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16. Abstract

The proposed Trans-Texas Corridor (TTC) will allow for faster and safer movement of people and goods throughout Texas, relieve congestion on existing roadways, divert hazardous materials away from urban areas, and stimulate economic growth and development along its path. However, to become fully integrated with the Texas transportation network, the TTC must also consider connections with the state's extensive airport system. While the TTC could produce significant opportunities for commercial services and general aviation airports, many of its planners and engineers are not familiar with the special land-use and connectivity needs of airports. While the TTC offers prospects for producing significant opportunities to commercial service and general aviation airports, it also has the potential to limit their safety, operation, and expansion if planned poorly. Possible airport benefits include increased usage because of improved airport user access and indirectly because of economic development along its path. Potential challenges include infringement on approaches and approach procedures, restriction of airport growth, limited accessibility or connectivity to the TTC, and competition with land-based modes for passenger and freight movement. Integrating Texas airports into the overall multimodal TTC design will leverage intermodal transportation for intercity travel and freight movement throughout Texas.

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Products

This report contains four products. Product 1, *Ensuring Texas Airport Connectivity and Accessibility to the Trans-Texas Corridor*, is included in Chapter 5. Product 3, *Technical Memorandum: The Role of Air Cargo in Developing Transshipment Centers*, is included in its entirety in Chapter 6. Portions of Product 4, *The Trans-Texas Corridor: Strategic Recommendations for Texas Airports*, are included throughout this report. Portions of Product 7, *Planning Guidelines for Airport Integration into the Trans-Texas Corridor*, are included in Chapter 4.

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Chapter 1. Introduction

1.1. Background

In 2002, Texas Governor Rick Perry announced a plan to build a series of tolled, multimodal transportation corridors across Texas adjacent to existing transportation routes. This proposed transportation network, named the Trans-Texas Corridor (TTC), will traverse rural areas of the state for a combined distance exceeding 4,000 miles (6,440 km), incorporating dedicated lanes for passenger traffic and commercial trucks, dedicated lines for high-speed, passenger, and freight rail, and a utility corridor. TTC proponents contend that it will permit faster and safer movement of people and goods throughout Texas, relieve congestion on existing roadways, divert hazardous materials away from urban areas, and stimulate economic development along its path.

Until now, Texas's immense size and complete reliance on highway transport and slow-moving freight rail has meant that air travel was the only quick and efficient means for moving passengers and express cargo. With the introduction of the TTC, land-based transportation will have the potential to become a competitive rival over long distances. Concurrently, the TTC could also play a complementary role to the state's airports by improving their connectivity to roadways and rail, which airports rely on for landside access. While the TTC could produce significant opportunities for commercial services and general aviation airports, many of its planners and engineers might not be familiar with special land use and connectivity needs of airports. Thus, the TTC offers prospects for producing significant opportunities to commercial service and general aviation airports; it also has the potential to limit their safety, operation, and expansion if planned poorly.

1.2. Objectives

To assist planners in integrating Texas airports into the TTC, this research has the following objectives:

- Evaluate the conceptual TTC plan vis-à-vis the Texas aviation system to identify key aviation facilities along the alignment;
- Identify the potential opportunities and challenges to Texas airports as a result of the TTC;
- Document existing airport layout requirements, operations standards, and accessibility guidelines; and
- Propose recommendations to maximize the potential opportunities and minimize the possible impact of the TTC on the Texas aviation system.

1.3. Methodology and Limitations

A synthesis of several research activities combined to formulate the recommendations to maximize the opportunities and minimize the challenges to Texas airports. To identify the aviation facilities near the TTC, Texas's public-use airports were mapped vis-à-vis the conceptual TTC alignment plan using ArcGIS software. Airports within 25 and 50 miles of a TTC route were identified as potential beneficiaries of TTC benefits or challenges. An opinion survey of Texas aviation experts and stakeholders was conducted to identify the key opportunities and challenges to airports as perceived by the Texas aviation industry. The survey results helped to confirm the key aviation interests to consider when integrating the aviation system with the TTC. A literature review on the physical and operational requirements for airports, connectivity and accessibility needs, and air cargo movement was performed to substantiate and support the planning recommendations. In addition, data analysis of federally reported air passenger and cargo movement within the state (from the Bureau of Transportation Statistics) was performed to provide quantitative support for the recommendations presented throughout this report.

At the time this report was written, preliminary planning for the TTC had only recently started. As a result, there were several underlying limitations to this research. First, there is no single corridor (much less a corridor network) in the world with which to compare the TTC in scope, magnitude, cost, or impact. As such, it is difficult to predict and plan for the TTC's impact on economic growth as well as on air passenger and cargo movement within Texas. Second, the preferred alignments of the TTC's priority and non-priority corridors have yet to be determined. As a result, it is impossible to know which airports will have connectivity and accessibility to the TTC. Third, the time frame for the TTC to begin operations is not yet known, but it is highly unlikely that even the most urgent corridors will be completed within three decades. Therefore, the predictions in this report span an extremely long period that will likely bring significant technological and economic change. Hence, some of the observations or recommendations of this research may become irrelevant over time. Likewise, some of the assumptions made throughout this research will no longer be valid before the project becomes operational. Despite the many limitations inherent at the beginning of the TTC planning process, however, early and continuous consideration of aviation interests is important as the planning and design of the TTC continues. This paper purports to identify general opportunities and challenges to Texas airports from the TTC based upon current assumptions.

1.4. Purpose

The purpose of this document is to provide airport mangers, airport governing boards, TxDOT Aviation Division staff, TxDOT Texas Turnpike Authority (TTA) staff, and TTC consultants with a series of recommendations for maximizing the benefits and minimizing the potential drawbacks associated with the development of the TTC. These recommendations are drawn from the researchers' literature review and from the results of an opinion survey conducted within the Texas aviation community, which identified the key opportunities and potential impacts of the TTC on the Texas airport system. Incorporating the key findings of the opinion survey with the literature reviews and data analysis performed throughout the duration of the project, the report ends with a summary of the strategic recommendations intended to maximize the potential opportunities and minimize the possible impact of the TTC on the Texas airport system.

1.5. Organization of the Report

Chapter 2 outlines the existing Texas aviation system and describes the elements of the conceptual TTC design. It also identifies the number and type of public-use airports potentially affected by the TTC by mapping the Texas aviation system vis-à-vis the conceptual TTC plan. Chapter 3 discusses the potential opportunities and challenges to Texas airports that may arise when an airport is located near the TTC. Results of an aviation expert and stakeholder opinion survey reveal which airport interests are considered the most important when integrating Texas airports into the TTC design. Chapter 4 discusses the physical and operational design requirements for airports and presents recommendations to prevent physical and operational hazards to airports. Chapter 5 outlines airport connectivity and accessibility issues, including the importance of airport access, the landside access planning process, considerations for rail access to airports, and connectivity needs of air cargo movement. The chapter includes several planning recommendations to ensure adequate connectivity and accessibility between the TTC and Texas airports. Chapter 6 discusses emerging national and international air cargo trends and the role of air cargo in developing transshipment centers. The chapter identifies several challenges and opportunities to air cargo movement in Texas as a result of the TTC and presents several recommendations to maximize the potential benefits. Finally, Chapter 7 provides a few additional planning recommendations and a brief summary and conclusion.

Chapter 2. Background on the Texas Aviation System and the Trans-Texas Corridor

2.1. Overview of the Texas Aviation System

A significant challenge to Trans-Texas Corridor (TTC) planners is to integrate it into one of the most extensive airport systems in the United States. Texas has more than 380 public-use airports scattered across the state (Figure 2.1), 300 of which are publicly-owned. Among these 380 airports, twenty-seven have been classified as "primary commercial," which means they offer scheduled service from national and/or regional carriers and enplane at least 10,000 passengers per year.[1] The commercial service airports located in Texas's major cities generate significant air traffic, and in terms of total passenger enplanements, Texas had five of the top 50 busiest airports in the United States in 2002. Dallas/Fort Worth International (DFW) was Texas's busiest commercial airport in 2002 and ranked as the fourth busiest in the United States, with almost 25 million passenger enplanements and 1.48 million tons of landed weight cargo.[2] Houston's George Bush Intercontinental (IAH) Airport ranked second in the state and eighth in the nation with almost 16 million total enplanements.[3]

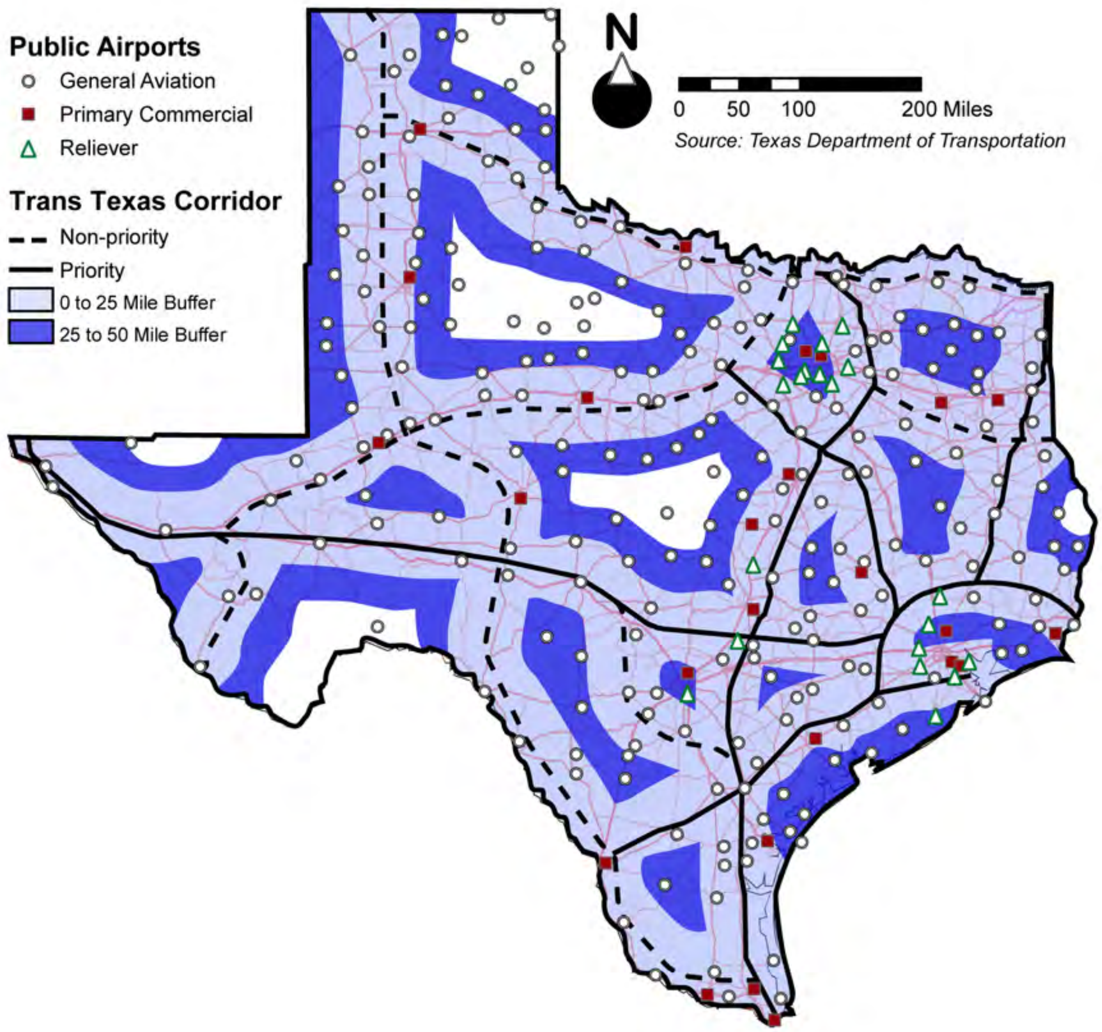

Figure 2.1 Public-use airports in proximity to the conceptual Trans-Texas Corridor plan

In addition to the primary commercial airports, there are also reliever airports located in major metropolitan areas, which provide alternate facilities to users that might otherwise use a commercial airport. Of the 23 reliever airports in Texas, Fort Worth's Alliance Airport is the largest, moving over 370,000 tons of landed weight cargo, ranking it fourth among all-cargo Texas airports in 2002.[4] The three all-cargo airports accommodating more landed weight cargo than Alliance are DFW, IAH, and Austin-Bergstrom International—all commercial service airports.

Most Texas airports, however, are categorized as general aviation airports. The state has 253 general aviation airports that can be further classified into three subgroups: transport, general utility, and basic utility.[5] The state's transport airports cater primarily to turboprop or turbojet business planes. The general utility airports serve agricultural and industrial needs, as well as personal single engine or light engine planes and some business aircraft. Finally, basic utility airports are located near other airports and used for training or clear-weather flying, but generally have very little activity.[6] In addition to these general aviation airports, the Texas airport system also includes three general aviation heliports.

The air transportation industry is critically important to Texas and is a significant stimulus to economic growth and development throughout the state. Airport facilities generate significant revenue, jobs, and wages. According to a 2003 economic impact analysis of general aviation in Texas, the sum of the direct and secondary impacts associated with aviation activity at Texas airports is considerably larger than that associated with many other industries in the state. Texas's general aviation activities alone accounted for almost $5.9 billion in total economic activity, supporting approximately 56,600 full-time positions and distributing more than $1.8 billion in annual payroll in 2001.[7] The sum of all aviation activity in Texas, including both commercial and general aviation services, accounted for $40.7 billion in total economic activity, $16.2 billion in payroll, and over 700,000 jobs.[8] Many people working in the air transportation industry in Texas work at one of several major air transportation companies headquartered in Texas. These airlines include American Airlines/American Eagle, Continental Airlines, and Southwest Airlines. Each company has had a major economic impact on its respective headquarter cities of Fort Worth, Houston, and Dallas. Additionally, increasing employment in the aviation industry benefits Texas workers because the average annual wages in the air transportation industry are higher than the average annual wages in all other industries. In fact, air transportation industries paid wages that were almost 15 percent higher than the national average in 2000.[9]

2.2. Conceptual Description of the Trans-Texas Corridor

As proposed by Texas Governor Rick Perry in 2002, the TTC network will traverse the state for a combined distance exceeding 4,000 miles. Within these corridors will be six controlled-access freeway lanes for passenger traffic, four controlled-access freeway lanes for commercial trucks, two tracks of high-speed rail, four tracks of slower passenger and freight rail, and a 200-foot-wide zone for various utilities (e.g., water, petroleum and natural gas, fiber-optic cables, high-power transmission lines, etc.). The Texas Department of Transportation (TxDOT) is proposing that the corridors have a right-of-way width of approximately 1,200 feet and that these corridors traverse only the rural areas of Texas to reduce right-of-way acquisition costs. Access to the corridor would be very limited, with few if any frontage roads and infrequent interchanges, occurring only at intersections with major roadways. Grade-separated bridge structures will allow existing rail lines and roadways (including farm to market highways, two-lane state highways, and local roads) to cross the corridor, but not have access to it.[10] Connections to major cities will use existing roadways or local passenger rail systems. As proposed, the total estimated cost of the TTC network ranges from $145.2 billion to $183.5 billion in 2002 dollars.[11] Given this incredible cost, it would be impossible for the state to construct the project solely with state and federal funds. Therefore, many or all of the TTC's segments will be constructed as toll roads or through other innovative financing techniques.

The conceptual TTC plan calls for nine corridors crossing rural parts of Texas from north to south and east to west (Figure 2.2). With the completion of this plan, every major city and many of the midsized cities of Texas will have access to the TTC. Because of existing traffic congestion on parallel routes, four of these corridors have been classified as priority corridors. These four corridors will roughly parallel Interstate 10, Interstate 35, Interstate 45, and the proposed Interstate 69 (US 59). The additional five non-priority corridors, with the exception of the one following Interstate 20, will parallel geographical elements rather than existing interstate highways.[12]

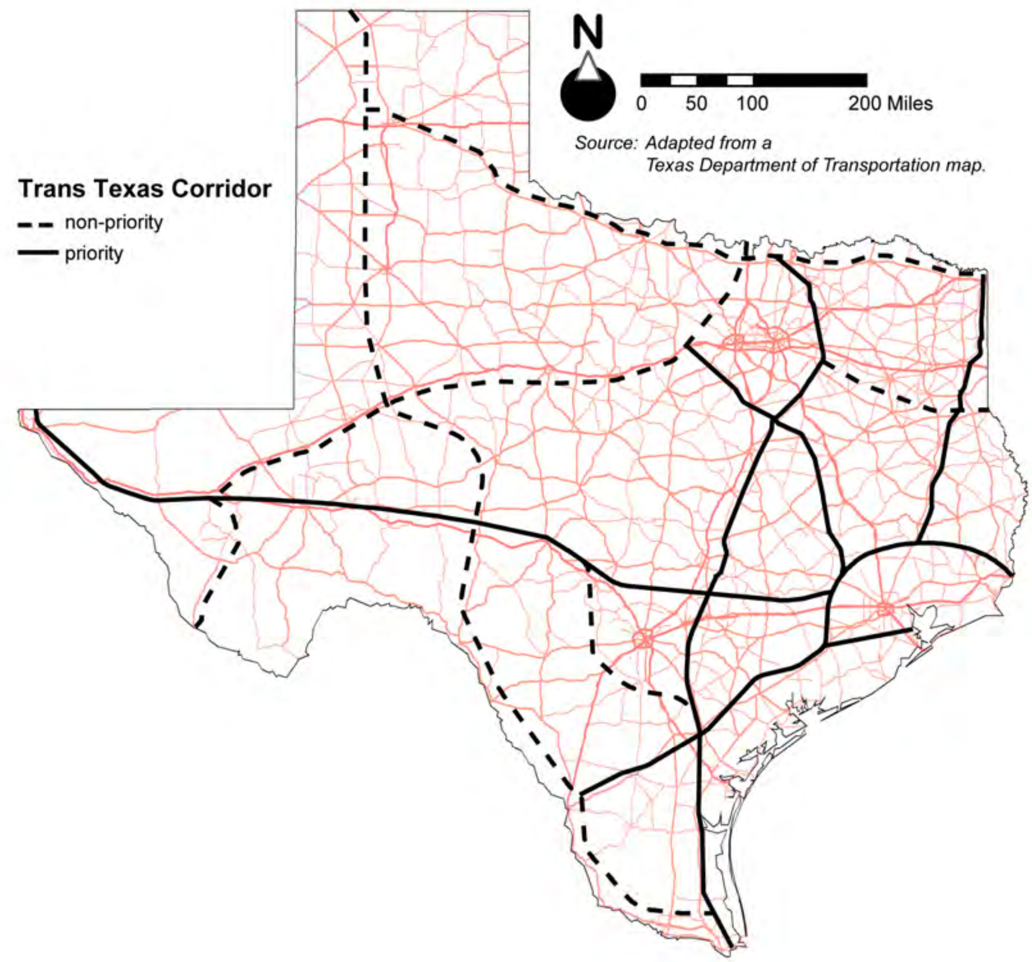

Figure 2.2 Trans-Texas Corridor conceptual plan

2.3. Airports Potentially Affected by the Trans-Texas Corridor

Planning for the TTC is in the early stages and the precise alignments of the TTC have yet to be determined. However, there is sufficient preliminary information from the conceptual plan to identify which airports in Texas lie within the study areas of each route and may be affected by the TTC. The study area used for preferred alignment analysis is approximately 25 miles in either direction of the conceptual plan. Airports within 25 to 50 miles of the TTC are expected to realize some of the benefits (or some of the challenges) associated with TTC connectivity. [i] As a result, the TTC could impact airports 50 miles in either direction of its conceptual design. The combined study areas of all nine corridors, however, will cover approximately 92 percent of the state and include 93 percent of Texas's public-use airports. Of

[i] A digital file showing the conceptual alignments of the TTC corridors was obtained from TxDOT's Transportation Planning and Programming Division (TPP). This file was entered into a Geographic Information System (GIS), which also created the 25- and 50-mile buffers around the conceptual alignments that was used to identify airports which might be influenced by the TTC.

the 388 public-use airports in Texas, 248 are within 25 miles (either side) and an additional 113 are within 50 miles (either side) of at least one of the conceptual TTC alignments. Of the publicly-owned, public-use airports, sixteen primary commercial, twelve reliever, and 150 general aviation airports are within 25 miles of the TTC. An additional nine primary commercial, eight reliever, and seventy-five general aviation airports are within 50 miles of a priority or non-priority corridor.

The following section describes individually the location of each of the nine TTC routes and identifies the number of public-use airports located within 50 miles of the each proposed corridor. It is important to remind the reader, however, that preferred alignments have yet to be chosen and identification of airports potentially affected by the TTC is only preliminary at this time. The authors intend to show the magnitude of the TTC's impact in relation to the number of airports that could be affected to emphasize the importance of planning for airport integration in the TTC design.

2.3.1. Priority Corridors

TTC-10

As it is currently proposed, TTC-10 will be approximately 740 miles long, crossing the state from east to west at its widest point. It will be composed of two segments, which will be connected by the component of TTC-69 that circles Houston. Beginning in Orange at the Louisiana State border, the first segment will intersect TTC-69 northeast of Houston. The second segment will begin at TTC-69 west of Houston and continue west traveling north of San Antonio and south of Austin, paralleling Interstate 10 across West Texas. The western terminus of TTC-10 will be near El Paso. TTC-10 intersects priority corridors TTC-35 and TTC-69, as well as non-priority corridors TTC-20, TTC-Panhandle/Rio Grande, and TTC-San Antonio (Figure 2.3).

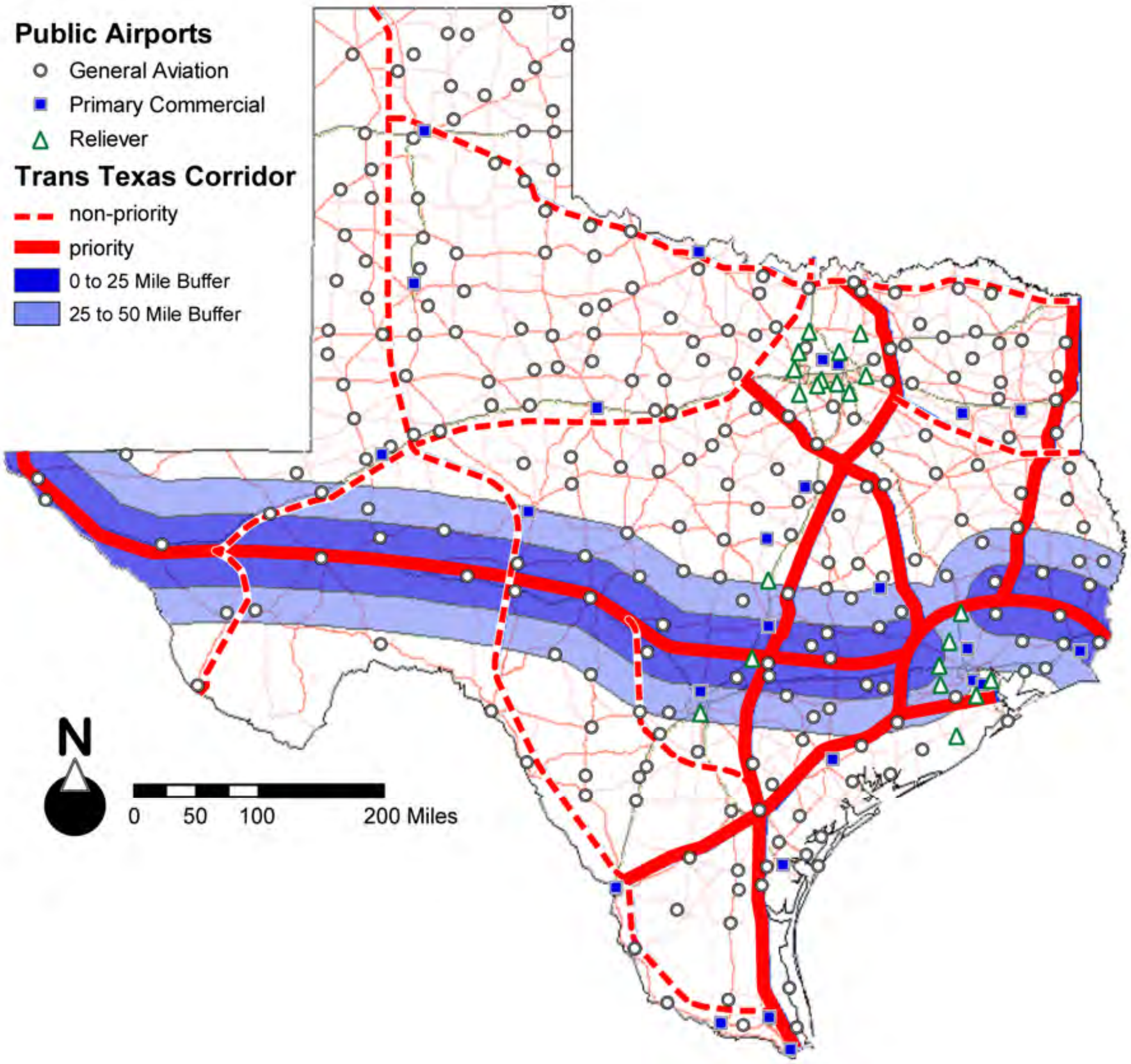

Figure 2.3 Interstate 10 Priority Corridor

Seventy airports are within 25 miles (either side) of TTC-10 and an additional twenty-six airports are within 50 miles (either side). Of these ninety-six airports, twenty-eight are privately owned and unclassified. Of the publicly-owned airports, there are fifty-five general aviation airports, six reliever airports, and seven primary commercial airports. Austin-Bergstrom International, Easterwood Field, El Paso International, San Angelo Municipal, and Southeast Texas Regional are all within 25 miles of the corridor. George Bush Intercontinental and San Antonio International are within 50 miles.

TTC-35

The proposed alignment for TTC-35 is approximately 670 miles. Beginning in the Sherman-Denison area at TTC-Red River, TTC-35 will circle Dallas to the east and travel southwest, paralleling Interstate 35 east of Waco toward Austin. It will continue south through the Rio Grande Valley to its terminus in Brownsville at the Mexico border. TTC-35 has interchanges with priority corridors TTC-10, TTC-45, and TTC-69, in addition to non-priority corridors TTC-Dallas/Louisiana and TTC-San Antonio (Figure 2.4).

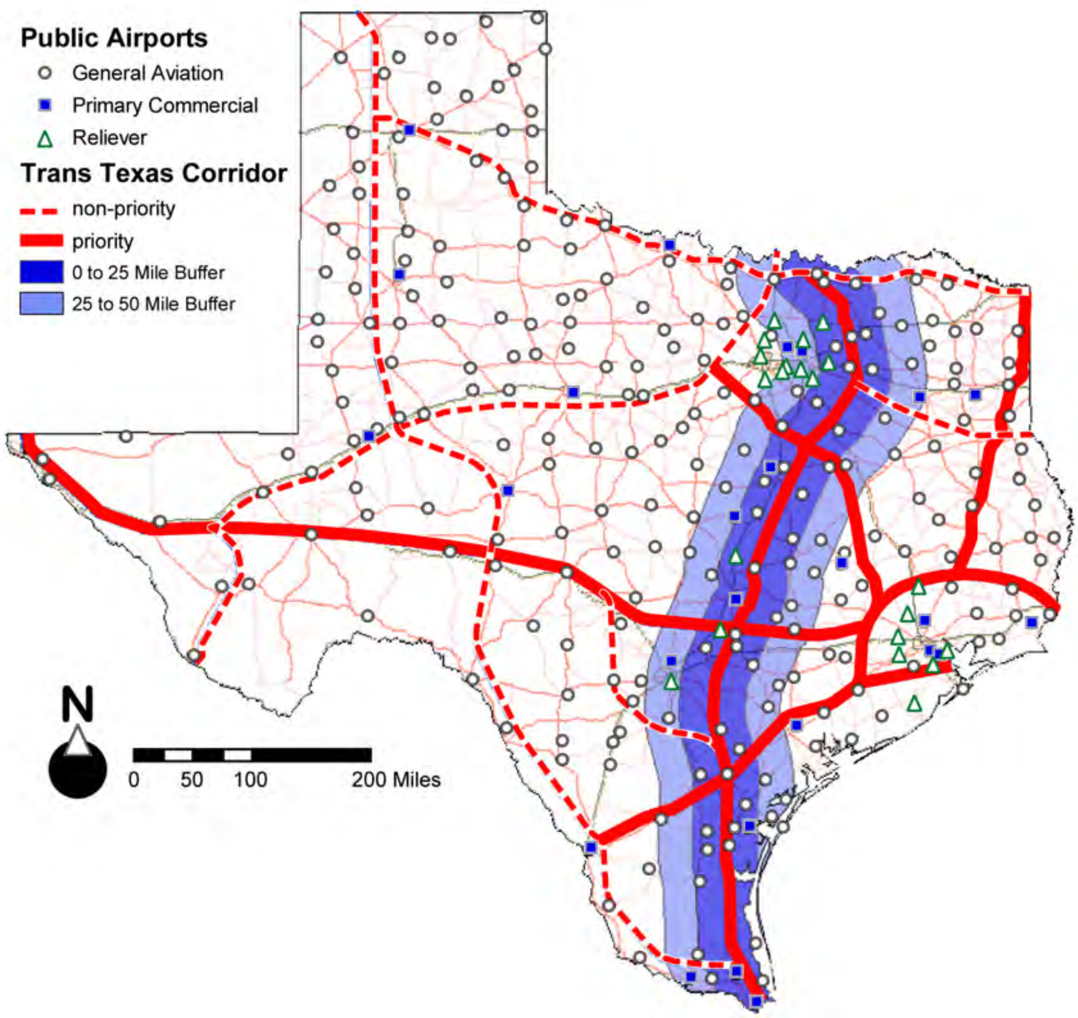

Figure 2.4 Interstate 35 Priority Corridor

Eighty-one airports are within 25 miles (either side) and another thirty-nine airports are within 50 miles (either side) of the TTC-35. Of these 120 airports, thirty-six are privately owned and unclassified. Of the publicly-owned airports, there are sixty general aviation airports, two general aviation heliports, eleven reliever airports, and eleven primary commercial airports. Austin-Bergstrom International, Brownsville/South Padre Island International, Corpus Christi International, McAllen Miller International, Tyler Pounds Regional, Valley International, and Waco Regional are within 25 miles of the corridor. Dallas/Fort Worth International, Dallas Love Field, Killeen Municipal, and San Antonio International are within 50 miles.

