Houston - Galveston Area Council

April 2004

U.S. 90A Corridor

Rail Feasibility Study

Edwards and Kelcey

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Study Sponsors

Houston-Galveston Area Council
Texas Department of Transportation
Metropolitan Transit Authority of Harris County
City of Houston
City of Meadows Place
City of Missouri City
City of Stafford
City of Sugar Land
City of Richmond
City of Rosenberg
Fort Bend County
Harris County

Consultant Team

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HDR Engineering
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1. INTRODUCTION

1.1 Context and Overview

The Houston-Galveston Area Council (H-GAC), as the Metropolitan Planning Organization (MPO), in partnership with the Metropolitan Transit Authority of Harris County (METRO), the Texas Department of Transportation (TxDOT), Fort Bend County, Harris County and the Cities of Houston, Meadows Place, Missouri City, Richmond, Rosenberg, Stafford and Sugar Land, is performing an evaluation of future transportation needs and determining the feasibility of implementing a passenger rail line along the U.S. Highway 90A corridor. This study represents the first step in an effort to improve access and increase mobility in the southwestern Houston metropolitan area.

1.2 Study Corridor

The study corridor is approximately 25 miles in length, extending from the vicinity of the METRORail Fannin South Park & Ride light rail station at Fannin and West Bellfort in the City of Houston, and paralleling Holmes Road and U.S. Highway 90A, to the State Highway 36 Bypass, located just west of the City of Rosenberg (Figure 1-1). The study corridor is located within Fort Bend County and Harris County. The Fort Bend County segment of the study corridor consists of the following municipalities (from west to east): Rosenberg, Richmond, Sugar Land, Stafford, Missouri City and Meadows Place. The following neighborhoods within in the City of Houston were included within the area under study: Greater Fondren Southwest, Fort Bend/Houston, Fondren Gardens, Westbury, Central Southwest, Willow Meadows/ Willowbend Area, South Main, Astrodome Area, Sunnyside and OST/South Union.

The study corridor centers on an existing railroad alignment owned and operated by the Union Pacific (UP) Railroad. The portion of the UP alignment under study begins at Milepost 9.5 (MP 9.5) and ends at MP 34.8.[1] The study corridor parallels U.S. 90A (South Main Street) from Rosenberg (MP 34.8) to West Junction (MP 12.90). Between West Junction and Fannin Street (MP 9.5), the line parallels Holmes Road.

The destination for many passenger rail riders will be within the City of Houston, along the METRORail light rail line. METRORail will connect riders to two of Houston's major employment centers - Downtown Houston and the Texas Medical Center - as well as several college campuses, including the University of Houston, Houston Community College and Rice University. Cultural, sports and entertainment complexes, such as Reliant Park, Houston Zoo, and the Museum District will also be reached via the light rail line. Within or in close proximity to the Fort Bend portion of the study corridor are many major trip generators and attractors, including the Sugar Land Airport, First Colony Mall, Texas Department of Corrections, Manor Care Hospital and Fort Bend Community Hospital.

1.3 Purpose, Need and Objectives

1.3.1 Purpose

The purpose of this study is to determine the need for high capacity transit and assess the technological and economic feasibility of establishing and operating efficient passenger rail service between METRORail's Fannin South Park & Ride light rail station and the City of Rosenberg.

Rail services are being examined in the corridor to:

[1] The UP Glidden Line begins at Milepost 0.0 at the Port of Houston.

- Help address congestion.
- Increase travel options.
- Provide time saving and reliability.
- Increase access for all (commuters, seniors, people with disabilities.)
- Support local businesses.[2]
- Increase residential and commercial property values.[3]
- Reduce harmful automobile emissions that contribute to smog.
- Provide fewer disturbances to the local environment.
- Allow for community integration and planned growth.
- Improve safety at rail crossings.[4]
- Provide safe travel.[5]
- Improve quality of life for travelers (relaxing travel, amenities, fewer weather delays, work/rest during travel, convenience)

1.3.2 Need

Over the past few decades both Fort Bend and Harris counties have experienced steady and significant population and employment growth. Future projections indicate that this rate of growth is expected to continue over the next 20 years, particularly in Fort Bend County.

