville	$	9	$	10	$	24	$	94	$	114
Bry-Coll Sta	$	10	$	23	$	39	$	60	$	122
Harlingen	$	5	$	20	$	20	$	51	$	71
Killeen-Temple	$	20	$	22	$	43	$	112	$	147
Laredo	$	20	$	52	$	66	$	149	$	255
Longview	$	12	$	22	$	22	$	47	$	118
Midland-Odessa	$	7	$	13	$	13	$	39	$	39
San Angelo	$	2	$	3	$	3	$	4	$	4
Sherman-Denison	$	1	$	7	$	7	$	28	$	28
Texarkana	$	11	$	10	$	22	$	40	$	62
Tyler	$	28	$	42	$	62	$	62	$	135
Victoria	$	9	$	9	$	9	$	13	$	13
Waco	$	3	$	7	$	12	$	37	$	37
Wichita Falls	$	5	$	6	$	6	$	11	$	11

Congestion cost is comprised of the value for travel delay and extra fuel consumed. Unit values are $16 per person hour and $105 per truck hour. Fuel is estimated as 8.4% of the delay value (average of last 20 years).

Table 7. Travel Delay Per Commuter (Hours Each Year)

		2030 Scenarios			
Region	Base Year - 2008	Reduce Congestion	Prevent Worse Congestion	Economically Competitive	Current Funding Trend
Austin	34	13	39	49	102
Corpus Christi	14	10	15	15	83
Dal-FtWorth	30	21	37	57	108
El Paso	12	9	16	29	54
Hidalgo	4	3	5	18	18
Houston	38	30	42	60	92
Lubbock	15	16	19	19	40
San Antonio	29	12	33	51	133
Abilene	1.0	2.2	2.2	5.6	5.6
Amarillo	1.3	2.2	2.2	3.4	3.4
Beaumont	9.1	8.3	9.8	18.8	18.8
Brownsville	4.2	2.2	5.2	20.2	24.4
Bry-Coll Sta	4.8	7.1	12.0	19.2	38.0
Harlingen	3.1	7.8	7.8	19.6	27.2
Killeen-Temple	9.4	3.6	7.2	20.8	25.0
Laredo	5.4	7.5	9.5	21.3	36.3
Longview	8.0	9.6	9.6	19.5	50.6
Midland-Odessa	2.2	3.2	3.2	9.5	9.5
San Angelo	1.3	1.3	1.3	1.8	1.8
Sherman-Denison	1.0	4.3	4.3	16.4	16.4
Texarkana	7.7	4.8	10.3	19.2	29.6
Tyler	18.2	14.4	21.1	21.1	46.2
Victoria	6.8	4.4	4.6	6.7	6.7
Waco	1.3	2.5	4.1	12.9	12.9
Wichita Falls	1.2	1.2	1.2	2.1	2.1

The 2030 Needs Committee used delay per peak period traveler (termed "commuter") as their preferred performance measure. This measure works well at a regional or statewide level. This statistic is the amount of extra travel time for a year for the average peak period traveler. Between 50% and 60% of a region's population travels in the peak; "commuter" in this case does not just refer to those traveling for a work purpose.

Table 8. Texas Congestion Index

Region	Base Year - 2008	Reduce Congestion	Prevent Worse Congestion	Economically Competitive	Current Funding Trend
Austin	1.25	1.09	1.25	1.32	1.65
Corpus Christi	1.08	1.07	1.12	1.12	1.62
Dal-FtWorth	1.29	1.20	1.36	1.52	1.86
El Paso	1.12	1.07	1.12	1.23	1.45
Hidalgo	1.07	1.06	1.09	1.35	1.35
Houston	1.33	1.21	1.38	1.51	1.78
Lubbock	1.11	1.10	1.12	1.12	1.25
San Antonio	1.25	1.10	1.28	1.42	2.06
Abilene	1.02	1.03	1.03	1.06	1.06
Amarillo	1.02	1.04	1.04	1.06	1.06
Beaumont	1.07	1.07	1.08	1.15	1.15
Brownsville	1.08	1.04	1.09	1.33	1.40
Bry-Coll Sta	1.06	1.06	1.08	1.16	1.33
Harlingen	1.05	1.10	1.10	1.26	1.36
Killeen-Temple	1.07	1.05	1.08	1.25	1.30
Laredo	1.14	1.12	1.16	1.34	1.58
Longview	1.05	1.06	1.06	1.13	1.33
Midland-Odessa	1.02	1.03	1.03	1.10	1.10
San Angelo	1.03	1.03	1.03	1.04	1.04
Sherman-Denison	1.02	1.04	1.04	1.14	1.14
Texarkana	1.07	1.03	1.07	1.13	1.20
Tyler	1.08	1.08	1.09	1.09	1.25
Victoria	1.07	1.04	1.07	1.10	1.10
Waco	1.01	1.02	1.02	1.11	1.11
Wichita Falls	1.05	1.04	1.04	1.08	1.08

The Texas Congestion Index indicates the amount of extra time required to make a trip in the peak period. It is the ratio of peak travel time to free-flow travel time. A value of 1.30 indicates a 20-minute midday trip requires 26 minutes in the peak. All freeways and arterial streets are included. The TCI was used in previous Mobility Plans as the primary performance measure, partly because it is relatively easy to communicate and because it can be used at a variety of geographies (e.g., corridor, subregion, etc.).

Table 9. Congestion Cost Per Commuter (2008$)

Region	Base Year - 2008	2030 Scenarios: Reduce Congestion	Prevent Worse Congestion	Economically Competitive	Current Funding Trend
Austin	$ 820	$ 308	$ 925	$ 1,124	$ 2,431
Corpus Christi	$ 416	$ 280	$ 439	$ 439	$ 2,475
Dal-FtWorth	$ 678	$ 459	$ 835	$ 1,075	$ 2,400
El Paso	$ 255	$ 192	$ 268	$ 495	$ 951
Hidalgo	$ 94	$ 69	$ 107	$ 409	$ 409
Houston	$ 848	$ 671	$ 946	$ 1,558	$ 2,364
Lubbock	$ 358	$ 371	$ 457	$ 457	$ 950
San Antonio	$ 722	$ 303	$ 831	$ 1,230	$ 3,182
Abilene	$ 34	$ 71	$ 71	$ 179	$ 179
Amarillo	$ 51	$ 85	$ 85	$ 127	$ 127
Beaumont	$ 241	$ 223	$ 263	$ 504	$ 504
Brownsville	$ 97	$ 52	$ 120	$ 468	$ 568
Bry-Coll Sta	$ 134	$ 202	$ 335	$ 521	$ 1,056
Harlingen	$ 72	$ 180	$ 180	$ 453	$ 628
Killeen-Temple	$ 221	$ 91	$ 176	$ 457	$ 602
Laredo	$ 169	$ 227	$ 292	$ 658	$ 1,122
Longview	$ 222	$ 267	$ 267	$ 560	$ 1,404
Midland-Odessa	$ 55	$ 86	$ 86	$ 248	$ 248
San Angelo	$ 40	$ 39	$ 39	$ 52	$ 52
Sherman-Denison	$ 29	$ 127	$ 127	$ 487	$ 487
Texarkana	$ 242	$ 161	$ 350	$ 650	$ 1,000
Tyler	$ 442	$ 362	$ 532	$ 532	$ 1,164
Victoria	$ 215	$ 141	$ 146	$ 212	$ 212
Waco	$ 29	$ 63	$ 103	$ 327	$ 327
Wichita Falls	$ 31	$ 32	$ 32	$ 57	$ 57

The total congestion cost (delay plus fuel) is divided by the number of peak period travelers to estimate an individual's average annual congestion cost.

Table 10. Lane Miles Added From 2009 through 2030

Region	Reduce Congestion	Prevent Worse Congestion	Economically Competitive	Current Funding Trend
Austin	4,297	3,685	3,485	1,822
Corpus Christi	642	543	543	210
Dal-FtWorth	18,290	16,029	11,831	6,879
El Paso	2,097	1,692	987	577
Hidalgo	1,239	1,075	449	449
Houston	11,834	10,728	9,070	5,200
Lubbock	378	345	345	161
San Antonio	2,855	2,105	1,286	348
Abilene	99	99	50	50
Amarillo	116	116	45	45
Beaumont	443	356	141	141
Brownsville	372	346	200	158
Bry-Coll Sta	502	413	305	83
Harlingen	275	275	120	71
Killeen-Temple	598	507	275	233
Laredo	1,218	1,177	944	553
Longview	296	296	227	37
Midland-Odessa	165	165	52	52
San Angelo	53	31	5	5
Sherman-Denison	257	257	24	24
Texarkana	649	472	353	283
Tyler	620	479	479	81
Victoria	480	248	80	80
Waco	273	191	21	21
Wichita Falls	78	78	27	27
Total	48,124	41,710	31,346	17,590

The total equivalent lane-miles added for each scenario (sum of freeways and arterials). Provided for the purposes of calculating scenario costs only. The actual improvements will be a range of strategies.

Appendix E:
Estimating Rural Person Travel Network Needs for 2030

The State's roadway data file containing traffic counts, growth projections, roadway mileage and number of lanes for all roads in all jurisdictions was used to examine the needed transportation improvements by 2030. Three levels of needs scenarios were examined; the analytical process is described below.

Analysis Description

One of the three need scenarios was a variation of the process used in the urban analysis. Because "need" is typically defined differently in rural areas, however, two additional scenarios were examined to focus on the connectivity needs in rural areas. The scenarios build on the results of previous analyses of transportation needs in Texas, but use the most recent data available. Three important steps were accomplished before the needs analysis began.

- Remove urban counties – Any county included in the metropolitan or urban analysis (conducted with the transportation planning models) was assumed to have been analyzed and the needs for those counties estimated.
- Estimate 2030 volumes – The future year for the dataset was 2026 (20 years beyond the base year). The average annual traffic volume growth rate from 2006 to 2026 was used to estimate 2030 volumes.
- Remove roadway added between 2006 and 2008 – The needs estimates are for the period from 2009 to 2030, but the analysis was based on 2006 data. The roadway estimated to be added in 2007 and 2008 was removed from the needs estimated for all three scenarios.

Congestion Thresholds

The average daily traffic volume per lane is a measure of the density of traffic and is a good estimate of congestion levels. The volume expectations have to be tailored to fit the road type (uninterrupted freeway/rural highway or street/county road with stop signs and traffic lights) and each area type (small urban or rural). This expectation recognizes both the physical limitations and the difference in expectations between acceptable conditions in cities and in rural areas. Using a set of criteria developed by TxDOT in the 1980s and updated to fit changes in roadway capacity standards, Exhibit 1 was developed as a set of congestion thresholds to be used in the rural needs analysis.

Exhibit 1. Congestion Thresholds Identified to Eliminate Serious Congestion

Area Type and Roadway Class	Daily Traffic Per Lane Threshold for Serious Congestion [1]
Small Urban	
Freeway or Tollway	16,000
Major Streets	5,500
Rural	
Freeway or Tollway	10,000
Major Roads	4,500

[1] Based on TxDOT Quality of Flow Guidelines and Updated Highway Capacity Manual

Rural Mobility Scenarios

The scenarios are described from the most aggressive mobility and connectivity target to the most conservative. The analysis used multiple techniques to identify sections that needed treatment, but segregated treated sections from untreated roads at each step to eliminate "double-counting" of needs. The compilation of needs for all three scenarios began with decreasing the amount of capacity required by the amount of roadway added between 2006 (the data year) and the end of 2008, so that the needs are for the period from 2009 to 2030. The scenarios are described below.

- Improve Congestion & Safety and Full Connectivity Scenario – This scenario targets congested roads and the population center connectivity system.
  - Roadways that will have traffic volume in 2030 above the congestion threshold (see Exhibit 1) were identified. Lanes were added in increments of two (one in each direction) until the volume per lane was below the threshold.
  - In addition, two levels of road addition were applied to sections of the Texas Trunk System road network. The Trunk System is composed of important regional and interregional connector routes. These roads ensure that every town with a population above 20,000, marine ports and points of entry will be served by a major designated highway. Two lanes were added to any Trunk System road that had volumes in excess of half the congestion standard in Exhibit 1. In addition, any Trunk System road that was only two lanes wide received two additional lanes, so that all Trunk System roads were at least four lanes wide. And all four-lane undivided Trunk System roads were converted to four-lane divided roadways to improve safety.
- Improve Congestion & Safety and Partial Connectivity Scenario – Roadways that were estimated to be congested in 2030 were identified and lanes added to reduce the volume per lane below the threshold levels. Texas Trunk System roads with volumes above 50 percent of the congestion threshold for that road type also received two additional lanes.
- Improve Congestion & Safety Scenario – Roadways that were estimated to be congested in 2030 were identified and lanes added to reduce the volume per lane below the threshold levels.

Scenario Results

Exhibit 2 presents the amount of lane-miles needed to meet each of the scenarios identified. The large amount of congested rural roadway might be surprising, but many road sections have large traffic volumes and growth in trade and travel will place great strain on the network.

Exhibit 2. Rural Connectivity and Congestion Relief Scenarios

Area Type and Roadway Class	Additional Lane-Miles Required to Meet Scenario Targets (Compared to 2008 Roadway Widths)		
	Congestion/ Safety + Full Connectivity	Congestion/ Safety + Partial Connectivity	Improve Congestion & Safety
Small Urban			
Freeway or Tollway	140	140	70
Major Streets	1,570	1,560	1,330
Rural			
Freeway or Tollway	2,070	2,070	850
Major Streets	13,420	9,980	5,720

Source: Texas Transportation Analysis of 2006 TxDOT Roadway Inventory Database

Appendix F:
Public Transportation Information

Part 1: Fleet Replacement and Expansion Methodology

This methodology uses the "small urban" statewide fleet data to demonstrate the methodology employed to estimate the cost of the replacement and expansion of the small urban fleet through 2030. The same methodology was applied to the rural fleet and to individual large urban fleets (where necessary).

The Public Transportation Division of the Texas Department of Transportation provided summary data on the small urban fleet. TTI removed from those fleet numbers those vehicles whose replacement costs had been incorporated into the *metropolitan* urban cost data in order to avoid double counting. The resulting small urban fleet data is below:

Table A-1. Existing Small Urban Fleet

Vehicle Type/Cost	Useful Life	Total Fleet	Fleet beyond 125% of useful life
Type 1 ($50k)	4	9	5
Type 2 ($60K)	4	62	28
Type 3 ($70K)	5	209	40
Type 7 ($40K)	4	7	1
Types 8/9/10 ($45K)	7	18	1
Type 11 ($120K)	7	139	56
Type 14 ($250K)	7	12	0
Type 15 ($300K)	12	28	0
Type 16 ($350K)	15	172	10

The fleet replacement plan reflects the following assumptions, as more fully discussed in Public Transportation Chapter of the report:

1. The fleet providing service to the public should be replaced based upon the useful life of the vehicles. For purposes of this analysis, agencies are assumed to replace vehicles when they reach 125% of their useful life.

2. The level of service, as expressed by revenue miles per capita, for agencies below the median level of service of their group (small urban or rural) is assumed to expand service to reach that median level. The resulting service level is used to calculate the number of additional vehicles necessary to provide that service level.

3. Additional vehicles will be required to permit all areas to accommodate the population growth between 2006 and 2030. Population growth rates are calculated based upon State Data Center information for each county for each year through 2030 and assumes that current provider

service area jurisdictions continue. The methodology then is designed to support these three assumptions.

Step One-A. Bring existing fleet to "125% of useful life" standard.

The first step is to calculate the cost to replace vehicles that are already beyond 125% of their useful life. The information provided by the Public Transportation Division already identified the number of vehicles of each vehicle type that were beyond 125% of their useful life; and the unit replacement cost in current year dollars. This cost is calculated by multiplying the number of vehicles, by type, times their unit cost and then summing the results:

Table A-2. Cost to Bring Existing Fleet to 125% of Useful Life Standard

Vehicle Type/Cost	Fleet Beyond 125% of Useful Life	Vehicle Unit Cost	Replacement Costs
Type 1 ($50k)	5	$50,000	$250,000
Type 2 ($60K)	28	$60,000	$1,680,000
Type 3 ($70K)	36	$70,000	$2,520,000
Type 7 ($40K)	1	$40,000	$40,000
Types 8/9/10 ($45K)	1	$45,000	$45,000
Type 11 ($120K)	10	$120,000	$1,200,000
Type 14 ($250K)	0	$250,000	$0
Type 15 ($300K)	0	$300,000	$0
Type 16 ($350K)	10	$350,000	$3,500,000
TOTAL			**$9,235,000**

Step One-B: Replace total fleets through 2030, reflecting the "125% of useful life" standard.

Each vehicle type has an assumed useful life. For the analysis, vehicles are replaced at 125% of that useful life (Column C below). For example, a Type 1 vehicle has a useful life of four years; Type 1 vehicles are assumed to operating at 125% of that useful life, or five years, prior to replacement.

The number of times each vehicle would be replaced during the 25-year planning horizon is equal to 25 years divided by the replacement cycle (Column E). In the case of a Type 1 vehicle, there would be five replacements of each vehicle through 2030. The number of replacements per vehicle is computed based upon the replacement cycle 125% of useful life. Multiplying the number of replacements per vehicle by the number of vehicles of that type calculates the total number of vehicles, by type, that would be purchased through 2030 (Column D x Column E = Column F). The total cost of fleet replacement is calculated by multiplying the number of vehicles being purchased by the unit cost per vehicle, by type (Column F x Column G = Column H).

Table A-3. Cost to Replace Existing Fleet through 2030

A	B	C	D	E	F	G	H
Vehicle Type/Cost	Useful Life	125% of Useful Life	Total Fleet	Replacements per Vehicle through 2030	Replacement Vehicles through 2030	Vehicle Unit Cost	Replacement Fleet Costs
Type 1 ($50k)	4	5	9	5	45	$50,000	$2,250,000
Type 2 ($60K)	4	5	51	5	255	$60,000	$15,300,000
Type 3 ($70K)	5	6.25	158	4	632	$70,000	$44,240,000
Type 7 ($40K)	4	5	7	5	35	$40,000	$1,400,000
Types 8/9/10 ($45K)	7	8.75	18	3	51	$45,000	$2,314,286
Type 11 ($120K)	7	8.75	55	3	157	$120,000	$18,857,143
Type 14 ($250K)	7	8.75	12	3	34	$250,000	$8,571,429
Type 15 ($300K)	12	15	28	2	47	$300,000	$14,000,000
Type 16 ($350K)	15	18.75	172	1	229	$350,000	$80,266,667
TOTAL			**510**		**1,486**		**$187,199,524**

Step Two: Calculate fleet expansion and replacement required to increase current service levels to bring providers below the median revenue miles per capital to the median service level.