TTC-45

Beginning northwest of Houston at TTC-69, TTC-45 will travel approximately 230 miles northwest toward Dallas and Fort Worth. Traveling east of the Bryan/College Station area, it will then travel in a more westerly direction, bypassing Waco to the north and Fort Worth to the south, terminating at TTC-20 in the Weatherford area. TTC-45 intersects priority corridors TTC-69 and TTC-35 and non-priority corridor TTC-20 (Figure 2.5).

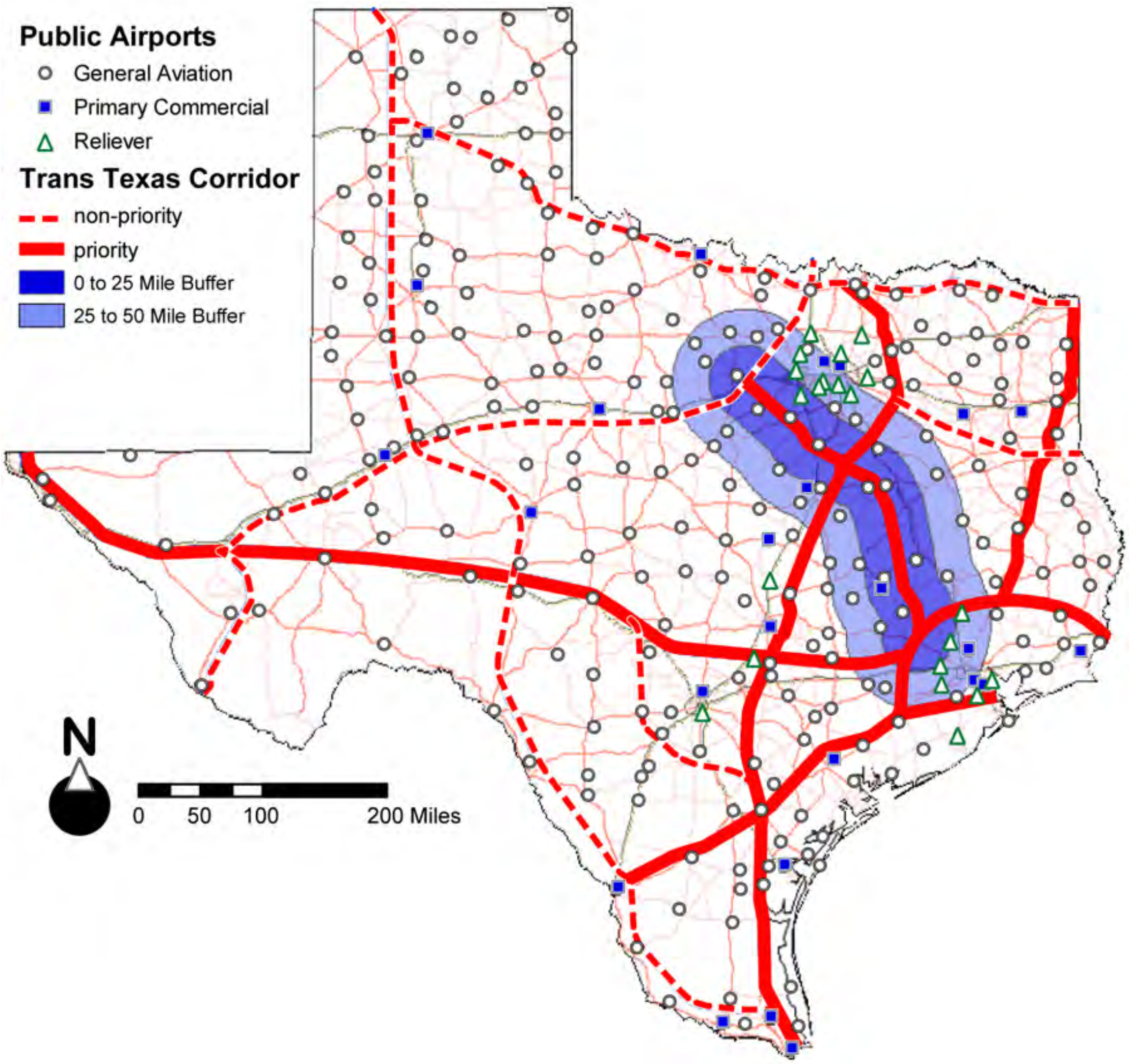

Figure 2.5 Interstate 45 Priority Corridor

Fifty-four airports are within 25 miles (either side) and twenty-six airports are within 50 miles (either side) of TTC-45. Twenty-nine of the eighty airports are privately owned and unclassified. Of the remaining fifty-one airports, thirty-four are general aviation airports, one is a general aviation heliport, eleven are reliever airports, and five are primary commercial airports. Easterwood Field and Waco Regional are within 25 miles of the corridor, and Dallas/Fort Worth International, Dallas Love Field, and George Bush Intercontinental are within 50 miles of the corridor.

TTC-69 (proposed)

TTC-69 (proposed) will be composed of two segments, which intersect just west of Houston. The two segments combine to extend approximately 640 miles across the eastern part of the state. Beginning in Texarkana, the first segment will travel southwest toward Houston and then arc around the northwest side of the city. The second segment, which would parallel proposed Interstate 69, will begin at Galveston Bay and then travel southwest. Staying north of Victoria, it will then intersect with both TTC-35 and TTC-San Antonio near Beeville before terminating in Laredo. TTC-69 has interchanges with priority corridors TTC-45 and TTC-10, as well as non-priority corridors TTC-Dallas/Louisiana and TTC-Panhandle/Rio Grande (Figure 2.6).

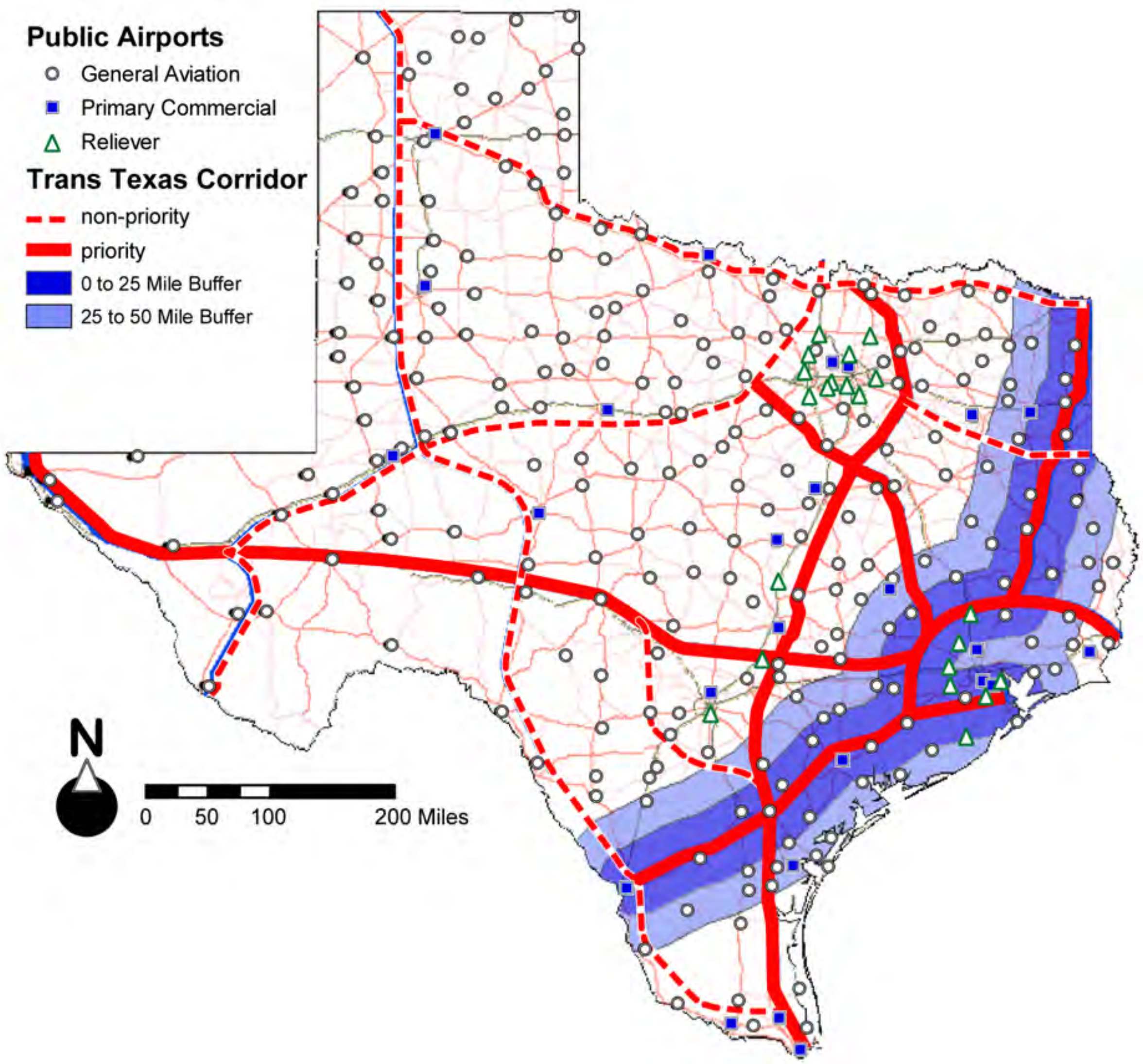

Figure 2.6 Interstate 69 (proposed) Priority Corridor

Seventy-five airports are within 25 miles (either side) and an additional twenty-five airports are located within 50 miles (either side) of the TTC-69 corridor. Twenty-six of these 100 airports are privately owned and unclassified. Of the remaining airports, fifty-nine are general aviation airports, seven are reliever airports, and eight are primary commercial airports. Corpus Christi International, Easterwood Field, Ellington Field, Laredo International, Victoria Regional, and William P. Hobby are within 25 miles of the corridor; George Bush Intercontinental and East Texas Regional are within 50 miles.

2.3.2. Non-Priority Corridors

TTC-20

TTC-20 will travel approximately 650 miles through West Texas from the Texas/Mexico border to the Texas/Oklahoma border. Starting in the southwestern area of the state in Presidio near the border with Mexico, TTC-20 crosses TTC-10 to run parallel with Interstate 20 south of Midland-Odessa and Abilene toward Dallas. Traveling northwest of Fort Worth, it terminates at the Oklahoma border in the Sherman/Denison area (Figure 2.7).

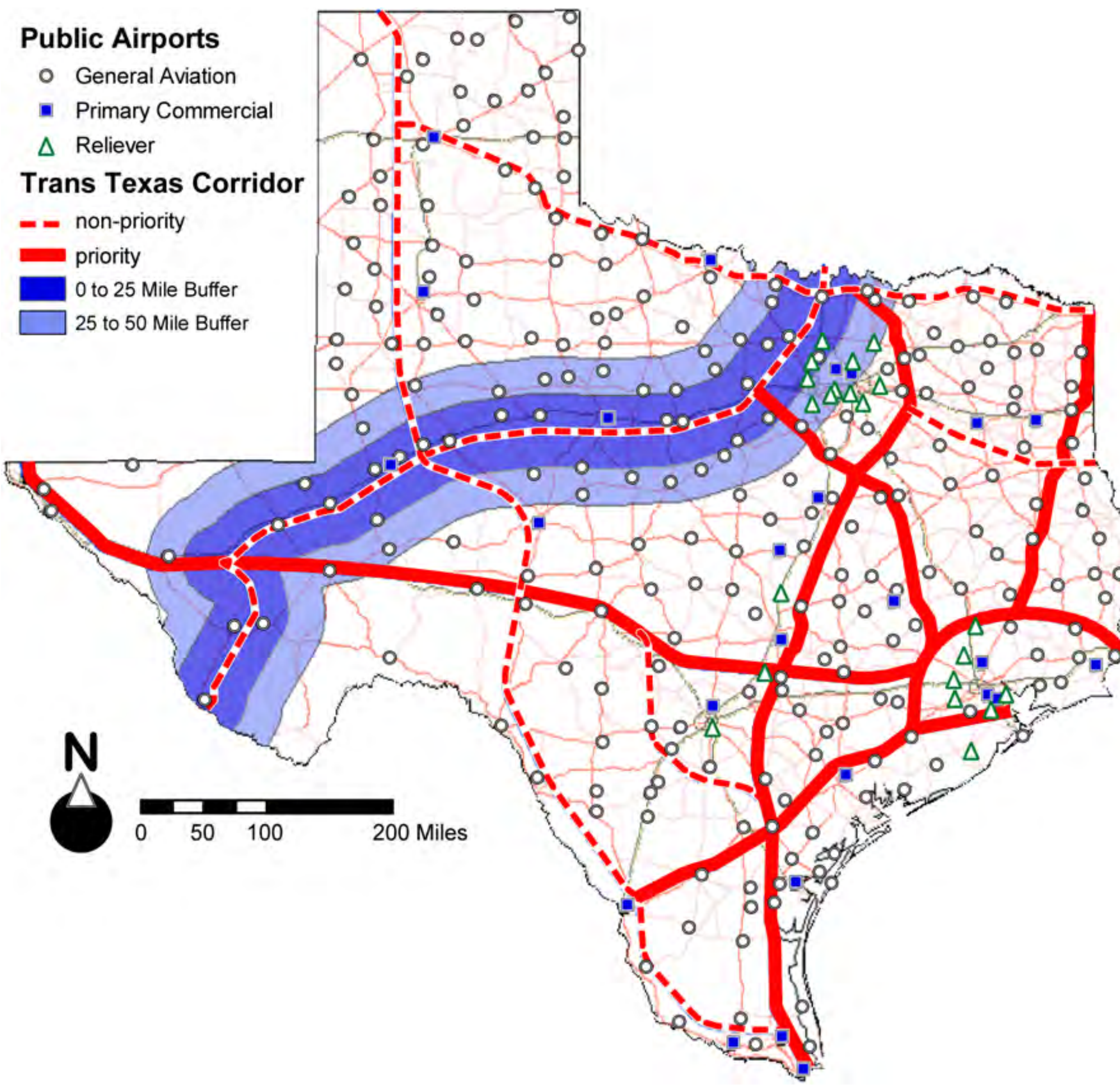

Figure 2.7 Interstate 20 Non-Priority Corridor

Sixty-three airports are within 25 miles (either side) and another twenty-eight are within 50 miles (either side) of the corridor. Of these ninety-one airports, thirty-one are privately owne4d and unclassified. Of the publicly-owned airports, there are forty-eight general aviation airports, eight reliever airports, and four primary commercial airports. Abilene Regional and Midland International are within 25 miles of the corridor; Dallas/Fort Worth International and Dallas Love Field are within 50 miles.

TTC-Dallas/Louisiana

TTC-Dallas/Louisiana is the shortest of the nine corridors, with an alignment that stretches approximately 140 miles. Beginning at the northern end of the Toledo reservoir at the Louisiana border, TTC-Dallas/Louisiana will travel toward Dallas in a northwesterly direction, staying south of Tyler, terminating southeast of Dallas at TTC-35 (Figure 2.8).

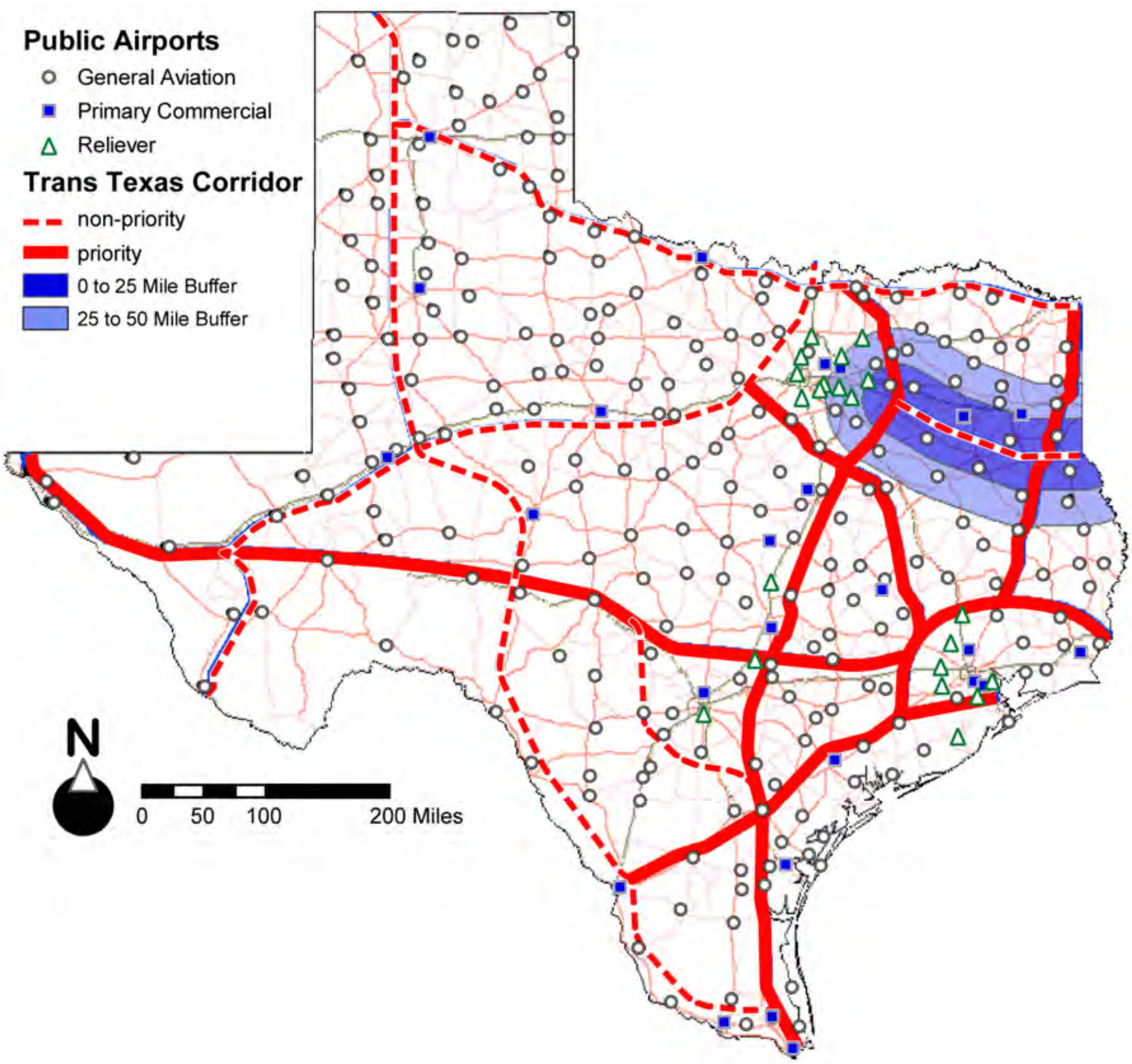

Figure 2.8 Dallas/Louisiana Non-Priority Corridor

Twenty-five airports are within 25 miles (either side) of the corridor, and another sixteen airports are within 50 miles (either side). Eleven of these forty-one airports are privately owned and unclassified. Twenty of the publicly-owned airports are general aviation airports, two are general aviation heliports, five are reliever airports, and three are primary commercial airports. Tyler Pounds Regional is within 25 miles of the corridor and both Dallas Love Field and East Texas Regional are within 50 miles.

TTC-Panhandle/Rio Grande

Stretching approximately 850 miles from the tip of the Texas panhandle down to the southern most point of the state at the Mexican border, TTC-Panhandle/Rio Grande will be the longest of the nine corridors. Beginning in the panhandle at the Oklahoma border, it will travel south, staying to the west of Amarillo and Lubbock toward Midland-Odessa. The alignment will then turn right to travel east toward San Angelo and then travel south again, paralleling State Route 277 toward Del Rio. Just north of Del Rio, it will turn southeast to follow the Rio Grande along the Mexican border north of Laredo. The southern terminus of TTC-Panhandle/Rio Grande will be at TTC-35 near Harlingen (Figure 2.9).

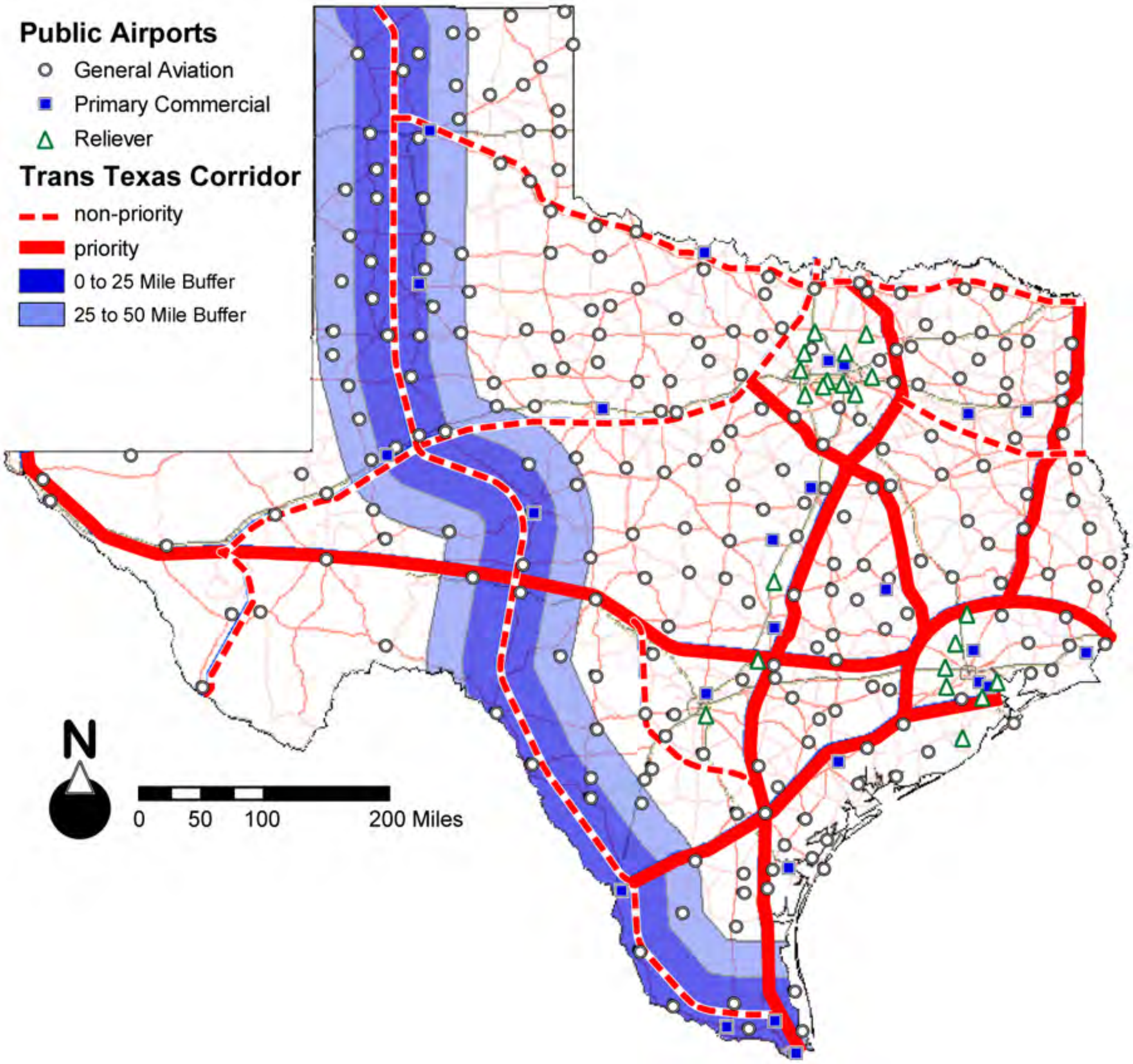

Figure 2.9 Panhandle/Rio Grande Non-Priority Corridor

Forty-eight airports are within 25 miles (either side) of the corridor and an additional twenty-five airports are within 50 miles (either side). Eleven of these seventy-three airports are privately owned and unclassified. Fifty-four of the publicly-owned airports are general aviation airports and eight are primary commercial airports. Amarillo International, Laredo International, Lubbock International, McAllen Miller International, Midland International, San Angelo Municipal, and Valley International are all located within 25 miles of the corridor; Brownsville/South Padre Island International is within 50 miles.

TTC-Red River

TTC-Red River will travel east to west for approximately 520 miles along the Texas/Oklahoma border. Beginning in Texarkana and traveling north of Wichita Falls and Sherman, the alignment travels along the Red River, which forms the border of Texas and

Oklahoma. Traveling north of Amarillo the corridor will terminate northwest of the city at TTC-Panhandle/Rio Grande (Figure 2.10).

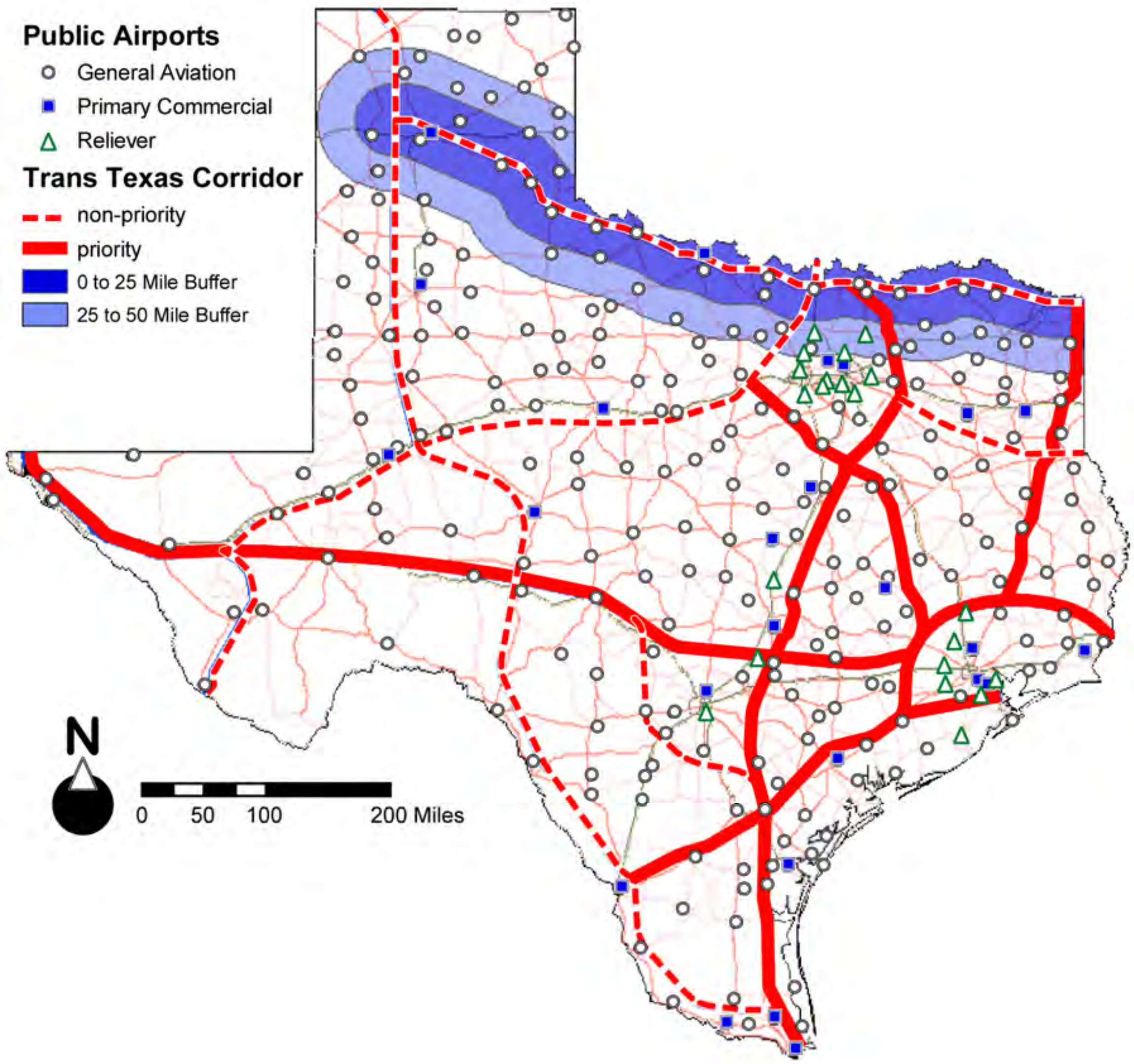

Figure 2.10 Red River Non-Priority Corridor

Twenty airports are within 25 miles (either side) of the TTC-Red River alignment; another forty-nine airports are within 50 miles of the corridor. Twenty-one of the sixty-nine airports are privately owned and unclassified. Of the remaining forty-eight airports, forty-three are classified as general aviation airports, three are reliever airports, and two are primary commercial airports. Amarillo International and Sheppard Air Force Base/Wichita Falls Municipal are both within 25 miles of the corridor.