[2] A study by NJ TRANSIT found that rail users spend more than $1,500 annually per person at local businesses in station areas.
[3] A study of the Dallas Area Rapid Transit (DART) light rail system (Wienstein, Clower, 1999) found that commercial and residential property values around DART stations were about 25% greater than in the control neighborhood. A study by NJ TRANSIT found that communities with rail stations have property values that are 10%-30% higher than similar communities without railroad stations.
[4] Safety is often improved due to the installation of state-of-the-art signaling systems and automated gates and warning signals, as well as the introduction of a rail safety education program in area communities and schools.
[5] Highway injuries are three times higher than rail injuries, per mile traveled (American Public Transportation Association).

Figure 1-1
U.S. 90A Study Corridor

Along with this rapid rate of growth has been an even greater increase in the daily automobile vehicle miles of travel, which has resulted in severe traffic congestion and associated mobility, accessibility, economic and environmental impacts to the region. Today, many of the region's primary roadways are congested not only during the rush hour commute times, but also throughout the day.

Approximately 40% of the peak period travel in the Houston region occurred under extreme and severe congestion in 1999, which was a 26% increase from 1982. According to the 2000 U.S. Census, the average journey to work in Fort Bend and Harris counties was about 30 minutes (32 minutes in Fort Bend County and 27 minutes in Harris County). However, this figure can be misleading because commuting times are often much longer when roadway construction, inclement weather, sun glare, traffic accidents, stalled vehicles and other impediments that restrict the movement of traffic are taken into consideration. For example, an average commute on U.S. 59 (Southwest Freeway) during the morning rush-hour period from Rosenberg to Downtown Houston takes 65 to 70 minutes to complete. However, in the frequent events where the traffic flow becomes restricted, commuting times may swell to 90 minutes or more.

Figure 1-2 – Traffic congestion on Houston area roadways is significant, and growing.

According to METRO, the average rush-hour speed on Houston freeways was roughly 24 miles per hour.[6] Over the last 10, years a dramatic increase in congestion along the U.S. Highway 90A corridor has resulted in afternoon speeds averaging about 15 miles per hour. Areas of severe congestion on U.S. 90A exist near Fondren Road, Beltway 8, and from U.S. 59 South to just west of State Highway 99. Along State Highway 6 in the Sugar Land/Missouri City area, moderate to serious traffic congestion exists.[7] To address this congestion, roadway expansion projects on U.S. 90A and U.S. 59 are underway. Improvement to these two major travel corridors will address short-term needs, however, they will not end congestion on U.S. 90A and U.S. 59 during the long term.

Statistics compiled by the Texas Transportation Institute (TTI) in their *2002 Urban Mobility Study* highlight the severity and cost of the traffic congestion faced by many of the daily commuters in the Houston metropolitan region. In 2000, the average rush-hour commuter in the Houston urban area spent 75 hours in traffic, the fifth worst delay of the 75 largest metropolitan areas in the United States (Table 1-1). As the region's population increases, there will be an increasing demand for relief from the growing congestion on the roadway system. Continuing to expand the roadway system without additional high-capacity transit improvements will prevent the region from keeping pace with the travel demand generated by future growth. Limited financial and land resources, in conjunction with environmental issues, will necessitate that non-roadway alternatives be considered for future implementation.

[6] Metropolitan Transit Authority of Harris County, Texas (METRO), www.ridemetro.org/services/hovsystem.asp, June 3, 2003.
[7] Houston-Galveston Area Council, *2022 Metropolitan Transportation Plan, Appendix C – Corridor and Sub-area Summaries*, March 22, 2002, pages C-22, C-28 and C-36.