This calculation assumes that the average fleet mix across all urban systems will remain constant and that the average mileage per vehicle will remain constant. The percentage increase in revenue miles that would be required to bring systems currently operating revenue miles per capita below the median up to the median would also be the percentage fleet increase required.

Based upon the spreadsheet below, a 25% fleet increase is required to achieve median service levels by those operators who are currently below the median. The cost of that increase is then based upon the average unit cost of the small urban fleet. This average can be computed by dividing the number of replacement vehicles by the total replacement costs as calculated in Table A-3. The average fleet replacement rate can likewise be computed by dividing the total number of replacement vehicles by the original number of vehicles in Table A-3. This assumes that the expanded service is introduced early in the planning period.

Average cost per vehicle in small urban fleet = **$125, 988**
Number of additional vehicles = 510*0.25 = **127.5 additional vehicles**
Vehicle acquisition cost = 127.7* $125, 988 = **$16.1 million**
Average fleet replacement rate = 1486/510 = **2.9 replacement vehicles per additional vehicle**
Vehicle replacement cost = $125,988*2.9*127.5 = **$46.8 million** (variance due to rounding)

TOTAL COST = $16.1 million + $46.8 million = **$62.9 million**

Table A-4. Small Urban Service Level and Calculation to Bring All Small Urban Systems to Current Median Service Level

	Population	Annual revenue miles	Revenue miles per capita	Additional rev. miles to reach median rev. miles per capita
City of Lubbock	202,225	2,264,927	1120.0	
City of Laredo	175,586	1,961,565	1117.2	
Collin County Committee on Aging	54,525	558,681	1024.6	
City of Abilene	107,041	1,072,831	1002.3	
City of Galveston	54,770	533,458	974.0	
City of Waco	153,198	1,297,063	846.7	
Texarkana Urban Transit District	48,767	333,303	683.5	
City of Beaumont	139,304	939,894	674.7	
City of Victoria	61,529	409,724	665.9	
College Station--Bryan	132,500	822,579	620.8	
Sherman-Denison	56,168	343,695	611.9	
City of Brownsville	165,776	1,011,503	610.2	
San Angelo	87,969	466,017	**529.8**	**MEDIAN**
City of Amarillo	179,312	870,212	485.3	79,696
City of Wichita Falls	99,396	457,266	460.0	69,286
City of Tyler	101,494	464,632	457.8	73,034
The Woodlands	89,445	407,818	455.9	66,018
Copperas Cove-Killeen & Harker Heights	167,976	735,404	437.8	154,451
Midland-Odessa Urban Transit District (a)	210,616	810,310	384.7	305,431
City of Longview	78,070	300,121	384.4	113,456
City of Temple	71,937	252,756	351.4	128,331
City of Port Arthur	114,656	342,659	298.9	264,733
Lake Jackson-Angleton	73,416	121,381	165.3	267,541
Hidalgo County	523,144	751,315	143.6	2,020,048
Texas City LaMarque	96,417	136,360	141.4	374,410
Harlingen - San Benito	110,770	31,380	28.3	555,426
TOTAL		**17,696,854**		
Additional revenue miles				**4,471,861**
Percentage change in total small urban revenue miles				**25%**

(a) Represents sum of two urbanized areas – Midland and Odessa

The increased service to Hidalgo County Urbanized Area represents 45% of the total increase in level of service for all small urban areas.

Step Three: Calculate fleet expansion and replacement to accommodate population growth.

This calculation is similar in approach as the Step Two calculation. Using data from the State Data Center, TTI developed a population growth rate for small urban communities, assuming no change in community boundary. Once that percentage is established, the remaining calculations follow the methodology used in Step Two with one exception. Since the Step Three new vehicles are required to maintain service levels as population grows in the future, the calculations assume that these vehicles are added steadily over time. Therefore, the vehicle replacement rate is only half of the rate that is applied to vehicles owned at the beginning of the 25-year planning period. Since it was assumes that Step Two vehicles would be a priority, they are assumed to be "baseline" vehicles and the requirements to accommodate population growth are based upon the sum of the current fleet and the Step Two fleet. (This assumption potentially overstates the cost of replacement in Step Two, but provides an estimated fleet expansion and replacement cost that is reflective of the fleet standards reflected in this plan).

The calculations for an expanded fleet to accommodate population growth and the replacement of those vehicles during the planning period are as follows:

- Anticipated small urban population growth rate (2006 – 2030) = **15%**
- Baseline vehicles = 510 + 127.5 = **627.5 vehicles**
- Additional vehicles = 627.5*0.15 = **95.6 vehicles**
- Cost of additional vehicles = 95.6*$125,988 (ave. vehicle cost) = **$12.0 million**
- Average fleet replacement rate = 2.9 (see Step Two) /2 = **1.45 replacement vehicles per new vehicle**
- Cost of replacement = 95.6*1.45*$125,988 = **$17.5 million**
- TOTAL COST = $12.0 million + $17.5 million = **$29.6 million** (variance due to rounding)
- TOTAL SMALL URBAN FLEET REPLACEMENT AND EXPANSION COSTS (in millions):

Step One-A. Bring existing fleet to "125% of useful life" standard.	$9.2
Step One-B: Replace total fleets through 2030, reflecting the "125% of useful life" standard.	$187.2
Step Two: Calculate fleet expansion and replacement required to increase current service levels to bring providers below the median revenue miles per capital to the median service level.	$62.9
Step Three: Calculate fleet expansion and replacement to accommodate population growth.	$29.6

TOTAL COST = $288.9 million

Part 2: Major Transit Projects Included in Metro Area MTPs

Austin

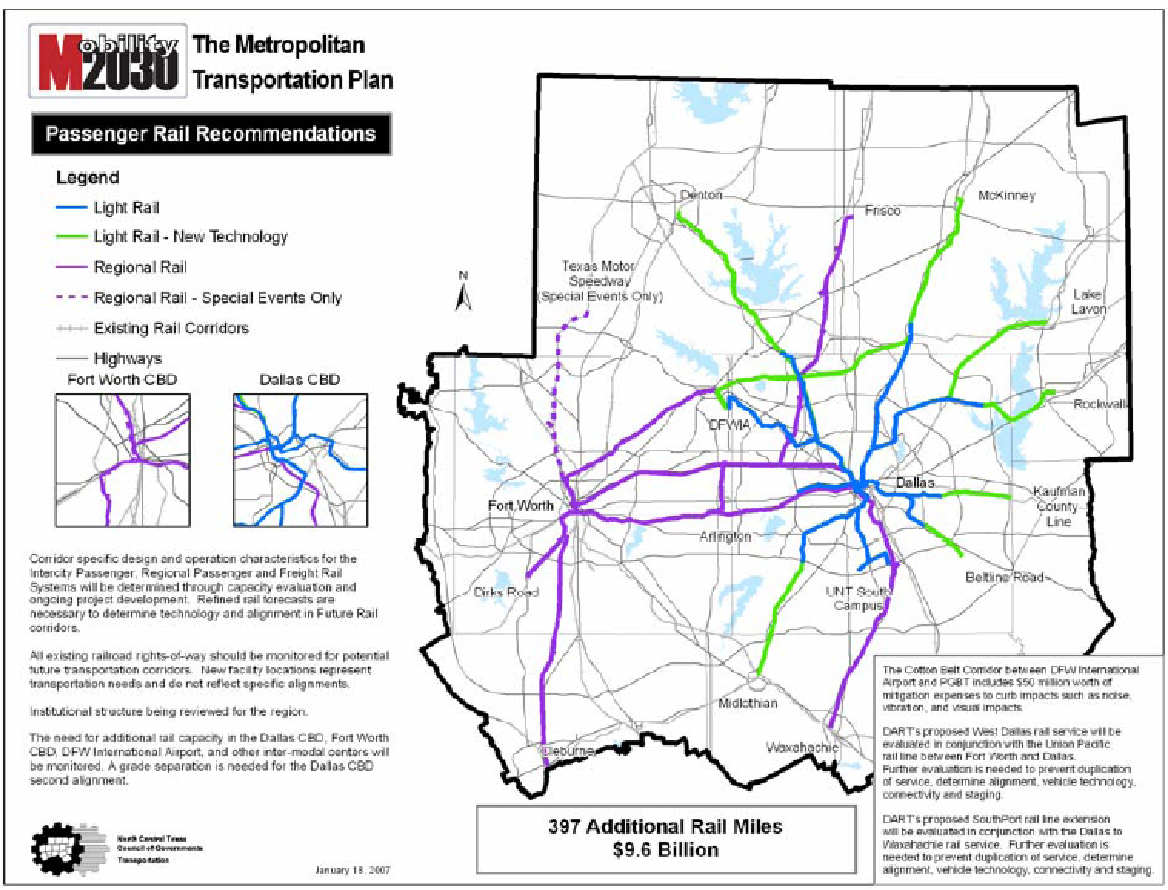
Austin-San Antonio commuter rail
Leander – Downtown commuter rail – Phases I and II
New Park & Ride lots (10)
New Transit Centers (5)
New operating facility
Upgrades to existing Park & Ride, Transit Center, operating facility
New and expanded bus rapid transit/ express services in 17 corridors

Corpus Christi

Vehicle replacement (estimated by TTI based on National Transit Database information)

Dallas-Fort Worth-Denton County

Vehicle replacement
Total 397 additional miles of rail
Includes 239 miles utilizing Regional Transit Initiative (RTI) efforts



El Paso

Bus and paratransit vehicle replacement
Bus Rapid Transit projects (4 corridors)
Information technology investment

Hidalgo County

Non-specific capital investment

Houston

Vehicle replacement
Intermodal terminals (4 new)
Park & Ride lots (6 new)
METRO Solutions (light rail) in five corridors
Signature Bus Rapid Transit
Commuter rail (Galveston; Southwest; Hempstead)
Guided rapid transit (2 corridors)
Transit Centers (3 new)
HOV conversion to 2-way HOT lane operation
Additional bus operating; rail operating; and guided rapid transit maintenance facilities
Main Street corridor and rail operating facility enhancements
Enhancements and modifications to existing facilities

Lubbock

Vehicle replacement
Safety and security investment
Bus wash/fueling station

San Antonio

Vehicle expansion and replacement
New and upgraded facilities

Appendix G:
Freight Rail Information

Texas Rail System Statistics and Modal Characteristics

The Freight Rail System in Texas

The freight rail system in Texas is expansive and ranks highly nationally as shown in the following statistics shown or described in Exhibits F-1 through F-4.

Exhibit G-1. Map of Texas Railroad System from the 2005 Texas Rail System Plan

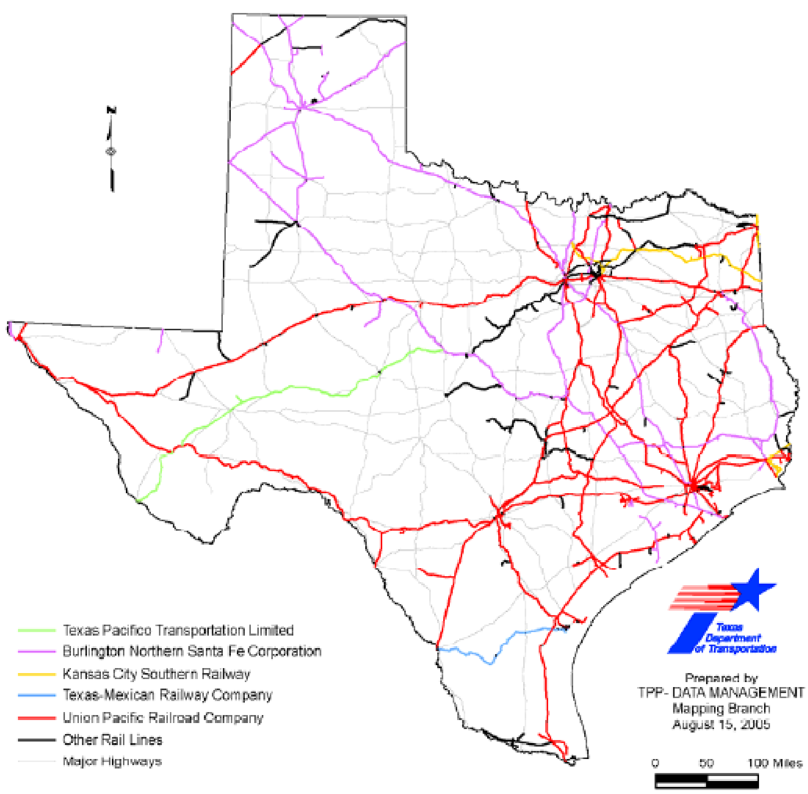


Exhibit G-2. Miles of Railroad Track in Texas by Railroad Class[1]

Texas Totals	Number of Freight Railroads	Miles Operated Excluding Trackage Rights	Miles Operated Including Trackage Rights
Class I	3	8,226	12,219
Regional	2	813	1,058
Local	19	669	697
Switching & Terminal	20	900	991
Total	44	10,608	14,965

Class I Railroad - As defined by the Surface Transportation Board, a railroad with 2006 operating revenues of at least $346.7 million.
Regional Railroad - A non-Class I line-haul railroad operating 350 or more miles of road and/or with revenues of at least $40 million.
Local Railroad - A railroad which is neither a Class I nor a Regional Railroad and is engaged primarily in line-haul service.
Switching & Terminal Railroad - A non-Class I railroad engaged primarily in switching and/or terminal services for other railroads.
Note: Railroads operating are as of December 31, 2006. Some mileage figures may be estimated.

Exhibit G-3. Texas Statewide Rail Ranking by Characteristic (2006 AAR Data)[2]

Characteristic	*National Ranking*	*Measure*
Total Rail Miles	1st	10,608 miles
Rail Tons Terminated	1st	218,294,813 tons
Freight Rail Employment	1st	17,394 employees
Freight Rail Wages	1st	$1,211,040,000
Rail Carloads Carried	2nd	10,141,437 carloads
Rail Tons Originated	2nd	115,132,816 tons
Number of Railroads	2nd	44 railroad companies
Rail Carloads Terminated	3rd	3.245,459 carloads
Rail Carloads Originated	4th	2,218,220 carloads
Rail Tons Carried	5th	395,222,630 tons

[1] Association of American Railroads (AAR), *AAR Railroads and States: Texas Summary, 2006*. Available at: http://www.aar.org. Accessed: September 26, 2008
[2] AAR State Rankings: 2006. Available at: http://www.aar.org. Accessed: September 26, 2008.

Exhibit G-4. Texas Rankings within Top 10 States for Top 12 Commodities Originated and Terminated (2006) [2]

Commodity	*Ranking*	*Tons*	*% of U.S. Total*
Chemicals Originated	1st	39,527,390	26.8
Chemicals Terminated	1st	23,042,975	13.5
Food Products Terminated	1st	12,289,637	12.5
Petroleum Products Originated	1st	9,760,498	17.8
Petroleum Products Terminated	1st	9,351,086	14.2
Coal Tons Terminated	2nd	68,164,252	8.0
Non-metallic Minerals Originated	2nd	26,891,452	16.0
Non-metallic Minerals Terminated	2nd	39,724,558	23.0
Farm Products Terminated	2nd	25,900,856	14.9
Glass and Stone Products Terminated	2nd	5,519,780	9.0
Waste and Scrap Material Originated	2nd	3,150,368	6.8
Lumber and Wood Products Terminated	2nd	3,873,280	6.2
Mixed Freight/ Intermodal Originated	3rd	8,055,400	7.3
Mixed Freight/ Intermodal Terminated	3rd	11,137,640	9.8
Glass and Stone Products Originated	3rd	4,158,436	7.7
Metallic Ores Originated	4th	804,336	1.2
Primary Metal Products Terminated	5th	6,083,268	8.5
Pulp and Paper Products Terminated	5th	3,1010,320	6.0
Food Products Originated	7th	4,389,244	4.6
Primary Metal Products Originated	7th	3,240,568	4.9

Benefits of Public Freight Rail Investment

The proliferation of trucks on our nation's highway system and on the highways of Texas has resulted in a level of usage that was largely unforeseen by planners 30 years ago when excess capacity on both road and rail seemed sufficient to support growth for decades. This abundant capacity fostered an expansion in trucking at the same time it motivated an extensive shedding of underutilized rail infrastructure and spawned the growth of the short line rail sector. Deregulation of both the rail and trucking industries played a key role in creating an environment that allowed dramatic change to occur—expansion of trucking and rationalization of the freight rail system.

Today, excess highway capacity has been largely consumed by a vibrant and highly competitive trucking industry that provides shippers with a flexible and low cost system for over-the-road goods movement. But the trucking system that has evolved is becoming challenged and even limited by the confluence of factors that range from highway congestion and driver shortages to rising energy costs. These factors and others such as rising insurance rates threaten the viability of the industry and particularly endanger many of the small trucking firms that make up a significant portion of the carrier fleet.

When these private sector constraints are added to the adverse public impacts attributable to trucking, namely roadway infrastructure damage, safety, and noise and emissions, the relative merits of freight transportation by rail become apparent. A renewed interest in rail on the part of those public sector entities responsible for setting transportation policy, is founded in part on the benefits to be realized by shifting truck traffic to rail whenever it appears logistically and economically viable to do so. Public policy can be fashioned in ways that encourage this shift when the full advantage of freight transportation by rail is recognized.

Modal Shift

The characteristics of freight rail, its relative speed and flexibility as well as its longer economic shipping distance must be considered when assessing the potential for diversion of truck traffic to rail. The fact that 3-4 truck loads can be transported by one railcar must be contrasted with the need for the greater distance required by rail to offset the normally longer shipping times associated with rail freight transport. Intermodal movement of truck trailers and containers usually become cost and time efficient for customers at distances of 500-750 miles, with railroads preferring 1,000 miles or longer to become most competitive with more responsive highway movements.

Shippers make modal-choice decisions based on a variety of factors – historical practices, the bulk or perishable nature of their product, existing transportation infrastructure, to name a few. Ultimately, the total cost of shipment decisions, which includes the value of time as well as price, will direct shippers toward the most efficient mode-choice for their needs. This simple equation is being shifted in the direction of rail as energy costs and time consuming highway congestion become more significant factors in the total cost calculation.

Fuel Efficiency

When the truck fuel efficiency rate of 6.2 miles per gallon is multiplied by the assumed maximum truckload of 25 tons of cargo, a truck fuel efficiency of 155 ton-miles per gallon is generated. If most return trips are assumed to be empty – or haul zero cargo tons – the fuel efficiency of the return trip in ton-miles per gallon mathematically would equal zero, but the fuel efficiency in vehicle-miles per gallon would still equal 6.2. Since an across the board comparison of the three modes requires the use of a ton-miles per gallon rate, 155 ton-miles per gallon is the proper figure to use, which describes the fuel efficiency of a loaded truck.