TTC-San Antonio

TTC-San Antonio encircles the western half of San Antonio for 180 miles, connecting TTC-10 and TTC-69. Beginning at TTC-10 to the northeast of Kerrville, TTC-San Antonio forms a rural ring road around the western side of San Antonio. Traveling west of Hondo, this alignment terminates just north of where TTC-35 and TTC-69 intersect near Beeville (Figure 2.11).

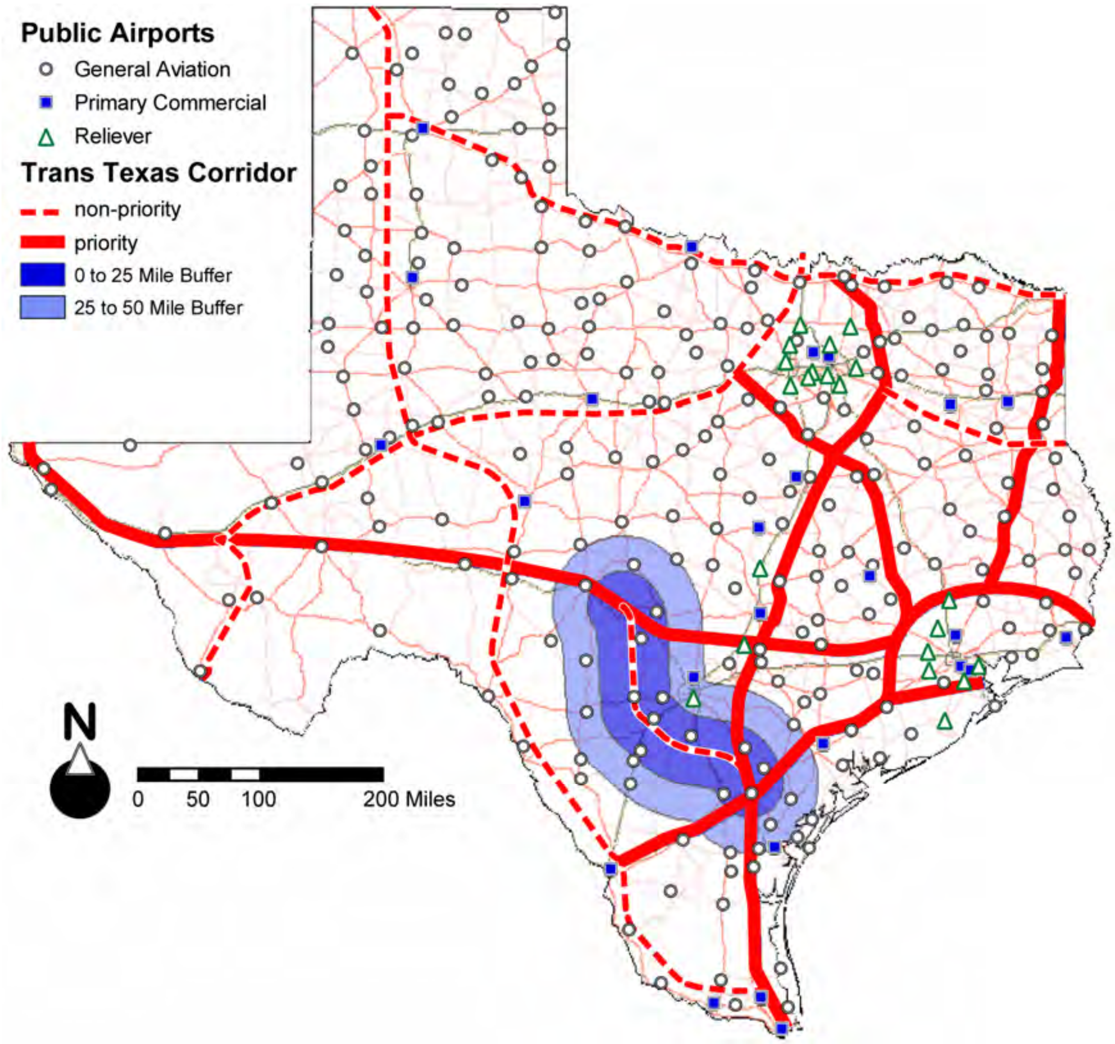

Figure 2.11 San Antonio Non-Priority Corridor

Twelve airports are within 25 miles (either side) of TTC-San Antonio and another nineteen airports are located within 50 miles (either side) of the corridor. Eight of the thirty-one airports are privately owned and unclassified. Twenty-one of the publicly-owned airports are general aviation airports, one is a reliever airport, and one is a primary commercial airport. San Antonio International is located within 25 miles of the corridor.

[1] Texas Department of Transportation. Aviation Division. Texas Airport System Plan Update 2002, 2002.
[2] U.S. Department of Transportation. Federal Aviation Administration. Airport Planning: Passenger Boardings and All-Cargo Data. 3 Mar. 2004. 7 June 2004 <http://www.faa.gov/arp/Planning/stats/index.cfm?ARPnav=stats>.
[3] Ibid.
[4] Ibid.
[5] Texas Department of Transportation. Aviation Division. Texas Airport System Plan Update 2002, 2002.
[6] Ibid.
[7] U.S. Department of Commerce. Office of Aerospace. Commission on the Future of the United States Aerospace Industry. U.S. Aerospace and Aviation Industry: State by State Analysis. Washington, D.C., 2002.
[8] Wilbur Smith Associates, Inc. The Economic Impact of General Aviation in Texas. Texas Department of Transportation, 2002
[9] U.S. Department of Commerce. Office of Aerospace. Commission on the Future of the United States Aerospace Industry. U.S. Aerospace and Aviation Industry: State by State Analysis. Washington, D.C., 2002.
[10] Texas Department of Transportation. Crossroads of the Americas: Trans-Texas Corridor Plan, June 2002, http://www.dot.state.tx.us/ttc/ttc_report_full.pdf. Accessed May 2004.
[11] Ibid.
[12] Ibid.

Chapter 3. Opportunities and Challenges to the Texas Aviation System

3.1. Aviation Stakeholder Opinion Survey

As with any new, large-scale transportation project, the construction of the TTC has the potential to create both opportunities and challenges for Texas airports. To identify potential impacts, the research effort included an opinion survey of industry experts and general aviation stakeholders in Texas. The short-answer survey asked respondents to describe what they believed to be the greatest benefits and threats to airports operating near the TTC and to indicate whether an airport's location near the TTC would be favorable. In addition, the survey solicited advice for TTC planners regarding aviation interests to consider when planning the priority and non-priority corridor alignments. Although the survey respondents offered a wide variety of comments and suggestions, their responses revealed some consistent observations.

Several of the survey questions solicited open-ended, short-answer responses. Rather than asking the respondents to rank the importance among several choices that had previously been identified, the short-answer questions allowed respondents to identify opportunities, challenges, and planning recommendations of their own. For several of the questions, many respondents listed more than one opportunity, challenge, or recommendation. A sample of the survey questionnaire is included in Appendix A. The following is a summary of the advice and concerns reported by the seventy-six survey respondents.

3.1.1. Respondent Characteristics

The survey was distributed to approximately 500 conference attendees during the 22nd Annual Texas Aviation Conference held in Austin, Texas, in April 2004. Although the aviation community expressed interest in the implications of the TTC on Texas airports, only 20 completed surveys were returned by the conclusion of the conference. To improve response rates, the survey was distributed to a ten-member advisory panel assembled to review and assess the findings of the research. In addition, with the aid of the Texas Department of Transportation (TxDOT) Aviation Division, a mail out–mail back version of the survey was included in a TxDOT industry-wide mailing to Texas's aviation stakeholders. By the end of the survey period, a total of seventy-six usable surveys had been returned.

The survey asked the respondents to indicate their relationship or affiliation with Texas aviation. The majority of the respondents (76 percent) represented a particular airport administration or airport operations position. Approximately 36 percent of the respondents represented a government agency (at any government level), 9 percent were from an aviation association, council, or committee, 4 percent were from consultant companies, and 4 percent indicated "other." Some of the respondents were affiliated with more than one aviation entity, so the percentages do not sum to 100.

Respondents associated with a particular airport administration and/or operations were asked to indicate whether their airport is located near one of the proposed TTC corridors based on a map of the early conceptual TTC plan. Although the term "near" is subjective, approximately 58 percent of airport administration/operations respondents indicated they were near at least one of the TTC corridors. Twenty-five percent of respondents indicated they were not near a TTC corridor, while a remaining 17 percent indicated they were not sure.

Approximately 94 percent of the airport administration/operations respondents represented general aviation. Twenty-two percent represented general aviation/transport airports, 52 percent were from general aviation/general utility airports, and 20 percent represented general aviation/basic utility airports. Two percent of the respondents were from primary commercial airports and 5 percent represented reliever airports.

3.2. Potential Opportunities for Texas Airports

The survey asked respondents to identify the potential opportunities and/or benefits for airports operating near the TTC. A summary of the potential opportunities and the associated response rates are included in Table 3.1. It is important to note that many of the survey respondents identified more than one potential benefit to airports operating near the TTC, while approximately 8 percent of respondents indicated that airports would not realize any benefits at all. A large number of survey respondents (but certainly not all) believed that their airport could realize some indirect benefits from the construction of the TTC.

Table 3.1 Survey results—Potential opportunities for airports operating near the TTC

Opportunity	Response Rate
Increased airport usage and growth	61%
Increased economic development	42%
Enhanced airport access	24%
Improved freight movement	16%
Improved intermodal operations	12%
Development of aviation-compatible land uses	5%
No foreseeable benefits	8%

The majority of respondents (61 percent) identified increased airport usage and airport growth as a potential opportunity for Texas airports. More specifically, they anticipated that the TTC's indirect benefits could conceivably result in an increase in the number of aircraft based at the airport, the number of daily aircraft operations, ground leases for hangars, and fuel sales. Increased airport usage would generate more revenue for the airport. Respondents indicated that general aviation airports could realize an increase in corporate, commuter, and other business aviation activity in addition to attracting more industry to the airport. Suppliers and manufacturers engaged in North American Free Trade Agreement (NAFTA) traffic may choose to locate at airports near TTC routes. Although the mode share of air is small for NAFTA trade by value and even smaller for trade by weight, sharing a border with Mexico positions Texas airports with an advantage to accommodate a high percentage of available NAFTA airfreight. U.S. carriers truck commodities across the Mexican border to one of the large airfreight airports in Texas, such as San Antonio International, Dallas/Fort Worth International, or Houston's George Bush Intercontinental. The TTC will allow for faster truck hauling of NAFTA commodities to these international gateway airports. In addition, foreign trade zones located at select Texas airports may be better utilized if located near a TTC route.

Approximately 42 percent of survey respondents identified opportunities for increased economic development within an airport's service area located near the TTC. Many of Texas's smaller communities view local general aviation airports as a significant element in both interacting with the larger economy and attracting new industry. The TTC will create new jobs and business opportunities that will result in more demand for aviation services.

An important benefit of the TTC, if effectively integrated with general aviation airports, is that it could offer improved regional access for freight and passenger movements. Approximately 24 percent of survey respondents identified enhanced access to airports as a potential benefit to airports operating near the TTC. This improved ground access might also include shorter travel times between the airport and the homes or workplaces of airport users, because travel time is an important consideration when general aviation users decide where to base their activities. Improved ground access could also expand an airport's market area, especially when it makes intermodal transportation connectivity available. Improved user access to airports will contribute to increased airport usage, as described above. However, for an airport to reap the benefits afforded by efficient, noncongested landside access, it must be located near one of the TTC's access points.

The TTC could provide specific opportunities for intra-Texas freight movement. Approximately 16 percent of survey respondents identified potential opportunities for enhanced freight movement. The TTC will provide new trucking corridors and rail alternatives for rapid freight movement in Texas. Texas's cargo airports located near the TTC could become important airfreight transshipment centers.

An additional opportunity identified by 12 percent of survey respondents includes improved intermodal transportation operations. Airports located near key TTC nodes can prove to be key transshipment centers between air and ground modes. Amenities such as passenger rail stations at Texas's major airports or improved trucking facilities on airport property will facilitate integration of airports with the ground-based transportation modes for passenger and cargo movement.

Approximately 5 percent of survey respondents indicated that the TTC could promote the development of aviation-compatible land uses. The TTC could act as a land-use buffer between airport property and land uses sensitive to aviation activities, such as residential neighborhoods. Several respondents suggested the creation of industrial parks or other aviation-compatible land uses on unused aviation property located near the TTC.

3.3. Potential Challenges to Texas Airports

In addition to identifying the potential opportunities for airports operating near the TTC, the survey requested that respondents identify the potential negative impacts. Many of the survey respondents were concerned about the negative impacts that could be created by the TTC. Its most striking element is the proposed width, which is almost without parallel in human history. If the TTC is constructed according to plan, then it will undoubtedly generate substantial land-use impact, which may be detrimental to Texas's general aviation airports. The geometric design requirements of the high-speed rail will make it very difficult for planners and engineers to weave the TTC alignments in order to avoid impact to sensitive environmental features and existing development. The potential threats to airports operating near the TTC identified in the surveys are included in Table 3.2. While many respondents identified more than one foreseeable challenge to airports, approximately 34 percent of respondents indicated that there was no foreseeable impact to airports operating near the TTC.

Table 3.2 Survey Results – Potential challenges to airports operating near the TTC

Challenge	Response Rate
Airport growth restrictions	22%
Reduced aviation demand or increased competition	18%
Environmental concerns	17%
Infringement on approaches or approach procedures	16%
Safety and security concerns	14%
Limited or inconvenient accessibility to the TTC	13%
No foreseeable impacts	34%

Approximately 22 percent of survey respondents indicated that the TTC and surrounding development could restrict future airport growth. TTC alignments positioned too close to existing airports could physically restrict future airport growth by taking land that would belong to restrictive zones. Development on or near airport properties could also prevent future runway extensions, thereby preventing the airport from accommodating larger aircraft or acquiring an instrument approach such as an instrument landing system (ILS) or precision approach radar (PAR). Airports wishing to initiate airfreight or scheduled passenger services require runways capable of accommodating fully loaded freight aircraft and all-weather operating capabilities.

Survey respondents (18 percent) expressed concern about the reduction of aviation demand as a result of the TTC. The introduction of high-speed rail and dedicated trucking routes through Texas will introduce new sources of competition by non-air modes for passenger and rapid freight movement. Thus, the diversion of passengers or freight from air to land-based modes could reduce the demand for general aviation and commercial air service. Intra-Texas, short-haul air cargo may be replaced by land-based modes because the TTC will offer a less expensive alternative than air for high-speed freight transport. The role of trucking in air cargo is expected to increase as the TTC offers new dedicated truck routes. Air cargo will be trucked from its origin to one of Texas's major gateway airports where it will be loaded onto an aircraft and flown to domestic or international markets. Smaller freight airports not positioned as international gateway airports may experience reduced demand as a result of the TTC.

In addition to reduced aviation demand, approximately 17 percent of survey respondents identified environmental concerns as an additional challenge to Texas airports operating near the TTC. While TTC proponents expect the new network to generate economic development along its routes, development of noise-sensitive areas incompatible with aviation activities could lead to strong public opposition to airport growth. The development of commercial and residential areas will lead to increased noise sensitivity, making it more challenging for future airport expansion. Additionally, airports located at key nodes along the TTC can be expected to experience growth in aviation demand. Increased airport volumes, however, will elevate noise levels as the number of aircraft operations increase. By circumventing cities, the TTC will divert hazardous materials from Texas cities. Several respondents, however, expressed concern about potential chemical spills along the TTC that could affect airport operations.

Approximately 16 percent of respondents indicated that the TTC could infringe on important airport approaches or approach procedures. Careful planning to prevent the infringement of protected airspace or runway protection zones will be required to ensure that the TTC does not endanger the utility of existing airports. Structures built in the corridors' rights-of-way could create hazards to nearby aviation. Tall utility poles, for example, penetrating one of the imaginary surfaces at an airport would affect aviation operations.

Similar to airside safety concerns regarding the protection of airport approaches, approximately 14 percent of survey respondents indicated that the TTC may present additional landside safety and security concerns for airports operating near the TTC. Vehicular traffic operating on the TTC near an airport may cause safety concerns as drivers watch departing or landing aircraft rather than the road. Increased traffic near an airport could prompt additional heightened security concerns if the airport is more visible to passersby. Several respondents also identified the potential for increased drug smuggling and vandalism at airports operating near the TTC.

A final challenge to Texas airports operating near the TTC, as identified by approximately 13 percent of survey respondents, is the impact of limited or inconvenient accessibility from the TTC to airports. The TTC could diminish the utility of existing airports by removing local accessibility and connectivity. Texas aviation stakeholders expressed concern that close proximity to the TTC does not ensure access, because planned access to the TTC is limited. As a result, airports with remote or inconvenient connections to the TTC will not be well integrated. Similarly, the TTC potentially could limit user accessibility to general aviation airports from surrounding communities by severing existing access roads or by increasing congestion on key access facilities. This will either force the airport users to shift to a different airport that is easier to access or new access facilities will need to be constructed to connect the airport to the population center.

3.4. Suggested Planning Considerations

After asking the respondents to identify the potential opportunities and challenges to Texas airports, the survey asked for recommendations regarding important airport interests that TTC planners should consider when planning the corridor's alignment. The planning considerations and their associated response rates provided by the survey respondents are included in Table 3.3. Although not all survey respondents included recommendations, many respondents included more than one planning consideration for TTC route choice.

Table 3.3 Survey results – Airport interests to consider when planning the TTC

Planning Consideration	Response Rate
Provide connectivity and accessibility between TTC and airports	45%
Protect airspace and instrument approach procedures	32%
Allow for future airport growth	21%
Consider potential impact on aviation safety and security	7%
Consider the needs of the differing types of aviation activity	7%
Consider the impact of local population growth on aviation	5%
Interact with the aviation community	4%
Plan for aviation-compatible land uses surrounding airports	3%
Minimize environmental impact	3%

As one can see, the planning considerations to integrate Texas airports into the TTC are similar to the areas identified as opportunities and challenges to Texas airports. The recommendations suggested by the survey respondents are intended to maximize the potential opportunities for Texas airports operating near the TTC while minimizing any undesirable impact.

Many of the survey respondents reiterated the importance of integrating airports into the TTC network. The aviation stakeholders identified the Texas aviation system as a critical transportation asset and an integral component of the national transportation system. As a result, the benefits of the TTC will be heightened by integrating the aviation system with the land-based transportation modes. Approximately 45 percent of the respondents suggested that TTC planners provide adequate connectivity and accessibility between the TTC and airports. Recommended accessibility considerations include prominent signage and simple directions for travel between the TTC and airports operating within a reasonable radius of the TTC. Additional accessibility considerations include access for public transportation and facilities to accommodate heavy freight trucks to established air cargo airports.

Thirty-two percent of survey respondents expressed the need to protect the airspace and the instrument approach procedures at airports operating near the TTC. Protecting airspace and instrument approach procedures includes limiting the proliferation of cell phone and other utility towers located within the utility corridor of the TTC. When determining the required distance between a TTC structure and an existing airport, TTC planners should consider both the existing and proposed protected airspace requirements to allow for future airport growth.

Approximately 21 percent of survey respondents suggested that TTC planners consider future airport expansion when designing TTC alignments. Many respondents suggested that the TTC be close enough to provide adequate connectivity and accessibility while maintaining enough distance to prevent airport growth restrictions. An additional 5 percent of respondents suggested that planners consider the impact of local population growth on aviation. While increased economic development in communities along the TTC is expected to generate increased aviation demand, development of land uses incompatible with aviation will make it more difficult for an airport to expand to meet new demand. Approximately 3 percent of survey respondents recommended that consideration be given to aviation-compatible land-use zoning surrounding airports.

To integrate the aviation system into the TTC, survey respondents (7 percent) suggested that TTC planners interact with the aviation community when designing the TTC routes.

Interaction with the aviation community, including the Federal Aviation Administration (FAA) and the TxDOT's Aviation Division will be important to maximize the benefits of airport integration while minimizing the potential impact on the aviation system.

Additional planning consideration cited by 7 percent of survey respondents included studying the impact of the TTC on airport safety and security. Further suggestions included that TTC and aviation planners consider the needs of different types of aviation activity operating near the TTC. For example, the accessibility needs of a general aviation airport operating near the TTC will differ from the needs of a major commercial airport operating within an urban area connected to the TTC. The potential for strategically located airports to develop air cargo services or the feasibility of connecting high-speed rail or dedicated truck routes to the airport should also be evaluated.

Chapter 4. Physical and Operational Challenges to Airports

4.1. Physical and Operational Airport Requirements

Obstruction clearance requirements protecting the airspace around airports help ensure safe air operations. It is also important to protect the surrounding airspace against new obstruction growth or development that could render an airport unusable. Federal Aviation Regulations, Part 77, *Objects Affecting Navigable Airspace* (14 CFR Part 77) protects publicly-owned and/or public-use airports from the development of nearby obstructions. In addition, the Federal Aviation Administration (FAA) Order 5190.6A, Airports Compliance Handbook requires all airports receiving federal grant funding to operate and maintain their airport facilities according to FAA standards and obtain FAA permission to sell or donate land. Guidelines defining FAA standards on airport obstructions, protected areas around runways, and object-free areas are contained in FAA Advisory Circular 150/5300-13, Airport Design. The clearance requirements apply to all objects of natural growth, terrain, permanent or temporary construction, transportation, and equipment, as well as to any height alteration of a permanent of temporary structure within the specified airspace limits. Additionally, the Airport Zoning Act specifies zoning regulations around Texas airports that can be enforced by Texas municipalities or counties to protect against airport hazards. This chapter summarizes the federal and state airspace and airport protection measures that are crucial to airport operations. The chapter concludes with some recommendations and a simple rule of thumb intended to help Trans-Texas Corridor (TTC) planners minimize potential impact to Texas airports.

4.1.1. Objects Affecting Navigable Airspace

Obstruction clearance requirements protecting the airspace around airports help to ensure safe air operations. It is also important to protect the surrounding airspace against new obstruction growth or development that could render an airport unusable. Federal Aviation Regulations, Part 77, Objects Affecting Navigable Airspace (14 CFR Part 77) protects publicly-owned and/or public-use airports from the development of nearby obstructions. An airport receiving federal grant funding is obligated to maintain and operate its airport facilities safely, efficiently, and in accordance with the policies and guidelines of the FAA.13

Federal aviation regulations define five civil airport imaginary surfaces that characterize the protected airspace around a runway (Figure 4.1). An object that penetrates any of the imaginary surfaces constitutes an obstacle to air navigation. An obstruction that an airspace study determines would substantially affect the safe passage of an aircraft is considered a hazard.[14] Construction of an object that penetrates an imaginary surface requires FAA notification and could result in the FAA raising the approach visibility minimums or canceling the approach, both of which are unacceptable impacts to airport operations. The five approach surfaces, illustrated in Figure 4.1, are defined as follows:[15]

- Primary surface: A surface that is longitudinally centered on the runway with width based upon runway approach. Widths vary from 250 feet to 1,000 feet. For runways with specially prepared hard surfaces, the primary surface extends 200 feet beyond each runway end. Otherwise, the surface ends at the runway's end.
- Horizontal surface: A horizontal plane 150 feet above the established airport elevation. The perimeter of the surface is constructed by swinging arcs of specified radii from the center of each primary surface's end and connecting the arcs with straight lines. The radii of the arcs vary according to runway approach visibility.
- Approach surface: A surface that is longitudinally centered on the runway and extending outward and upward from the end of the primary surface. The length, width, and slope of the approach surface is based on the type of approach and applied to both ends of each runway. The inner edge width is equal to the primary surface width, and the outer edge width varies from 1,250 feet to 16,000 feet. The length can be either 5,000 feet or 10,000 feet.
- Conical surface: An inclined surface that extends outward and upward from the perimeter of the horizontal surface at a slope of 20 to 1 for a horizontal distance of 4,000 feet.
- Transitional surface: Inclined planes that extend outward and upward from the sides of the primary and approach surfaces at a slope of 7 to 1. Transitional surfaces that project beyond the limits of the conical surface extend for a horizontal distance of 5,000 feet from the edge of the approach surface.

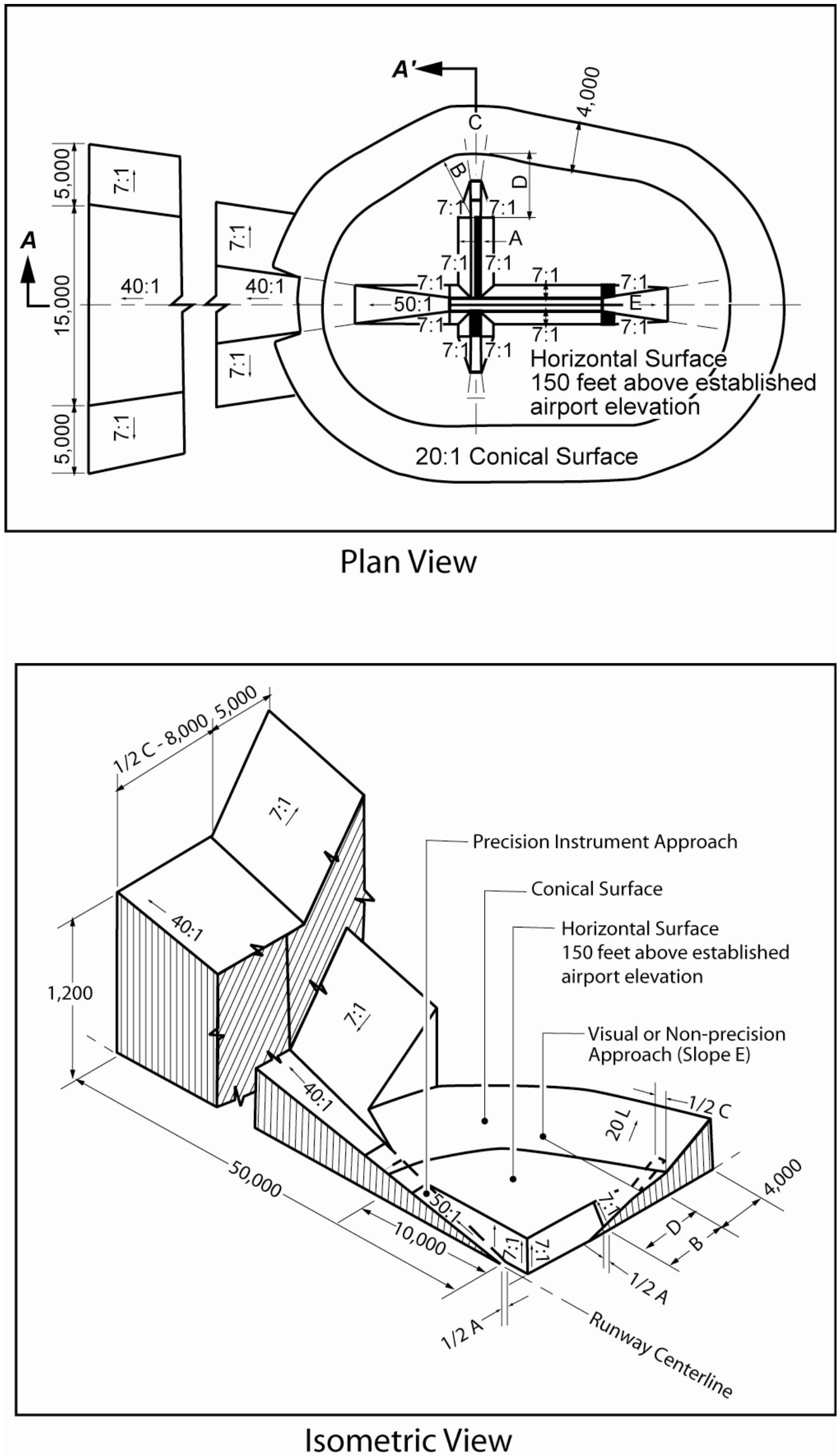

Figure 4.1 FAA imaginary surfaces. Plan view and isometric view of A-A.

The type of approach procedure implemented or planned for a runway determines the dimensions of each imaginary surface (Table 4.1). For example, the design slope for a precision instrument approach starts 200 feet beyond the end of a paved runway at 50:1 for the inner 10,000 feet and 40:1 for an additional 40,000 feet.[16] For runways without a specially prepared hard surface (such as a turf strip), the approach slope begins at the runway's end. For visual runway approaches that do not utilize instrumentation, the design slope of the approach surface is 20:1. Because a slope of 50:1 is the most conservative design approach used for defining approach imaginary surfaces and because an airport's function and required design standards change over time, the 50:1 design slope should be used when planning TTC alignments to provide the maximum protection of airspace.

Table 4.1 Dimensional standards for civil airport imaginary surfaces

<table>
<tr><th rowspan="4">DIM</th><th rowspan="4">ITEM</th><th colspan="6">Dimensional Standards (Feet)</th></tr>
<tr><th colspan="2">Visual Runway</th><th colspan="3">Non-Precision Instrument Runway</th><th rowspan="3">Precision Instrument Runway</th></tr>
<tr><th rowspan="2">Utility</th><th rowspan="2">Larger than Utility</th><th rowspan="2">Utility</th><th colspan="2">Larger than Utility</th></tr>
<tr><th>X</th><th>Y</th></tr>
<tr><td>A</td><td>Width of primary surface and approach surface width at inner end</td><td>250</td><td>500</td><td>500</td><td>500</td><td>1,000</td><td>1,000</td></tr>
<tr><td>B</td><td>Radius of horizontal surface</td><td>5,000</td><td>5,000</td><td>5,000</td><td>10,000</td><td>10,000</td><td>10,000</td></tr>
<tr><td rowspan="3"></td><td rowspan="3"></td><th colspan="2">Visual Approach</th><th colspan="3">Non-Precision Instrument Approach</th><th rowspan="3">Precision Instrument Approach</th></tr>
<tr><th rowspan="2">Utility</th><th rowspan="2">Larger than Utility</th><th rowspan="2">Utility</th><th colspan="2">Larger than Utility</th></tr>
<tr><th>X</th><th>Y</th></tr>
<tr><td>C</td><td>Approach surface width at end</td><td>1,250</td><td>1,500</td><td>2,000</td><td>3,500</td><td>4,000</td><td>16,000</td></tr>
<tr><td>D</td><td>Approach surface length</td><td>5,000</td><td>5,000</td><td>5,000</td><td>10,000</td><td>10,000</td><td>*</td></tr>
<tr><td>E</td><td>Approach slope</td><td>20:1</td><td>20:1</td><td>20:1</td><td>34:1</td><td>34:1</td><td>*</td></tr>
</table>

X - Visibility minimums greater than 3/4 mile
Y - Visibility minimums as low as 3/4 mile
* - Precision instrument approach slope is 50:1 for inner 10,000 feet and 40:1 for an additional 40,000 feet
Source: Federal Aviation Regulations, Part 77, Objects Affecting Navigable Airspace

A visual runway is one intended for visual approach procedures with no instrumentation. A utility runway is one constructed for use by propeller driven aircraft weighing 12,500 pounds or less. A nonprecision instrument runway has limited horizontal or area-wide instrument guidance. A precision instrument runway is fully equipped for instrument approaches with an instrument landing system (ILS) or a precision approach radar (PAR). The Texas Airport System Plan (TASP) 2002 identifies the number of public airports in the state by service level and associated design standards (Table 4.2 and Table 4.3).

Table 4.2 Texas Airport System Plan inventory by service level and role classification

Service Level	Airport Role/Design Standards	Number in TASP*	Approach Procedure
Primary Commercial Service	Transport	27	Precision Instrument Approach
Non-Primary Commercial Service	Transport	0	Precision Instrument Approach
Reliever	Transport or General Utility	23	Non-Precision Instrument Approach**
General Aviation	Transport	59	Non-Precision Instrument Approach**
General Aviation	General Utility	125	Non-Precision Instrument Approach
General Aviation	Basic Utility	66	Visual Approach
General Aviation	Heliport	3	NA

* Includes airports currently meeting standards plus those proposed to be upgraded or constructed to those standards in the next 20 years.
** In some cases, a precision approach may be justified depending on the volume and type of activity.
Source: Texas Airport System Plan Update 2002

Table 4.3 Texas Airport System Plan minimum design standards

	Commercial Service		General Aviation		
	Primary	**Non-Primary**	**Transport**	**General Utility**	**Basic Utility**
Airport Design	Transport	Transport	Transport	General Utility - Stage I or II	Basic Utility - Stage I or II
Design Aircraft	Heavy transport	Light transport, business jet	Business jet	Light twin, turboprop, light business jet	Light twin and single piston
Landing Area	As required by hub size	136 acres	136 acres	62 or 40 acres	36 acres
Approach Area	As required by hub size	160 acres	160 acres	60 or 50 acres	50 acres
Building Area	As required by hub size	24 acres	24 acres	24 or 12 acres	12 acres
Runway Length*	As required by critical aircraft	5,000 ft	5,000 ft	5,000 ft or 4,000 ft	3,200 ft
Runway Width	As required by critical aircraft	100 ft	100 ft	75 ft or 60 ft	60 ft
Approach Type	Precision	Precision	Precision	Non-precision	Visual
Visibility Minimums	200 ft - 1/2 mile	200 ft - 1/2 mile	400 ft - 3/4 mile straight-in	No minimum standard	Not applicable

* Runway length is based on sea level and increases at higher altitudes: see FAA Advisory Circulars 150/5300-13 and 150-5325-4.
Source: Texas Airport System Plan 2002.

The following examples identify possible scenarios within the TTC design and discuss how to calculate the required distance the structure would have to be placed from the TTC to avoid penetrating an imaginary surface.

Example 1: A doublestack freight train requires a clearance of 23 feet from the top of the rails. Therefore, at a slope of 50 to 1 that begins 200 feet beyond the end of the paved runway surface, the alignment of a freight rail line would have to be at least 1,350 feet away from a precision instrument approach runway to avoid penetrating an approach surface. Construction of a rail line at this distance, however, would fall within the runway protection zone (RPZ) (2,700 feet from end of the runway). Therefore, the requirement to protect the RPZ, rather than the approach surface, will govern the minimum distance the TTC doublestack freight rail line can be from the end of the nearest runway.

Example 2: Grade-separated bridge structures will allow existing rail lines and roadways, including farm to market highways, two-lane state highways, and paved county roads, to cross the TTC. To avoid penetrating an imaginary surface, the bridge structures must be placed far enough away from a runway to provide the clearance for all vehicles traversing the TTC, the adjustment for the height of the bridge structure itself, and the accommodation for vehicles traveling on the grade separated facility. As a worst case scenario, suppose the required bridge clearance is 23 feet from the top of the rails to the lowest component of the bridge structure (to allow for doublestack trains traveling along the TTC), an existing rail line accommodating doublestack trains requiring an additional height clearance of 23 feet from the top of the rails is grade separated, and the bridge structure itself is 10 feet. The total required clearance of the grade-separated bridge structure is 56 feet. As a result, the bridge structure would need to be placed at least 3,000 feet away from a PAR (to include the additional 200 feet required between the runway's end and the beginning of the 50:1 approach surface). In this example, the minimum distance required to protect the runway approach surface will exceed the RPZ dimension.

In accordance with 14 CFR Part 77.13, the FAA requires notice of any proposed construction or alteration with height greater than 200 feet from ground level or construction that would extend above the following imaginary surfaces extending upward and outward from the nearest point of the nearest public-use runway:

- 100 to 1 slope over a 20,000 foot horizontal distance for public-use airports with at least one runway greater that 3,200 feet in length;
- 50 to 1 slope over a 10,000 foot horizontal distance for public-use airports with all runways less than 3,200 feet in length; and
- 25 to 1 slope over a 5,000-foot horizontal distance for public-use heliports.[17]

For highways, railroads, and other traversable construction, notice must be given if, adjusted upward by 17 feet for interstate highways; 15 feet for other public-use roadways; and/or 23 feet for railroads, if the height of construction exceeds 200 feet or extends higher than an imaginary surface described above.[18] FAA Form 7460-1 must be completed and submitted to the manager of the Air Traffic Division within the FAA Regional Office having jurisdiction over the proposed construction area. It is important to draw a distinction between the imaginary surfaces described here, requiring FAA notification of proposed construction, and the five civil imaginary surfaces previously described that affect approaches and approach procedures. The imaginary surfaces requiring notice of construction are extra conservative, do not affect approaches and approach procedures, and should not be used to determine how close and tall an object can be to the end of a runway.

4.1.2. Runway Protection Regulations

Guidelines defining FAA standards on airport obstructions, RPZs, and object free areas (OFAs) are contained in FAA Advisory Circular 150/5300-13, Airport Design (AC). The clearance requirements apply to all objects of natural growth, terrain, permanent or temporary construction, transportation, and equipment, as well as to any height alteration of a permanent or temporary structure within the specified airspace limits.[19] The airport design standards depend upon approach visibility minimums, type of landing approach, size of aircraft using the runway, and runway length. As a result, the required dimensional standards for RPZs and OFAs vary depending upon an airport's operational characteristics (Table 4.4). The maximum required horizontal distance of the RPZ for an airport with a precision approach and visibility minimums lower than three quarters of a mile is 2,500 feet.

Airports receiving federal grants are required to comply with standards defined in the AC. Within the AC are standards protecting certain areas on or near an airport from all objects except those with a certain function, composition, and/or height.[20] These areas include RPZs, OFAs, runway and taxiway safety areas, obstacle free zones (OFZs), thresholds, critical areas for navigational aids (NAVAIDS), and the aforementioned imaginary surfaces described in 14 CFR Part 77. The AC also requires that all airport layout plans illustrate a building restriction line

(BRL). The BRL encompasses the RPZs, the OFAs, the runway visibility zone, critical NAVAID areas, instrument procedure areas, and the airport traffic control tower clear line of sight. Areas outside of the BRL are identified as suitable building locations.

Intended to enhance the protection of people and property on the ground, runway RPZs are trapezoidal areas centered on the runway's centerline and located 200 feet beyond the usable ends for takeoff or landing. The RPZ dimension for a particular runway end depends upon the type of aircraft using the runway and the approach visibility minimums associated with the runway end (Table 4.4). An RPZ's length varies from 1,000 feet to 2,500 feet and its width varies from 250 feet to 1,750 feet. The RPZ is composed of two components: the controlled activity area and a portion of the runway object free area (ROFA). The ROFA is a rectangular area surrounding the runway centered on the runway centerline. The width of the ROFA varies from 250 feet to 800 feet depending on aircraft size and approach visibility minimums.[21] The length of the ROFA also depends upon aircraft size and approach visibility minimums and varies from 240 feet to 1,000 feet beyond the runway's end. Airport owners must have positive control over development within the RPZ and are encouraged to own the property under the runway approach and departure areas to at least the limits of the RPZ (FAA Advisory Circular 150/5300-13).

Table 4.4 Runway Protection Zone Dimensions

Approach Visibility Minimums*	Facilities Expected To Serve	Dimensions			
		Length, L (feet)	Inner Width, W1 (feet)	Outer Width, W2 (feet)	RPZ Area (acres)
Visual and Not lower than 1-Mile	Small Aircraft Exclusively	1000	250	450	8.035
	Aircraft Approach Categories A & B	1000	500	700	13.77
	Aircraft Approach Categories C & D	1700	500	1010	29.465
Not lower than 3/4-Mile	All Aircraft	1700	1000	1510	48.978
Lower Than 3/4-Mile	All Aircraft	2500	1000	1750	78.914

* The RPZ dimensional standards are for the runway end with the specified approach visibility minimums. The departure RPZ dimensional standards are equal to or less than the approach RPZ dimensional standards. When an RPZ begins other than 200 feet beyond the runway end, separate approach and departure RPZs should be provided.

The two-dimensional OFA includes the ROFA, the taxiway and taxilane OFA, and the precision object free area (POFA). The taxiway and taxilane OFAs are centered on their respective centerlines and vary in width according to the airplane design group using the runway. The widths for taxiway and taxilane OFA range between 89 and 386 feet, and 79 and 334 feet, respectively. The POFA applies to runways with instrument approach procedures visibility minimums less than three quarters of a mile. Beginning at the runway threshold, the POFA is 200 feet long and 800 feet wide. All non-essential objects for air navigation or aircraft ground maneuvering are required to be cleared from the OFA. Where sufficient land is available, however, the runway end safety area may be extended up to 3,000 feet in length and 2,000 feet in width.[22]

Runway and taxiway safety areas must be cleared of all objects except those serving a function. In addition, the safety areas must be graded such that no potentially hazardous bumps or depressions exist on the ground's surface. The most common obstructions found in runway safety areas are roadways varying from small airport service roads to major interstate highways. In order to meet the FAA approach slope clearance requirements, the roads and highways may need to be depressed. Road depressions, however, may be hazards to aircraft that overrun or undershoot the runway. Major highways within the 3,000-foot extended safety area should be depressed and bridged with a structure capable of supporting the largest aircraft using the airport. If this is impractical, gradual slopes should replace steep embankments and all surface obstructions, such as light poles or signage, should be removed.

Three-dimensional OFZs also require clearing of objects, but are more applicable to objects interfering with airspace. Proposed construction violating an OFZ would also be in violation of the OFA. The threshold is also a three-dimensional volume indicating the beginning portion of runway available for landing aircraft. The shape, dimensions, and slope of the surface used to locate a threshold depends upon the type of aircraft using or planning to use the runway, landing visibility minimums, and the type of approach instrumentation available.

FAA Advisory Circular 150/5300-13 also describes critical areas for NAVAIDS and air traffic control (ATC) facilities. NAVAIDS and ATC locations influence airport planning and installation requires FAA assistance. Proposed construction limiting the effectiveness of NAVAIDS or interrupting the ATC line of sight would substantially impair or cripple airport operations.

4.2. Recommendations

While the TTC could produce significant opportunities for Texas's commercial service and general aviation airports, its planners need to understand the benefits of integrating airports into the TTC's multimodal design. This includes designing the TTC so it minimizes any impact that could threaten the usefulness of airports by developing preferred alignments that will accommodate present and future airport needs and enhance the multimodality of the TTC. The following guidelines were developed to help planners effectively integrate airports into the overall TTC design.

4.2.1. Protect Existing and Planned Runways

TTC planners should be made aware of the unique design standards that protect an airport's air and ground operations, which are based on the airport's existing and planned approach visibility minimums, the type of landing approach, the size of aircraft using the runway, and runway length. Because the required dimensional standards for RPZs and OFAs will vary, depending on an airport's operational characteristics, the TTC planners should make their initial alignment decisions using a simple rule of thumb. Although it is not based upon FAA requirements or state laws, the rule of thumb being proposed is that the TTC should not come within *one mile* of an airport. The universal application of this rule to all public-use airports will prevent undesirable safety and operational impact, though in some cases it is more stringent than may be necessary. This proposed separation distance between airports and TTC alignments is based upon the maximum required horizontal distance (2,500 feet) of the runway protection zone for an airport with a precision approach and visibility minimums lower than three-quarters of a mile (FAA Advisory Circular 150/5300-13). This rule also allows for adjustments to the horizontal distance of the runway protection zone, should there be future runway extensions and/or changes to the airport's design requirements. If the TTC planners are unable to identify an alignment located farther than one mile from an airport, they will need to evaluate the proposed alignment's compliance with existing federal and state laws. The TTC planners need to ensure that all proposed alignments meet FAA guidelines and the airport's master plan, which identifies future runway extensions, approach adjustments, and/or design standard changes. When further evaluation is warranted, planners should consult the Aviation Division at the Texas Department of Transportation (TxDOT) to acquire information about each airport's long-term plans.

4.2.2. Prevent Airspace Obstructions

Enforced by federal regulations, obstruction clearance requirements protect the airspace around publicly owned and/or public-use airports and ensure safe air operations. It is also important to protect the surrounding airspace against new obstruction growth or development that could render an airport unusable. The clearance requirements apply to all objects of natural growth, terrain, permanent or temporary construction, transportation, and equipment, as well as to permanent or temporary structure height alteration within the specified airspace limits (Advisory Circular 150/5300-13). An airport receiving Federal grant funding is obligated to maintain and operate its airport facilities safely, efficiently, and in accordance with the policies and guidelines of the FAA (Order 5190.6A).

Federal aviation regulations define five civil airport imaginary surfaces that characterize the protected airspace around a runway. The type of approach procedure implemented or planned for a runway determines the dimensions of each imaginary surface (Title 14 Part 77). For example, the design slope for a precision instrument approach starts 200 feet beyond the end of a paved runway at 50:1 for the inner 10,000 feet and 40:1 for an additional 40,000 feet (Title 14 Part 77). For runways without a specially prepared hard surface (such as a turf strip), the approach slope begins at the runway's end. An object that penetrates any of the imaginary surfaces constitutes an obstacle to air navigation. An obstruction that an airspace study determines would substantially affect the safe passage of an aircraft is considered a hazard. Construction of an object that penetrates an imaginary surface requires FAA notification and could result in the FAA raising the approach visibility minimums or canceling the approach, both of which are unacceptable impacts to airport operations. In most cases, adherence to the one-mile rule of thumb will prevent TTC construction from interfering with protected airspace.

4.2.3. Leave Adequate Room for Future Airport Growth

While the one-mile rule of thumb separation distance was developed to permit future runway extensions and airport growth, airport zoning regulations also protect the land surrounding existing airports. The Airport Zoning Act, passed in 1987 as part of the Texas Local Government Code, allows municipalities, counties, or joint airport zoning boards of multiple municipalities or counties to adopt and enforce zoning regulations that prohibit land uses incompatible with public-use airport operations and public safety. Airport zoning regulations may control land use outside of an airport’s boundaries within a rectangular area bounded by lines up to 1.5 miles from the centerline of a runway (minimum applicable runway length is 3,200 feet) and within five miles from each runway’s end.[23] Within this controlled, compatible land-use area, airport hazard area zoning regulations can specify the types of land uses permitted, regulate the type of structures, and restrict the height of structures and natural objects. Height-hazard zoning protects against penetrations to imaginary surfaces, while compatible land-use zoning protects against noise sensitive land uses that are not compatible with aviation. Airport zoning regulations may require a permit for any new structure construction. TTC alignments conflicting with adopted airport zoning ordinances require a request of variance from the municipality, county, or joint airport zoning board that enacted the ordinance.

Planning considerations and zoning protection to accommodate future airport growth are important for environmental reasons as well. Environmental impact often limits or prevents an airport from expanding. Airports often face strong public opposition to airport growth because of the potential disturbance of noise-sensitive areas. The TTC is expected to stimulate economic growth and development along its path. While economic development in communities surrounding airports promotes increased airport usage and growth opportunities, the airport will not be able to grow to meet this new demand if the airport is not protected against the development of noise sensitive land uses that are incompatible with aviation. The one-mile rule of thumb is intended to protect airports from physical and operational impact, while allowing for airport growth.

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[13] U.S. Department of Transportation. Federal Aviation Administration. Order 5190.6A, Airports Compliance Handbook. 1989

[14] U.S. Department of Transportation. Federal Aviation Administration. Title 14Aeronautics and Space Part 77 Objects Affecting Navigable Airspace.. 8 Mar. 2004 <http://www.gpoaccess.gov/ecfr/>

[15] Ibid.

[16] Ibid.

[17] Ibid.

[18] Ibid.

[19] U.S. Department of Transportation. Federal Aviation Administration. Advisory Circular 150/5360-13, Planning and Design Guidelines for Airport Terminal Facilities. 1999

[20] Ibid.

[21] Ibid.

[22] Ibid.

[23] Texas Legislative Council. Municipal and County Zoning Authority Around Airports. Local Government Code, Subtitle C, Chapter 241. 1987

Chapter 5. Airport Connectivity and Accessibility

Texas's airports provide commercial and reliever services for passengers and cargo in the state's large population centers and general aviation services for its industrial, agricultural, and remote areas. User access to airports is vital to support these airport operations, promote favorable user perceptions, and ensure the efficient utilization of the Texas transportation system. Within this chapter, the authors intend to highlight the importance of adequate airport accessibility and summarize the planning process used in developing landside airport access plans. In addition, the authors present the important airport connectivity and accessibility issues on a statewide level, keeping in mind the number of Texas airports that potentially could be affected by the TTC as exhibited in Chapter 2. The chapter concludes with planning recommendations to ensure adequate airport connectivity and accessibility to the TTC.

5.1. Literature Review

5.1.1. Importance of Airport Access

Quality landside airport access is a principal concern to airports of all sizes because it allows for the transport of passengers, cargo, and airport employees to and from the airport. Nationwide literature indicates that a wide variety of landside access limitations affect airports of all sizes and locations. Landside airport access facilities are composed of two elements: off-airport roads and on-airport roads.[24] Off-airport facilities include highways, local streets, and public transit that connect the airport to the population it serves. Off-airport travel patterns for trips to and from an airport often depend on the locations of regional population and employment, tourist attractions, hotels, off-airport parking, and rental car facilities.[25] On-airport facilities include the terminal access roads, parking circulation, transit, and curbside facilities located on airport property, and provide the circulation and storage of people and vehicles.

Traffic and access road considerations depend on the proximity to the airport and the relative size and activity level of the airport.[26] For example, Dallas/Fort Worth International airport, with approximately 25 million annual passenger enplanements in 2002[27], requires dramatically different access considerations than a general aviation airport serving as few as 10,000 annual aircraft operations with no scheduled service. Vehicular access improvements are not limited to roads that are in proximity to the airport or to roads that provide direct airport access. Conversely, improved vehicular access to airports can be achieved through physical and operational changes to roads in regions that are far removed from the airport, as well as roads nearby and on-airport roads.[28]

There have been many studies performed discussing measures to improve both off-airport and on-airport access to commercial airports. Recommendations such as expanding public transportation services (rubber-tired and rail) to the airport, utilization of off-airport terminals, and initiating high-occupancy vehicle lanes on airport access roads discourage the use of the private automobile for airport access—one major contributing factor to congested airport roadways. Off-airport and some on-airport access plans and programs often require coordination between a large number of public and private agencies and must be consistent with regional and state short-term and long-term transportation plans.[29] One report, *Intermodal Ground Access to Airports: A Planning Guide,* was prepared for the Federal Highway Administration and Federal

Aviation Administration in 1996 to provide policy guidance, rules of thumb, data, and analytical techniques related to airport access.[30]

Airports are among the largest generators of people and traffic in metropolitan areas. Airport demand, however, is temporal in nature, varying by season, day of the week, and hour of the day.[31] Most airport-related trips are made by low-occupancy vehicles (primarily the personal automobile), placing significant demand on off-airport and on-airport roads. For short-haul trips, where the ratio of access time to overall trip time is high, the impact of poor access has maximum implications from a user perspective.[32] Travelers tend to perceive airport access as an integral part of the total air trip. The cost, time, reliability, convenience, and quality of airport access influence the demand for air travel and can affect a passenger's choice of departure (or arrival) airport when other alternatives are available.[33] Furthermore, the main advantage of air transport is speed, and its value diminishes as airport access time increases

General aviation includes all aviation activities other than military or commercial service operations. General aviation airports are important to many Texas industries including agriculture, mining, fishing, emergency services, and oil and gas exploration and production.[34] In addition, small, rural, and remote communities depend on general aviation for connectivity to the rest of the state, while larger urban areas rely on general aviation to relieve larger commercial airports and increase system capacity. Small rural communities are often more dependent on general aviation facilities than other communities. For example, access to general aviation facilities is essential to attract and maintain businesses so the community can remain competitive. General aviation is also critical to time-sensitive industries, such as agriculture, that has special needs and contributes greatly to the Texas economy.[35] Although general aviation is less visible and less widely understood than commercial air carriers, it is no less important to the Texas economy. Currently, there are 253 general aviation airports included in the Texas Airport System Plan[36] that supported 56,600 full-time jobs and accounted for almost $5.9 billion in total economic activity in Texas in 2001[37]. The general aviation concept, however, is not well understood because it is not marketed as widely as other products or services. As a result, general aviation airports are often overlooked and taken for granted despite playing vital roles in many communities.

5.1.2. Landside Access Planning Entities

The responsibility for the planning, development, and operation of landside airport access infrastructure is divided among a large number of public and private agencies. Airport access improvements are often locally initiated, and local agencies are responsible for project development.[38] Funding for airport access projects and review of proposed projects is performed by a variety of agencies at the local, state, and national level. Some of the planning organizations involved in airport access planning, however, are unfamiliar with the differences between the access needs of airports and the transportation needs of other land uses or do not view the airport as their most important concern.[39] Some of the agencies involved in landside airport access planning include:

- Federal Aviation Administration (FAA)
- Federal Highway Administration (FHWA)
- Federal Transit Administration (FTA)
- Texas Department of Transportation (TxDOT)

- Airport Authorities
- Local Government and Metropolitan Planning Organizations

5.1.3. Landside Access Planning Process

Similar to the planning process originally outlined in the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), development of airport ground access strategies requires eight steps.[40] The airport ground access planning cycle is broad in scope so it can be applied to the unique needs and characteristics of individual airports. The same planning process can be applied to solving the accessibility problems encountered when connecting the state's airports to the TTC. The following is a brief description of each of the eight steps.

Step 1: Define the Problem

Prior to evaluating an airport access system or determining a strategic plan to improve airport access, evaluators must identify the problems affecting landside access at the particular airport.[41] When defining the problem, it is important to identify the central policy issues faced by the airport, its unique characteristics, and the goals and objectives of the planning process. The problem definition will direct the focus of the data collection, performance analysis, and proposal of improvements performed in the remaining seven steps of the planning process.

Step 2: Establish Performance Measures

After identifying the landside access problems, goals, and objectives, evaluators establish performance measures with which to measure the success or failure of the airport access system. Although landside accessibility is a major concern for airports of all sizes, there is no generally accepted definition of what constitutes adequate ground access.[42] The perceived success of airport accessibility will vary among passengers (focusing on the cost, time, reliability, convenience and quality of airport access); airport and airline management (stressing operating and implementation costs); and the neighboring community (emphasizing environmental, noise, and traffic concerns). Performance measuring parameters may include total travel time, cost and volume for moving cargo and passengers, origins and destinations, capacity, accidents, ease of access, perceived quality, and the average time to transfer people or freight from one mode to another.[43]

Step 3: Collect the Data

Data collection efforts should include asset inventory and condition, airport activity, traffic demand, user characteristics, and anticipated changes in land use.[44] Airport access data are usually understood by examining a variety of data sources, including periodic ground access and passenger surveys, ridership and revenue data, regional trip models, the airport's master plan, enplanement data, and facility visits. Although the data collection step typically involves the collection of some new data, compilation of existing data also should be considered to avoid repeating efforts of the master plan or other previous work.[45]

Step 4: Understand Present Conditions and Performance

After evaluating the landside accessibility data, evaluators assess the existing airport access system and explore possible explanations for the problems identified in Step 1.[46] The data can provide insight into the system as a whole or by individual access modes or infrastructure components. Using the performance measures identified in Step 2 to evaluate the existing conditions, opportunities for future improvements can be identified.

Step 5: Forecast Future Conditions and Performance

Forecasts of future conditions, demand, and land use help planners to evaluate future system performance. The performance of the existing landside access system under forecasted demand allows planners to identify future problems and improvement opportunities.47 Forecasts of future conditions can include a multitude of time frames, such as 5, 10, or 20 years into the future.

Step 6: Develop Candidate Strategies and Actions

After identifying the deficiencies of the airport access system, evaluators develop a range of reasonable alternatives and suitable strategies for improving landside access performance that is consistent with the stated goals, objectives, and characteristics of the airport.[48] Typically, one general solution to improve all of the problems identified in Step 1 does not exist. Therefore, the candidate strategies, including a full range of possible solutions, are designed to ensure maximum success despite each alternative's inevitable limitations.

Access improvements can be categorized into three groups: transportation system management (TSM), transportation demand management (TDM), and physical improvements.[49] TSM and TDM are policy strategies that work with existing transportation facilities and services, including public transportation. TSM strategies strive to enhance airport access service to increase system capacity, while TDM strategies strive to reduce traffic demand, thereby decreasing the required system capacity. Physical improvements include construction or expansion of on-airport and off-airport roadways and extension of rail service to the airport. The best strategies often fall into more than one of the three categories and provide improvements to a variety of performance measures.

Step 7: Assess Effectiveness and Select Actions

Each of the alternative solutions are compared and weighed against the performance measures established in Step 2 to determine which strategy, or combination of strategies, would most effectively improve the airport access system. Each of the strategies must be evaluated for both feasibility (including cost of implementation and any land, legal, environmental, or social constraints) and potential effectiveness. Based on the feasibility and effectiveness of each strategy, planners prioritize the candidate strategies and select the optimal action that provides the most significant system improvement within a reasonable implementation cost and acceptable environmental and social impacts.[50]

Step 8: Monitor and Feedback

After implementing the selected actions, periodic assessment of the actions should be conducted to determine the effectiveness of the improvements and to ensure that the estimated conditions were sufficiently accurate. Performance evaluation results will provide guidance on the selection of effective strategies for future projects.