Exhibit F-5 shows recently published ton-miles per gallon values for the major North American railroads as well as an industry average. The railroad average of 413 ton-miles per gallon is 2.66 times the value obtainable with trucking. Recent AAR figures show even greater fuel efficiency growth in the past two years—reporting 436 ton-miles per gallon for 2007.[3]

[3] AAR, "Railroads Building a Cleaner Environment', Washington, DC. Available at: http://www.aar.org/IndustryInformation/~/media/AAR/BackgroundPapers/364.ashx, Accessed: October 24, 2008.

Exhibit G-5. Calculated Railroad Fuel Efficiency (Based on 2005 Data)

Reporting Entity	*Gross Revenue Ton-Miles ($x10^6$)[4]*	*Fuel Consumed-Gallons ($x10^6$)[5]*	*Ton-Miles/Gallon[6]*
AAR	N/A	N/A	414
BNSF	594,676	1,402.3	424
CN (Canadian National)	54,064	110.7	488
CPR (Canadian Pacific Railway)	23,595	49.3	478
CSX (CSX Transportation)	247,411	595.5	415
KCS	25,167	74.0	340
NS	202,751	513.4	395
UP	548.761	1,362.9	403
Average East Roads	504,226	1,219.6	413.4
Average West Roads	1,192,199	2,888.5	412.7
Average All Roads	1,696,425	4,108.1	412.9

Freight Rail Environmental Benefits

Greater fuel efficiency translates into improved air quality when ton-miles are used as the metric for comparison. While the diesel power plants found in locomotives produce more emissions than there highway counterpart, the fact that railroads move over 2.6 times the amount of goods and material per gallon of diesel means that relatively less pollution is the result. Consequently, freight rail has positioned itself as the environmentally-friendly freight alternative.

The emission comparison between truck and rail is shown in Exhibit F-6. The emissions for railroads are divided into East and West to underscore the difference in operating environments.

[4] STB R-1 Annual Report, Schedule 755, Line 110: Total Gross revenue ton-miles all trains.
[5] STB R-1 Annual Report, Schedule 750, Line 4: Total Fuel Consumed all trains except passenger.
[6] TTI calculated value, gross revenue ton-miles divided by fuel consumed.

Exhibit G-6. Summary of Emissions - Grams per Ton-Mile[7]

Emissions (grams/ton-mile)				
	HC Volatile Organic Hydrocarbons	**CO Carbon Monoxide**	**NO_x Oxides of Nitrogen**	**PM Particulate Matter**
Eastern Railroad	0.02419	0.06434	0.65312	0.01624
Western Railroad	0.02423	0.06445	0.65423	0.01621
Truck	0.020	0.136	0.732	0.018

Railroad companies are supporting several state and local programs to reduce emissions in terminals by substituting lower emission "GenSet" switcher locomotives for yard operations. These newer power units are often co-funded with the public sector under grants or purchase programs to clean up the air in urban switching yards. Each GenSet locomotive reduces emissions from 80 to 90% with a 15% improvement in fuel efficiency. In addition, and in response to stricter EPA regulations, newer generation line-haul locomotives are significantly lower emitters of harmful gases and particulates. Self-imposed idling restrictions, largely in response to the sharp rise in diesel costs, add to the improvement by reducing the hours that sitting locomotives create emissions.

Reduced Infrastructure Damage

One legal 80,000 pound tractor-trailer truck does as much damage to road pavement as 9,600 cars.[8] This is due to the exponential impact of weight on pavement surfaces, specifically flexible pavements composed of compacted subgrade materials and asphalt. As a result of this hugely disproportionate damage function, high weight and overweight trucks significantly underpay their share of taxes and user fees for use of highways and bridges. The FHWA's highway cost allocation study places the ratio of user charges for fully-loaded, 5-axle trucks at 0.8, or 80 percent.[9] That means that heavy trucks pay in federal user fees only 80 cents for every dollar in damage they inflict on our publicly funded roads and bridges. Light-duty truck and pickups, on the other hand over pay by a ratio of $1.50 for each dollar in damage.

Thus, proponents of rail have a strong argument for policies that encourage the shift of truck-borne freight to rail, either bulk or intermodal. The savings to the public for roadway damage that is avoided by shipments over the private rail network is a clear financial incentive for the public sector to promote rail as the freight mode of choice.

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[7] Texas Transportation Institute (TTI). *A Modal Comparison of Domestic Freight Transportation Effects on the General Public*. College Station, Texas. December 2007.
[8] Highway Research Board, National Academy of Sciences, 1962.
[9] Addendum to the 1997 Federal Highway Cost Allocation Study, Final Report, U.S. Department of Transportation, Federal Highway Administration, May 2000 Available at: http://www.fhwa.dot.gov/policy/otps/costallocation.htm Accessed: October 20, 2008.

Recent Freight Rail Research Projects Funded by TxDOT
Current State DOT Freight Rail Planning Activities

The Texas Department of Transportation (TxDOT) has become increasingly involved in freight rail planning activities over the past decade but has only recently been given some of the necessary tools to begin actively pursuing railroad projects as a strategy to address both current and future transportation needs. Historically, TxDOT's Multimodal Section has funded several research and engineering studies regarding freight rail to assess freight rail system impacts on highways and other modes of transportation in the state. A list of these studies is included in Exhibit F-7.

Exhibit G-7: Recent TxDOT-Sponsored Freight Rail-Related Research Projects Completed by CTR and TTI

TxDOT Project #	*Title*	*Performing Agency*	*Year*	*Summary*
0-1703	The Railroad System of Texas- A Component of the State and National Transportation System	CTR/TTI	2000	This series of reports provided a detailed overview of the Texas Rail System and identified best practices of other states in funding rail transportation improvements and administering state-level funding programs.
0-2128	The Impact of Mexican Rail Privatization on the Texas Transportation System	TTI	2001	The purpose of this research project was to determine the effect of the privatization of Mexico's railroad system and closer operational ties to U.S. railroads upon the amount of international truck trade passing between the U.S. and Mexico. The project also provided TxDOT with information on current and future infrastructure and operational plans conducted by the U.S. and Mexican railroad private sectors and their potential impact on TxDOT highway infrastructure.
N/A	TxDOT State Rail Plan Assistance	TTI	2003	This project reviewed the previous Texas Rail System Plan (TRSP) draft from a consulting firm, identified necessary changes, and submitted a new draft TRSP to TxDOT.

0-4007	The Role of Rural Rail Transportation Districts in Texas	TTI	2003	This series of reports examined the effectiveness and provided a guidebook for creating and operating a Rural Rail Transportation District (RRTD) to preserve existing rail lines or construct new rail facilities. The studies examined past RRTDs, determined best practices, and made recommendations to TxDOT on their interaction with RRTD activities throughout the state.
0-4058	Sketch Planning Tool for the Appraisal of Freight Modal Investments	CTR	2004	This report summarizes the development and use of the Multimodal Analysis Freight Tool (MAFT) as a sketch planning tool to appraise multimodal freight investment alternatives.
0-4565	Enhancing Intermodal Service through Public-Private Partnerships in Texas	TTI	2004	This project developed a model for determining public and private costs associated with public-private partnerships in intermodal projects, examined several potential projects in Texas as case studies, and produced a user's manual for TxDOT use in applying the model to future proposed projects.
0-4723	State Supported Intercity Passenger Rail Corridors-Project Costs & Funding Strategies	TTI	2005	This research documented project costs and funding strategies that are currently being used by U.S. states and coalitions of states to fund intercity passenger rail projects- most over active freight rail lines.
N/A	Rail Capacity and Market Demand on the South Orient Railway	CTR	2005	This assessment of market demand and rail capacity issues was conducted by CTR to assist TxDOT TPP(M) staff.
0-4410	Diverting Containerized Freight from Key Texas Corridors	CTR/TTI	2005	The report covers the results of a study to examine container flows in Texas, display available data using a GIS platform, and evaluate the potential for diverting containerized traffic from Texas highways to other modes, such as rail and barge.
0-4702	Design and Operation of Inland Ports as Nodes of the Trans-Texas Corridor	CTR	2006	This project evaluated data, models and developed potential guidelines for TxDOT staff, or its consultants, to use when addressing issues of location, design, and impacts of inland ports.

0-4437	Landside Access Needs for Deep-Water Ports in Texas	CTR	2006	The report chronicles the landside access needs at Texas deepwater seaports. It focuses on how the needs for Landside Access improvements are assessed, planned and financed. Trends in maritime trade in Texas are analyzed. The report also provides guidelines for Metropolitan Planning Organizations and ports in prioritizing their landside access needs.
0-4169	Defining and Measuring Rural Truck Traffic Needs in Texas	CTR	2006	The objectives of the reports in this series were to highlight the factors that result in greater demands on rural roads, describe the condition of the existing rural road system in Texas, provide evidence of the impacts of increased demand for trucking on rural roads, and highlight the role of rail in rural areas.
0-5322	Investigation of Rail Facilities Relocation in the U.S. & Potential Lessons for Texas Transportation Planning	TTI	2006	This project examines rail relocation projects in the United States to determine best practices, document cost-benefit analysis factors, and develop recommended policies for TxDOT use in assessing potential urban rail relocation projects throughout the state. Case studies of several major rail relocation projects were completed highlighting the varied motivations, time periods and funding levels that relocation projects can have.
0-5068	Planning for Container Growth along the Houston Ship Channel and Other Texas Seaports	CTR	2007	This project examined corridor improvement initiatives at all Texas seaports contemplating future container operations, with a primary focus on rail systems and current facilities under the Port of Houston Authority (POHA).
0-5546	Protecting and Preserving Rail Corridors Against Encroachment of Incompatible Use	CTR	2008	This report provides an overview regarding encroachment and the elements that contribute to potentially incompatible development along rail corridors.
0-5684	Impacts of Dray System Along Ports Intermodal Yards, and Border Ports of Entry	CTR	2008	The objective of this report was to determine and quantify the impacts of drayage operations at ports, border ports, inland ports, and intermodal terminals on local communities, and to identify and recommend potential mitigation measures.

0-5930	Potential Development Of an Intercity Passenger Transit System In Texas	TTI	On-going	This project is evaluating the overall need for an improved intercity/interregional mass transit system by identifying passenger demand between Texas cities—first, by examining the capacity of existing highway, rail, and air corridors throughout the state and, second, by assessing the ability of such a system to interface with local public transit systems in urban terminal areas. The second year of research will estimate the costs and benefits of implementing such a system and determine how it would interact with existing transportation and mass transit systems.
0-5973	Emerging Trade Corridors and Texas Transportation Planning	CTR/TTI	On-going	This project is examining the potential for alternative trade patterns brought about by improved rail systems in Mexico, widening of the Panama Canal, and other global trade changes. The impact of these changes on freight traveling through Texas and affecting Texas' roads and rails will then be examined.
0-6268	Acquisition, Uses, & Funding Options for Abandoned Rail Corridors	TTI/CTR	On-going	This project is determining the availability of and legal statutes necessary to preserve abandoned rail corridors for future transportation use within the state of Texas.

0-6297	Freight Planning Factors Impacting Texas Commodity Flows	CTR	On-going	The objectives of this project are to: (a) gain an understanding of the size, scope, and type of commodities that are produced, consumed, and that flow trough different regions in Texas, (b) gain an insight into the business and transportation system factors that shippers and receivers consider when making shipping decisions, (c) identify and describe factors that impact the competitiveness of multimodal freight modes operating in Texas, (d) provide commodity data regarding origin and destination flows that will facilitate updates to various Texas freight models and studies, (e) identify and document significant multimodal freight system trends, needs, and issues in Texas, (f) recommend freight policies, strategies, performance measures, and infrastructure improvements that TxDOT can consider for implementation and funding, and (g) explore the interest, feasibility, and requirements for forming a Freight Advisory Committee in Texas.

Freight Rail Company Principles for Commuter/Intercity Passenger Rail Operations on Freight Rail Tracks and Corridors

Introduction

Class I railroads provide the vast majority of trackage for Amtrak's intercity passenger services, and an increasing amount of capacity for regional commuter rail as well. While individual freight rail carriers have different policies about adding commuter / passenger services to an already highly utilized network, one point that is critical that any expansion of passenger/commuter use of the freight rail network must protect current and future freight capacity and ability to respond to shipper's demands for increased volume and improved service. Adding highly service sensitive passenger/commuter services to the rail network without a corresponding increase in capacity will make the long-term capacity challenge worse.

Example Freight Rail Company Principles

Below, as reference, are BNSF's Passenger Principles that the company uses when it engages public agencies that wish to establish or grow commuter services. Through the successful adoption of these principles, BNSF has grown to be a leading provider of services to the commuter community with recently established or expanded services in key metropolitan areas such as Los Angeles, Seattle, and Minneapolis.

Passenger Principles – BNSF's relationships with commuter railroads and agencies are governed by the following principles. Other Class I railroads have similar policies. It is extremely important for the public to take these considerations into account when contemplating new or expanded commuter service on freight lines.

- Any commuter operation cannot degrade BNSF's freight service, negatively affect BNSF's freight customers, or BNSF's ability to provide them with service.

- BNSF must be compensated for any and all costs incurred in providing commuter service and make a reasonable return for providing the service.

- Capital investments necessary for commuter service are the responsibility of the public, including investments for future capacity which is potentially more expensive, especially in urbanized areas.

- BNSF will not incur any liability for commuter operations that it would not have but for those operations. These operations are provided by BNSF primarily as a public service; the relatively modest compensation BNSF receives does not begin to justify assuming the significant liability associated with passenger service.

- Studies of how commuter service might be provided must take into account not only the current freight traffic levels, but projected freight traffic growth.

- Investments made for commuter projects must not result in BNSF incurring a higher tax burden. Property improvements should not become part of our tax base; materials used should be exempt from all sales and use taxes, etc. or BNSF must be made whole for any increased tax burden.

- BNSF must retain operating control of rail facilities used for commuter service. All dispatching, maintenance and construction must be done under the control of BNSF. Passenger stations, parking lots and other non-rail facilities may be publicly owned and operated.

- Studies must reflect BNSF's actual operating conditions and cost structures. For example, construction work estimates must reflect our labor contract costs, schedules cannot assume that we will not operate any freight trains during peak commuter periods, etc.

- BNSF will limit commuter operations to the commuter schedules initially agreed upon and for which the capital improvement plan has been designed. Future expansions will have to undergo the same analysis and provide any required capital improvements before schedules can be altered, service added, or stations added.

- Improvements must include grade crossing protection and inter-track fencing as required to minimize the risk of accidents, due to liability and service interruption concerns.

Texas State Agencies with Roles in Freight Rail

TxDOT Role

TxDOT has become increasingly involved in freight rail planning over the past decade as it has evolved from being a highway department into a multimodal department of transportation. While this transition has taken several years, TxDOT is beginning to actively pursue railroad projects as a strategy to address both current and future transportation needs. In 2005, TxDOT published the Texas Rail System Plan (TRSP). The TRSP is a comprehensive review of rail projects and plans throughout the state covering freight rail/intermodal, current intercity passenger rail service, rail safety, rail service to port areas, and rail funding programs. This document set a baseline from which TxDOT has begun to further develop its ability to account for the rail mode in meeting its goals of moving people and goods statewide.

TxDOT has also been active in continued funding of rail-related research projects over the past several years through its research program. CTR, TTI, and other state universities have conducted studies regarding Texas rail system development, rail and intermodal service in and around port areas, container movement within the state, trade routes for freight rail, and the potential for public-private partnerships in freight rail projects. A list of TxDOT funded research projects regarding freight rail is included at the end of this chapter.

In early 2005 the state legislature passed HB 3588, a comprehensive transportation bill which included new, specific authority for TxDOT to undertake rail transportation projects. Prior to HB 3588 passage, TxDOT had very limited authority to carry out freight rail projects. TxDOT had made rail purchases prior to this time but only as the result of direct legislative appropriation or in limited cases where rail projects were necessary for roadway improvements. This was the case with the TxDOT purchase of the 391-mile South Orient Railroad between Coleman and Presidio in 2001 in order to prevent its abandonment. The passage of HB 3588 and the approval by the voters later that same year of a constitutional amendment allowing the creation of the Texas Rail Relocation and Improvement Fund (RRIF) have set TxDOT on a footing to become increasingly involved in freight rail projects. The state-level RRIF, however, has not yet been capitalized leaving TxDOT with very limited funding available to pursue rail construction, relocation, or acquisition or to partner with private railroad companies on mutually beneficial projects.

TxDOT has been working with several engineering consulting firms over the past three years to conduct detailed engineering studies of freight rail system needs in major urban areas and regions of the state. These studies are focused on improving freight flows and identifying areas where rail lines could potentially be consolidated or relocated to reduce traffic impacts and, at the same time, improve freight rail flows. As a secondary consideration, such projects could also potentially free up existing rail corridors for introduction of commuter or light rail transit service or for other transportation uses. Reports on the Houston-Galveston area and the San Antonio Region as well as a study examining the possibility of relocating freight rail through trains in

Central Texas between San Antonio and Taylor have been completed and posted on TxDOT's website. Studies are currently underway in East Texas, West Texas, the Corpus Christi area, and the Dallas-Fort Worth area. A future planned study area is the Rio Grande Valley region in south Texas.

In addition to these rail planning activities, TxDOT has also recently acquired new responsibilities in rail safety from the reorganization of the Texas Railroad Commission (RRC) by the legislature. Railroad safety inspectors from the RRC were transferred to the TxDOT Transportation Planning and Programming Division's Multimodal Section. TxDOT's Traffic Safety Division Railroad Section continues to work on improving highway-rail intersection safety throughout the state by administering federal grade crossing safety funding and approving the design of grade crossing safety devices.

Rural Rail Transportation Districts (RRTDs)

In 1981, the Texas Legislature passed Article 6550c of Vernon's Texas Civil Statutes which allowed two or more counties in which a rail line had been proposed for abandonment (or that was "in danger of abandonment" due to low traffic levels) to form a Rural Rail Transportation District (RRTD). RRTDs are divisions of state government with eminent domain and other powers, including the ability to issue bonds to purchase and keep a threatened rail line in place or to preserve the rail corridor right of way for future rail use through interim uses such as a hiking or bicycle trail. The general powers and capabilities of RRTDs are described in several reports from TxDOT Research Project 0-4007 on RRTD formation and lessons learned completed by TTI between 2001 and 2003.

RRTDs formed during the 1980's and early 1990s met with limited success. Only a few were able to acquire abandoned rail lines intact, others received the corridor only after the track structures had been removed and sold for salvage value, while most RRTDs did not have the resources to act quickly enough to prevent railroad company consummation of the abandonment process and consequent reversion of all properties held in easement to adjoining property owners. The biggest obstacle for RRTDs was finding the financial means to purchase existing rights-of-way from the abandoning railroad company in a timely manner. Without a revenue source to pay off bonds, most RRTDs were not able to effectively use the bonding authority granted to them by the legislature. Consequently, several lengthy, multi-county corridors that could have been important in the future as rail corridors or as alternative transportation corridors were lost within the state.