5.1.4. Off-Airport Access Road Considerations

The FAA's *Intermodal Ground Access to Airports: A Planning Guide* provides several planning guidelines for ensuring adequate off-airport access roads. The access routes to major airports should be considered from a regional perspective, meaning all routes serving the airport and the key links in the region's highway network should be included in the highway access network.[51] Proper navigation information, including signs, located along primary access routes and at important route decision points help motorists access the airport. Signs adhering to the guidelines in the *Manual on Uniform Traffic Control Devices (MUTCD)* should be provided on all appropriate interstate highways, state freeways, and selected principal arterial highways to direct motorists to major airports. Similarly, signs directing users to general aviation airports located along interstate highways or other principal arterial highways should be provided. As a rule of thumb, all roads feeding directly into an airport and all major roads intersecting the feeder roads within a radius of 10–25 miles from the airport should include signs directing airport users to the airport.[52]

5.1.5. Rail Access to Airports

To address mobility issues in congested urban areas and to improve multimodal transportation access to airports, larger airports sometimes consider the extension of rail service to the airport. Because of the high capital costs of connecting the airport to an existing or new rail system, airport-rail connectivity is not a viable option for most airports.[53] Even the most successful airport access rail service in the United States, serving some of the country's largest airports, typically carry less than 10 percent of originating and terminating passengers to and from the airport and traffic congestion on airport access roads to most U.S. airports continues to worsen.[54, 55] Six U.S. airports that have rail stops within walking distance of the airport terminal are Washington National, Atlanta Hartsfield, Boston Logan, Chicago O'Hare, Chicago Midway, and Philadelphia.[56] Nine U.S. airports with shuttle service to a rail station are Cleveland Hopkins, Washington Dulles, Baltimore Washington, Oakland, San Francisco, Lambert St. Louis, Fort Lauderdale/Hollywood, San Jose, and Burbank-Glendale-Pasadena.[57]

Rail connections to airports can be divided into three basic categories: intercity commuter rail, urban rail rapid transit, and intercity high-speed rail.[58] Commuter rail— carrying passengers on conventional freight railway—consists of special spur lines typically connected to a main station in the central business district (CBD) and provide connections to the existing regional rail network. Rapid transit systems (including light and heavy rail transit) are often coordinated components of the overall metropolitan transit system, connecting airport passengers and employees to all portions of the urban area serviced by the transit system. High-speed rail service to airports is available when spur lines connect the airport to the CBD and the rest of the regional high-speed rail network. High-speed rail access extends an airport's catchment area for passengers and employees located within service areas providing acceptable access times.[59]

The idea of complementing air and high-speed rail services at airports appeared in Europe in the mid-1980s. The first high-speed rail connection to an airport was completed in Lyon, France, in July 1994 servicing Charles de Gaulle airport.[60] Several months later, a high-speed rail connection linking three high-speed rail routes and servicing Charles de Gaulle airport began operation. Since that time, a multitude of other European airports, including Zurich, Munich, Frankfurt, London Gatwick, and Amsterdam Schiphol have successfully developed high-speed rail connections to airports. Two of the common characteristics leading to the success of European air-rail integration are the availability of connections to a wider national (and international) high-speed rail system and the transit-oriented population.[61] Both factors increase high-speed rail ridership.

Desirable Characteristics of Airport Rail Service and Stations

Regardless of the type of rail service (commuter rail, urban rail rapid transit, and intercity high-speed rail), the airport rail systems that attract the highest percentage of airport passengers and employees tend to have the same common characteristics. The desirable characteristics of rail serving an airport include:

- **Direct service** – Rail service allowing passengers and employees to travel between the airport and major activity centers (such as the CBD or tourist attractions) without making transfers or requiring too many stops. A 50 percent drop in ridership is expected to occur when passengers must switch trains and greater than 50 percent when required to transfer to bus.[62]
- **Frequent service** – Rail service that minimizes passenger waiting times by providing ten minute or less peak period headways offers reduced travel times and enhances the convenience of the system.
- **Extensive regional coverage and through service** – Airport rail systems that are part of a wider, national (or international) system of rail service and fed by local public transportation systems extend the airport's catchment area. Rail access that is fully integrated as part of a comprehensive regional transit system provides more mobility options than a single dedicated line between two end points (typically the airport and the CBD).
- **Available parking** – Overnight parking at the rail station is necessary for most trips. The availability of parking at off-airport stations will influence the rail ridership for airport access.

In addition to airport rail service, there are several common characteristics of airport rail stations that attract the highest percentage of airport passengers and employees. The common characteristics of successful airport rail stations include:

- **Convenient walking distances** – Rail stations located within close walking distance of the airport terminal will be more attractive than stations requiring shuttle service. In addition, stations minimizing the need to change levels via stairways, escalators, or elevators and enclosed walking spaces are more attractive to the user.[63]
- **Baggage services** – Services ranging from the availability of baggage trolleys to baggage check at the rail station improve the success of air-rail integration.
- **Combined air/rail ticketing** – Code-sharing agreements between airlines and the rail authority allow passengers to travel on the two modes using only one ticket.

The common characteristics of airport rail service and stations described above strive to maximize the rail ridership for airport access. Additional beneficial qualities found within an airport rail station include good information systems (providing airline flight information and clear signage) and amenities to enhance passenger comfort and convenience (such as security features, telephones, concession areas, and benches).[64] Owing in part to differing attitudes toward the private automobile and the existence of a nationwide and international rail network, European airports with rail access realize higher rail mode shares than U.S. airports. Planners looking to increase rail access and favorable rail ridership forecasts to Texas's major airports will find it challenging to sway Texans from their private automobiles, the mode currently dominating airport access in Texas.

The Trans-Texas Corridor and Airport Rail Service Opportunities

The TTC's dedicated passenger vehicle lanes, high-speed rail, and passenger rail lines will offer travelers more mobility options for intrastate travel. High-speed rail services in Europe and in population-dense areas of the northeastern United States operate as a competitive or complementary alternative to air passenger travel. However, given Texas's population density, high-speed rail service will not be economically feasible along all 4,000 miles of the proposed TTC. For a high-speed rail service to approach some level of viability, it will need to:

- Connect cities with large populations and high population densities
- Connect to cities that are already grouped along a major passenger traffic flow corridor and within a range of approximately 100 to 300 miles
- Operate between cities with strong economic ties and the propensity for travel between them
- Serve cities with developed local transit systems to feed the high-speed rail stations[65]

Based upon these criteria, the only Texas cities that could be considered are located within the "Texas Triangle": Dallas/Fort Worth, Houston, San Antonio, and Austin.

Where they do operate, high-speed rail systems have had an impact on air passenger traffic, but the degree of the impact depends on a variety of factors including cost, travel time, and passenger demand. To make high-speed rail an attractive alternative to intra-Texas passengers, it obviously must have competitive fares with air transport. Second, the two modes must offer comparable travel times. In other parts of the world, high-speed rail competes effectively with air transport over distances between 100 and 300 miles or between one and three hours of travel time.[66] Shorter trips are generally the domain of automobiles or regional passenger rail, whereas longer trips are almost exclusively serviced by air. Third, the type and volume of passenger demand (i.e., business versus non-business trips) between city pairs also can affect the impact of high-speed rail on commercial aviation. If high-speed rail stations are located in a city's central business district (CBD), then the system has the potential to cater to intercity commuters. Business travelers may find high-speed rail more convenient than air travel if their destination is close to the CBD.

Connecting high-speed rail services to airports is an important consideration when planning a network. A 1993 ridership study (from Texas's previous, failed foray into high-speed rail) determined that the incorporation of Dallas/Fort Worth International Airport (DFW) into the plan was necessary to achieve favorable total ridership and revenue, because the largest percentage of passenger diversion would come from local air travelers, not automobile commuters.[67] Depending on the alignment scenario then under consideration, between 60 and 65 percent of local air travelers in the Texas Triangle were expected to divert to high-speed rail. In the case where high-speed rail substituted for both American Airlines and Delta Air Lines service in the Triangle, however, the ridership study estimated that 72 percent of the local air market and 83 percent of the connecting air market would use high-speed rail instead of air.[68] At present, there are no ridership studies that predict the impact of the TTC's proposed high-speed rail system on Texas's commercial aviation industry. However, growing populations in Texas's major cities and increasing roadway congestion will continue to place pressure on transportation agencies to provide alternate modes to commuters, while commercial airlines would likely oppose any attempt to provide a government-subsidized, competitive mode of transport.

5.1.6. Off-Airport Terminals

Another method to reduce the airport-generated traffic demand on both off-airport and on-airport access roads is to develop strategically located off-airport terminals. Off-airport terminals, otherwise known as satellite terminals, provide parking facilities, passenger-processing activities, and express shuttle service between the off-airport location and the airport. The facilities can be classified broadly as full-service terminals, limited-service terminals, and nonservice terminals owing to the varying range of amenities and services they provide. A full-service terminal provides all of the passenger processing services available at the airport including ticketing, passenger check-in, and baggage claim. Conversely, a nonservice terminal does not provide any passenger handling services and primarily serves as an off-airport parking facility with a sheltered waiting area. Limited-service terminals provide services between the full-service and nonservice terminals.

Typically either public or private agencies operate off-airport facilities, rather than the local airport.[69] Airlines once operated off-airport terminals in several U.S. cities including New York, Phoenix, and San Francisco, however, the terminals have since closed.[70] Successful off-airport terminals, providing baggage check-in and/or baggage claim facilities are operating in several cities abroad, including Hong Kong, London, and Zurich. As planners continue to consider programs to reduce congestion on landside airport access facilities, development of off-airport terminal facilities still stand as a viable alternative in several U.S. cities.

The TTC will skirt the outside of Texas's major cities, therefore airports centered within the urban areas, such as Dallas/Fort Worth International, George Bush Intercontinental, and San Antonio International will have limited direct connectivity to the TTC. However, connectivity between the TTC and strategically located off-airport terminals serving major Texas airports could prove to be an efficient means of connecting the TTC and major airports. The off-airport terminal location will be the most important factor leading to the success or failure of such a service. The terminal location must serve a large enough market to be economically viable. In addition, the terminal must be located far enough away from the airport that the travel time to the off-airport terminal is short and the shuttle service to the airport is efficient and reliable. Passengers likely will not use the off-airport terminal if the total trip time to the airport by way of the satellite terminal is increased considerably from the total trip time to the airport itself.

5.1.7. Connectivity Needs for Air Cargo Movement

The role of trucking in air cargo is expected to increase in the years to come. Trucks are now able to compete with air transport for providing time-definite services. As a result, combination (including passenger airlines) and integrated air carrier (providing time-definite, door-to-door service) companies have continued to increase their reliance on trucks for the regional movement of cargo. Truck accessibility to airports is a critical component for any airport wishing to initiate or expand its air cargo operations. Trucks must be able to access cargo facilities to facilitate the transfer of cargo between the two modes. Many airport managers, however, consider trucks to be an unwanted nuisance causing congestion and wear and tear on airport facilities.[71] In addition, airports often simply do not consider accommodations for trucks because trucks do not generate any direct revenue for the airport. However, airports that plan and accommodate truck accessibility and movement will be better able to attract additional air cargo services as air trucking increases. Accommodations for air cargo will be discussed in great detail in Chapter 6.

In Texas, a significant amount of air cargo is flown into Dallas/Fort Worth International (DFW) and Houston Intercontinental (IAH) airports and trucked to cities and customers in the state. Conversely, a significant volume of air cargo exiting the state is trucked from its origin to DFW or IAH for lift to domestic or international markets. Interviews with the leading airfreight carriers in Texas indicate that it is much more economical and makes better logistical sense to truck, rather than fly, air cargo between most Texas cities. For example, a City of San Antonio air cargo study revealed that about 314,172 tons of air cargo moved through the San Antonio and Austin airports in 2000. As least as much air cargo in the San Antonio-Austin market, however, was trucked to major gateways, such as Los Angeles International Airport and DFW, to integrator hub airports for FedEx or UPS, or to its final destination.[72]

5.2. Recommendations

There are no general solutions or rules of thumb to ensure adequate connectivity and accessibility between the TTC and each of Texas's 388 public-use airports. In addition, there is no generally accepted definition of what constitutes adequate landside access to airports. To complicate matters further, the precise alignments for the TTC routes have yet to be determined. However, enough preliminary information exists within the TTC conceptual plan to roughly determine which airports are located within the study area for each TTC route. The following recommendations are intended to help TTC planners consider the connectivity and accessibility needs of airports as they further develop the TTC alignments.

5.2.1. Provide Direct Connections to Texas's Major Airports

The primary mode for airport access in Texas is the private automobile and dependency on the private automobile is expected to continue in the future. To maintain current accessibility, TTC routes passing along the outskirts of an urban area should connect into the existing interstate highway system and other major routes used for airport access. This will permit direct passenger vehicle access to existing airport access roads from the TTC. To mitigate congestion on access facilities leading to airport property, planners also should study the feasibility and effectiveness of rail connections at the airport in the form of rail spur lines from the TTC. Connecting high-speed rail, for example, to the state's major airports and cities will increase the potential ridership and revenue on high-speed rail. Airlines serving the regional market, however, may resist proposals for high-speed rail connections to airports because of the potential diversion of passengers from air to rail.

In addition to connecting the TTC to passenger vehicles carrying airport passengers and employees, TTC connectivity to airport access facilities can improve cargo movement entering or exiting through Texas airports. Texas's six largest commercial airports handle the majority of the state's airborne international trade. A significant volume of this cargo is carried in the belly of commercial passenger planes. As a result, it is recommended that the TTC provides direct connections to all major airports in Texas for the benefit of cargo movement, as well as the movement of passengers and employees. Connectivity to Texas's major airports can be achieved by constructing interchanges with existing interstates and state highways providing access to the major airports.

5.2.2. Consider the Accessibility Needs of General Aviation Airports

Whereas commercial airports will be linked to the TTC by way of interstate and state highway interchanges, the general aviation airports may face a more difficult task of acquiring access, because access to the TTC is proposed to be very limited. When planning the TTC, it will be important to avoid isolation of rural airports (and the population and economic activity centers they serve) by not providing adequate connection to the TTC (if appropriate), the nearest highway access facility, or both (if appropriate). To ensure connectivity and accessibility to the state's airports and to promote an integrated, multimodal transportation system, appropriately spaced TTC access facilities should be included to replace existing airport access roads that it severs.

The local drive time required to connect an airport and its associated city should not be increased substantially by the TTC. At present and with the exception of commercial airports, most public-use airports can be accessed within a 10-minute drive from the airport's associated city. Accommodations should be considered when planning the TTC to connect airports and population centers if they are to be disconnected by the TTC. Simple solutions, such as installing airport direction signs along key access routes, may be sufficient to ensure adequate access to general aviation airports. In other instances, additional access facilities, including expensive grade-separated bridge structures, may be required to provide access from the TTC to adjacent population, industrial, or agricultural centers and their associated general aviation airports.

5.2.3. Plan for Truck Accessibility

The TTC conceptual plan calls for dedicated lanes for passenger cars and commercial trucks. To accommodate the differing accessibility needs of cargo-carrying trucks and passenger vehicles, airports should consider providing separate facilities for trucks and passenger vehicles. The differing operating characteristics between passenger and cargo vehicles can cause conflicts and safety concerns. For major airports serving as transshipment centers between air cargo and trucking, feasibility studies should be performed to determine any advantages to the provision of separate truck and passenger vehicle access facilities from the TTC.

5.2.4. Integrate High-Speed Rail and Air Passenger Transport

A small but growing number of airports around the world are integrating air and high-speed rail (HSR) services at commercial airports. This configuration supports complementary rather than competitive operations between air passenger carriers and rail through public-private partnerships and ticket code-sharing agreements. Rather than losing passengers to high-speed rail, some airlines operate high-speed rail routes, offering identical baggage, ticketing, and transfer services to both air and rail passengers. In addition, high-speed rail service has the potential to reduce congestion at busy airports by diverting traffic from short- and medium-distance flights to rail, thereby freeing takeoff and landing slots for aircraft that serve longer-distance routes. A complementary air-rail interface would be more attractive to passengers and could maximize ridership, revenue, and intermodal connectivity if the high-speed rail stations were located at major commercial airports. However, in many cases, extending rail lines to an airport terminal station can be an extraordinarily expensive retrofit and can involve extensive tunneling, relocation of existing facilities, and substantial reconstruction of terminal buildings.

After TTC planners select preferred alignments for priority and non-priority routes, it is recommended that feasibility and economic impact studies be performed to determine the associated costs and benefits of connecting HSR to major commercial airports.

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Chapter 6. Air Cargo Movement

The air transportation industry, used to transport high-value, time-sensitive goods, is of critical importance to Texas and is a significant stimulus to economic growth and development throughout the state. Air cargo is also a major contributor to the national economy and a valuable component of the global supply and distribution chain. Worldwide, the air cargo industry is growing and is forecasted to triple over the next 20 to 25 years. The demand for airfreight depends on the country, region, or city's economic activity, transportation costs, and allowable shipment time. As a result, the air cargo industry is dynamic and constantly evolving. Many airports actively encourage cargo operations because they generate additional jobs, airport revenues, and client stability. The land surrounding an airport often is most compatible with industrial uses, such as manufacturing and distribution, which rely on fast accessibility to transportation systems and are less sensitive to noise than other land uses. A good air cargo airport, however, requires good landside connectivity to local population centers and ground access routes in addition to other attributes that produce fast, reliable airfreight service.

Within this chapter, the authors provide an overview of the air cargo industry and outline the existing air cargo flows in Texas. Supported by domestic and market air cargo data and interviews with air cargo stakeholders in Texas, this chapter also attempts to identify how the TTC will affect regional airfreight movement in Texas. In addition, this chapter identifies where potential opportunities exist for the development of airfreight transshipment centers near the TTC and concludes with recommendations for air cargo development along the TTC.

6.1. Literature Review

6.1.1. Structure of the Air Cargo Industry

The air cargo market is made up of two basic components: mail and freight. *Airmail*, composed of envelopes, documents, and light packages, is contracted out by the U.S. Postal Service (USPS) for transport in the cargo holds of scheduled commercial passenger aircraft and freighter aircraft. A large fraction of the mail shipped in the U.S., however, moves in ground vehicles and the USPS air shipments tend to be small and light (Table 6.1). *Airfreight* refers to all cargo other than mail and passenger baggage. The airfreight industry can be further divided into two types of cargo operations: combination carriers and all-cargo carriers. *Combination carriers* are accordingly named accordingly because they transport both cargo and passengers. Most passenger airlines, such as Delta, American, and Southwest, carry freight and mail in the belly of their aircraft. In fact, more than half of the world's freight moves on passenger flights. Some passenger carriers, such as Northwest and China Airlines, also operate all-freight aircraft in addition to their passenger aircraft. Freight forwarders, U.S. Customs brokers, air trucking companies, postal services, and couriers typically form partnership agreements with combination carriers to provide air transport services. The combination carriers, however, are not responsible for picking up, assembling, sorting, or delivering the freight. Aside from providing contracted mail and small package services for USPS, passenger airlines dominate the airport-to-airport movement of large shipments with a much higher average weight per shipment.

Table 6.1 Types of Air Cargo Carriers

Type of Carrier	Example of Carrier	Origin-Destination of Movement	What's Carried
Combination Carrier	Most Passenger Airlines	Airport to airport	Mail and freight
Integrated Carrier	UPS, FedEx, etc.	Door to door	Packages
Traditional/Line Haul Carrier	Cargolux, Kitty Hawk, etc.	Airport to airport	Larger more specialized freight
Integrated Forwarder	BAX, Global, Menlo Worldwide	Feeder services (pickup and delivery)	Ocean and airfreight pickup and delivery

Unlike combination carriers, *all-cargo carriers* solely transport cargo. All-cargo carriers can be further categorized into three types of operations: integrated freight carriers, traditional/line-haul freight carriers, and integrated forwarders. *Integrated carriers*, including United Parcel Service (UPS), Federal Express (FedEx), and DHL, provide door-to-door service by managing a fleet of ground pickup and delivery trucks, freight sorting and processing terminals, a fleet of long-haul trucks to move freight between terminals, and an air fleet for transporting freight between terminals. Integrated carriers rely on an extensive hub-and-spoke network to provide their integrated, door-to-door services. Whereas combination carriers tend to move large shipments with high weights per shipment, integrated carriers dominate the time-definite, small-package, express market. Integrated carriers, however, have recently begun increasing their express capabilities to accommodate heavy freight. The integrated carriers have enjoyed dramatic market share growth and annual increases within the air cargo market since the first integrated carriers began service in the mid 1970s. Express carriers transported 60.5 percent of the total U.S. air cargo domestic market in 2001 and are continuing to rapidly expand.[73]

Traditional/line-haul freight carriers, including Cargolux, Kitty Hawk, and Nippon Cargo, provide airport-to-airport service. They typically transport larger or more specialized freight, offer subcontractor services to other carriers, and do not provide complete door-to-door transportation services. Like the combination and nonintegrated all-cargo carriers, freight forwarders can use traditional freight carriers providing scheduled or chartered service as needed or under long-term contracts. Growth in the traditional airfreight industry is tied closely to the growth of the overall economy and changing transportation costs. Today, the scheduled airfreight market remains fairly stable, capturing 20.1 percent of the total U.S. domestic air cargo market in 2001.[74]

Integrated forwarders, such as BAX Global and Menlo Worldwide, operate their own fleets of aircraft and trucks and also purchase airline capacity and resell it to shippers. They provide ground feeder services and specialized support services for their customers. The largest freight forwarders provide international pickup and delivery services and serve both ocean and airfreight movement.

6.1.2. Air Cargo Market Trends

The air cargo industry is dynamic and constantly evolving. The flow of regional, domestic, and international air cargo is influenced by the economies in which it operates, new technology development, individual carrier business decisions, and the evolving global supply chain. The following section contains descriptions of several emerging air cargo market trends identified in the literature.

Growth of deferred/time-definite delivery

Deferred delivery (shipments taking place on the second or third day after ordering) of packages between two and 150 pounds is growing and predicted to surpass the overnight delivery of letters, documents, and packages. Business and personal use of electronic mail and facsimiles is replacing the overnight express letter and document market. Deferred delivery offers customers a lower cost, time-definite service and allows carriers greater flexibility in mode-choice for freight transport. Deferred delivery is also being used to move heavy freight shipments with increasing frequency.[75]

Increasing use of trucks

Airfreight operations are inherently intermodal because other modes are required to transport freight between the airport and its origin and ultimate destination. Beyond moving freight to and from the airport, however, the role of trucking in air cargo is a significant and growing component of the industry. Trucks are used increasingly as feeders to regional hubs.[76] Combination carriers are reducing the size of the passenger aircraft used in domestic markets. As a result, the available air cargo capacity for domestic shipments has been constrained. To offset the loss of available cargo capacity on domestic passenger flights, combination carriers have substituted air connections with scheduled "truck flights," or road feeder service (RFS).[77] In addition, the growth of deferred and time-definite delivery options offers air cargo carriers more choices for cargo movement.[78]

In the U.S. domestic market, the less than truckload (LTL) trucking industry is competing with the air cargo industry for time-definite shipments on routes less than 1,000 miles. To compete with the LTL companies, airlines now own or are affiliated with trucking companies. Air cargo that moves by truck travels under an air waybill and the responsibility of the combination carrier, but is transported physically by truck. Also utilized by integrated carriers, trucks are commonly used for line-haul transport of airfreight within a 300- to 400-mile radius of air hubs.[79] According to the Boeing 2002/2003 World Air Cargo Forecast, more than 500 city pairs in the U.S. and Canada are connected by truck flights. Between 1995 and 2000, freight transported by truck grew 4.5 percent while airfreight grew only 1.9 percent. In 2001, however, truck freight continued to grow 4.5 percent while airfreight contracted 9.2 percent.[80] An interview with an airfreight representative suggested that after the economic slow down in the first two quarters of 2001, and exacerbated by the September 11, 2001 terrorist attacks, people found alternatives to air for the movement of cargo and have yet to return.[81]

Trucks complement and compete with air cargo operations. Trucks offer an efficient, reliable, and inexpensive means of moving freight between cities within a region. Combination carriers have to lower their prices for domestic shipments to remain competitive with trucks. As a result, combination carriers are most interested in long-haul segments or international shipments because they are the most profitable. Integrated carriers rely on trucking to efficiently and economically move time-definite freight. The mode on which a particular shipment travels depends upon the distance it has to travel and how quickly it has to be there. For example, if a customer pays for "next-day air" to move a package between Dallas and Austin, the package will likely travel overnight by truck and still arrive at its destination on time.[82]

The role of trucking in air cargo is expected to increase in the years to come. Trucks are now able to compete with air transport for providing time-definite services. As a result, combination and integrated carrier companies have continued to increase their reliance on trucks for the regional movement of cargo. Truck accessibility to airports is a critical component for any airport wishing to initiate or expand its air cargo operations. Trucks must be able to access cargo facilities to facilitate the transfer of cargo between the two modes. Many airport managers, however, consider trucks to be an unwanted congestion nuisance causing wear and tear on airport facilities.[83] Additionally, airports often do not consider accommodations for trucks because the trucks do not generate any direct revenue for the airport. On the other hand, airports that plan for and accommodate truck accessibility improve their likelihood of attracting demand for additional air cargo services as air trucking increases.

In Texas, a significant amount of air cargo coming into the state is flown to Dallas/Fort Worth International (DFW) and Houston Intercontinental (IAH) and trucked to cities and customers in the state. Conversely, a significant volume of air cargo leaving Texas is trucked from its origin to DFW or IAH for lift to domestic or international markets. Interviews with the leading airfreight carriers in Texas indicated that it is much more economical and makes better logistical sense to truck, rather than fly, air cargo between most Texas cities. For example, an air cargo study for the City of San Antonio revealed that about 314,172 tons of air cargo moved through San Antonio and Austin airports in 2000. As least as much air cargo in the San Antonio/Austin market, however, was trucked to major gateways, such as Los Angeles International Airport and DFW, to integrator hub airports for FedEx or UPS, or to its final destination.[84]

U.S. Open Skies policy

Under the international Treaty on Open Skies agreement, signed March 24, 1992, and subsequent expansion of the Open Skies policy, new markets in the air cargo industry have been opened with the liberalization of bilateral air rights between the U.S. and foreign countries. To date, the U.S. has signed Open Skies agreements with over 50 countries, eliminating restrictions on routes, flight frequency, and number of airlines operating in U.S. markets. This gives foreign and domestic air carriers greater flexibility in choosing their service markets.[85]

Expanded transnational alliances and code-sharing

Strategic transnational alliances allow carriers to provide better service, offer a broader range of services, expand their geographic coverage, and provide a larger concentration of services in the markets they serve. Since 1993, there have been approximately 390 strategic airline alliances involving 177 airlines.[86] Alliances also have been made between international airports. In combination with the U.S. Open Skies policy, alliances are useful for increasing international service and for attracting carriers to new markets.[87]

Just-in-time inventory systems

During the last 20 years, many manufacturing firms worldwide have replaced their traditional material inventory and stockpile at production sites with the just-in-time (JIT) inventory system. The JIT system allows firms to reduce costs by limiting stored materials and reducing the handling and storage space required for material stockpiles. Instead, production supplies are delivered to manufacturers just when they are needed. This requires careful coordination with the supplier and reliable, time-definite transportation. Under the JIT system, any significant delay in shipments results in a shutdown of production because inventory stockpiles are not available. Many industries, such as automotive, electronic, and textiles industries, are conducive to using air transport to maintain their JIT inventories owing to their time-sensitive nature and high value. The demands of JIT inventory transport promote better efficiency among airfreight forwarders and air carriers.[88]

Globalization, logistics, and trade

Industrial globalization has increased with the worldwide reduction in trade barriers, new communication technology, and transportation deregulation. As a result, firms can manufacture products in one part of the world, transport the parts to another location for assembly, and then distribute the finished product to consumers. The speed and reliability of air transport makes it conducive to time-sensitive industries that are willing to pay a high transport cost to avoid the even higher costs of delayed delivery.[89] For example, suppose a maquiladora (assembly plant or factory in the border states of Mexico) near Laredo fails to receive a regular delivery of a specific part required for the production of refrigerator components. The factory must be shut down until the parts arrive, meanwhile costing the company huge penalties, competitive disadvantages, and overtime labor. To minimize costs incurred by the delay, the firm can fly the spare parts to Laredo International on the "next flight out" and know exactly when the parts will arrive. Time-sensitive industries particularly conducive to air transport include toys, apparel, agriculture, and high-tech products.[90]

Value-added services

Today, customers are looking for air carriers that provide value-added services, such as computerized tracking, multimodal delivery, and logistics solutions. At some airports located near manufacturing and assembly facilities, value-added services take place adjacent to the airport prior to transport to the product's final destination. To accommodate the needs of small freight forwarders lacking the capability to perform value-added services, third-party logistics companies can be contracted. The third-party logistic firm manages freight throughout the supply chain, including manufacturing, assembly, packaging, warehousing, and distribution.[91]

Use of non-gateway airports

Many of the traditional gateway airports on the east and west coasts are experiencing congestion on the airside and on airport highway access facilities. As a result, there has been a shift of air carriers away from the traditional gateway airports to secondary airports capable of providing larger warehouse and distribution facilities, uncongested landside access, and uncrowded airspace—and in some cases, rail connection. In addition, new aircraft now have longer-range capability and the Open Skies policy allows foreign carriers more choice in location.[92]

Development of secondary and tertiary integrator hubs

The integrator carriers operate an extensive hub and spoke network. To accommodate growing demand for their express services, integrated carriers have established secondary and regional hubs in addition to their central hubs. FedEx, for example, opened a regional hub at Alliance in Fort Worth and secondary hubs in Oakland, Indianapolis, and Newark. Combination carrier airlines serving regional markets are also looking to secondary markets to accommodate long term growth in demand.[93] Hub expansion to secondary and tertiary airports improves service by diverting flights from the main hubs experiencing over-capacity.[94]

Downsizing of passenger aircraft and increasing use of freight aircraft

Combination carriers are reducing the size of the passenger aircraft used in domestic markets. As a result, the available air cargo capacity for domestic shipments has been constrained. To offset the loss of available cargo capacity on domestic passenger flights, the air cargo industry is relying on an increased use of dedicated freighters. The Boeing World Air Cargo Forecast expects the freighter fleet to double over the next 20 years. The number of widebody freighters is expected to grow from 39 percent to nearly 60 percent of the total freighter fleet. In addition, the medium widebody fleet will more than triple in the next 20 years, representing the greatest increase among widebody aircraft.[95] The growth of the widebody freighter fleet will add air cargo carrying capacity to accommodate the forecasted growing air cargo demands.

In addition to the production of new freighters, a somewhat new trend is the emergence of “wet-lease” carriers. As traditional all-cargo and combination carriers restructure their services to better compete with the integrated carriers, many are embracing new contract methods for securing aircraft. Freight wet-lease carriers, also known as ACMI (aircraft, crew, maintenance, and insurance), offer airlines flexible contracts for use to augment existing markets or in markets with uncertain or highly seasonal demand. ACMI companies allow cargo carriers the opportunity to expand their services without requiring capital investment in equipment.[96]

6.1.3. Factors Influencing the Location of Freight Centers

Combination carriers and all-cargo carriers have somewhat differing perspectives and criteria when choosing an airport to serve. The top 20 North American airports by landed weight are shown in Table 6.2. A large percentage of air cargo operations take place at commercial airports because about half of all air cargo is transported on scheduled passenger flights. As a result, a large percentage of air cargo operations are tied to passenger operations where there is ample capacity available in the baggage holds of passenger aircraft. Airports positioned as international gateways, such as Los Angeles (ranked third), Miami (ranked forth), and New York (ranked fifth), service international airlines and handle a large percentage of air cargo.

Table 6.2 Top 20 North American air cargo airports by weight (2003)

Rank	**Airport**	**Total Air Cargo (Metric Tons)**
1	Memphis (MEM)	3,390,515
2	Anchorage (ANC)	2,102,025
3	Los Angeles (LAX)	1,833,300
4	Miami (MIA)	1,637,278
5	JFK-New York (JFK)	1,626,722
6	Louisville (SDF)	1,618,336
7	Chicago O'Hare (ORD)	1,510,746
8	Indianapolis (IND)	889,163
9	Newark (EWR)	874,641
10	Atlanta Hartsfield (ATL)	798,501
11	Dallas/Ft. Worth (DFW)	667,574
12	Oakland (OAK)	597,383
13	San Francisco (SFO)	573,523
14	Philadelphia (PHL)	524,485
15	Ontario (ONT)	518,710
16	Honolulu (HNL)	421,930
17	Cincinnati/No. Kentucky (CVG)	392,695
18	Houston (IAH)	381,926
19	Boston Logan (BOS)	363,082
20	Seattle-Tacoma (SEA)	351,418

Source: Airports Council International: North American Traffic Report

Another large percentage of air cargo operations occur at the hub facilities of small-package, express-delivery service companies like those operated by FedEx (ranked first) and UPS (ranked sixth). These integrated carriers operate hub-and-spoke systems in which hubs are strategically located for efficient sorting before distribution to smaller facilities. Freight airport locations are chosen for a combination of reasons. Location selections for UPS, FedEx, and DHL hubs, located in Louisville, Kentucky, Memphis, Tennessee, and Wilmington, Ohio, respectively, were chosen because of their close proximity to U.S. population centers, minimal snowfall, and attractive labor pool.[97] Their hubs are located away from major metropolitan areas at less congested airports. Despite being located away from major metropolitan areas, the integrator companies chose to base their hubs in the Ohio Valley region because it is within approximately 1,000 miles from nearly 60 percent of the industrial population, employment, and retail purchasing power of the U.S.[98]

Other large freight airports are home to domestic freight hubs or are located within highly populated regions, such as Chicago (ranked seventh) and DFW (ranked eleventh). Geographically isolated airports, such as Anchorage (ranked second), serve as refueling stops for international traffic. Other successful cargo airports are multipurpose reliever or general aviation airports near urban areas that provide an alternative to primary commercial airports. Facilities such as the Fort Worth Alliance Airport built to serve the manufacturers, distributors, and cargo carriers located there (including Verizon and Motorola) and Houston’s Ellington Field act as reliever airports to nearby primary commercial airports. Express transportation and air cargo service have allowed manufacturing and high technology plants to choose low cost locations in small communities and rural areas, thereby generating economic growth because of the express delivery services made available by the air cargo industry.[99]

It is important to understand airport selection criteria to identify future cargo opportunities at an airport and the type of market that it will serve. Air cargo airlines rely on a multitude of criteria developed to suit their unique financial and operational objectives. The selection criteria presented in this section, however, are divided into three general areas: airport market area, airport location, and airport infrastructure.[100] Although integrated carriers may rank the importance of each of the three criteria differently than, for example, the combination carriers, generally all three criteria are important in strategic air cargo airport location decision making.

Airport Market Area

The size of a local market area is important to all carriers because there must be sufficient population to generate enough shipments to make their service profitable. The threshold at which a carrier can sustain service in a particular market, however, differs significantly among carrier types. Integrated carriers often have more flexibility in the size of their threshold markets because they rely on a hub-and-spoke network and can adjust their services and fleet composition to meet the needs of a particular market. Combination carriers and traditional all-cargo carriers, on the other hand, require large markets because they provide only airport-to-airport service. They rely on an extensive network of freight forwarders, consolidators, and trucking companies to generate, consolidate, and transport their shipments between the shipper and the airport. The market area they serve must be sufficiently large to generate a substantial volume of shipments requiring air transport between airports.[101] Combination carriers are further constrained to airports capable of supporting scheduled passenger service.

In addition to market size, traditional all-cargo carriers prefer to serve markets that will generate similar volumes and maximize aircraft utilization in both directions of travel. Unlike combination carriers that cover most of their operating costs from the passengers they transport, all-cargo carriers prefer markets that will generate balanced shipments to offset operating costs and facilitate competitive prices to the customer.[102]

Non-integrated all-cargo carriers rely on freight forwarders to assemble shipments just as freight forwarders rely on air carriers to provide lift. Freight forwarders, generating almost 70 percent of the world's air cargo shipments, must also be able to draw from a large enough population of businesses to fill a large number of airfreight containers. Freight forwarders must be able to make a profit on what they charge to the shippers versus what the airlines charge them for use of a container. As a result, freight forwarders benefit by locating in large metropolitan cities near international gateway airports where there is a wide variety of destinations, flight frequencies, prices, and aircraft types available from which to choose. Because freight forwarders are so vital to the non-integrated air cargo carriers, the presence of freight forwarders in or near an airport's market is key for attracting air carriers to an airport.

An attractive market for air cargo service is typically one that maintains a strong local production and consumption (within a 100 to 200 miles radius) of air-eligible commodities. A distance between 100 and 200 miles can easily be serviced by truck in one day. The San Antonio air cargo study indicated that, "at a minimum, it is estimated that approximately 28,000 annual tons of total inbound and outbound shipments to/from a single market would be needed to support a twice-a-week freighter flight by a non-integrated freighter operator."[103] In addition, once service is initiated, it is not unusual for an airport to be able to draw from a secondary market within 400 to 600 miles. Therefore consideration of the secondary market strength is also important.

Large markets also provide the opportunity for non-integrated air carriers to extend their services through the formation of alliances with other passenger carriers, charter companies, and trucking firms. It is unusual for non-integrated carriers to operate in isolation because they only offer line-haul service between airports. Code-sharing between domestic and international freighter operators is becoming increasingly popular. Consequently, markets capable of facilitating alliance partnerships between domestic and international carriers and land-based carriers will be attractive to air carriers.

Airport Location

A second important characteristic air carriers consider when choosing an airport is its physical proximity to the local and regional population and the carrier's hub-and-spoke distribution network. The physical location of an airport is of most concern to integrated carriers because of the door-to-door services they provide. Non-integrated all-cargo and combination carriers are less concerned with the airport's physical location because they offer only line-haul, airport-to-airport service.

The integrated carriers' time-definite express service requires a combination of air and ground transport. On the airside, integrated carriers strategically choose airports that will enhance the efficiency of their hub-and-spoke distribution network. Hubs serve as sorting and redistribution facilities with flights connecting dozens of destination cities. Integrated carriers typically operate three levels of hubs: primary, secondary, and regional.[104] Primary hubs can generate up to 300 flights per day and include locations such as Memphis for Federal Express (FedEx), Louisville for United Parcel Service (UPS) and Wilmington for DHL. Secondary hubs typically generate between 30 and 50 flights per day and include locations such as Oakland, Newark, and Indianapolis. Regional hubs, such as Salt Lake City, Denver, Alliance in Fort Worth, typically generate four to 12 flights per day.[105] As discussed in Section 2, airports in the Ohio Valley were chosen for primary hubs because of their close proximity to U.S. population centers, minimal snowfall, and attractive labor pool.[106] In addition, integrated carriers plan their service schedules to allow time zones to work to their advantage.

On the groundside, integrated carriers are concerned with the airport's physical proximity to the local service area.[107] To maximize the drop-off and pick-up times for their customers, integrated carriers give careful thought to the strategic locations of customer service facilities surrounding an airport. If the airport is excessively far from the customer service locations, the integrator must narrow the drop-off and pick-up times available to the customer to accommodate for the additional time it takes to transport the packages between the service center and the airport. Remote airports make efficient routing and scheduling difficult.

Airport Infrastructure

For a regional air-cargo center to be successful, it must offer uncongested infrastructure and ease of access to attract cargo customers and operators from the metropolitan airports.[108] In order to support a regional air-cargo center, an airport should provide the basic facilities required to support air cargo operations. Basic facilities include adequate runways, landing aids, buildings for sorting and storage, ground transportation infrastructure, support infrastructure, and a good labor pool.

Runways designed to the appropriate length and pavement strength must be available to support fully loaded wide-body aircraft. For example, to support the take-off of a fully loaded Boeing 747-400F freighter with a maximum take-off weight of 870,000 pounds on a long-haul, non-stop intercontinental flight, a runway should be 10,000 to 12,000 feet long and 150 feet wide.[109]

An airport should also have landing aids to allow 24-hour operations as well as continuous and reliable operations during visibility-restricting weather conditions. Landing aids include an air traffic control tower (ATCT), airport surveillance radar, appropriate instrument landing system (ILS), and landing light systems.

In addition, an airport must have adequate facilities to allow for cargo and container storage, freight consolidation, distribution, and movement. Ramp and apron space for truck access and land for cargo buildings are necessary to support the needs of cargo operators. In addition, the cargo facilities should have the capability to handle special cargo, such as perishables, live animals, hazardous materials, and over-sized items.

Convenient ground transportation access is also critical for an airport to establish itself as an air cargo center. All air cargo is inherently intermodal, relying on trucks or trains to move the cargo to and from the airport. Convenient access to both north-south and east-west highways and rail connections are ideal.[110]

The airport must also be equipped with security measures, such as fencing, supervision, and close-circuit television to monitor activity within the storage and sorting areas. On-airport regulatory authorities, such as U.S. Customs and U.S. Department of Agriculture officials, should also be available on-site.

In addition to transportation infrastructure, facilities required to support air cargo operations must also be installed. Support infrastructure of this nature includes adequate electric power and water supplies, environmentally approved waste-disposal and noise abatement systems, and high-capacity communications systems.[111] Finally, the airport must be located near an attractive labor pool capable of providing sufficient skilled workers.

6.2. Existing Air Cargo Flow in Texas

The following section identifies Texas airports currently accommodating air cargo. It also discusses intra-Texas, domestic, and international trade patterns recorded in available literature and supported by air cargo data and interviews with Texas's leading air cargo carriers.

6.2.1. Existing Airfreight Transshipment Centers in Texas

The Federal Aviation Administration (FAA) defines all-cargo (or cargo service) airports as airports that provide service to aircraft transporting only cargo with a total annual landed weight of more than 100 million pounds. An airport, however, can provide both all-cargo and commercial service. Landed weight includes that of all-cargo operations serving intrastate, interstate, and foreign air markets. During each of the landed weight data reporting periods between 2000 and 2003, ten airports in Texas qualified as all-cargo airports: Fort Worth Alliance, Austin-Bergstrom International, Brownsville/South Padre Island International, Dallas/Fort Worth International (DFW), Ellington Field, El Paso International, Valley International, George Bush Intercontinental (IAH), Laredo International, and San Antonio International (Table 6.3, Figure 6.1). The annual landed weight data reported by all of the all-cargo airports in the U.S. are used to determine the allocation of annual Airport Improvement Program cargo entitlement funds.

Table 6.3 Landed weight of cargo at Texas airports (CY 2002)

Airport Code	Airport	City	Landed Weight (lbs.)
DFW	Dallas/Fort Worth International	Fort Worth	2,961,222,470
IAH	George Bush Intercontinental	Houston	964,367,027
AUS	Austin - Bergstrom International	Austin	801,387,150
AFW	Fort Worth Alliance	Fort Worth	740,308,872
SAT	San Antonio International	San Antonio	682,574,950
ELP	El Paso International	El Paso	571,997,880
EFD	Ellington Field	Houston	314,917,350
LRD	Laredo International	Laredo	262,475,560
HRL	Valley International	Harlingen	135,146,400
BRO	Brownsville/South Padre Island International	Brownsville	132,929,282
			Total = 7,567,326,941

Source: FAA Passenger and All Cargo Data for CY 2002

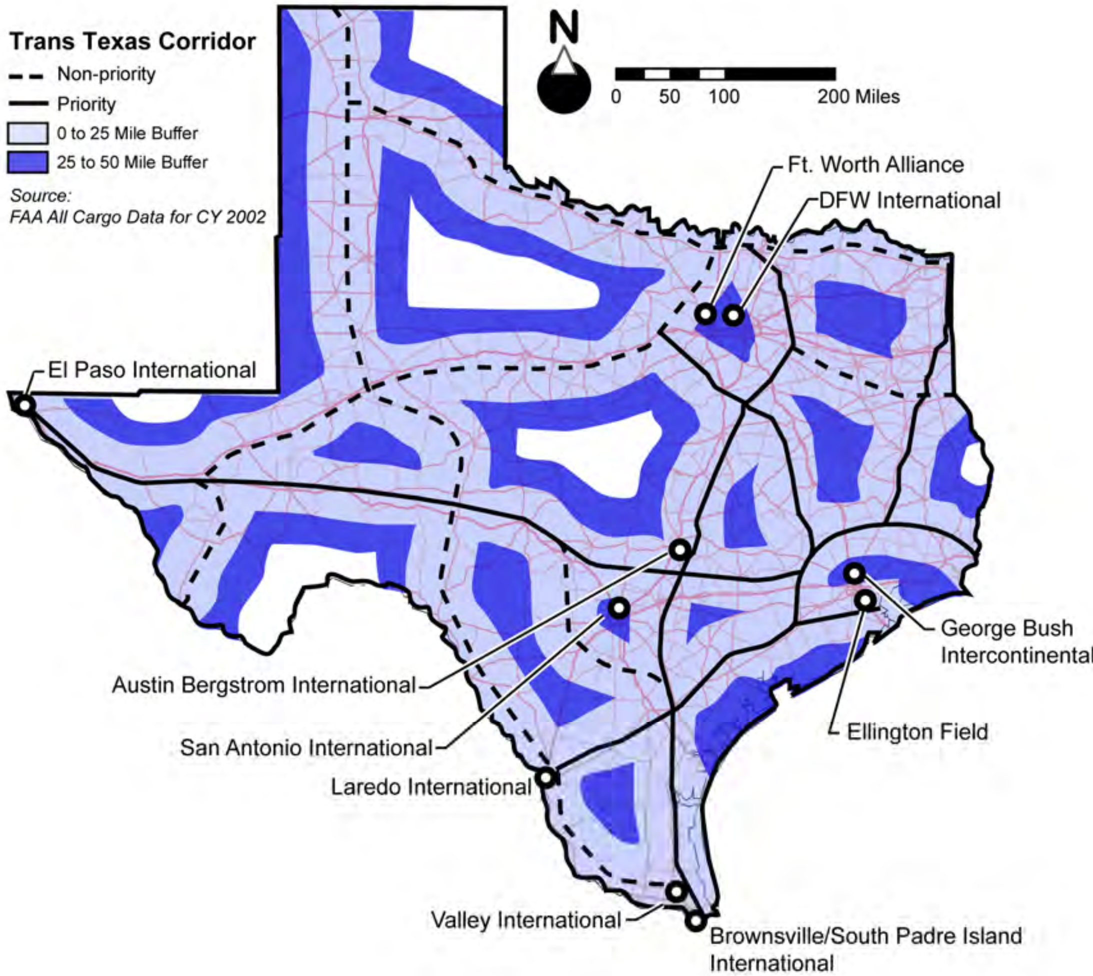

Figure 6.1 All-cargo airports in Texas and their proximity to the Trans-Texas-Corridor

6.2.2. Present Trade Patterns

In 2000, approximately 2.4 million tons of freight and mail moved through Texas airports.[112] This volume accounts for all air cargo passing through Texas airports, including intra-Texas, domestic, and international cargo. DFW remains the largest airport in Texas, ranked eleventh in the U.S. and twenty-fifth in the world (2003 data) for total air cargo. Houston's IAH is Texas's second largest airport, ranked eighteenth in the nation. Both airports have undergone recent runway and/or terminal improvements to increase their capacities. Although today cargo operations at Texas airports are not constrained by airport congestion, airport congestion at busy commercial airports is expected to increase as the volume of air cargo and passenger demand increases.

NAFTA and maquiladora trade and its implications on airfreight in Texas

The North American Free Trade Agreement (NAFTA) implemented on January 1, 1994, eliminated trade restrictions and tariffs between the U.S. and Mexico over a 15-year period, thereby stimulating cross-border trade and travel. Between 1994 and 2000, total U.S. trade with Mexico grew by 16 percent per year, from approximately $100 billion in 1994 to $248 billion in 2000.[113] Modal shares of NAFTA trade vary depending on whether traded value or traded weight is considered. In terms of value, trucks transported about 75 percent of the U.S.-NAFTA exports and about 63 percent of the imports between 1994 and 2000 and remain the dominant mode for trade crossing the U.S.-Mexico border. Between 1994 and 2001, the estimated dollar value of air imports increased by 360 percent, representing an increase in modal share from 2.3 percent to 4.0 percent.[114] Air exports increased by a dollar value of 153 percent, representing an increase in modal share from 5.2 percent to 6.6 percent. Although truck and rail remain dominant and fairly stable for U.S.-NAFTA trade by value, air transportation and pipeline increased the fastest and their shares of trade value experienced a slight increase.[115] When considering modal shares by weight, air transportation plays a much less significant role in NAFTA trade. For U.S. trade with Mexico, air transportation accounted for only 0.1 percent of trade by weight, preceded by pipeline (2 percent), rail (6 percent), trucks (24 percent), and water (69 percent). Air transportation makes up a small percentage by weight because air-eligible commodities are often high-value, low-weight goods. Time-sensitive, air-eligible commodities transported as a result of NAFTA trade include automotive parts, electronics, textiles, and agriculture.

One of the outcomes of NAFTA was expansion of the maquiladora industry, a large family of assembly plants and factories located in the northern border states of Mexico. Within the maquiladora program, foreign-based companies are permitted to purchase land in Mexico, construct plants or factories, supply managers and supervisors, and import duty-free materials and component parts into Mexico. The companies must hire Mexican workers to perform the labor in the plants or factories and the finished products must be exported from Mexico unless special approval is given to sell them in the Mexican market.[116] As of June 2004, a total of 2,801 maquiladora plants were operating throughout Mexico, employing 1,128,324 workers. Approximately 73 percent of the maquiladora plants are located in Mexico's six northern states bordering the U.S. Of the manufactured products coming out of the maquiladora region, there is a heavy concentration of air-eligible commodities such as textiles, electronics, and automotive parts.[117]

Although the mode share of air is small for NAFTA trade by value and even smaller for trade by weight, sharing a border with Mexico positions Texas airports with an advantage to accommodate a high percentage of available NAFTA airfreight. Commodities are trucked by U.S. carriers across the Mexican border to one of the large airfreight airports in Texas, such as San Antonio International, DFW, or Houston's IAH. For intra-Texas airfreight shipments lifted near the border ports, there are six airports near the Mexican border serving origin and destinations for air cargo. Border airports include Laredo International, Valley International, El Paso International, Brownsville/South Padre Island International, McAllen Miller International, and Del Rio International.

International air cargo through Texas airports

Boeing forecasts that world air cargo will grow at an average annual rate of 6.4 percent over the next two decades, with airfreight growing more rapidly than mail.[118] In addition, world air traffic is expected to triple over the next 20 years. Market growth, however, will vary worldwide, by region, and by carrier type. Asian air cargo markets are expected to lead the world in air cargo growth over the next 20 years. Despite a contraction in 2001 as a result of a slowdown in the technology industry, economic recession, and the September 11 terrorist attacks, the domestic air cargo market has grown about 41 percent over the past 10 years.[119] The express market grew at an average annual rate of 6.1 percent between 1991 and 2001 and made up 60.5 percent of the total U.S. domestic air cargo market in 2001.[120] Predictably, air traffic delays will worsen as airport capacities are unable to keep up with traffic demand.

The Bureau of Transportation Statistics (BTS) data indicate that only six Texas airports serve as origins and/or destinations to international air cargo (Table 6.4, Table 6.5). These airports include DFW, IAH, San Antonio International, El Paso International, Laredo International, and Austin-Bergstrom International. Both DFW and IAH serve as U.S. gateway airports for both passengers and air cargo. Laredo and El Paso International airports are located on the U.S.-Mexico border and cater to NAFTA trade. San Antonio and Austin-Bergstrom International serve as hubs for the central Texas region.

Table 6.4 Origin airports in Texas serving international air cargo (2003)

Rank	Airport	City	Enplaned Freight (lbs)	Enplaned Mail (lbs)	Total Air Cargo (lbs)
1	Dallas/Fort Worth International	Dallas/Fort Worth	13,963,723	472,503	14,436,226
2	George Bush Intercontinental	Houston	11,627,208	194,632	11,821,840
3	San Antonio International	San Antonio	731,561	0	731,561
4	El Paso International	El Paso	250,655	0	250,655
5	Laredo International	Laredo	8,488	0	8,488
	Grand Total		**26,581,635**	**667,135**	**27,248,770**

Source: Bureau of Transportation Statistics

Table 6.5 Destination airports in Texas serving international air cargo (2003)

Rank	Destination Airport	City	Enplaned Freight (lbs)	Enplaned Mail (lbs)	Total Air Cargo (lbs)
1	Dallas/Fort Worth International	Dallas/Fort Worth	16,918,663	479,327	17,397,990
2	George Bush Intercontinental	Houston	11,468,587	9,696	11,478,283
3	Austin-Bergstrom International	Austin	733,402	0	733,402
4	El Paso International	El Paso	406,364	0	406,364
5	San Antonio International	San Antonio	6,510	0	6,510
	Grand Total		**29,533,526**	**489,023**	**30,022,549**

Source: Bureau of Transportation Statistics

The top ten origin and destination countries for air imports and exports, respectively, are show in Table 6.6 and Table 6.7.

Table 6.6 Top 10 origin countries for air imports to Texas airports in 2003 (ranked by weight)

Rank	Origin Country	Enplaned Freight (lbs.)	Enplaned Mail (lbs.)	Total Air Cargo (lbs.)
1	South Korea	4,337,669	0	4,337,669
2	Taiwan	4,335,866	0	4,335,866
3	United Kingdom	3,457,355	113,127	3,570,482
4	Mexico	3,105,986	66,828	3,172,814
5	Germany	2,980,607	105,343	3,085,950
6	Japan	2,311,567	63,961	2,375,528
7	Netherlands	2,252,297	0	2,252,297
8	France	2,236,540	809	2,237,349
9	Singapore	914,547	0	914,547
10	Brazil	748,548	85	748,633
	Total Top 10	**26,680,982**	**350,153**	**27,031,135**

Source: Bureau of Transportation Statistics

Table 6.7 Top 10 destination countries for air exports from Texas airports in 2003 (ranked by weight)

Rank	Destination Country	Enplaned Freight (lbs.)	Enplaned Mail (lbs.)	Total Air Cargo (lbs.)
1	United Kingdom	6,023,628	84,364	6,107,992
2	Taiwan	3,208,696	0	3,208,696
3	France	2,772,965	14,366	2,787,331
4	Germany	2,221,427	207,248	2,428,675
5	Netherlands	2,113,198	4,370	2,117,568
6	South Korea	1,974,823	0	1,974,823
7	Mexico	1,435,652	120,145	1,555,797
8	Belgium	1,470,533	0	1,470,533
9	Japan	1,327,893	118,469	1,446,362
10	Luxembourg	1,189,052	0	1,189,052
	Total top 10	**23,737,867**	**548,962**	**24,286,829**

Source: Bureau of Transportation Statistics

A fraction of the air cargo originating from or destined to Texas airports will land at another U.S. airport prior to continuing on to its final destination. Cargo that stops at a domestic airport outside of Texas, however, is not counted as international air cargo. As a result, the international data will be lower than expected and the domestic cargo volumes will be inflated.

Domestic air cargo movement through Texas Airports

In addition to the ten all-cargo airports shown in **Error! Reference source not found.**, Texas had over 20 additional airports serving as origins and destinations for domestic air cargo in 2003 (Table 6.8, Table 6.9).

Table 6.8 Origin airports in Texas serving domestic air cargo (2003)

Rank	Origin Airport	City	Enplaned Freight (lbs)	Enplaned Mail (lbs)	Total Air Cargo (lbs)
1	Dallas/Fort Worth International	Dallas/Fort Worth	513,419,291	69,512,860	582,932,151
2	George Bush Intercontinental	Houston	221,950,655	37,324,813	259,275,468
3	San Antonio International	San Antonio	142,429,036	10,999,802	153,428,838
4	Fort Worth Alliance	Fort Worth	150,364,242	0	150,364,242
5	Austin - Bergstrom International	Austin	112,851,307	3,357,851	116,209,158
6	El Paso International	El Paso	78,501,079	1,136,637	79,637,716
7	Love Field	Dallas	38,956,658	525,119	39,481,777
8	Laredo International	Laredo	21,478,483	0	21,478,483
9	Lubbock International	Lubbock	20,339,190	267,437	20,606,627
10	Valley International	Harlingen	18,551,395	200	18,551,595
11	William P. Hobby	Houston	16,241,541	1,165,002	17,406,543
12	Brownsville/South Padre Island International	Brownsville	12,896,281	30	12,896,311
13	Midland International	Midland	3,445,279	204,746	3,650,025
14	McAllen Miller International	McAllen	1,430,912	849,300	2,280,212
15	TSTC Waco	Waco	1,332,674	0	1,332,674
16	Amarillo International	Amarillo	479,610	341,132	820,742
17	Corpus Christi International	Corpus Christi	499,994	189,166	689,160
18	Abilene Regional	Abilene	647,575	1,468	649,043
19	San Angelo Regional/Mathis Field	San Angelo	512,724	3,916	516,640
20	Brownwood Regional	Brownwood	394,360	168	394,528
21	Meacham International	Fort Worth	63,274	0	63,274
22	Addison Municipal	Dallas	58,873	0	58,873
23	Dyess Air Force Base	Abilene	41,888	0	41,888
24	Del Rio International	Del Rio	35,588	0	35,588
25	Robert Gray Air Force Base	Fort Hood	22,222	0	22,222
26	Tyler Pounds Regional	Tyler	0	13,988	13,988
27	Waco Regional	Waco	5,658	303	5,961
28	Southeast Texas Regional	Beaumont/Port Arthur	4,764	0	4,764
29	Easterwood Field	College Station	1,430	0	1,430
30	Killeen Municipal	Killeen	650	1,349	1,999
31	East Texas Regional	Longview	100	1,149	1,249
32	Montgomery County	Conroe	450	0	450
33	Big Spring Airport	Big Spring	400	0	400
	Grand Total		**1,356,997,456**	**125,896,436**	**1,482,893,892**

Source: Bureau of Transportation Statistics

Table 6.9 Destination airports in Texas serving domestic air cargo (2003)

Rank	Destination Airport	City	Enplaned Freight (lbs)	Enplaned Mail (lbs)	Total Air Cargo (lbs)
1	Dallas/Fort Worth International	Dallas/Fort Worth	544,951,596	64,012,805	608,964,401
2	George Bush Intercontinental	Houston	240,624,085	43,381,650	284,005,735
3	San Antonio International	San Antonio	137,053,001	12,025,863	149,078,864
4	Fort Worth Alliance	Fort Worth	134,352,542	0	134,352,542
5	Austin - Bergstrom International	Austin	114,617,594	7,704,133	122,321,727
6	El Paso International	El Paso	86,720,081	3,618,780	90,338,861
7	Love Field	Dallas	36,963,435	983,429	37,946,864
8	Lubbock International	Lubbock	30,985,431	135,445	31,120,876
9	Laredo International	Laredo	25,217,729	4,520	25,222,249
10	Valley International	Harlingen	23,083,599	6,272	23,089,871
11	William P. Hobby	Houston	14,081,757	2,222,694	16,304,451
12	Brownsville/South Padre Island International	Brownsville	13,747,575	2,065	13,749,640
13	Midland International	Midland	3,665,639	18,514	3,684,153
14	TSTC Waco	Waco	2,665,662	0	2,665,662
15	McAllen Miller International	McAllen	1,628,272	24,318	1,652,590
16	Amarillo International	Amarillo	1,013,352	62,273	1,075,625
17	San Angelo Regional/Mathis Field	San Angelo	1,055,202	60	1,055,262
18	Corpus Christi International	Corpus Christi	740,605	281,977	1,022,582
19	Abilene Regional	Abilene	982,880	1,303	984,183
20	Brownwood Regional	Brownwood	357,840	137	357,977
21	Dyess Air Force Base	Abilene	342,167	0	342,167
22	Robert Gray Air Force Base	Fort Hood	282,098	0	282,098
23	Addison Municipal	Dallas	161,635	0	161,635
24	Del Rio International	Del Rio	97,452	0	97,452
25	Meacham International	Fort Worth	57,545	0	57,545
26	Sheppard Air Force Base / Wichita Falls Municipal	Wichita Falls	32,446	442	32,888
27	Killeen Regional	Killeen	29,323	1,588	30,911
28	Southeast Texas Regional	Beaumont/Port Arthur	23,057	814	23,871
29	Easterwood Field	College Station	8,241	1,294	9,535
31	Waco Regional	Waco	7,739	540	8,279
32	East Texas Regional	Longview	6,689	886	7,575
33	Tyler Pounds Regional	Tyler	4,996	624	5,620
34	Coleman Municipal	Coleman	2,640	0	2,640
35	Ellington Regional	Houston	1,707	400	2,107
36	Victoria Regional	Victoria	1,945	14	1,959
	Grand Total		**1,415,567,557**	**134,492,840**	**1,550,060,397**

Intra-Texas air cargo movement

Over thirty Texas airports serve as origins and/or destinations for intra-Texas air cargo movement. Intra-Texas freight accounts for shipments with origins and destinations in Texas. While the volume of intra-Texas freight is significant (174.7 million pounds in 2003 with a Texas airport origin) (Table 6.10, Table 6.11) a majority of airfreight passing through Texas's larger airports is destined for domestic or international locations outside of Texas.