In 1997, the legislature amended the RRTD statutes to allow single counties to form an RRTD. As a result of this change, the focus of RRTDs shifted largely from the preservation of long rail corridors to become more site project-based on development and promotion of new rail projects within counties such as the development of a rail-served industrial park or adding a spur line to an existing facility—thereby allowing access by another Class I railroad to a customer creating competitive pricing for rail transportation. Since the passage of this change, many more RRTDs have been formed, most comprising a single-county. In fact, several single-county RRTDs have been formed within previously existing multi-county RRTDs. Current state law does not required RRTDs to report their formation to TxDOT or any other state agency, so no official, comprehensive list exists. Based on information from the Texas Alliance of Rail Districts, there are 39 known RRTDs in Texas in 2008. Exhibit F-8 is a listing of the known RRTDs. Exhibit F-9 is a map of the current RRTDs in the state. Some RRTDs near urban areas could also potentially be interested in developing passenger rail service along the lines and ROWs that they own or control.

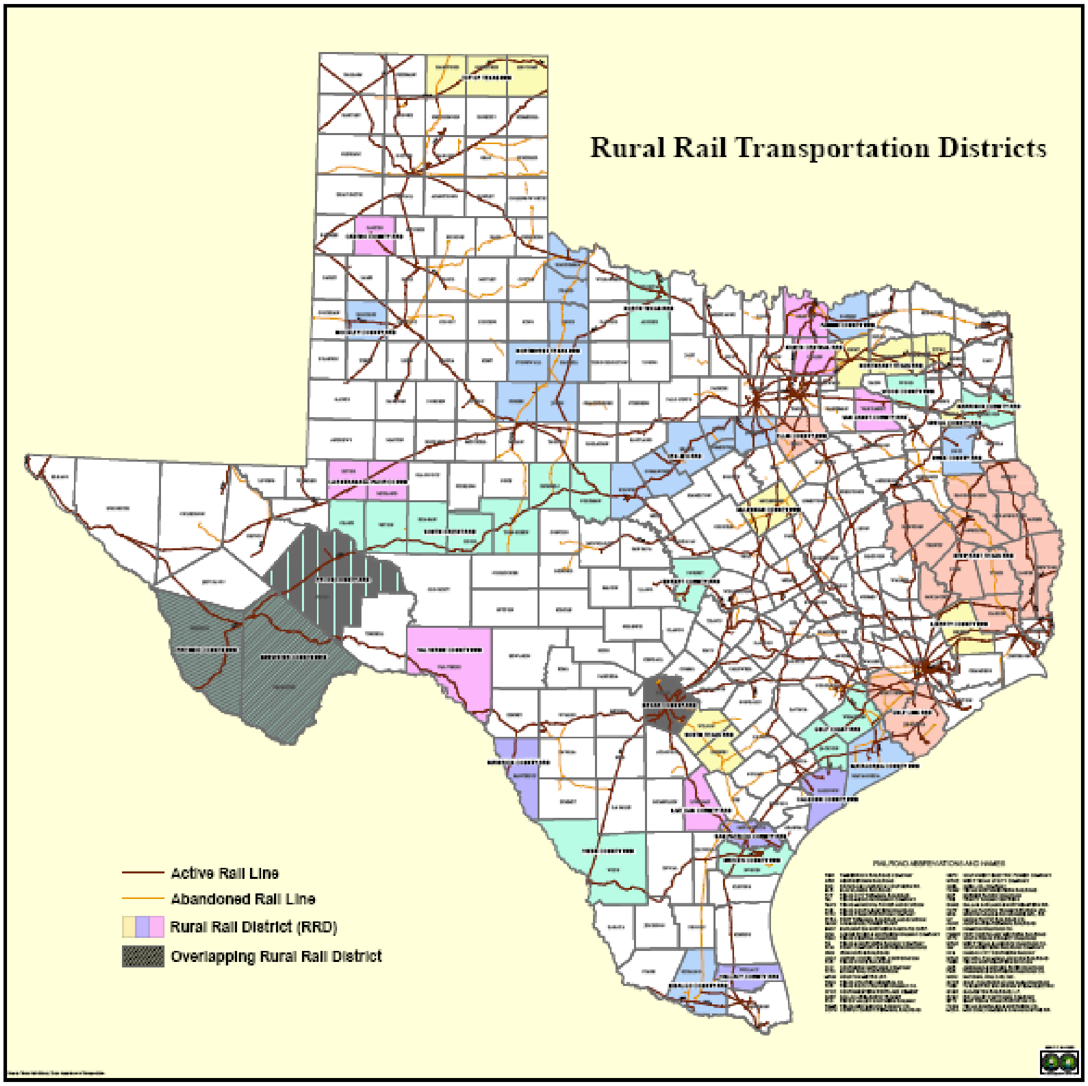
Exhibit G-8. Current Rural Rail Transportation Districts in Texas, 2008

Source: Texas Alliance of Rail Districts

Bexar County	Gregg County	Maverick County	San Patricio County
Brewster County	Gulf Coast	McLennan County	South Orient
Burnet County	Gulf Link	North Central	South Texas
Calhoun County	Harrison County	North Texas	Top of Texas
Castro County	Hidalgo County	Northeast Texas	Val Verde County
Centex	Hockley County	Northwest Texas	Van Zandt County
Coleman County	La Entrada Al Pacifico	Nueces County	Webb County
Deep East Texas	Liberty County	Pecos County	Willacy County
Ellis County	Live Oak County	Presidio County	Wood County
Fannin County	Matagorda County	Rusk County	

Exhibit G-9. Map of Current Texas RRTDs

Source: Texas Legislative Council/Texas Alliance of Rail Districts



Other State, Regional, and Local Government Entities with Freight Rail Interests

In addition to RRTDs, several regional and local government entities have interests associated to freight rail development. Several of these entities are recognized as subdivisions of state government and are capable of receiving federal funds directly through appropriation for advancing rail projects. As the state's population grows during the years covered by this study, the interaction between these entities and railroad companies is likely to become increasingly important. These entities include:

Metropolitan Planning Organizations (MPO). MPOs are responsible for allocating transportation funds within major urbanized areas of the state. Several MPOs have conducted studies of the potential of commuter or light rail service to address transit needs. Often these plans are focused on adding these services on existing freight rail lines, in freight rail rights-of-way, or in adjacent corridors. Some MPOs have also successfully purchased excess rail property or rights-of-way for redevelopment associated with providing rail- or bus-based transit corridors.

Regional Mobility Authorities (RMA). RMAs were also created by HB 3588 in 2005. Several have been formed throughout the state with a current emphasis on development of toll road projects; however, the authority granted to RMAs also allows them to plan and fund freight and passenger rail projects. An RMA could develop a rail project independently or in cooperation with an existing rail company. RMAs, while similar in structure to RRTDs, have more tools to raise funds through taxes. Excess revenue from toll road projects could also be used to build freight rail projects in the future.

Commuter Rail Districts (CRD). Article 6550c has been amended twice to allow the formation of CRDs which have the goal of instituting commuter rail service in designated corridors. Currently only the Austin-San Antonio Intercity Commuter Rail District has been officially formed; however, the 2007 legislature authorized the formation of a CRD in the Valley region of south Texas. Unique to this CRD was the authority to levy taxes for the service—previous CRDs (and RRTDs) have not been granted this authority. CRDs will likely want to partner with railroad companies to add service on existing freight lines. Alternatively, they may be interested in adding line capacity within existing rights-of-way to support such operations.

Freight Rail Districts (FRD). Article 6550c was also amended to allow the formation of an FRD to provide regional input into decisions on publicly-funded freight rail improvements. The only FRD currently formed is the Gulf Coast Freight Rail District (GCFRD) in the Houston area. GCFRD members consist of local government representatives from cities and counties in the region as well as representatives of the Port of Houston. The GCFRD has been working with TxDOT and the railroad companies operating in the areas to develop priorities and a list of projects to pursue should public funds for rail become available.

Other State Agencies. Several other state agencies beside TxDOT have potential interests that could impact freight rail. Among these are the General Land Office (administration of state-owned lands), the Department of Parks and Wildlife (conversion of abandoned railroad property into parklands or trails), the Economic Development and Tourism division of the Governor's Office (preservation and expansion of rail service to encourage economic development), and the State Historical Commission (preservation of historic rail buildings or structures).

AAR Study Findings

Infrastructure Expansion/Capacity Improvements/Bottlenecks

The recent *National Rail Freight Infrastructure Capacity and Investment Study* conducted by Cambridge Systematics for the AAR used an AAR forecast that grew traffic at a modest annual rate just over 2 percent, roughly doubling traffic by 2035.[1] This study was based on the Federal Highway Administration's (FHWA) Freight Analysis Framework (FAF) 2.2 model, and assumed no increase in rail market-share. The study estimated capacity needs and selected a number of critical bottlenecks where substantial investment was needed on the national level. The predicted capital replenishment and needs figure to accommodate forecast growth on the national level was estimated to be $148 billion (2007 dollars) over the 30 year period from 2005 to 2035. It concluded that $13 billion of this figure would be the responsibility of shortline railroads and that $96 billion could be funded by the Class I railroads themselves—leaving a $39 billion shortfall that would need to be funded from outside the freight rail industry. The study suggests that this estimate of $1.4 billion per year over the 28 years between 2007 and 2035 would need to be funded by public sector tax incentives, public-private partnerships, or other sources. This suggests that a higher capital and replenishment figure based on stronger growth and truck diverted freight would need to be funded from other sources at an even higher level.

Exhibits F-10 through F-13 show maps excerpted information from the AAR study which point out the need for additional freight rail capacity investment in Texas over the period covered by this effort. Exhibit F-10 shows 2005 and 2035 trains per day. Exhibit F-11 shows trains per day increase over current levels for that period and the percent increase in trains per day over the same period. In order to mirror the A-F levels of service used in most roadway studies to indicate traffic congestion, the AAR study developed the table shown in Exhibit F-12 which relates volume to capacity ratio to level of service for the major rail lines of the state. Exhibit F-13 shows that, currently, only minor rail congestion exists, but it is fairly widespread throughout the state. The second map in Exhibit F-13 points out that, assuming only modest traffic growth, Texas is forecast to have significant freight rail congestion by 2035 if funding is not allocated to address this problem.

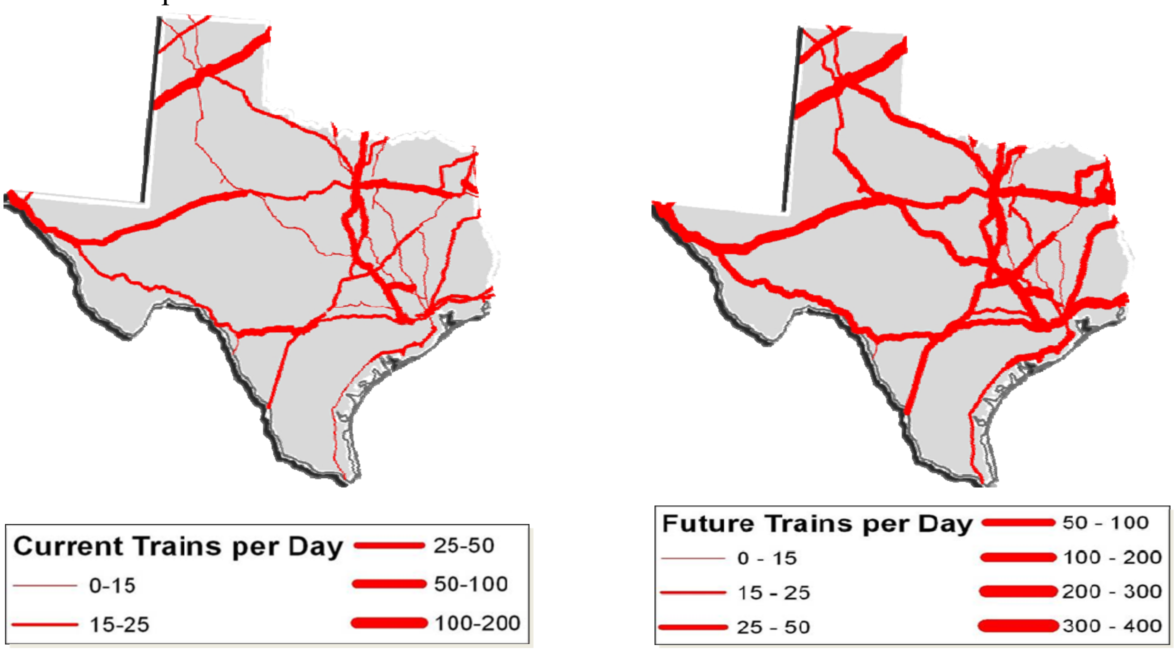


Exhibit G-10. AAR Capacity and Investment Study Trains per Day for 2005 and 2035[10]

[10] AAR, *National Rail Freight Infrastructure Capacity and Investment Study*, Performed by Cambridge Systematics, Washington, DC, September 2007. Available at: www.aar.org. Accessed: October 16, 2008. Texas-only maps from TxDOT Short Course Presentation by Alan Rutter, Cambridge Systematics, October 2008.

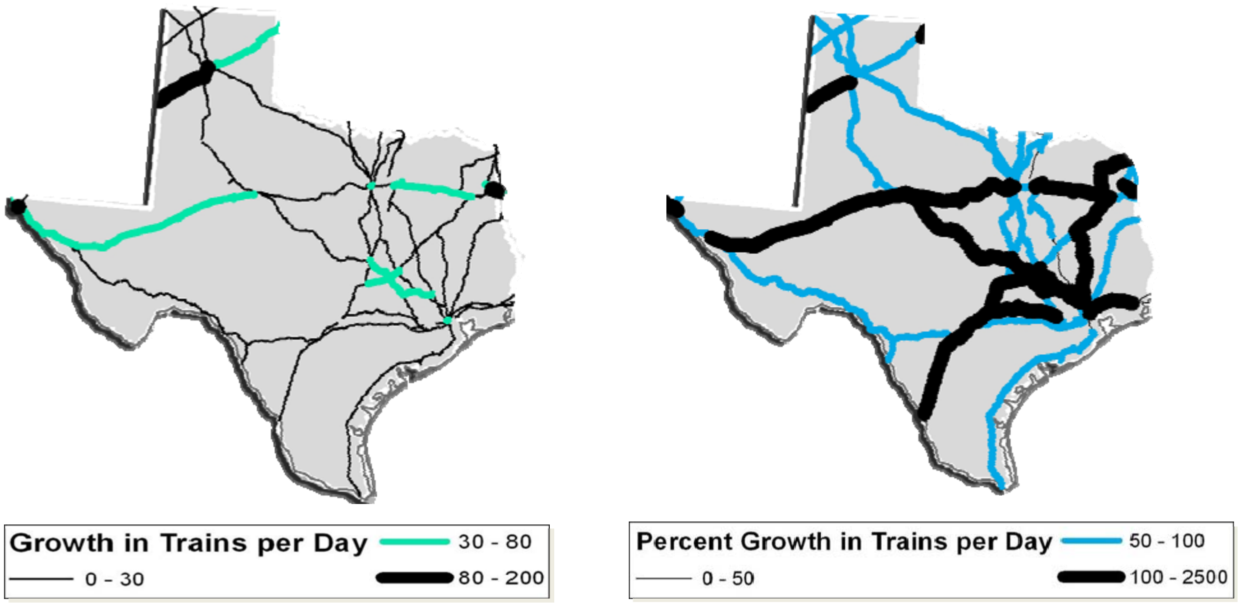


Exhibit G-11. Growth in Train Numbers per day and Percent Growth in Trains per Day between 2005 and 2035[11]

Table 4.3 Volume-to-Capacity Ratios and Level of Service (LOS) Grades

LOS Grade	Description		Volume/Capacity Ratio
A B C	Below Capacity	Low to moderate train flows with capacity to accommodate maintenance and recover from incidents	0.0 to 0.2 0.2 to 0.4 0.4 to 0.7
D	Near Capacity	Heavy train flow with moderate capacity to accommodate maintenance and recover from incidents	0.7 to 0.8
E	At Capacity	Very heavy train flow with very limited capacity to accommo-date maintenance and recover from incidents	0.8 to 1.0
F	Above Capacity	Unstable flows; service break-down conditions	> 1.00

Source: Cambridge Systematics, Inc.

Exhibit G-12. Rail Volume-to-Capacity Ratios and Level of Service (LOS) Grades[12]

[11] Ibid.
[12] Ibid.

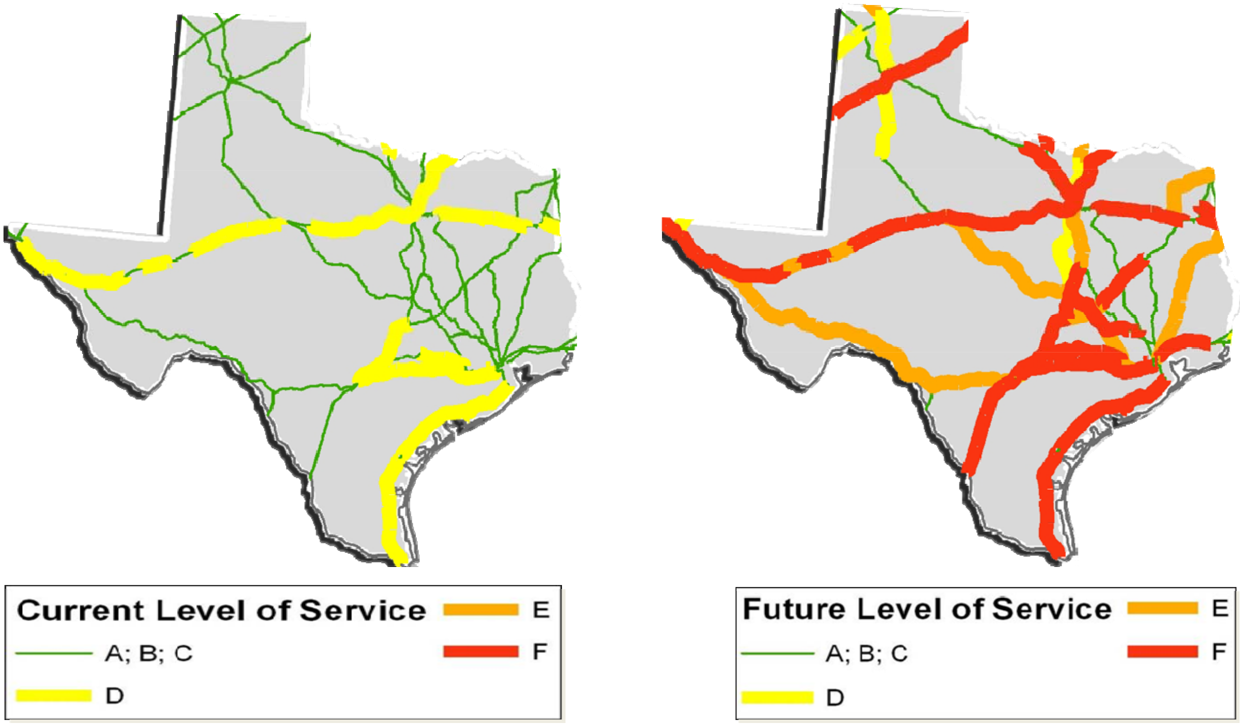


Exhibit G-13. Current and Estimated Future Major Rail Line Levels of Service 2005 and 2035 Without Capacity Expansion[13]

[13] Ibid.