Table 6.10 Origin airports serving intra-Texas freight (2003)

Rank	Origin Airport	City	Enplaned Freight (lbs)	Enplaned Mail (lbs)	Total Air Cargo (lbs)
1	San Antonio International	San Antonio	30,434,794	3,589,478	34,024,272
2	Dallas/Fort Worth International	Dallas/Fort Worth	22,692,077	5,708,037	28,400,114
3	George Bush Intercontinental	Houston	22,574,064	3,599,747	26,173,811
4	Fort Worth Alliance	Fort Worth	19,835,524	0	19,835,524
5	Laredo International	Laredo	10,946,833	703	10,947,536
6	Austin-Bergstrom International	Austin	8,608,811	1,232,857	9,841,668
7	Valley International	Harlingen	8,448,280	193	8,448,473
8	Lubbock International	Lubbock	7,388,222	142,856	7,531,078
9	El Paso International	El Paso	5,963,697	550,172	6,513,869
10	Love Field	Dallas	5,916,414	210,421	6,126,835
11	William P. Hobby	Houston	5,112,958	485,758	5,598,716
12	Midland International	Midland	3,211,669	95,813	3,307,482
13	Brownsville/South Padre Island International	Brownsville	2,690,755	30	2,690,785
14	McAllen Miller International	McAllen	1,143,317	844,832	1,988,149
15	TSTC Waco	Waco	861,042	0	861,042
16	Abilene Regional	Abilene	646,775	1,251	648,026
17	Corpus Christi International	Corpus Christi	495,891	145,089	640,980
18	San Angelo Regional/Mathis Field	San Angelo	512,724	1,232	513,956
19	Amarillo International	Amarillo	421,350	79,559	500,909
20	Brownwood Regional	Brownwood	434,280	168	434,448
21	Tyler Pounds Regional	Tyler	0	15,350	15,350
22	Addison Municipal	Dallas	10,020	0	10,020
23	Southeast Texas Regional	Beaumont/Port Arthur	4,764	0	4,764
24	Easterwood Field	College Station	1,430	854	2,284
25	Killeen Municipal	Killeen	650	1,285	1,935
26	Del Rio International	Del Rio	1,546	0	1,546
27	Waco Regional	Waco	0	1,362	1,362
28	Sheppard AFB/Wichita Falls Municipal	Wichita Falls	0	996	996
29	East Texas Regional	Longview	100	701	801
30	Robert Gray Army Airfield	Fort Hood/Killeen	450	0	450
31	Victoria Regional	Victoria	9	0	9
	Grand Total		**158,000,000**	**16,708,744**	**174,708,744**

Source: Bureau of Transportation Statistics

Table 6.11 Destination airports serving intra-Texas freight (2003)

Rank	Destination Airport	City	Enplaned Freight (lbs)	Enplaned Mail (lbs)	Total Air Cargo (lbs)
1	San Antonio International	San Antonio	27,554,119	3,596,874	31,150,993
2	George Bush Intercontinental	Houston	24,770,443	3,817,805	28,588,248
3	El Paso International	El Paso	19,597,488	1,962,827	21,560,315
4	Dallas/Fort Worth International	Dallas/Fort Worth	18,687,871	3,581,408	22,269,279
5	Valley International	Harlingen	11,095,097	2,838	11,097,935
6	Fort Worth Alliance	Fort Worth	10,451,033	0	10,451,033
7	Austin-Bergstrom International	Austin	9,889,722	2,365,037	12,254,759
8	Lubbock International	Lubbock	7,570,386	90,458	7,660,844
9	Love Field	Dallas	6,080,058	597,992	6,678,050
10	Laredo International	Laredo	4,963,578	3,795	4,967,373
11	William P. Hobby	Houston	4,593,798	393,548	4,987,346
12	Brownsville/South Padre Island International	Brownsville	4,392,918	2,065	4,394,983
13	Midland International	Midland	3,124,054	11,951	3,136,005
14	McAllen Miller International	McAllen	1,587,784	24,302	1,612,086
15	San Angelo Regional/Mathis Field	San Angelo	1,055,202	999	1,056,201
16	Abilene Regional	Abilene	982,880	1,321	984,201
17	Amarillo International	Amarillo	757,824	50,445	808,269
18	Corpus Christi International	Corpus Christi	720,163	195,844	916,007
19	Brownwood Regional	Brownwood	357,840	137	357,977
20	Sheppard AFB/Wichita Falls Municipal	Wichita Falls	32,446	1,146	33,592
21	Killeen Municipal	Killeen	29,323	1,467	30,790
22	Southeast Texas Regional	Beaumont/Port Arthur	20,620	814	21,434
23	Easterwood Field	College Station	8,241	1,836	10,077
24	Waco Regional	Waco	7,739	1,358	9,097
25	Addison Municipal	Dallas	7,480	0	7,480
26	Del Rio International	Del Rio	5,022	0	5,022
27	Tyler Pounds Regional	Tyler	4,996	1,391	6,387
28	Coleman Municipal	Coleman	2,640	0	2,640
29	East Texas Regional	Longview	2,209	672	2,881
30	Victoria Regional	Victoria	1,945	14	1,959
31	Ellington Field	Houston	1,707	400	2,107
	Grand Total		**158,356,626**	**16,708,744**	**175,065,370**

Source: Bureau of Transportation Statistics

It is an interesting observation that while DFW dominates other Texas airports in terms of annual total landed weight (including intra-Texas, domestic, and international shipments), San Antonio International enplaned the most intra-Texas freight. It is important to note that the enplaned air cargo data does not include cargo traveling by an air waybill but physically moved by truck. Based on interviews with Texas air carriers, approximately half of the cargo traveling by an air waybill between Texas cities is actually moved by truck.

The top airfreight carriers serving the intra-Texas air cargo market are shown in Table 6.12. One will find that all of the air carrier categories described in Section 2 operate at one or more Texas airports, with the integrated carriers leading the market.

Table 6.12 Top airfreight carriers in Texas serving the intra-Texas market (2003)

Rank	Carrier Name	Total Enplaned Freight (lbs)	Total Enplaned Mail (lbs)	Total Air Cargo (lbs)	Carrier Category
1	United Parcel Service	45,727,277	0	45,727,277	Integrated
2	Federal Express Corporation	43,373,320	0	43,373,320	Integrated
3	Southwest Airlines, Co.	19,475,147	2,145,619	21,620,766	Combination
4	Continental Air Lines, Inc.	7,959,503	6,172,017	14,131,520	Combination
5	Air Transport International	10,189,612	0	10,189,612	Forwarder
6	American Airlines, Inc.	2,191,474	7,175,529	9,367,003	Combination
7	Ryan International Airlines	9,013,322	0	9,013,322	Combination
8	Empire Airlines, Inc.	5,332,046	0	5,332,046	Combination
9	Airborne Express, Inc.	4,960,584	0	4,960,584	Integrated
10	Kitty Hawk Air Cargo	4,211,958	0	4,211,958	Line-haul
11	Express.Net Airlines	3,380,691	0	3,380,691	Line-haul
12	Atlantic Southeast Airlines	152,769	498,887	651,656	Combination
13	Capital Cargo International	517,780	0	517,780	Line-haul
14	Custom Air Transport	515,207	0	515,207	Line-haul
15	Continental Express Airlines	313,649	158,207	471,856	Combination
16	Comair, Inc.	449,597	876	450,473	Combination
17	Skywest Airlines, Inc.	42,929	320,144	363,073	Combination
18	American Eagle Airlines, Inc.	251,288	45,837	297,125	Combination
19	Delta Air Lines, Inc.	193,925	91,679	285,604	Combination
20	Chautauqua Airlines, Inc.	2,713	99,099	101,812	Combination
21	USA Jet Airlines, Inc.	42,030	0	42,030	Line-haul
22	Astar Air Cargo, Inc.	25,008	0	25,008	Line-haul
23	Kalitta Air LLC	18,317	0	18,317	Line-haul
24	Ameristar Air Cargo	17,000	0	17,000	Line-haul
25	Northwest Airlines, Inc.	1,300	545	1,845	Combination
	Total	**158,358,446**	**16,708,439**	**175,066,885**	

Source: Bureau of Transportation Statistics

6.2.3. Regional Air Carrier Interviews

To better understand the flow of air cargo in Texas, the researchers conducted interviews with the leading air carriers in Texas. Three combination carriers and two integrated carriers were interviewed for the study. The carriers were asked about the locations of their regional hubs serving Texas markets, approximately how much air cargo moves by truck versus air within the region, desirable characteristics for choosing air cargo facilities, and long-term plans for adapting to airside and landside congestion growth. The responses from the air carriers were also used to help reinforce the intra-Texas BTS data used in this project.

Within Texas, combination air carriers transport more cargo (by weight) via truck than by air. The passenger airlines indicated that they are not interested in intra-Texas freight movement because long-haul cargo movement to international markets is much more profitable.[121] In addition, industry restrictions prohibit combination carriers from transporting intra-Texas airfreight—freight with both origin and destination in Texas—by truck.[122] Although a segment of the trip can be made by truck, combination carriers are restricted from providing air truck service for intra-Texas freight. Because airlines have to compete with trucks, they have to lower their prices for regional air cargo movement. As a result, passenger airlines prefer to book freight for longer linked segments and focus on transporting goods to overseas markets. The combination carriers interviewed stated that approximately 80 percent of the airfreight flying out of DFW and IAH is destined for international markets.[123] The cargo transported by passenger airlines is typically not destined for any of the domestic 48 states.[124] The carriers agreed that it does not make logistic sense to fly bulk cargo between Texas cities. The volume and mass of the cargo is too great to move efficiently by air. Instead, bulk cargo is loaded into trailer trucks, transported to a large air cargo facility for consolidation, and flown to its final destination. For example, Dell computers are assembled in Austin, trucked to Dallas where they are loaded onto large aircraft, and flown to overseas markets. However, it is important to note that cargo moved by truck under the control of an air carrier travels by an air waybill.

New all-cargo airport hubs reasonably can be expected to develop at other strategic locations in Texas (near major population and economic centers) with or without the construction of the TTC. Interviews with air cargo stakeholders suggested that the more compelling question is not why and where air cargo airports are developing, but why and where they are not they developing.[125] Aviation planners and developers are discovering that one cannot simply designate an airport as an air cargo hub. Instead, special conditions must come together at the right location for an airport to become a successful all-cargo hub, as discussed in the previous section of this chapter.

6.3. Air Cargo Challenges and Opportunities

According to several air carrier interviews, Texas currently has a surplus of aviation capacity. As a result, Texas may realize a growth in air traffic because of traffic diversion to Texas from more congested states.[126] Landside congestion on airport entrances and access roads, however, may constrain aviation activities at busy airports. Unless the TTC spurs connect directly to the airports, some stakeholders do not expect the TTC to be able to solve future landside or air-side congestion problems. Corridor spurs connecting airports to the TTC, however, must be careful to avoid disruption of existing or planned airport infrastructure.

The following section identifies some of the expected challenges and opportunities afforded by the TTC. It also discusses the possible impact the TTC will have on regional freight flows.

6.3.1. New Truck Corridors

With the introduction of new truck routes and high-speed rail (HSR), the TTC has the potential to take intra-Texas freight business away from airports because airfreight companies will choose to move more freight by truck. The TTC, however, is planned as a toll facility, which may complicate a carrier's decision to move freight along its routes. Air and truck carriers will have to weigh the comparative costs and benefits of transporting cargo via the TTC against air and/or routes without user fees.

Friction at several U.S.-Mexico border crossings caused by security issues and congestion problems has several cargo operators considering alternatives, such as processing freight further inland.[127] Opening the U.S. border to cross-border trucking with Mexico would provide considerable opportunities for development of air cargo facilities and inland ports. If the border were moved inland to KellyUSA in San Antonio, for example, air cargo activities there would likely experience a dramatic increase. Located approximately 150 miles from Laredo, San Antonio often serves as a transshipment point for products imported from Mexico where they are repackaged and loaded onto trucks or airplanes for distribution.[128] Local and regional freight forwarders near the U.S.-Mexico border expect that San Antonio will see growth in the amount of Mexican agricultural shipments passing through the city and destined for all parts of the United States. While trucks transport a majority of agricultural shipments, a fraction of the shipments will be flown to East Coast cities.[129] Limits on commercial truck operations and access between Mexico and the United States were supposed to be eliminated by January 1, 2000. Because of concerns about the safety of Mexico-based vehicles and drivers, however, Mexican trucks continue to have only limited access to commercial zones along the U.S.-Mexico border. An air cargo study for the City of San Antonio purported that the delay of open-border implementation is hindering the development of KellyUSA or other potential transshipment centers in Texas as major inland ports for U.S.-Mexico trade.[130, 131]

6.3.2. Airfreight-Rail Interface

With the exception of European systems, there presently exists very limited air-rail integration at airports worldwide. The Alameda Corridor in California, designed to improve highway and rail access to the Ports of Long Beach and Los Angeles, is the domestic example most comparable to the TTC. The Alameda Corridor consolidated four low-speed branch freight rail lines into one high-capacity freight rail expressway.[132] United Parcel Service (UPS) is trying to integrate some of its systems with rail along the Alameda Corridor.[133] The problem in Southern California, and specifically Los Angeles International (LAX), is that it serves as a congested international gateway for freight. Freight coming into the Ports of Long Beach and Los Angeles becomes stacked up at the ports. Rather than processing the freight at the port of entry, rail is used to move the freight quickly and efficiently to an inland site.

Currently, there is very little air-rail interface between air carriers and railroads at Texas airports. The Alliance inland port in Fort Worth operates a Burlington Northern Santa Fe (BNSF) intermodal rail facility, in addition to a private airport. Even with its state-of-the-art facilities, there does not appear to be any substantial interaction between cargo carried by rail and air. Located at the former Kelly Air Force Base in San Antonio, KellyUSA is connected to a Union Pacific rail line and shares use of the runway with the U.S. Air Force. To date, the KellyUSA inland port has not attracted a significant volume of cargo that is transshipped within the facility, much less transshipped between air and rail modes. Generally, rail is not a good mode choice for transporting air-eligible commodities because freight rail schedules are not as fast or reliable as are trucks.

As previously stated, one of the proposed components of the TTC is track for HSR, which has been proven in Europe and in dense areas in the northeastern United States as an alternative to air passenger travel. In addition, opportunities exist for freight transport on HSR that could be competitive with, or complementary to, air cargo transport. Given the high cost of operating a HSR system, it does not appear economically feasible to include HSR along all 4,000 miles of the proposed TTC. The ridership and revenue forecasts along most of the TTC routes are not sufficient to cover the capital and operating costs of HSR. From a passenger transport perspective, several conditions must be satisfied for HSR to be economically feasible. HSR linkages are limited to cities with high populations and high population densities, cities that are grouped along major passenger traffic flow routes within a range of approximately 100 to 300 miles, cities with strong ties and a propensity for travel between them, and cities with developed local transit systems to feed the HSR stations.[134] Based on these criteria, the cities located in the

"Texas Triangle" (Dallas/Fort Worth, Houston, San Antonio, and Austin) are candidates for HSR linkage.

Use of HSR for cargo movement would resemble the services provided by combination carriers. Just as the combination carriers rely on passenger fares to cover most of their operating costs, the economic feasibility of HSR hinges on passenger ridership and revenues. Freight transport could prove to be an additional and valuable source of revenue for HSR; however, the routing, scheduling, and frequency of the system will be centered on accommodating passenger needs. Some of the growing air cargo volume moving by truck could be diverted to HSR because it offers faster connections between cities. Likewise, some of the air cargo transported by air could be shifted to HSR. Air-rail code-sharing agreements, through which air carriers operate service on HSR, would offer air carriers and freight forwarders more mode-choice options. As a result, implementation of HSR along some segments of the TTC could compete with, or supplement, traditional freight transport by air and/or truck depending on the presence of intermodal agreements between carriers.

For air carriers and freight forwarders to consider HSR as a viable alternative to air and truck transport, several criteria must be present, such as speed, cost, flexibility, frequency, and reliability of service, as well as location in proximity to air cargo sorting, warehousing, and distribution facilities. Carriers consider all of the criteria in combination to determine the strategic advantages of one mode over another. In other words, an HSR advantage for one of the required parameters, such as speed, does not necessarily mean that the carriers will choose HSR for freight transport.

Speed

By definition, HSR requires top speeds of at least 90 miles per hour along some portion of the route.[135] Very high speed rail operates at speeds in excess of 200 miles per hour. Ridership and revenue projections of proposed new systems (versus track upgrades of existing networks) within the U.S. have often cited design speeds of 200 miles per hour.

HSR has the advantage over trucks because it can travel at speeds far exceeding average truck speeds and avoids congestion by traveling on dedicated guideways. In addition, HSR does not have to adhere to the trucking "hours-of-service" rule, limiting the number of consecutive hours a driver can operate a vehicle. For relatively short-to-moderate distances between 100 and 400 miles, HSR has an advantage over short-haul air passenger travel because it does not require long check-in and security screening delays. Future security concerns, however, may require HSR passengers to undergo security screenings similar to those of air passengers. Required security screenings for HSR passengers would diminish its advantage over air.

An additional advantage of HSR is that the stations are often located in or near a city's central business district (CBD), thereby eliminating the travel time between the airport and the CBD. Direct connection to the CBD is advantageous for business passengers traveling between two cities. HSR connections to the airport, however, would be required for air passenger and cargo carriers to fully utilize the system. Unless connections are made to both the CBD and the city's primary commercial airport, HSR connection at the airport would eliminate the advantage of direct connections between CBDs. For routes that do not connect CBDs, the door-to-door travel time of HSR is comparable to that of driving. Air transport maintains the advantage in such situations.

Cost

To make HSR attractive to air carriers and freight forwarders, the cost of freight transport by HSR must be competitive with air and/or truck transport.

Flexibility and Frequency

One of the advantages trucking offers freight carriers is its flexibility of scheduling and route assignment. Flexibility of transport is of particular importance to integrated carriers that rely on their own fleet of trucks and aircraft to deliver door-to-door, time-definite shipments. Chartered, on-demand airfreight companies provide flexible service to shippers requiring immediate "next flight out" air transport. Like scheduled air passenger service, HSR will operate under scheduled departures and arrivals, thereby limiting its flexibility. In addition, as previously discussed, HSR is economically feasible only in large, dense, urban cities (e.g., Dallas/Fort Worth, Houston, San Antonio, and Austin). As a result, HSR is limited in the number of markets it can serve. Air cargo destined to other markets will require transfers to alternate modes. Scheduling coordination between air and rail would also be vital for code-sharing agreements between air and rail. In addition to flexibility and frequency of scheduling, air carrier investment in HSR could affect a company's flexibility to enter and leave markets. HSR scheduling flexibility is further constrained by noise. Although HSR could theoretically operate at night, the noise it makes would limit the hours of operation.

Reliability

One of the most important considerations in mode-choice decisions for integrated carriers is reliability. Integrated carriers guarantee the arrival time of their shipments, therefore reliability within all legs of transport is paramount. Reliability considerations can include the average annual number of weather-related delays at an airport, average delay owing to land-side or air-side congestion, and average annual delays because of mechanical malfunction. Until HSR has an opportunity to establish itself as a reliable choice for freight transport, air carriers may be slow to switch from air or truck to HSR.

Location

As previously stated, air passenger and cargo carriers would require HSR connections at the airport to take advantage of HSR as a complement to their services. This is because the passenger and air cargo sorting, warehousing, and distribution facilities are located at the airport. The physical location of the HSR station at the airport, however, could affect an air cargo carrier's decision to utilize rail for cargo movement. If it is inconvenient or inefficient to transfer cargo between rail and the sorting/distribution facilities, then air carriers will be less likely to consider HSR as a reasonable alternative to air or trucking.

Potential for shifting from air to high-speed rail

The airfreight companies expressed mixed opinions regarding their potential use of HSR for airfreight movement. Some companies identified opportunities for freight movement by HSR to replace the trucking segment, although presently they are not prepared for such a change. The airfreight companies already have all of their infrastructure in place to meet the needs of their customers. To be competitive with trucks, however, HSR must be able to move goods faster than trucks, the system must be reliable, and the rail stations must be located in close proximity to the company's freight consolidation and sorting facilities. Carrier companies base their mode choice decisions on the relative level of service and price comparisons between the modes. Airfreight companies interviewed, however, affirmed that an hour or two advantage on any leg of the trip would be considerable, even when accounting for overseas shipments. Therefore, HSR potentially could be attractive to airfreight companies if it allowed for a faster connection between cities. However, unless HSR offers a competitive advantage to the airfreight companies by reducing the time it takes for freight to travel between cities on the ground, trucks will continue to dominate the land-based component of airfreight movement.

The combination carriers expressed their skepticism that the TTC would not provide much of a benefit for their companies. At present, there is little congestion within the Texas airport system that affects movement of cargo within Texas. As a result, the air carriers currently are not seeking landside alternatives to increase capacity to accommodate airfreight demand. In addition, combination carriers receive only a small percentage of their revenues from air cargo, instead relying on passenger fares. Many carriers interviewed suggested that it would not be cost effective for their companies to transfer freight to HSR because they would be promoting revenue on a competitive mode. With the exception of regional combination carriers specializing in regional and domestic service, such as Southwest Airlines, combination carriers are more focused on international markets. Therefore, improvements to Texas's landside infrastructure are likely to have little impact on their air cargo operations.

Integrated carriers operate somewhat differently from the passenger airlines. Integrated carriers, such as Federal Express (FedEx) and UPS guarantee the timing of their shipments, therefore the urgency of the package determines whether it will be trucked or flown. Integrated carriers rely on the hub-and-spoke system to efficiently accommodate the time-sensitive nature of their services. Although large integrated carriers such as FedEx and UPS utilize rail for freight movement at some hub locations, no intra-Texas freight is moved by rail. Currently, trucks provide the reliability, flexibility, and efficiency that integrated carriers require. When choosing a strategic location for a cargo hub, integrators look for direct feeds to major highways, ramps, and runways capable of supporting the size and number of their aircraft, and close proximity to a growing urban area with increasing volume orders. Airfreight carriers provide door-to-door service, therefore connectivity between their customers, their consolidation and sorting facilities, and the airport is key.

6.3.3. General Aviation Airports

General aviation airports, serving all aviation activities other than military or commercial service operations, are not often utilized for air cargo movement. Many general aviation airports lack the runway length or instrument approaches required to accommodate freighters or allow all-weather flying. Although nearby companies may utilize a general aviation airport for emergency freight shipments, infrequent shipments of this nature are often small and light.

General aviation airports adjacent to interchanges between two TTC corridors or an existing major highway could be in the position to realize considerable growth. Economic development is expected to occur at nodes along the TTC such as interchanges. Given good connectivity and room for airport and runway expansion, select general aviation airports may be attractive candidates for air cargo development to meet the demands of growing economic activity in the area. The airport must have adequate room for expansion to lengthen the runway and allow for the required 50:1 instrument approach slope beginning 200 feet from the end of the runway. Without instrument approaches, an airport will not be able to operate under adverse weather conditions. Air cargo and passenger services, however, require reliable, scheduled service to be offered regardless of weather conditions. Expansion of a general aviation airport to serve air cargo demand may prove more attractive than development of a green field site because of public opposition and environmental challenges associated with new airport sites.

6.3.4. Opportunities for Texas's Major Air Cargo Airports

Although the preferred alignments of the TTC have yet to be determined, one can reasonably expect to see growth and development at several of Texas's major air cargo airports as a result of nearby TTC connections. The following discussion identifies some of the cities and airports in the position to benefit most from the TTC.

Dallas/Fort Worth

Dallas/Fort Worth International (DFW), located near the midpoint of the Dallas/Fort Worth Metroplex, is currently the busiest Texas airport in terms of total landed weight and was ranked eleventh busiest air cargo airport in North America in 2003. There are seven runways at DFW, with four over 11,000 feet in length. DFW is the national hub and headquarters for American Airlines and serves as a regional hub for UPS. Fort Worth's Alliance, located approximately 16 miles north of the city's central business district, ranked fourth among Texas airports for total landed weight and intra-Texas air cargo. Alliance operates two parallel runways at 9,600 feet and 8,220 feet, respectively. FedEx utilizes Alliance as a regional hub, accounting for a high percentage of the air cargo operations there. Dallas Love Field, located approximately 2 miles east of Interstate 35E running through Dallas, ranks in the top ten Texas airports for intra-Texas freight movement. Dallas Love Field maintains three runways, the longest of which is 8,800 feet. The airport is the national headquarters and hub for Southwest Airlines.

As proposed, two TTC priority corridors (TTC-35 and TTC-45) and two non-priority corridors (TTC-20 and TTC-Red River) will ring Dallas/Fort Worth in the rural areas surrounding the cities (Figure 6.2). Because DFW and Love Field are centrally located in the heart of the metroplex, connectivity between the TTC and existing interstates and highways will be critical for ground access to the airports. Congestion on existing ground access facilities to DFW, however, may limit accessibility between the airport and the TTC. Despite urban ground access congestion between the airports and the TTC, it is expected that air cargo operations will continue to grow and dominate at DFW.

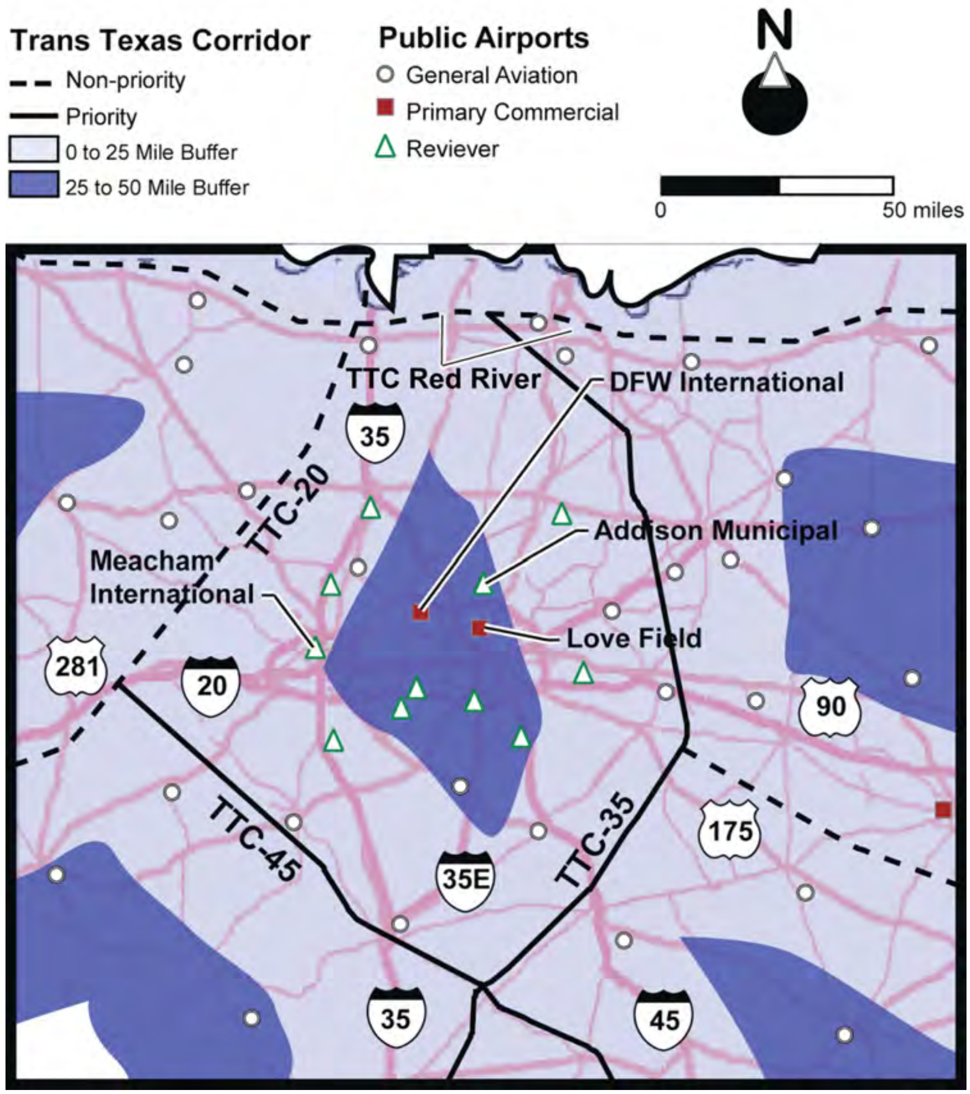

Figure 6.2 Public-use airports and the Trans-Texas Corridor in the Dallas/Fort Worth area

Considerable opportunities for Alliance to benefit from close proximity to the TTC-20 non-priority corridor are foreseeable. Alliance is located north of the Fort Worth urban area and approximately 18 miles east of the TTC-20 route. When the operators of Alliance were informed of the plans for the TTC, they expressed their willingness to donate land for construction of a link to a nearby route passing through the northwestern edge of Fort Worth. Connectivity between Alliance and the TTC could leverage its attraction as an inland port and a freight transshipment center. Intermodal connections, including access to the TTC and nearby highways, the BNSF rail facility, and the airport, as well as close proximity to the large Metroplex population, would provide attractive selling points for integrated and all-cargo carriers to bolster air cargo operations at Alliance.

Houston

Houston is home to three primary commercial airports offering scheduled air cargo service. The Federal Aviation Administration (FAA) defines two of the airports, George Bush

Intercontinental (IAH) and Ellington Field, as all-cargo airports because they support at least 100 million pounds of landed weight cargo each year. IAH ranked second among Texas all-cargo airports in terms of total landed weight in 2002. There are five runways at IAH, two of which are over 10,000 feet. IAH serves as a hub to Continental Airlines and home to ten scheduled all-cargo airlines. Ellington Field is a joint-use civil/military airport and supports freight operations by the U.S. military, Continental Express, and UPS. Ranking sixth among Texas's all-cargo airports in 2002, Ellington Field operates three runways, the longest of which is 9,001 feet. The third primary commercial airport is William P. Hobby. Hobby airport ranked eleventh among Texas airports for intra-Texas freight in 2003. Hobby operates four runways, all less than 8,000 feet in length.

Houston is located at the convergence of three priority corridors, TTC-10, TTC-45, and TTC-69 (proposed) (Figure 6.3). The conceptual plan of the TTC indicates that TTC-69, paralleling the proposed Interstate 69, will form a loop around three-fourths of Houston while providing connectivity to four radiating fingers of the TTC. As a result, Houston will be connected in all directions to other parts of the state. A finger of TTC-69, extending to the south of Houston, will come within 8 to 12 miles of both Hobby and Ellington Field. Connectivity between these two airports and the TTC would enhance truck access and could increase the volume of air cargo transported to the airports for lift or away from the airport for distribution. The present lengths of the runways at Hobby, however, prevent it from accommodating overseas flights. As a result, the majority of international operations are expected to remain at IAH. Cargo flying into IAH from other domestic or international markets can be loaded onto truck (or HSR) for transport to other Texas cities via any of the priority corridors radiating from Houston. Regional carriers, such as Southwest Airlines, often consider and select secondary market airports, such as Hobby, over the larger, busier airports because they are sometimes easier to access for both passengers and cargo. Regional carriers indicated that they will continue to look at secondary markets in the future to accommodate their growth.[136]

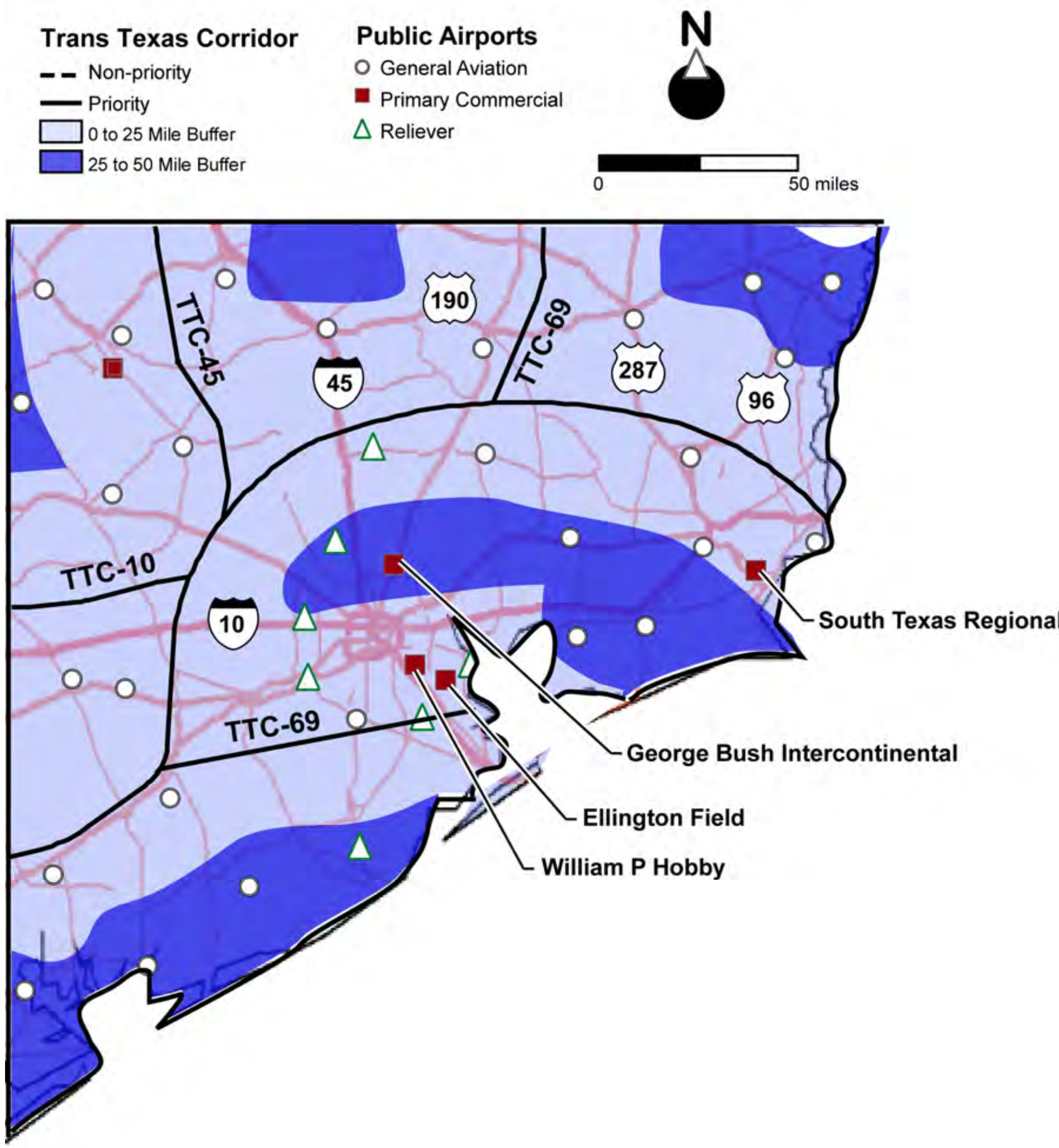

Figure 6.3 Public-use airports and the Trans-Texas Corridor in the Houston area

San Antonio

As revealed by the 2003 Bureau of Transportation Statistics data, San Antonio International is the leading Texas airport for intra-Texas freight. In terms of total landed weight, the FAA determined San Antonio to be the fifth busiest Texas all-cargo airport. In 2002, Airports Council International identified San Antonio International to be the thirteenth fastest growing airport in the world, enjoying a 22.7 percent increase between 2001 and 2002.[137] In addition to the enplaned airfreight, a considerable volume of air cargo generated by firms in the San

Antonio/Austin region and maquiladoras in border states of Mexico is trucked through San Antonio to other airports. An air cargo study performed for the City of San Antonio in 2002 identified San Antonio International as a potential location for a major transshipment facility for air cargo carriers transporting goods in freighters between Mexico, Central America, and the U.S.[138] The study, however, was completed prior to the unveiling of the TTC concept in 2002. The study also identified KellyUSA, located approximately 12 miles southwest of San Antonio International, to be in the position to develop into an inland port providing distribution and logistic services in addition to international air cargo service. Located approximately 150 miles and a one-half day drive from the Mexico border, San Antonio offers an attractive location for a freight transshipment center. Regionally produced and Mexican imported goods can be trucked to San Antonio International or KellyUSA for lift to other domestic and/or international markets.

The TTC could provide significant opportunities for the continued development of San Antonio International and Kelly USA into nationally competitive airfreight facilities. The airports are located within 30 to 40 miles of two priority corridors (TTC-35 and TTC-10) and within 40 to 50 miles on a non-priority corridor (Figure 6.4). As proposed, the two priority alignments and the one non-priority alignment loop the city, providing the opportunity for excellent connectivity to the TTC network via Interstates 10 and 35. The inclusion of HSR in the design, potentially connecting the major cities in the "Texas Triangle" (San Antonio, Austin, Dallas/Fort Worth, and Houston), would further enhance San Antonio's transportation connectivity and help to attract air carriers and freight forwarders to the city. Despite connectivity to the TTC in San Antonio, a significant portion of the region's cargo will continue to be trucked to gateway airports such as those in Dallas/Fort Worth, Houston, Los Angeles, and Miami.

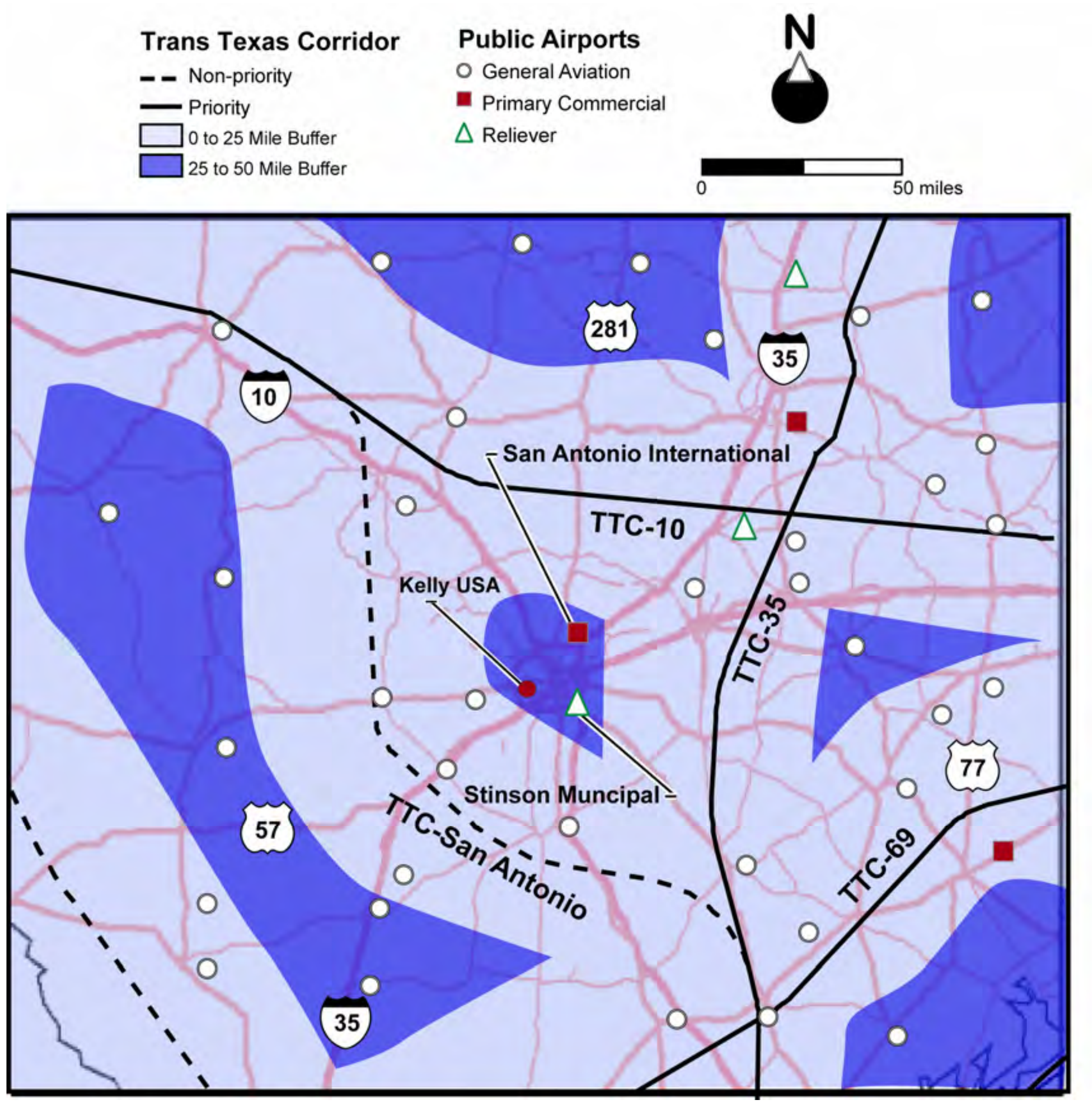

Figure 6.4 Public-use airports and the Trans-Texas Corridor in the San Antonio area

Austin

Austin has one FAA-defined all-cargo airport: Austin-Bergstrom International (ABI). It ranked third among other Texas airports in terms of total landed weight in 2002. Austin has two runways with lengths of 12,248 feet and 9,000 feet.

Austin and San Antonio are often considered together when evaluating cargo flow in the region, but ABI and San Antonio International are in competition with one another for attracting air carriers and freight forwarders. Both cities offer many of the same locational benefits in terms of access to highway facilities and local and regional markets. Any competitive advantage at one of the airports, such as accessibility to one or more TTC corridors, could shift the balance of freight movement away from the other airport. Austin is located in the northwest quadrant formed by the near-perpendicular intersection of priority corridors TTC-10 and TTC-35 (Figure

6.5). TTC-10 passes approximately 19 miles south of ABI, while TTC-35 passes approximately 9 miles east. ABI's close proximity to the TTC may provide a potential locational advantage for truck access arriving from north, south, east, or west.

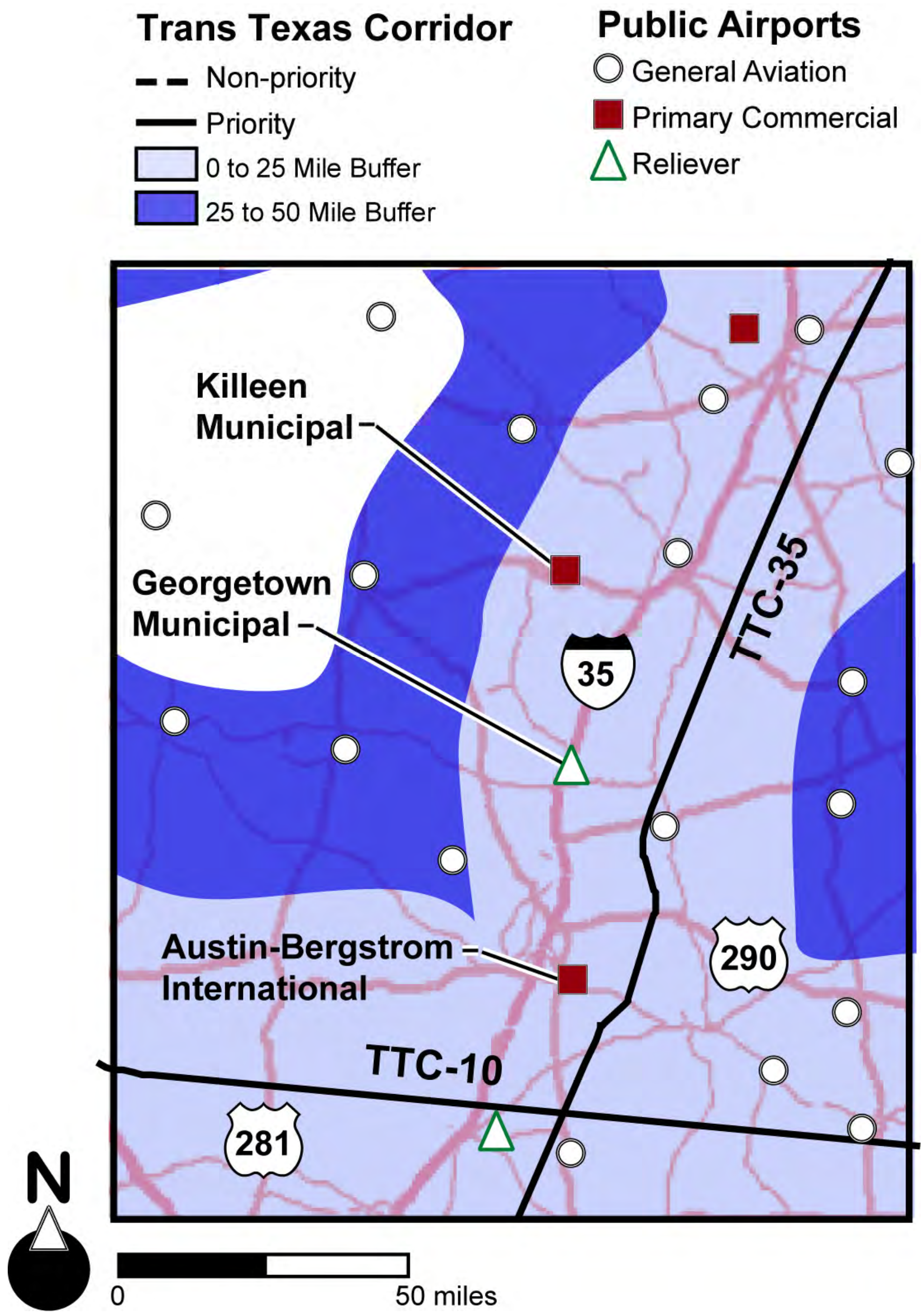

Figure 6.5 Public-use airports and the Trans-Texas Corridor in the Austin area

The TTC is expected to promote economic activity at key nodes along its routes. It is important to acknowledge, however, that many of Texas's airports may experience negligible air cargo growth, despite construction of the TTC. Special conditions must come together, including good connectivity to the TTC, a strong market, and sufficient infrastructure, to realize a noticeable increase in air cargo as a result of the TTC. Air cargo development along the TTC requires good strategic planning.

6.4. Recommendations

The Trans-Texas Corridor (TTC) will permit a much faster and safer movement of people and goods throughout Texas and stimulate new economic activity. Integration of Texas's leading cargo airports into the TTC will provide opportunities for the development of air cargo transshipment centers at strategic locations along the TTC. Strategic planning for the development of air cargo transshipment centers, however, should consider the emerging air cargo market trends and the factors influencing freight center location decisions previously discussed. The following recommendations are intended to facilitate air cargo development along the TTC.

6.4.1. Consider the Development of Competitive Air Cargo Facilities

Because the TTC network is not planned to pass through urban areas, it will be necessary to develop freight centers at urban limits, where shipping, repackaging, distribution, and other services can be undertaken. The obvious candidates for such freight centers are inland ports. The size of inland ports can range from the relatively small and simple to the large and complex with a variety of value-added services. Inland ports can become a significant economic/employment stimulus to the local economy, as Alliance Airport has been to the Dallas/Fort Worth area. Inland ports are most likely to arise along the TTC near major metropolitan areas such as Dallas/Fort Worth and Houston. They may start as small complexes with truck and rail service and, as they develop, may require services by air transportation as well.

The TTC will permit a much faster and safer movement of people and goods throughout Texas and stimulate new economic activity. Integration of Texas's leading cargo airports into the TTC will provide opportunities for the development of air cargo transshipment centers at strategic locations along the TTC. Strategic planning for the development of air cargo transshipment centers, however, should consider emerging air cargo market trends and the factors influencing freight center location decisions.

6.4.2. Provide Facility Accommodations for Trucks

To maximize benefits to airports as a result of the increasing role of trucking in the air cargo industry, airport planning and cargo facility design should consider accommodations for trucks, such as adequate ramp space adjacent to cargo warehouses for truck loading and unloading, truck parking and holding areas, and nearby truck refueling stations. Adequate space should be provided for truck queuing at entrances and exits based on anticipated peak-hour traffic volumes.

6.4.3. Generate Airport Revenue from Trucking

Airports should consider charging cargo carriers for the use of trucks on airport property in exchange for the provision of on-airport trucking facility accommodations. In this way, airports can generate some revenue from the trucks utilizing airport facilities. This revenue can be used to improve cargo facilities that would attract even more air cargo operations at the airport. The trend of increased use of trucking service among integrated carriers will foster the need for development of trucking facilities at an airport's cargo facilities.

6.4.4. Develop Secondary Markets

Airports near the TTC in secondary markets should evaluate the benefits of ramping up their air cargo capacities in anticipation of long-term congestion growth at gateway airports, such as Dallas/Fort Worth International and Houston's George Bush Intercontinental. Secondary market airports with connectivity to the TTC stand to attract air carriers because they are easier to access for passengers and cargo.

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[117] Leigh Fisher Associates.
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[119] Ibid.
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[121] Telephone interview by Kelsey Thompson with John Campbell, Delta Airlines, June 2004.
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[124] Telephone interview by Kelsey Thompson with Joe Goode, American Airlines, June 2004.
[125] Telephone interview by Kelsey Thompson with Ray Brimble, CargoPort Development, June 2004.
[126] Ibid.
[127] Leigh Fisher Associates.
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[131] Telephone interview by Kelsey Thompson with Tom Phillips, Keiser Phillips Associates, June 2004.
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Chapter 7. Additional Recommendations and Conclusion

7.1. Additional Recommendations

7.1.1. Airport Authorities Should Take a Proactive Planning Role

Airport authorities are responsible for planning and funding airport facilities, but responsibility for the development of airport ground access facilities is often divided among a number of public agencies. Frequently, these agencies do not prioritize the airport as their most important area of concern (Gosling). As a result, it is recommended that airport authorities take a proactive role in the coordinated development of ground access between airports and the Trans-Texas Corridor (TTC). Airport access is vital to take advantage of development opportunities afforded by close proximity to the TTC. Airport master plans for airports near the TTC should be updated to reflect the accessibility needs of connecting to the TTC.

7.1.2. Consider Aviation System Requirements in TTC Planning

While airport authorities are charged with taking a proactive planning role to integrate the Texas aviation system into the TTC, it is also recommended that TTC planners take responsibility for planning airport integration into the new land-based transportation network. It is recommended that TTC planners communicate with TxDOT's Aviation Division and the FAA throughout the TTC planning process and develop their own supporting documentation for recommendations or suggestions.

7.1.3. Perform Future Evaluation

As the preferred alignments for each of the priority and other TTC routes are determined, it will become necessary to perform further airport accessibility analysis. After the precise alignments are determined, predictions of possible opportunities and impact for airports near the TTC can be studied with better clarity. Landside airport access planners should first analyze the existing airport accessibility conditions and the forecasted traffic demand. Planners can then compare existing and forecasted demand with future conditions when considering the availability of TTC accessibility. Plans and programs to connect nearby airports to the TTC can then be developed and evaluated. Future evaluation will also require airport access feasibility plans and updates of airport master plans.

In addition to further accessibility evaluation, it will become necessary to perform further air cargo flow evaluations to pinpoint opportunities for specific airports along the TTC. It will be important to study the regional flow of air cargo in Texas because many airports share air cargo markets. Competitive advantages in one market or at one airport could divert some of the air cargo traffic from another airport within the region (i.e., development at either Austin-Bergstrom or San Antonio International, or at secondary airports within a city). Air cargo market share lost to other locations is difficult to regain after the establishment of facilities and networks at the chosen location. As a carrier consolidates facilities at an airport, the likelihood of further market development at that location is strong.

The individual, strategic business decisions made by air carriers will also affect the flow of regional air cargo. For example, Dallas/Fort Worth International lost significant air cargo volume when Federal Express relocated its southwest regional hub to Alliance Airport in Fort Worth. Integrated carriers and freight forwarders are keenly sensitive to the time-definite demands of their services and continuously evaluate strategies to improve efficiency. To maximize the potential opportunities afforded by connectivity to the TTC, it is recommended that airports (or their managing entities) prepare detailed air cargo business plans specifying the intended strategies used to attract air carriers to the airport.

7.1.4. Develop Strategies Consistent with the Texas Aviation System Plan

Originally developed in 1970 and updated approximately every four to five years, the Texas Airport System Plan (TASP) has driven the development of the state's aviation system. TASP objectives include adequate air access to all population and economic activity centers in the state, timely development of the airport system, maximization of the economic benefits and growth opportunities afforded by aviation, integration of the airport system with other transportation modes, and minimization of adverse environmental impact (TxDOT 2002). When planning for the integration of Texas airports into the TTC, it will be important to develop strategies that reflect the goals and objectives of TASP.

7.2. Research Summary

The air transportation industry is of critical importance in Texas and a stimulus for economic growth and development throughout the state. Likewise, the TTC is expected to become an important land-based transportation component capable of generating significant economic growth along its path. It is important to consider airports when designing the TTC so the utility of one mode (airports) in exchange for the growth of others (highways and rail) is not diminished. New highway and rail alignment plans, however, rarely consider opportunities and challenges to the airports they bypass.

Careful planning to integrate airports into the TTC can prevent obstructions to air navigation and development surrounding airports that are incompatible with aviation. In addition, considerations to ensure adequate connectivity and accessibility between the TTC and nearby airports will be critical to integrate the Texas airport system into the TTC. Likewise, airport planning to accommodate the emerging trends in the air cargo industry and the opportunities to develop into transshipment centers will allow airports to further establish themselves as a critical cog in the Texas transportation network.

By incorporating automobile lanes, commercial truck lanes, HSR, freight rail, commuter rail, and a utility corridor into the design, the TTC is inherently multimodal. The multimodal design, however, would be strengthened greatly by considering airport connectivity and allowing for future airport growth when designing the preferred TTC alignments. The integration of Texas airports into the TTC will enhance its ability to efficiently move people and goods throughout the state, relieve roadway and airport congestion, and stimulate new economic development.

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Appendix A

The following survey is intended to help researchers understand attitudes within Texas' general aviation industry, regarding the Trans Texas Corridor (TTC). Your responses will assist the researchers in developing a strategic business plan and recommendations for TxDOT to maximize the TTC's benefits and minimize its impacts. Please help us by spending a few minutes completing this survey and sharing your opinions, concerns, and general comments. *Be assured that your responses are completely confidential and will be viewed **solely** by staff at the Center for Transportation Research at the University of Texas in Austin. No responses will be reported that could identify any individual or airport.* ***Please return completed surveys in the self-addressed, stamped envelope provided.*** Thank you for sharing your opinions! Feel free to detach the brief description page of the TTC and its proposed locations (attached) for future reference.

With which Texas aviation entity are you associated? (Please check all that apply)

☐ Airport Administration/Operations

☐ Government Agency

☐ Consultant

☐ Academic

☐ Association, Council, or Committee

☐ Other (please specify) ______________________

If you did not check "Airport Administration/Operations", please proceed to Question 5.

1. Is your airport located near one of the proposed TTC segments? ☐ Yes ☐ No ☐ Not Sure

2. How is your airport classified?

☐ Primary Commercial	☐ Reliever
☐ GA Transport	☐ GA General Utility
☐ GA Basic Utility	☐ GA Heliport

3. If the TTC were to pass near your airport, what negative impacts do you foresee on aviation activities?

4. What opportunities might your airport realize if located near the TTC?
Please proceed to Question 7.

5. What do you perceive to be the greatest threats to airports operating near the TTC?

6. What do you perceive to be the greatest benefits to airports operating near the TTC?

7. Overall, do you consider an airport's location near the TTC as favorable? Briefly explain why.

8. What airport interests should TTC planners keep in mind when planning the corridor's alignment?

9. Would you like to receive a summary of the survey results? ☐ Yes ☐ No
If yes, please include your name and contact information (preferred method):

Name: ______________________________________

☐ Email address: ______________________________

☐ Mailing address: ____________________________