Appendix H:
Ports and Waterways Information

Goal

Ensure that the State of Texas has a marine transportation system that matches world standards in terms of operational efficiency, energy efficiency, environmental sustainability, and equity of access for the full state population.

Background

Ports are typically measured (and compete) in a few basic areas:
- Cost
- Speed of throughput
- Safe handling of cargo
- Capacity

Texas ports must compete with each other in these areas, but they must also compete against other states and even Mexican ports. In this age of intermodalism—where a container destined for Chicago or Houston can enter the country through Los Angeles—it is very important for Texas ports to be as competitive as they can be.

Typically, Texas ports compete against each other for much of their cargo, although almost all container activity is located in the Houston/Freeport area. This has the practical effect of keeping rates low and forcing each port complex to keep its infrastructure up to date.

There is wide variation among the states in terms of the structure and operation of ports. In Texas, port authorities are primarily political subdivisions of the State of Texas, with control and responsibility at the local level. Ten port complexes handle virtually all of the state's oceangoing cargo. Eight of these ports are navigation districts, one is a municipal agency (Galveston), and one is private (Texas City).
- Port of Beaumont
- Port of Brownsville
- Port of Corpus Christi
- Port Freeport
- Port of Galveston
- Port of Houston
- Port of Orange
- Port of Port Arthur
- Port of Port Lavaca
- Port of Texas City

In addition to these ports, there are several port complexes that handle barge traffic only. The most significant of these are:
- Chocolate Bayou
- Victoria
- Harlingen

It is extremely important for ports to have good highway and rail connections. Ports are only transfer points—not final destinations. Even the most efficient port finds it impossible to compete without good landside connections.

The quality of life of Texas citizens is directly affected by the efficiency (or lack thereof) of the port system. Without a focus on efficiency, the areas around the ports become congested with heavy traffic, air pollution becomes an issue, and the prices of the goods and commodities that Texas industry and consumers purchase rise. Our economy is global. Almost every sector of the economy needs materials that are sourced either outside the state or outside the country—quite often as far away as China.

Ship channels and the Gulf Intracoastal Waterway are federal waters. The federal government, through the U.S. Army Corps of Engineers, is responsible for maintaining all navigation channels and pays anywhere from 50% to 65% of the cost of any channel deepening or widening projects.

Sources of Funds

During fiscal years 1994-2004, public port authorities in Texas added almost $1 billion in assets to their books, primarily infrastructure components such as docks, road, and warehouses. This does not include amounts contributed by the federal government to construct deeper or wider channels.

Asset Additions by Public Deep Sea Ports

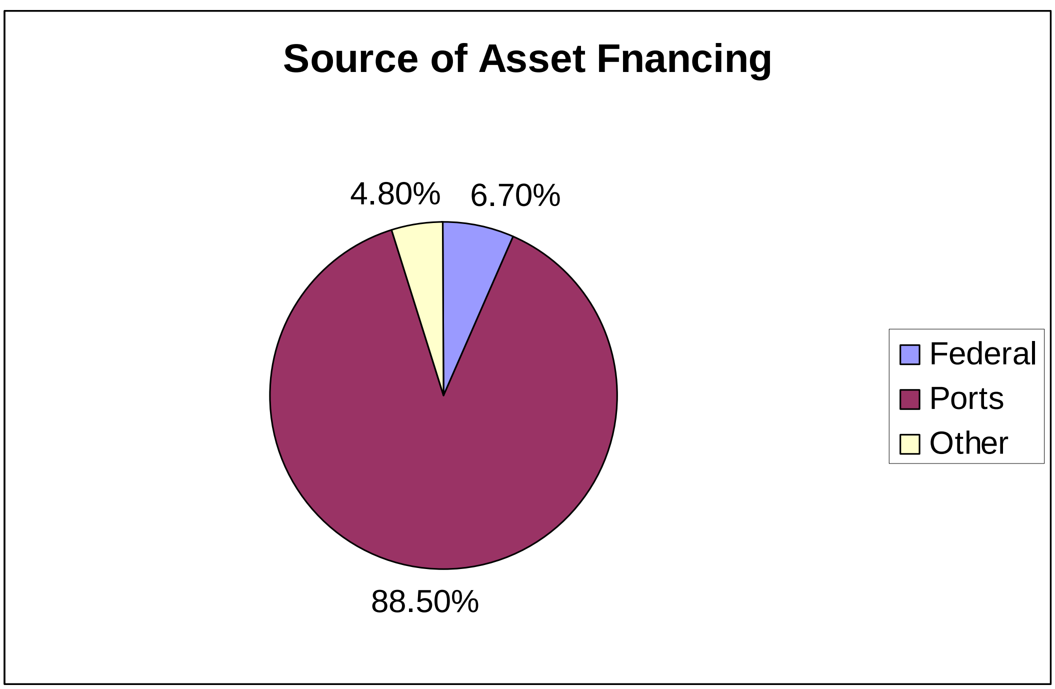
Asset Additions by Port FY 1994 through FY 2004	
Port	**Amount**
Beaumont	52,959,269
Brownsville	99,266,116
Corpus Christi	114,243,314
Freeport	53,585,740
Galveston	48,422,177
Houston	515,217,000
Orange	3,300,218
Port Arthur	66,255,188
Port Lavaca	33,114,472
System-wide Total	986,363,494

Ports (both deep sea and barge) typically finance their asset growth via general obligation bonds, revenue bonds, ad valorem taxes, and operating revenues. The following table shows the proportional use of these financing vehicles.

Asset Financing of Deep Sea Ports by Source of Funds.

Sources	Dollar Amount	% of Total
Public Financing:		
General Obligation Bonds	$431,375,920	43.7%
Grants – Non-Security	$32,939,793	3.3%
Grants – Security	$14,406,754	1.5%
Capital Contribution from Government	$19,173,985	1.9%
User Financing:		
Revenue Bonds	$73,097,052	7.4%
Loans	$43,008,051	4.4%
Reimbursements	$17,536,834	1.8%
Other Contributions	$3,721,344	0.4%
Cash & Miscellaneous	$351,103,761	35.6%
	$986,363,494	100.0%

Almost 89 percent of port asset financing comes from the port authorities, approximately 7 percent comes from the federal government, and just less than 5 percent comes from other sources. The State of Texas has historically appropriated $1.35 million each biennium to cover its expenses as non-federal sponsor of the Gulf Intracoastal Waterway (GIWW). This money funds acquisition and maintenance of dredged disposal sites and beneficial use projects for the GIWW. Additionally, in 2001 the Texas Legislature created a funding program called the Port Access Account Fund for port security, projects, and studies. At this time, the fund is not capitalized and is unavailable for funding port projects.



The ability to raise funds via the issuance of general obligation bonds or ad valorem taxes is directly proportional to the appraised value of property within the port's taxing jurisdiction. Within the Texas port system, there is a vast range of appraised values, ranging from $1.9 billion (Port Lavaca) to $193.7 billion (Houston). This means that an equivalent tax rate in Houston will produce 102 times more revenue than in Port Lavaca.

Appraised Taxable Property Values by Port for FY 2004

Port	Appraised Taxable Property Value
Beaumont	$7,749,632,061
Brownsville	$4,331,426,055
Corpus Christi	$15,619,651,089
Freeport	$7,510,311,000
Galveston	N/A (city department, no taxing authority)
Houston	$193,683,513,000
Orange	$3,424,582,764
Port Arthur	$2,787,257,307
Port Lavaca	$1,918,234,247

There are no data available on private investment in port complexes. Infrastructure items typically funded by the private sector generally consist of docks and related items. Private operators located on port authority property may either rent the warehouse and equipment or finance them on their own.

Dredging

Without constant maintenance, silt, mud, and sand will accumulate in ship channels and waterways, making it impossible for a fully loaded vessel to pass through. Dredging, the process of removing that accumulation, is mandatory so that vessels and barges can operate efficiently and safely. The cost of dredging is significant. The table below shows the value of dredging contracts issued by the U.S. Army Corps of Engineers for calendar years 2001-2006. The dollar amounts are adjusted to 2007 price levels in order to show constant dollars.

Column (1) shows that the Corps typically spends $62 million a year in maintenance work, of which it pays 100 percent (discounting minor contributions by other federal agencies). Column (4) shows what state and local entities must pay in order to maintain dredge material disposal areas, relocate utilities, and other expenses related to the Corps' maintenance dredging. Columns (2) and (5) show what was spent to widen and/or deepen existing channels.

History of Dredging Expense in Texas in 2007 Dollars

Year	(1) Corps Maint	(2) Corps New Work	(3) Other Fed Maint	(4) Local/ State Maint	(5) Local/State New Work
1998	55,931,983	5,795,885	112,721	1,236,425	2,046,416
1999	74,556,785	32,970,236	0	1,415,495	13,517,838
2000	63,851,802	83,411,499	0	650,259	30,522,157
2001	81,239,511	31,353,510	0	1,907,656	9,981,994
2002	63,847,211	41,033,511	158,764	769,504	10,994,811
2003	71,897,821	60,350,532	6,336,253[31]	3,659,616	22,847,110
2004	52,976,920	60,555,013	0	343,707	20,265,254
2005	37,903,994	21,266,962	0	654,658	11,606,791
2006	58,360,425	6,626,975	0	559,274	1,984,279
Average	**62,285,161**	**38,151,569**	**734,193**	**1,244,066**	**13,751,850**

The level of funding over the last 10 years has not been sufficient to maintain all ship channels at their authorized dimensions—the dimensions which Congress has instructed the Corps to maintain (typically described in terms of width and depth). Up to an additional 20 percent in funding could be required to maintain all projects at their authorized dimensions. If the severity and/or frequency of major storms increase, the figures in Column (1) and (4) will increase accordingly. Finally, a continual escalation in fuel prices will also cause a significant increase in the cost of dredging. Given these factors, either the cost of dredging will increase or dredging activity will be reduced. At a minimum at least $71 million will be needed each year to maintain channels. It is conceivable that the number could be as high as $90 million. Channel deepening and widening projects are discussed below.

Needed infrastructure

Infrastructure in the port context focuses on basic facilities such as docks, roads, rail lines, and berthing areas/channels. Additionally, channel widening/deepening projects are being pursued by various Texas ports with the hope of accomplishing them by 2030. To the degree that the available information allowed, items such as buildings, security equipment, etc., were eliminated from the figures shown below.

According to the Federal Highway Administration's (FHWA's) Freight Analysis Framework, total waterborne tonnage will almost double to 2.2 billion tons in the period of 2002 to 2035, due mostly to growth in international trade. The rate of growth for the containerized portion of international trade is expected to be significantly higher, although such projections have not been well substantiated.

[31] $4 million of this amount was contributed by the Coast Guard for work performed in Galveston. The remainder comes from Maintenance Operations of Dams and Improvements of Navigable Waters.

The completion of the project being undertaken by the Panama Canal Authority to expand the capacity of the Panama Canal could result in further growth. This expansion will make it economically more feasible for ships—primarily container ships—to sail directly from Asia to ports in the Gulf of Mexico. In a study commissioned by TxDOT in 2006, the authors stated that the proposed expansion of the Panama Canal will have significant impacts on Texas ports, their surrounding communities, and the highways and rail lines that serve them Texas ports are still evaluating their needs for additional port infrastructure resulting from the Panama Canal project. It could be argued that the projected Bayport Terminal expansion in Houston and the proposed La Quinta Gateway in Corpus Christi are affected by the potential increased demand from the Panama Canal widening, but both port authorities expect these terminals to be built by 2030 based on the demand from other sources. The main effect of the Panama Canal will be to accelerate the growth curve.

Basic Infrastructure

The Texas Ports 2008-2009 Capital Program is the basis for analysis of basic infrastructure needs. Unfortunately, little information is available for forecasting purposes. Therefore, several assumptions were made by the research team members based on their best judgment.

Projected Non-Channel Infrastructure Improvements

Port	Data Supplied	Assumptions	Total Requirement	Expected Federal Funds	Expected Port Funds	State Funding Requirement
Responding Ports:						
Brownsville	$6 mill for 2 years	Assume $2 mill/yr after that	$42,000,000	$25,486,284	$8,256,858	$8,256,858
Corpus Christi	Provided total	N/A	$57,529,000	$1,060,000	$13,645,000	$42,824,000
Houston	Provided total through 2017	Extend another 11 years	$ 810,000,000	$664,000,000	$73,000,000	$73,000,000
Mansfield	$2.5 mill for 2 years	Assume $400,000/yr after that	$9,750,000	$3,441,156	$3,154,422	$3,154,422
Palacios	$9.05 mill for 2 years	Assume $700,000/yr after that	$ 21,650,000	-0-	$10,825,000	$10,825,000
Freeport	$35.4 mill for 2 yrs.	Assume $2 mill/yr after that	$71,400,000	-0-	$35,700,000	$35,700,000
Port Arthur	$41.9 mill for 2 yrs	Assume $2 mill/yr after that	$77,900,000	$37,201,528	$20,349,236	$20,349,236
Others						
Galveston	$19.2 for 2 years	Assume $2 mill/yr after that	$55,200,000	-0-	$27,600,000	$27,600,000
Harlingen	$300,000 for 2 years	Assume $100,000/yr after that	$2,100,000	-0-	$1,050,000	$1,050,000
Victoria	$14.6 for 2 years	Assume $1.5 mill/yr after that	$41,600,000	-0-	$20,800,000	$20,800,000
Beaumont	$53.9 for 2 years	Assume $2 mill/yr after that	$89,900,000	$82,098,932	3,900,534	3,900,534
Coverage for small ports		10% of total for above ports	$127,902,900	$81,328,790	$21,828,105	$24,746,005
Total			**$1,406,931,900**	**$894,616,690**	**$240,109,155**	**$272,206,055**

Draft – Appendix H: Ports and Waterways Information

Page 183

The number shown above as the State Funding Requirement assumes that the Texas Legislature will sufficiently capitalize the Port Access Account Fund, and the ports will apply to the account for $272 million from the fund. Barring that capitalization by the State of Texas, other sources of funds must be secured or the amount of infrastructure development will most likely be curtailed.

Given the history of port infrastructure development in the last 10 to15 years, these numbers are probably conservative. It is reasonable to assume that at some point vessel sizes will stabilize (at least in Texas). To increase the depth of Texas ship channels to the point where they could accommodate the largest vessels that might enter West Coast or East Coast ports would require an inordinate amount of money. However, freight volumes will continue to increase significantly. Over the last ten years, the growth in freight has far exceeded the growth in general economic activity, both in the United States and around the world. This is primarily because of the globalization of the manufacturing process.

Channel Deepening projects

The following projects are channel widening/deepening projects being pursued by various Texas ports with the hope of completing them before 2030. In several cases, it is too early to predict what the cost will be because the new channel dimensions have not been defined. However, a number that is "reasonable" in comparison to historical activity is included. For analysis purposes the research team selected a number that the research team deemed reasonable in comparison to historical activity.

	Total Est. Cost	Federal Share	Non-federal Share
Brownsville	$100,000,000	$65,000,000	$35,000,000
Corpus Christi	$339,730,000	$168,730,000	$171,000,000
Freeport	$290,000,000	$145,000,000	$145,000,000
Matagorda	$500,000,000	$250,000,000	$250,000,000
Sabine-Neches	$900,000,000	$675,000,000	$225,000,000
Texas City	$73,000,000	$47,450,000	$25,550,000
TOTAL	**$2,202,730,000**	**$1,351,180,000**	**$851,550,000**

Currently, the Port of Houston does not envision the need to deepen its channel in order to support new container operations at Barbours Cut. It is possible that a deeper channel will be required at Bayport; however, the timing and cost are very uncertain.

<u>Container capacity</u>

Texas is a major importer and exporter of containerized marine cargo. Houston was the destination of the world's first containerized vessel in 1956 and containers have since played a strong role in the development of the Texas economy. Marine containers enter Texas by rail if these containers have first entered the country at the major West Coast Ports of entry of Los

Angeles and Long Beach. Almost all containerized cargo that arrives directly to Texas is handled by the Port of Houston which in 2007 processed slightly over one million containers or 1.7 million Twenty-Foot Equivalent Units (TEUs)[32]. A small number of containers are also handled at nearby Port Freeport.

Due to its unique geography, Texas has the ability to engage in direct containerized trade with every continent in the world through its own maritime ports. Container ports are strong facilitators of trade-related jobs, the majority of which are concentrated near the port facilities. Barbours Cut, which is currently Texas's largest container facility, has reached virtual capacity; however the Port of Houston is planning technological enhancements to speed the rate of container processing, including the acquisition of next generation container cranes and handling equipment. The new Bayport container terminal, located near Barbours Cut and operated by the Port of Houston Authority, is projected to accommodate 2.3 million TEUs when fully built out. New rail infrastructure will be a major component of the total cost of the Bayport expansion.

The baseline driver for growth in demand for containerized goods is population growth within a port's principal market, which for Houston area container terminals is the Gulf region. The rate of containerized trade growth can exceed population growth if a port can attract new markets, either through a change in trade patterns or a change in transportation costs that makes a port more competitive. Year-on-year growth is also impacted by business cycles, energy costs, and major infrastructure improvements. In a 2006 report, marine container growth for Texas was projected to average between 4-10% per year between 2006 and 2020. Using a moderately aggressive estimate of 7% future average annual growth, which is consistent with recent trends, by 2020 Texas ports would receive between 3-4 million TEU per year, compared with 1.7 million in 2006. That number should grow to 6 million by 2030. Texas is likely to see continued market shift to all-water delivery of Asian cargo, particularly after the completion of the Panama Canal expansion, which will drive some of the growth, despite the fact that the largest containerships are unlikely to regularly enter the Gulf. After receiving an investment grade rating in September, the Canal Authority has now secured its final financing structure which will help to ensure that the expansion is completed within the projected time frame.

The development of container terminals is driven by fees collected by the port authority for services provided such as dockage and wharfage. TxDOT supports container port facilities in providing upgrades and maintenance to the connecting road network. Rail connections are also important. The rail intermodal terminal at Bayport is expected to cost $68 million over the next 8 years. Approximately $14 million of this funding is expected to come from local sources.

The proposed development of a container terminal in Corpus Christi to serve South Texas and northern Mexico, a region whose population and economy is growing rapidly, would involve substantial private sector involvement through a concession arrangement. Such an agreement in the port environment usually calls for the concessionaire to make a significant investment in infrastructure in exchange for a long-term lease. Although the plan is not finalized, the Port of Corpus Christi has pursued a private concession model using project revenue bond funds bonds

[32] TEU=Twenty-foot Equivalent Unit. One 20-ft container is one TEU, while one 40-ft container is two TEUs. This is the standard unit of measure for container freight volumes.

to finance a large component of the estimated $83 million cost. Other financing arrangements for capital expansions, such as private financing arrangements, have been proposed.

TxDOT Focus

Texas ports face several significant challenges, as described below.

1. **Lack of dredging.** As discussed above, the level of federal funding over the last 10 years has not been sufficient to maintain all ship channels at their authorized dimensions. Up to an additional 20 percent in funding could be required to maintain all projects at their authorized dimensions. If the funding cannot be obtained from the federal budget, then either the ports or the state will have to pay for this dredging.

2. **Container capacity.** Almost all oceangoing containerized cargo arriving directly in Texas is handled by the Port of Houston. A small number of containers is also handled at nearby Port Freeport. Barbours Cut, which is currently Texas' largest container facility, has reached virtual capacity; however, the Port of Houston is planning technological enhancements to speed the rate of container processing, including the acquisition of next-generation container cranes and handling equipment. The new Bayport container terminal, located near Barbours Cut and operated by the Port of Houston Authority, will more than double its capacity when its build out is complete. The effects of Hurricane Ike have not affected the plans of the Port of Houston to develop the Bayport facility. It is too early to determine how the hurricane may impact the plans for the development of a terminal on Pelican Island. The Pelican Island project will only be initiated once the Bayport facility is completely built out.

   The proposed development of a container terminal in Corpus Christi to serve South Texas and Northern Mexico, a region where the population and economy are growing rapidly, would involve substantial private sector involvement through a concession arrangement—specifically, a one-year Memorandum of Understanding with Zachry American Infrastructure, Inc. Under the terms of the MOU, the Port of Corpus Christi and Zachry American will engage in discussions with shipping lines, port operators, financial institutions and other private sector companies interested in investing or participating in the project. The goal is to enter into a long-term agreement for the design, financing, construction and operation of the La Quinta Trade Gateway Terminal. Although the plan is not finalized, the Port of Corpus Christi plans to arrange for $83 million of the total cost. Other financing arrangements for capital expansions, such as private financing arrangements, also have been proposed.

3. **Environmental and congestion issues.** As freight traffic at ports and waterways in Texas grows, so will the need to address the environmental and congestion impacts of port activity. At several of the rapidly growing container ports along the West Coast (such as Los Angeles/Long Beach, Oakland, Seattle, and Tacoma), rapid growth has been met with pressure to perform significant mitigation to ensure that port activity does not disproportionately impact quality of life in the surrounding areas.

Texas already handles more than 20 percent of the nation's oceangoing tonnage. Using the more conservative estimates that have been produced for container traffic at the Port of Houston, volume at the Port of Houston in 2030 is projected to be greater than the current volume handled at any other U.S. port in 2008, with the exception of the Los Angeles/Long Beach port complex. This will almost certainly give rise to increased public concern about environmental and congestion issues.

Some of the proposed measures for improving the environmental performance of ports focus on modernizing the dray trucking fleet as have now been mandated in California. Recent research has shown that the dray industry will respond to economic stimulation and fair, but effective, enforcement of existing state laws regarding safe operation, as evidenced by the fact that dray fleets in the Houston area have safety records analogous to other trucking firms.[33] Ports could also expand to evening and weekend operation, establish a system for ships to plug into electrical power when docked, or pursue improvements in the rail connections to container ports so that a greater proportion of containers and other cargo can be handled without burdening the road network. None of these proposals are inexpensive and there may be a need state and/or federal funding to accelerate adoption. There are also several operational enhancements aimed at enhancing container security and visibility which may require government assistance.

4. **Security Requirements**. The security measures required by the federal government have created a significant increase in operating expenses for port authorities. While the federal government has provided grant money for security assets, it does not provide money for on-going maintenance or for the personnel expenses incurred because of the required measures. In 2005, the Texas Transportation Institute (TTI) performed an analysis that showed security expenses were absorbing an average of 7 percent of operating revenues across all Texas ports, with a range of anywhere from 5 percent to 17 percent. New requirements have been implemented since then (one of the most notable being the Transportation Workers Identification Credential). The effect is that operating expenses are certainly higher today than in the past.

5. **Intermodal Connectivity.** Ports and the federal government are investing billions of dollars in maritime infrastructure. However, the value of that investment is directly dependent on the landside connections of ports. It is very important to have safe and efficient highway and rail connections for Texas ports to be competitive.

Recommended "next steps" include:

1. Fund the Port Capital Access Account.
2. Preserve waterfront areas for water-dependent industries.
3. Prevent encroachment on the Gulf Intracoastal Waterway.

[33] Drayage Activity in Texas / Harrison, Robert; Hutson, Nathan; Prozzi, Jolanda; West, Jason; Gonzalez, Juan; McCray, John -- College Station, TX: Southwest Region University Transportation Center (SWUTC) 2007., http://swutc.tamu.edu/publications/technicalreports/0-5684-2.pdf

4. Develop a program to target infrastructure needed for an efficient freight flow to and from the port system.
5. Work with ports to develop best practices for minimizing impacts on surrounding communities.

Appendix I:
Airports Information

Background/National Perspective on Airports
The Federal Aviation Administration (FAA) through its National Plan of Integrated Airport Systems (NPIAS) identifies airports that are significant to the national air transportation system and consequently eligible to receive federal grant money for capital improvements. The FAA updates this plan every two years and provides five-year development costs for these airports. Previously, the FAA calculated longer term development costs but now only publishes development costs for the five-year time frame.

Funding Needs
According to the 2009-2013 NPIAS, there were 3,356 airports in the country eligible to receive federal funding. The total development costs for this five-year period are approximately $49.7 billion. In Texas, there are 213 airports in the NPIAS with five-year development costs totaling more than $4.0 billion. This includes both commercial service and general aviation airports.

These capital improvements are classified according to one of nine types of development categories. These include standards, capacity, reconstruction (rehabilitate facilities, pavement, lighting, etc.), terminals (modification, replacement, development, etc.), access, safety, environment, security and new airports.

Capacity Needs/Issues
Growth in the air transportation system has prompted federal officials to examine future capacity needs across the country. This effort was accomplished and published in the report entitled *Capacity Needs in the National Airspace System 2007-2025: An Analysis of Airports and Metropolitan Area Demand and Operational Capacity in the Future*. The methodology used in this analysis, measuring the 2007 capacity level against 2025 demand, revealed three airports and one metropolitan airport in Texas will be in need of additional capacity. The three airports are George Bush Houston Intercontinental Airport, Houston Hobby Airport, and San Antonio International Airport. The metropolitan area in need of additional capacity is the Houston area. At the time the analysis was published, all three airports were in the environmental phase of projects to increase airfield capacity. By 2025, if the planned improvements at these airports are completed, they are not expected to have capacity limitations. The same is true for the Houston metropolitan area.

NextGen Air Transportation System
For several years, a multi-agency effort has been underway to ensure that the national air transportation system will be able to accommodate the demand required to meet the safety, operational, economic, mobility and security needs of its many users. This effort, dubbed the Next Generation Air Transportation System or NextGen, is expected to transform the industry by utilizing new technologies that will be safer, more secure and capable of accommodating the new demand imposed on the system induced by the growth of both the domestic and global economy. It is anticipated that much of the new technology will be available and implemented across our

system by the year 2030. According to the multi-agency Joint Planning and Development Office, which oversees the NextGen work effort, the goals include retaining U.S. leadership in global aviation, expanding capacity, ensuring safety, protecting the environment, ensuring our national defense and securing the nation. Their roadmap for success includes the following eight strategies:

1. Develop airport infrastructure to meet future demand;
2. Establish an effective security system without limiting mobility or civil liberties;
3. Establish an agile air traffic system;
4. Establish user-specific awareness;
5. Establish a comprehensive proactive safety management approach;
6. Develop environmental protection that allows sustained aviation growth;
7. Develop a system-wide capability to reduce weather impacts; and harmonize equipage and operations globally.

According to the established timeline, the Next Generation Air Transportation System is expected to become operational by 2025.

Airspace/Terminal Constraints
As part of and in addition to NextGen, new technologies will be deployed in the future to address congestion in our skies. These constraints are most prominent in the terminal airspace as aircraft approach the airports for landing or depart the airport for other destinations. With only one or two commercial airports in our metropolitan areas, all of the aircraft originating from and approaching that area are funneled into and out of a relatively small area. New technologies have allowed for the ability to maximize the airspace we do have and use. This is in large part to global positioning systems and their increasing accuracies that have allowed new applications to accommodate more aircraft both en route (cruise altitude) and in the terminal environment.

Texas Airport System Plan: Number, Type, Role and Function
The Texas Airport System is comprised of 300 airports including 27 primary commercial service airports, 25 general aviation (GA) reliever airports and 248 general aviation airports (non-reliever).

Since 1966, The State of Texas has participated in the development of a statewide system of airports. It has done so by providing grants and loans to communities for aviation facility improvements. In October 1989, the state legislature created the Texas Department of Aviation (TDA) along with an aviation financial aid program, significantly improving the potential for airport development in the state. In 1991, the legislature created the Texas Department of Transportation (TxDOT) and the TDA became the TxDOT Aviation Division. The Texas Transportation Commission directs the actions of the Texas Department of Transportation through policy and program decisions.[34]

[34] Texas Department of Transportation, Aviation Capital Improvement program, August 2007.

Pursuant to the Texas Statutes Transportation Code, Title 3, Chapter 21, "Administration of Aeronautics," the Aviation Division of the Texas Department of Transportation (TxDOT) is to "establish, prepare, and adopt an aviation facilities development program to provide for a statewide airport system that serves the state's air transportation needs for the least practicable cost." In doing so, the Aviation Division prepares and updates the Texas Airport System Plan (TASP).[35]

The TASP was first published in 1970 as the Texas Aeronautical Facilities Plan (TAFP) and is revised continuously through an ongoing airport system planning process comprised of the use of yearly Regional Planning Meetings, sponsor/stakeholder meetings, and approval of letters of interest. A TASP summary report is published on an approximate four-year rotation. This summary report not only identifies a system of more than 300 airports that meets specific goals and objectives for the state's airport system, it describes the extent, type, nature, location, and timing of airport development needed in the state to establish a viable, balanced and integrated system of airports. The continuous airport system planning process:

- Identifies the cost and the level of federal, state and local capital investment required to maintain and develop system airports;
- Satisfies the requirements of the Texas Transportation Code, Chapter 21;
- Provides guidance for the expenditure of funds under the Federal Aviation Administration (FAA) Airport Improvement Program;
- Provides guidance for expenditure of funds under TxDOT Aviation Division Facilities Development Program; and
- Supports development of state aviation policy.

The state's airport system goals include:

- Protecting the viability and vitality of airports as an important asset to both the state and local economies;
- Providing a safe, efficient, cost effective, well-maintained and environmentally sound air transportation system;
- Providing adequate access by air to the population and economic activity centers of the state;
- Maximizing the opportunities for economic growth, international trade and tourism in Texas; and
- Effectively integrating the airport system with other modes of transportation.

The state's airport system objectives include:

- Providing airports capable of supporting scheduled commercial service within a 60-minute drive of major population centers;

[35] Texas Airport System Plan Update, 2002.

- Providing airports capable of supporting business jet aircraft within a 30-minute drive of population and mineral resource centers and the economic activity generated by urban development;
- Providing airports capable of supporting single- and twin-engine powered aircraft within a 30-minute drive of agricultural resource centers;
- Providing adequate airport capacity to meet forecast aviation demand;
- Providing an airport system developed to appropriate federal and state planning and design standards; and
- Encouraging community support of and involvement in the development and maintenance of local airports.

Additionally, the airports are categorized by service role and function. These help to further delineate the role and significance of these airports to the region they serve as well as to the state and country. The five airport service roles are:

1. Commercial service (primary and non-primary);
2. GA Reliever;
3. GA Business/Corporate;
4. GA Community service; and
5. GA Basic service.

The nine functional categories are:

1. Commercial;
2. Reliever;
3. Multipurpose;
4. Industrial;
5. Agricultural;
6. Special use;
7. Remote; and
8. Access.

These are described in detail in the *Texas Airport System Plan Update*.

Together, these 300 airports serve a variety of communities - rural, urban and everything in between. They serve as large hubs for passenger service to domestic and global destinations and as small outposts for agricultural communities assisting in the growth and protection of crops important to the Texas and national economies. Needless to say, their economic impact is significant.

Economic Impact
According to a recent economic impact study, the impact of aviation in Texas is substantial. Table 1 shows the economic impact for both commercial service and general aviation airports. This study, conducted in 2005, shows the economic impacts have increased since the previous

study was conducted in 2001. In those four years, employment has grown 12 percent, payroll has increased by 26 percent, and total economic output has increased by 20 percent. Additional investment in the system is likely to have additional economic benefits as it will increase jobs and economic activity. Development to meet needs will increase capacity and/or the number of passengers/cargo tons served and will further increase the benefits and return on investment. Clearly, the commercial service airports offer a larger potential for this type of economic return as they move passengers and freight across the country and globe. General aviation's economic return is more subtle and related to business location decisions and employment at the community and regional level.

Table 1. Economic Impact of Aviation in Texas

Type of Airport	Employment	Payroll	Economic Output
Commercial Service	721,800	$18.1 billion	$40.1 billion
General Aviation	61,900	$2.5 billion	$8.7 billion
Total	**783,700**	**$20.6 billion**	**$48.8 billion**

Source: Economic Impact of General Aviation in Texas, 2005, Wilbur Smith Associates.

Funding Texas' General Aviation Airports

As with all states, the funding for airport capital improvement projects in Texas comes from a variety of sources. The single largest source is the Airport Improvement Program (AIP) administered by the Federal Aviation Administration. This federal program provides funding for both commercial service and general aviation airports but, in Texas, they are administered differently. The amount of local matching funds varies and depends on the funding source (state or federal money) and the type of airport (commercial service or general aviation).

Federal Funding

The Texas Department of Transportation – Aviation Division is a participant in the FAA's State Block Grant Program which gives it the lead responsibility in carrying out the AIP for the FAA for general aviation airports. Texas is one of nine states that participate in this program and this applies only to the general aviation airports. Commercial service airports still work directly with the FAA in planning, programming, and implementing airport projects using federal money. For general aviation airports, the AIP is a 90/10 split, meaning the FAA share for the project is 90 percent of the project costs with the airport sponsor (owner) paying the remaining 10 percent.

For commercial service airports, the federal share may range from 75 to 90 percent depending on the size of the airport. Larger airports pay a greater share as they have a greater ability to generate revenue from sources not available to smaller airports. These include revenues from their bonding ability and fees from concessions/advertising, parking, and facility rental. Additionally, airports receive money according to their activity levels such as enplaned passengers and cargo.

State Funding

The State of Texas also has a state airport grant program that increases eligibility to airports not in the NPIAS. These are airports that the state has determined to be important to the state's population and economic centers, meet the state airport system's goals and objectives, and thus are eligible to receive state funding. The state program also operates on a 90/10 cost-sharing basis for most projects.

Other Types of Funding Programs
The Aviation Division administers state funding programs for a variety of specific purposes whose matching requirements are different than those noted above. This includes the:

- routine airport maintenance program (RAMP);
- the terminal building program;
- the air traffic control tower program; and
- the automated weather observing system (AWOS) program.

The RAMP and Terminal Building programs are 50/50 matching programs while the AWOS program is a 75/25 matching program with the state paying 75 percent of the cost.

Historical general aviation funding levels from 2005 to 2007 are shown in Table 2. Table 3 shows the level of funding in the capital improvement program for 2008-2010. The local, state and federal share of the funding is also shown.

Table 2. General Aviation Airport Funding Levels in Texas, 2005-2007

Year	State Funding	Federal NPE/ Discretionary Funding	Total Federal Funding	TOTAL FUNDING
2005	$16,000,000	$34,696,294	$55,580,850	$71,580,850
2006	$16,000,000	$35,983,105	$57,423,649	$73,423,649
2007	$16,000,000	$34,915,993	$54,310,707	$70,310,707

Source: TxDOT-Aviation Division

Table 3. Summary of 2008-2010 General Aviation Capital Improvement Program Costs

Fiscal Year	Airport Sponsor Share	TxDOT-Aviation Share	FAA Share	Total
2008	7,678,000	11,879,000	53,028,000	72,585,000
2009	10,144,000	20,211,000	55,808,000	86,163,000
2010	8,420,000	11,692,000	55,947,000	76,059,000
Total	**26,242,000 (11%)**	**43,782,000 (19%)**	**164,783,000 (70%)**	**234,807,000**

Source: TxDOT-Aviation Division

Funding Commercial Service Airports
With the state involved primarily in funding general aviation airports through both state and federally funded programs, funding for commercial service airports is handled directly with the

FAA. Commercial Service airports in Texas, like those around the country, receive funding directly from the FAA. Commercial Service airports are airports having scheduled passenger service of at least 2,500 enplanements per year. These airports are further classified into *primary* and *non-primary*. Primary airports have scheduled enplanements of 10,000 or more and are broken down into Large Hub, Medium Hub, Small Hub and Non-Hub according to additional criteria. Non-primary airports have scheduled enplanements of 2,500 to 10,000.

Funding for primary commercial service airports is referred to as primary entitlements. It is determined by formula by the FAA and is a function of the number of enplanements. Of the 26 commercial service airports in Texas, 25 received primary entitlement funds in Fiscal year 2007. They ranged from $23,509,291 to $1,000,000. These are shown in Table 4.

For fiscal year 2007, each of the primary airport's entitlement funds are based on the number of passenger enplanements at the airport. The minimum amount of entitlement funds apportioned to the airport sponsor of a primary airport ranged from $1,000,000 to a maximum of approximately $23,000,000. As prescribed by the authorizing statute, FAA calculates individual airport annual entitlement funds as follows:

- $7.80 for each passenger boarding up to 50,000 passengers;
- $5.20 for each additional passenger boarding up to 100,000 passengers;
- $2.60 for each additional passenger boarding up to 500,000 passengers;
- $0.65 for each additional passenger boarding up to 1,000,000 passengers; and
- $0.50 for each additional passenger boarding from 1,000,001 passengers and up.

Many primary airports have pursued passenger facility charges to increase revenue at the airport. Airports were given this authority by Congress in 1990 and must apply to the FAA for authority to do so. Initially, the charge per enplaning passenger was $1 to $3. AIR-21 changed this and allowed airports to charge $4 and $4.50 per enplaning passenger. When airports do this, they are subject Airport Improvement Program (federal airport funding) reductions (Section 47114(f) of Title 49 U.S.C.).[36] For airports designated as large or medium hubs, their entitlement funds will be reduced by 50 percent if they impose a $1, $2 or $3 passenger facility charge. They will lose 75 percent if they impose more than $3. In FY 2006, 61 of the 67 large and medium hub airports had a PFC in place, and all were subject to these reductions. Of these 61 airports, the following applied:

- 23 airports were subject to the 50-percent reduction in entitlements; and
- 38 airports were subject to the 75-percent reduction in entitlements.

In providing funding for airports with cargo operations, the FAA allocates 3.5 percent of AIP to cargo service airports. Each cargo service airport receives funds in the same proportion as its proportion of landed weight of cargo aircraft to the total landed weight of cargo aircraft at all qualifying airports. In FY 2008, there were 123 airports that qualified as cargo service airports, which shared the 3.5 percent of funding, totaling $118.8 million.[37] Specifically, cargo entitlement money is available for airports with 100 million pounds of cargo measured by gross landing weight. In Fiscal year 2008, Texas had nine airports meeting these criteria. Amounts ranged from $2,685,327 to $149,181. Funding is shown in Table 5.

[36] FAA Airport Improvement Program 23rd Annual Record of Accomplishment, Fiscal Year 2006, August 14, 2007.
[37] FAA Airport Improvement Program, Cargo Entitlement Data.

Table 4. Primary Entitlement Funds for Texas Commercial Service Airports, FY 2008

Airport Name	CY 2006 Boardings	FY 2008 Apportionment
Dallas/Fort Worth International	28,627,749	$6,500,000
George Bush Intercontinental/Houston	20,479,291	$23,509,291
William P Hobby	4,115,021	$3,572,511
Austin-Bergstrom International	3,945,020	$1,743,755
San Antonio International	3,915,428	$3,472,714
Dallas Love Field	3,443,537	$6,473,537
El Paso International	1,658,102	$4,688,102
Lubbock Preston Smith International	564,799	$3,464,239
Midland International	473,986	$3,244,727
Rick Husband Amarillo International	446,926	$3,104,015
Valley International	431,365	$3,023,098
Corpus Christi International	429,394	$3,012,849
McAllen Miller International	396,157	$2,840,016
Robert Gray AAF	209,236	$1,868,027
Laredo International	97,331	$1,272,242
Abilene Regional	90,918	$1,205,547
Brownsville/South Padre Island International	90,580	$1,202,032
Easterwood Field	85,754	$1,151,842
Tyler Pounds Regional	79,076	$1,082,390
Waco Regional	74,235	$1,032,044
San Angelo Regional/Mathis Field	68,236	$1,000,000
Sheppard AFB/Wichita Falls Municipal	46,526	$1,000,000
Southeast Texas Regional	38,626	$1,000,000
East Texas Regional	25,353	$1,000,000
Del Rio International	16,967	$1,000,000
Total	**69,849,613**	**$82,462,978**

Source: Federal Aviation Administration

Table 5. Cargo Entitlement Funds for Texas Airports, FY 2008

Airport Name	Landed Weight (lbs.)	FY 2008 Cargo Entitlement
Dallas-Fort Worth International	3,444,283,437	$2,685,327
Houston George Bush Intercontinental	1,392,447,797	$1,085,618
Fort Worth Alliance	1,288,235,456	$1,004,370
San Antonio International	795,980,856	$ 620,585
Austin-Bergstrom International	577,157,294	$ 449,979
El Paso International	520,893,380	$ 406,114
Laredo International	357,353,428	$ 278,610
Valley International	248,888,700	$ 194,045
Lubbock Preston Smith International	191,344,436	$ 149,181
Total	**8,816,584,784**	**$6,873,829**

Source: Federal Aviation Administration

Texas Airport System Plan Development Needs

With responsibility for the planning, programming, and project implementation for general aviation airports, the Aviation Division closely monitors the development needs of the airports in the state system plan. This is largely accomplished through its continuous planning approach, which includes visits to the airports and periodic public meetings held to make sure the airport serves the needs of the community, region and state. The needs of the commercial service airports are determined by the airports working in conjunction with FAA planning officials from the Southwest Regional office in Fort Worth, Texas.

General Aviation Airports

Development needs for general aviation airports are viewed in terms of three distinct planning timeframes: short-term, mid-term and long-term. They are classified according to nine different categories similar to the federal classifications in the NPIAS. They are: capacity, new access, new capacity, planning, preservation, reconstruction, safety, standards and upgrade. Tables 6 through 8 show the development needs by planning timeframe and airport role. Table 9 shows the total development costs for general aviation airports for the next 20 years (2028). These costs are calculated in current (2008) dollars.

Table 6. General Aviation Airport Development Needs, 0-5 Years (2008 Dollars).

Airport Role	Capacity	New Access	New Capacity	Planning	Preservation	Re-construction	Safety	Standards	Upgrade	Total
Basic Service	1,281,735	0	0	2,042,252	21,839,092	5,130,853	776,178	20,357,629	2,549,308	53,977,047
Community Service	9,029,190	8,217,037	0	7,959,817	53,924,053	12,040,016	2,487,338	6,325,777	15,086,699	115,069,927
Business/ Corporate	15,126,811	3,604,207	0	13,970,042	97,034,617	54,524,943	6,719,976	49,067,437	31,822,128	271,870,161
Reliever	101,490,794	0	8,792,900	14,595,178	58,041,684	44,291,495	26,581,271	39,641,971	164,311,023	457,746,316
Total	126,928,530	11,821,244	8,792,900	38,567,289	230,839,446	115,987,307	36,564,763	115,392,814	213,769,158	898,663,451

Source: Texas Department of Transportation, Aviation Division.

Table 7. General Aviation Airport Development Needs, 6-10 Years (2008 Dollars).

Airport Role	Capacity	New Access	New Capacity	Planning	Preservation	Re-construction	Safety	Standards	Upgrade	Total
Basic Service	1,653,450	0	0	0	23,182,874	675,117	339,512	11,768,769	4,388,093	42,007,815
Community Service	11,407,659	21,776,622	0	726,045	66,094,542	2,673,835	1,041,219	39,936,025	26,895,940	170,551,887
Business/ Corporate	18,391,275	0	0	796,262	106,490,824	12,075,432	5,005,709	25,270,059	33,500,262	201,529,823
Reliever	58,878,491	0	0	40,000	41,417,602	16,805,640	896,200	6,228,519	25,926,200	150,192,652
Total	90,330,875	21,776,622	0	1,562,307	237,185,842	32,230,024	7,282,640	83,203,372	90,710,495	564,282,177

Source: Texas Department of Transportation, Aviation Division.

Table 8. General Aviation Airport Development Needs, 11-20 Years (2008 Dollars).

Airport Role	Capacity	New Access	New Capacity	Planning	Preservation	Re-construction	Safety	Standards	Upgrade	Total
Basic Service	929,370	0	0	0	24,384,711	559,959	69,977	11,952,568	6,221,848	44,118,433
Community Service	5,364,304	0	0	313,147	76,584,786	3,006,826	396,669	17,171,406	14,232,375	117,069,513
Business/ Corporate	15,098,474	0	0	0	318,508	326,463	0	15,675,614	29,637,403	61,056,462
Reliever	42,421,494	0	0	0	46,448,594	0	490,000	3,948,804	6,919,321	100,228,213
Total	63,813,642	0	0	313,147	147,736,599	3,893,248	956,646	48,748,392	57,010,947	322,472,621

Source: Texas Department of Transportation, Aviation Division.

Table 9. General Aviation Airport Development Needs, Total through 2028 (2008 Dollars).

Airport Role	Capacity	New Access	New Capacity	Planning	Preservation	Re-construction	Safety	Standards	Upgrade	Total
Basic Service	3,864,555	0	0	2,042,252	69,406,677	6,365,929	1,185,667	44,078,966	13,159,249	140,103,295
Community Service	25,801,153	29,993,659	0	8,999,009	196,603,381	17,720,677	3,925,226	63,433,208	56,215,014	402,691,327
Business/ Corporate	48,616,560	3,604,207	0	14,766,304	203,843,949	66,926,838	11,725,685	90,013,110	94,959,793	534,456,446
Reliever	202,790,779	0	8,792,900	14,635,178	145,907,880	61,097,135	27,967,471	49,819,294	197,156,544	708,167,181
Total	281,073,047	33,597,866	8,792,900	40,442,743	615,761,887	152,110,579	44,804,049	247,344,578	361,490,600	1,785,418,249

Source: Texas Department of Transportation, Aviation Division.

Commercial Service Airports

Development needs for commercial service airports are determined by the FAA and published in the NPIAS every two years. The plan previously calculated long-term costs but now only focuses on a rolling five-year basis. The most recent NPIAS report was released in early October and shows development costs for 2009-2013. These are shown by airport in Table 10.

Table 10. Texas Commercial Service Airport Development Costs, 2009-2013.

Airport Name	Five-Year Enplanements	2009-2013 Development Cost (dollars)
Dallas/Fort Worth International	31,170,328	191,184,146
George Bush Intercontinental/Houston	23,285,961	840,581,063
William P Hobby	4,788,178	182,773,330
San Antonio International	4,596,258	300,744,920
Austin-Bergstrom International	4,594,022	209,497,253
Dallas Love Field	4,275,602	543,369,251
El Paso International	1,746,852	38,373,087
Lubbock Preston Smith International	652,790	86,742,082
Midland International	478,154	13,214,578
Corpus Christi International	454,415	23,275,742
Rick Husband Amarillo International	445,547	33,660,914
Valley International	435,797	20,523,702
McAllen Miller International	431,669	130,290,000
Robert Gray AAF	198,017	25,048,993
Laredo International	101,715	86,334,914
Brownsville/South Padre Island International	97,304	29,424,273
Easterwood Field	96,579	16,354,952
Abilene Regional	94,018	10,406,625
Tyler Pounds Regional	83,050	35,500,294
Waco Regional	81,241	31,899,927
San Angelo Regional/Mathis Field	76,909	3,322,084
Southeast Texas Regional	43,547	12,497,418
Sheppard AFB/Wichita Falls Municipal	43,373	20,180,000
East Texas Regional	27,218	31,438,646
Del Rio International	16,023	4,957,895
Victoria Regional	9,405	8,962,632
Total	**78,323,972**	**2,930,558,721**

Source: National Plan of Integrated Airport Systems, 2009-2013, Federal Aviation Administration.

Longer term development cost estimates were also obtained from the FAA's Southwest Region for commercial service airports in Texas. These development needs were developed by the FAA in conjunction with the administrators of the commercial airports themselves. Every year, the FAA asks the airports for their needs for the next three years. Every other year, the airports are asked for their short-term, mid-term and long-term needs. These needs represent justified and eligible projects. This includes projects eligible to be funded through the federal Airport Improvement Program or through revenue produced from passenger facility charges. These are shown in Table 11.

It should be noted that many of the airports are not certain of the needs in the longer planning period at the current time. This deficiency is likely to underestimate the longer-term needs of the state's airports to some extent. Also, these development needs do not include such items as rail or transit connections that may be desired by the individual airports. Other projects on a particular airport's desired list that are not eligible for federal money may ultimately be part of their need. However, if they are not eligible for the federal money and not justified they will not appear in Table 11. These projects will need to be funded through other means, and, if they are financed, the total cost of the project is likely to be significantly higher than the initial construction costs.

As a point of reference, it may be useful to note the costs of some large projects at commercial service airports. At Dallas-Fort Worth International Airport, the cost for Terminal D was approximately $1 billion. Additionally, the Sky Link system cost approximately $800 million. These are large projects that are not required very frequently. At Houston's George Bush Intercontinental Airport, there may be a future need for additional runways that are not yet reflected in Table 11. One of them may cost approximately $1 billion but the other is likely to be substantially less.

Table 11. Texas Commercial Service Airport 20-Year Development Needs.

Development Time Period	Development Costs (in 2008 dollars)
1-5 Year	3,436,000,000
6-10 Year	1,737,000,000
11-20 Year	1,522,000,000
Total	**6,695,000,000**

Source: Federal Aviation Administration, Southwest Region, Texas Airports Development Office.

Although a specific breakdown of development costs by type of project is not given for Texas' airports, the 2009-2013 NPIAS document does provide a breakdown on a national level. Table 12 shows these breakdowns and includes previous NPIAS years for comparison purposes. Table 13 shows the historical development needs for NPIAS airports nationally and in Texas according to airport service role.

Table 12. NPIAS Development Cost Allocation by Project Type.

Development Category	2009-2013	2007-2011	2005-2009	2001-2005
Standards	27%	27%	36%	30%
Reconstruction	19%	17%	13%	13%
Terminal	18%	17%	16%	20%
Capacity	17%	21%	19%	18%
Environment	5%	5%	4%	4%
Access	4%	4%	5%	10%
Safety	4%	5%	3%	3%
New Airport	3%	2%	2%	2%
Security	2%	3%	2%	-*

Source: Federal Aviation Administration. *= Security was not a separate category in this report year.

Table 13. Historical Summary of NPIAS Development Needs by Airport Service Role (in billions)

	2001-2005		2005-2009		2007-2011		2009-2013	
	$	%	$	%	$	%	$	%
Total US	46.2	100%	39.5	100%	41.2	100%	49.7	100%
Commercial Service	37.7	82%	30.0	76%	29.664	72%	35.287	71%
General Aviation	5.8	13%	6.7	17%	7.828	19%	9.443	19%
Reliever	2.6	6%	2.8	7%	2.884	7%	3.479	7%
New Airport	0.0	0%	0.0	0%	0.824	2%	1.491	3%
Texas	4.600	100%	3.442	100%	2.677	100%	4.039	100%
Commercial Service	4.094	89%	2.909	85%	1.967	73%	2.931	73%
General Aviation	0.235	5%	0.217	6%	0.368	14%	0.524	13%
Reliever	0.255	6%	0.283	8%	0.257	10%	0.546	14%
New Airport	0.017	0%	0.030	1%	0.086	3%	0.039	1%
Texas Share	9.96%		8.71%		6.50%		8.13%	

Source: Federal Aviation Administration, Individual NPIAS Documents.

Significance of Modal Relationships

While airports are a vital part of our overall transportation system, they rely on other modes to function effectively and efficiently. They have a relationship principally with highways but also with other modes.

Relationship between Airports and Highways

The success and viability of an airport is dependent on other modes of transportation to a large degree. Aircraft move people and goods across the country and world. These people and goods move into and out of airports primarily in conjunction with the highway system. The roadway and highway system must accommodate airport users, employees, and affiliated businesses. It must also provide sufficient access to large trucks associated with an airport's air cargo operations. In some cases, this also means access to/from storage and distribution facilities located adjacent to or near an airport. This surface network and infrastructure is critical to the success of an airport and, in many ways, is a critical extension of the airport itself.

Relationship between Airports and Other Modes
While most airport users and employees of airport businesses utilize the roadway system to access the airport, other modes are also important. Some airports have public transportation system access, which provides an alternative to both users and employees. These will become increasingly important in the future as growth occurs. With airport property at a premium for both passenger terminal facilities and revenue-generating facilities, one can expect an increased reliance on alternative modes of travel to the airport including, potentially, improved rail connections in our larger cities with rail systems.

In Dallas, the Dallas-Fort Worth International Airport is accessible with a combination of rail (Trinity Rail Express) and bus service while Dallas Love Field is accessible using bus service. A DART rail station at the airport itself is planned. Currently, both Houston airports are accessible using Houston Metro bus service. Bus service is currently the only public transportation alternative for accessing airports in Texas.

Additionally, freight rail access is an important element to airports as well. Some of Texas' larger airports have rail access to improve the inter-modal connectivity for freight activities, requiring the seamless transfer of goods.

Complementary Modes
Depending on their role and function, airports have a certain reliance on other modes of transportation. This reliance is likely to grow as populations and urban areas grow and develop. The airport and its ability to function will depend on the surrounding transportation network that supports it. The mobility and accessibility of one network will play a role in the other.

Current Activity and Expected Growth
System wide enplanements at commercial service airports in Texas have rebounded since 2001 and are expected to continue to rise in the decades to come. The 26 commercial service airports in the state enplaned nearly 70 million passengers in 2006. This is expected to increase by nearly 73 percent in 2025 to approximately 120 million. These Terminal Area Forecasts are developed by the FAA which is also responsible for determining the development needs costs for the NPIAS airports reported earlier. Table 14 shows the 2006 and 2025 activity by commercial service airport in Texas. Table 15 shows commercial service airport activity system wide for all the years from 2002 to 2025. Tables 16 and 17 show the growth rates used to arrive at the forecasts in Table 14 and 15, respectively.

Table 14. Texas Commercial Service Airport Activity 2006 and 2025.

LOCID	Airport Name	Total Enplanements		Airport Operations							
				Commercial		General Aviation		Total Airport Operations		Instrument Operations	
		2006	2025	2006	2025	2006	2025	2006	2025	2006	2025
ABI	Abilene Regional	86,692	107,115	14,248	16,066	38,605	53,873	68,404	85,245	47,901	57,784
ACT	Waco Regional	73,754	123,929	10,048	14,432	23,640	30,157	34,601	45,534	19,793	26,153
AMA	Rick Husband Amarillo International	446,510	542,330	21,655	25,596	27,880	31,618	72,356	77,230	59,808	69,364
AUS	Austin-Bergstrom International	3,873,476	6,870,122	119,584	190,106	80,523	106,423	201,300	297,550	203,079	297,432
BPT	Southeast Texas Regional	34,741	57,857	4,859	6,858	39,453	45,442	44,406	52,300	28,644	40,835
BRO	Brownsville/South Padre Island International	88,174	128,295	5,501	6,669	25,005	27,265	39,393	44,866	17,285	20,437
CLL	Easterwood Field	86,310	122,564	6,732	9,335	35,140	46,073	48,879	59,615	18,037	22,171
CRP	Corpus Christi International	430,676	590,126	22,452	30,712	26,224	28,458	96,057	104,538	72,006	83,444
DAL	Dallas Love Field	3,243,589	8,653,965	131,967	237,313	107,220	174,716	239,187	412,036	242,702	411,261
DFW	Dallas/Fort Worth International	28,616,410	47,209,688	694,436	1,037,528	9,696	7,692	704,132	1,045,222	704,205	1,040,301
DRT	Del Rio International	16,023	16,023	720	720	14,516	14,516	15,236	15,236	0	0
ELP	El Paso International	1,650,470	2,093,231	63,814	76,995	32,185	38,365	97,374	116,810	93,819	114,311
GGG	East Texas Regional	24,364	33,991	2,699	3,635	89,535	121,790	97,886	129,327	40,382	49,553
GRK	Robert Gray AAF	176,383	198,017	0	0	0	0	424	424	0	0
HOU	William P Hobby	4,095,772	6,337,201	154,414	212,713	83,862	129,232	238,414	341,947	236,471	338,447
HRL	Valley International	428,473	573,687	16,682	19,826	15,574	21,431	49,144	57,661	22,840	29,496
IAH	George Bush Intercontinental/Houston	20,238,788	36,623,278	580,894	900,548	15,977	19,423	596,871	919,971	596,072	920,172
LBB	Lubbock Preston Smith Intl	560,617	843,454	32,401	41,597	44,118	48,259	84,131	96,196	71,154	83,755
LRD	Laredo International	91,843	163,963	14,035	19,008	24,056	39,606	48,574	70,051	27,508	41,276
MAF	Midland International	466,606	654,338	25,942	31,195	31,231	33,407	74,142	81,168	65,323	77,711
MFE	Mc Allen Miller International	386,527	591,856	12,299	17,288	42,459	61,740	55,124	79,830	31,932	43,584
SAT	San Antonio International	3,884,934	6,763,520	120,599	190,211	89,317	122,428	210,659	312,967	206,143	309,772
SJT	San Angelo Regional/Mathis Field	68,206	85,291	7,594	8,512	32,140	43,568	70,015	90,720	21,327	26,065
SPS	Sheppard AFB/Wichita Falls Muni	47,181	43,373	10,972	10,972	19,857	19,857	30,829	30,829	0	0
TYR	Tyler Pounds Regional	82,667	117,348	9,772	11,754	46,258	49,991	56,230	62,110	16,701	20,122
VCT	Victoria Regional	9,463	11,643	2,466	2,561	20,190	27,817	22,656	30,378	0	0
Totals		**69,208,649**	**119,556,205**	**2,086,785**	**3,122,150**	**1,014,661**	**1,343,147**	**3,296,424**	**4,659,761**	**2,843,132**	**4,123,446**

Source: Federal Aviation Administration, Terminal Area Forecast.

Table 15. Summary of Historical and Forecasted Activity at Texas Commercial Service Airports, 2002-2025

Year	Enplanements			Airport Operations								Total Operations	Total Instrument Operations
				Itinerant Operations					Local Operations				
	Air Carrier	Commuter	Total	Air Carrier	Air Taxi & Commuter	General Aviation	Military	Total	General Aviation	Military	Total		
2002	50,885,182	6,611,173	57,496,355	1,265,449	694,543	898,928	183,787	3,042,707	341,590	239,454	581,044	3,623,751	1,995,314
2003	49,151,780	8,381,983	57,533,763	1,198,776	792,771	865,648	191,511	3,048,706	338,962	219,248	558,210	3,606,916	1,926,705
2004	51,785,541	10,916,122	62,701,663	1,243,015	870,110	839,789	181,838	3,134,752	289,992	217,528	507,520	3,642,272	1,877,721
2005	54,209,812	10,845,840	65,055,652	1,251,749	831,569	779,469	168,762	3,031,549	263,334	215,577	478,911	3,510,460	1,843,457
2006	55,983,733	13,224,916	69,208,649	1,233,178	853,607	771,632	153,587	3,012,004	243,029	194,978	438,007	3,450,011	1,832,056
2007*	57,428,950	13,469,092	70,898,042	1,276,024	837,626	726,700	154,965	2,995,315	219,041	194,464	413,505	3,408,820	1,778,478
2008*	57,922,717	13,976,372	71,899,089	1,283,812	859,813	739,304	154,965	3,037,894	222,041	194,464	416,505	3,454,399	1,795,637
2009*	59,548,923	14,470,910	74,019,833	1,313,175	878,478	761,125	154,965	3,107,743	225,092	194,464	419,556	3,527,299	1,822,349
2010*	61,180,635	14,980,558	76,161,193	1,342,094	897,341	783,702	154,965	3,178,102	228,193	194,464	422,657	3,600,759	1,852,142
2011*	62,815,066	15,508,906	78,323,972	1,370,480	916,387	807,052	154,965	3,248,884	231,347	194,464	425,811	3,674,695	1,885,031
2012*	64,496,334	16,056,630	80,552,964	1,399,514	935,861	831,206	154,965	3,321,546	234,560	194,464	429,024	3,750,570	1,920,006
2013*	66,225,863	16,624,470	82,850,333	1,429,207	955,779	856,223	154,965	3,396,174	237,825	194,464	432,289	3,828,463	1,957,142
2014*	68,387,668	17,213,167	85,600,835	1,466,223	976,168	882,118	154,965	3,479,474	241,157	194,464	435,621	3,915,095	1,995,173
2015*	70,598,958	17,823,487	88,422,445	1,503,686	997,018	896,925	154,965	3,552,594	244,539	194,464	439,003	3,991,597	2,029,416
2016*	72,861,283	18,456,252	91,317,535	1,541,636	1,018,349	912,030	154,965	3,626,980	247,987	194,464	442,451	4,069,431	2,064,283
2017*	75,176,416	19,112,294	94,288,710	1,580,111	1,040,172	927,398	154,965	3,702,646	251,496	194,464	445,960	4,148,606	2,100,478
2018*	77,546,029	19,792,475	97,338,504	1,619,151	1,062,507	943,055	154,965	3,779,678	255,067	194,464	449,531	4,229,209	2,137,660
2019*	79,971,592	20,497,721	100,469,313	1,658,781	1,085,367	959,004	154,965	3,858,117	258,705	194,464	453,169	4,311,286	2,175,619
2020*	82,454,480	21,228,952	103,683,432	1,698,837	1,108,745	975,257	154,965	3,937,804	262,402	194,464	456,866	4,394,670	2,214,157
2021*	84,679,969	21,987,136	106,667,105	1,735,011	1,132,660	991,810	154,965	4,014,446	266,167	194,464	460,631	4,475,077	2,251,675
2022*	86,969,848	22,773,306	109,743,154	1,772,003	1,157,149	1,008,676	154,965	4,092,793	270,006	194,464	464,470	4,557,263	2,289,332
2023*	89,326,096	23,588,474	112,914,570	1,809,840	1,182,185	1,025,850	154,965	4,172,840	273,911	194,464	468,375	4,641,215	2,327,676
2024*	91,750,756	24,433,748	116,184,504	1,848,535	1,207,813	1,043,358	154,965	4,254,671	277,888	194,464	472,352	4,727,023	2,367,079
2025*	94,245,942	25,310,263	119,556,205	1,888,112	1,234,038	1,061,208	154,965	4,338,323	281,939	194,464	476,403	4,814,726	2,407,758

Source: Federal Aviation Administration, Terminal Area Forecast. (* denotes forecast)

Table 16. Enplanement and Operations Growth Summary by Texas Commercial Service Airport

LOCID	Airport Name	Total Enplanements		Airport Operations				Instrument Operations	
				Commercial		General Aviation			
		Historic	Forecast	Historic	Forecast	Historic	Forecast	Historic	Forecast
ABI	Abilene Regional	2.37	1.11	3.58	0.63	-2.11	1.76	2.48	0.49
ACT	Waco Regional	2.64	2.76	-1.60	1.92	-2.49	1.28	3.65	2.39
AMA	Rick Husband Amarillo International	2.24	1.02	1.26	0.88	-2.02	0.66	1.77	1.03
AUS	Austin-Bergstrom International	7.68	3.06	5.69	2.46	-1.73	1.47	3.99	1.94
BPT	Southeast Texas Regional	-2.67	2.72	-4.14	1.83	-2.62	0.74	2.55	1.88
BRO	Brownsville/South Padre Island International	0.87	1.99	2.13	1.01	-1.76	0.45	-0.53	0.88
CLL	Easterwood Field	4.90	1.86	-0.81	1.73	-2.40	1.43	0.55	1.09
CRP	Corpus Christi International	2.48	1.67	2.54	1.66	-3.90	0.43	3.78	0.93
DAL	Dallas Love Field	6.05	5.30	5.30	3.13	-3.09	2.60	4.14	2.56
DFW	Dallas/Fort Worth International	4.32	2.66	2.45	2.13	-1.54	-1.21	2.39	2.06
DRT	Del Rio International	7.59	0.00	-2.41	0.00	-3.84	0.00	0.00	0.00
ELP	El Paso International	3.45	1.25	2.66	0.99	-4.76	0.92	-0.45	1.05
GGG	East Texas Regional	0.74	1.76	-4.49	1.57	-0.00	1.63	6.45	1.63
GRK	Robert Gray AAF	45.75*	0.61	0.00	0.00	0.00	0.00	0.00	0.00
HOU	William P Hobby	7.48	2.32	7.16	1.70	-3.92	2.30	3.24	1.91
HRL	Valley International	3.17	1.54	3.85	0.91	-3.56	1.69	3.32	1.35
IAH	George Bush Intercontinental/Houston	5.98	3.17	4.36	2.33	-2.97	1.03	3.69	2.39
LBB	Lubbock Preston Smith Intl	2.59	2.17	1.84	1.32	-2.63	0.47	-1.78	1.19
LRD	Laredo International	4.22	3.09	15.22	1.60	-1.76	2.65	999.99**	2.15
MAF	Midland International	2.14	1.79	1.29	0.97	-3.79	0.35	3.88	1.26
MFE	Mc Allen Miller International	5.92	2.26	3.59	1.80	-1.17	1.99	3.83	1.65
SAT	San Antonio International	4.11	2.96	2.71	2.42	-1.67	1.67	0.68	1.76
SJT	San Angelo Regional/Mathis Field	2.12	1.18	2.46	0.60	-2.26	1.61	-0.48	1.06
SPS	Sheppard AFB/Wichita Falls Muni	-1.15	-0.44	3.06	0.00	-1.76	0.00	0.00	0.00
TYR	Tyler Pounds Regional	4.41	1.86	-1.15	0.97	-0.31	0.40	1.64	0.98
VCT	Victoria Regional	-0.06	1.09	-1.59	0.19	-0.43	1.70	0.00	0.00

Source: Federal Aviation Administration, Terminal Area Forecast.
Note: Historical rate is from first available history to 2006. Forecasted rate is from 2006 to 2025.
* - The historic enplanement growth rate at Robert Gray AAF is reflective all commercial service activity transferring from Killeen Municipal airport in 2004.
** - This indicates that there is missing data in the airport's history for which the database assigned a "0". Growth rates based on recent and existing data is available.

Table 17. Summary of Enplanement and Operations Annual Growth Rates at Texas Commercial Service Airports, 2002-2025

Fiscal Year	Enplanements			Airport Operations								Total Operations	Total Instrument Operations
				Itinerant Operations					Local Operations				
	Air Carrier	Commuter	Total	Air Carrier	Air Taxi & Commuter	General Aviation	Military	Total	General Aviation	Military	Total		
2002 - 2003	-3.40	26.78	0.06	-5.26	14.14	-3.70	4.20	0.19	-0.76	-8.43	-3.92	-0.46	-1.34
2003 - 2004	5.35	30.23	8.98	3.69	9.75	-2.98	-5.05	2.82	-14.44	-0.78	-9.08	0.98	2.37
2004 - 2005	4.68	-0.64	3.75	0.70	-4.42	-7.18	-7.19	-3.29	-9.19	-0.89	-5.63	-3.61	-2.89
2005 - 2006	3.27	21.93	6.38	-1.48	2.65	-1.00	-8.99	-0.64	-7.71	-9.55	-8.54	-1.72	-0.09
2006 – 2007*	2.58	1.84	2.44	3.47	-1.87	-5.82	0.89	-0.55	-9.87	-0.26	-5.59	-1.19	-1.49
2007 – 2008*	0.85	3.76	1.41	0.61	2.64	1.73	0.00	1.42	1.36	0.00	0.72	1.33	1.18
2008 – 2009*	2.80	3.53	2.94	2.28	2.17	2.95	0.00	2.29	1.37	0.00	0.73	2.11	2.01
2009 – 2010*	2.74	3.52	2.89	2.20	2.14	2.96	0.00	2.26	1.37	0.00	0.73	2.08	2.06
2010 – 2011*	2.67	3.52	2.83	2.11	2.12	2.97	0.00	2.22	1.38	0.00	0.74	2.05	2.10
2011 – 2012*	2.67	3.53	2.84	2.11	2.12	2.99	0.00	2.23	1.38	0.00	0.75	2.06	2.15
2012 – 2013*	2.68	3.53	2.85	2.12	2.12	3.00	0.00	2.24	1.39	0.00	0.76	2.07	2.20
2013 – 2014*	3.26	3.54	3.31	2.58	2.13	3.02	0.00	2.45	1.40	0.00	0.77	2.26	2.36
2014 – 2015*	3.23	3.54	3.29	2.55	2.13	1.67	0.00	2.10	1.40	0.00	0.77	1.95	2.11
2015 – 2016*	3.20	3.55	3.27	2.52	2.13	1.68	0.00	2.09	1.41	0.00	0.78	1.94	2.10
2016 – 2017*	3.17	3.55	3.25	2.49	2.14	1.68	0.00	2.08	1.41	0.00	0.79	1.94	2.11
2017 – 2018*	3.15	3.55	3.23	2.47	2.14	1.68	0.00	2.08	1.41	0.00	0.80	1.94	2.11
2018 – 2019*	3.12	3.56	3.21	2.44	2.15	1.69	0.00	2.07	1.42	0.00	0.80	1.94	2.11
2019 – 2020*	3.10	3.56	3.19	2.41	2.15	1.69	0.00	2.06	1.42	0.00	0.81	1.93	2.10
2020 – 2021*	2.69	3.57	2.87	2.12	2.15	1.69	0.00	1.94	1.43	0.00	0.82	1.82	1.96
2021 – 2022*	2.70	3.57	2.88	2.13	2.16	1.70	0.00	1.95	1.44	0.00	0.83	1.83	1.95
2022 – 2023*	2.70	3.57	2.88	2.13	2.16	1.70	0.00	1.95	1.44	0.00	0.84	1.84	1.95
2023 – 2024*	2.71	3.58	2.89	2.13	2.16	1.70	0.00	1.96	1.45	0.00	0.84	1.84	1.96
2024 - 2025*	2.71	3.58	2.90	2.14	2.17	1.71	0.00	1.96	1.45	0.00	0.85	1.85	1.98

Source: Federal Aviation Administration, Terminal Area Forecast. (* denotes forecast)

Concluding Thoughts

Airports are limited in their ability to generate revenues needed to sustain operations, provide for maintenance and make necessary capital improvements. Larger airports with passenger service have more tools at their disposal. A recent Airport Cooperative Research Program study entitled *Innovative Finance and Alternative Sources of Revenue for Airports* [38] listed the following as the primary revenue sources for airport capital development:

- Proceeds of bonds and other forms of debt;
- Passenger facility charges;
- Airport Improvement Program (AIP) grants from the FAA;
- Internally generated capital resulting from retained airport revenues;
- Security grants from the Transportation Security Administration; and
- State grants and local financial support.

Airports are continuously looking for new ways to increase revenue in the wake of increasing construction costs and economic turmoil in the airline industry. According to the same ACRP study noted above, the non-airline revenue at airports is typically limited to:

- Airport parking revenues;
- Rental car revenues;
- Terminal concessions;
- Advertising programs; and
- Commercial development and land use.

The larger revenue sources are tied to airline service and passenger traffic levels more than anything else. This makes it difficult for the smaller commercial service airports to generate revenue as they do not have enough traffic to take advantage of parking, rental car, and terminal concession revenues. Some smaller airports may have land to sell off, but this can be a long-term problem. The land may eventually be used for a less than ideal (incompatible) purpose and it also limits the ability of the airport to use the land for an aeronautical purpose in the future, which may also be a revenue generator. Few of the aforementioned ideas pertain to general aviation airports, as they are typically not applicable in terms of revenue generation.

Compounding the funding issue in the state is the fact that Texas is among a small number of states that do not have a dedicated source of airport development money. According to the National Association of State Aviation Officials (NASAO/2003)[39], 19 states fund airport development from the general fund, 30 have aviation fuel taxes that support airport development, 10 have aircraft sales and uses taxes and 27 use other sources. Texas is among the "other" category as funding comes through the Texas

[38] *Innovative Finance and Alternative Sources of Revenue for Airports.* Airport Cooperative Research Program, Transportation Research Board 2007.

Department of Transportation and it is the sole source of state airport development funds. Twenty-two states utilize two sources of funding, while four states utilize three sources and three states have four sources of revenue.

Other funding streams have been discussed and/or implemented in other states in order to fund airport development. These include state fuel taxes on AVGAS and/or Jet A; redistributing existing aviation-related sales tax revenues to airport development; aircraft registration fees; property tax on aircraft; and pilot registration fees.

When considering the smaller commercial service airports in the state system that have to rely on primary airport entitlement money, they simply do not have the passenger and cargo activity to generate the revenue they need. They, too, could benefit from additional sources of revenue to fund airport improvements. These smaller commercial service airports have additional financial burdens to comply with due to their status. However, they do not necessarily enjoy any accompanying revenue. For example, Laredo International Airport spends approximately $1 million per year on security alone. Its passenger and cargo entitlement funds total approximately $1.5 million, which does not allow for other improvements given the security and other expenses. Other smaller commercial service airports have sought resources from the municipalities they serve in an effort to maintain operations and preserve air service. This need is not limited to only the smaller commercial service airports as the larger ones are often in need of additional resources for improvements as well.

Going forward, issues will arise that require an unexpected and unplanned investment for airports of all sizes and functions. Airports often face needs that they are not able to adequately address. Recently, issues associated with security, including fencing, gates, cameras and other technologies have put airports in a difficult position to secure their facility without additional levels of funding. Other seminal issues of today that may require significant investment include protecting airports by ensuring compatible surrounding land uses and developing hangars at general aviation airports. Both are critical to the long-term viability of airports, which provide significant economic returns to the communities they serve. The same can be said about larger airports where major capacity/infrastructure upgrades, inter-modal facilities, and other expensive project needs may emerge due to changing economic and/or demographic conditions. These are likely to be needed, if at all, at a point near the end of the planning horizon and are sure to be raised as conditions begin to change.

The development needs in the next 20 years will be different in size and scope for commercial service airports and general aviation airports, as will be their ability to pay for them. As illustrated earlier, the largest of commercial service airports will have some ability to meet those needs on their own. Smaller commercial service airports and general aviation airports will have to rely on additional public investment and innovative methods.

[39] *State Aviation Funding and Organizational Data Annual Report, Fiscal Years 2002 and 2003*. National Association of State Aviation Officials.