Table 1-1
Annual Hours Of Delay Per Rush Hour Commuter, 2000

URBAN AREA	RANK	ANNUAL HOURS
Los Angeles, CA	1	136
San Francisco-Oakland, CA	2	92
Washington, DC-MD-VA	3	84
Seattle-Everett, WA	4	82
Houston, TX	5	75
Dallas-Fort Worth, TX	6	74
San Jose, CA	6	74
New York, NY-Northeastern, NJ	7	73
Atlanta, GA	8	70
Miami-Hialeah, FL	9	69
Boston, MA	10	67
Chicago, IL-Northwester, IL	10	67
Denver, CO	10	67

Source: Texas Transportation Institute, *2002 Urban Mobility Study*

Traffic congestion is not only a quality of life and environmental concern, but also an economic issue. Congestion costs include lost time, increase in fuel consumption and impacts on businesses. In the year 2000 the cost of congestion *per person* in the Houston region was $675 annually, which was the highest congestion cost in the State of Texas and the fourth highest cost in the nation (Table 1-2).

Table 1-2
Annual Cost Of Congestion *Per Person,* **2000**

URBAN AREA	RANK	ANNUAL COST ($)
Los Angeles, CA	1	1,155
San Francisco-Oakland, CA	2	795
Dallas-Fort Worth, TX	3	695
Houston, TX	4	675
Seattle-Everett, WA	5	660
Washington, DC-MD-VA	6	655
Denver, CO	7	640
Atlanta, GA	8	635
San Jose, CA	8	635
Miami-Hialeah, FL	9	600
San Bernadino-Riverside, CA	10	575
Orlando, FL	10	575

Source: Texas Transportation Institute, *2002 Urban Mobility Study*

The annual cost of congestion *per rush-hour commuter* was $1,410, which represents the sixth most expensive rush hour commuter cost in the United States (Table 1-3). Traffic congestion will worsen in the future and have an even greater economic impact on the region. In 2000, the total cost of congestion in the Houston urban area exceeded $2.3 billion, and it is projected to top $7.5 billion within the next 25 years. This economic burden will continue to erode the economic competitiveness of the region unless action is taken to improve the movement of goods and people.

Table 1-3
Annual Cost Of Congestion *Per Rush- Hour Commuter*, **2000**

URBAN AREA	RANK	ANNUAL COST ($)
Los Angeles, CA	1	2,510
San Francisco-Oakland, CA	2	1,770
Seattle-Everett, WA	3	1,605
Washington, DC-MD-VA	4	1,595
San Jose, CA	5	1,415
Houston, TX	6	1,410
New York, NY-Northeastern, NJ	7	1,400
Dallas-Fort Worth, TX	8	1,390
Atlanta, GA	9	1,350
Boston, MA	10	1,255
Miami-Hialeah, FL	10	1,255

Source: Texas Transportation Institute, *2002 Urban Mobility Study*

1.3.3 Objectives

Working with the U.S. 90A Steering Committee, objectives to guide the study analysis were developed. These objectives include:

- Identify the need for high capacity transit.
- Analyze the physical feasibility of operating rail transit in the Union Pacific Railroad right of way.
- Prepare preliminary passenger rail operating plans, capital and operating costs.
- Identify and evaluate potential impacts on rail freight operations.
- Develop ridership forecast.
- Evaluate and rank the service options.
- Encourage public involvement.

Seven tasks undertaken addressing these objectives to complete this study include the following:

- **Identify the need for high capacity transit** by analyzing current and future levels of mobility and access, corridor growth patterns, land use, demographics, environmental issues, condition of rail and related infrastructure, and major destination, travel centers and travel patterns;
- **Analyze the physical feasibility of operating rail transit in the Union Pacific Railroad right of way** by evaluating rail infrastructure conditions, existing and future freight service, existing right of way along the corridor, and grade crossing locations and conditions;
- **Prepare preliminary passenger rail operating plans, capital and operating costs estimates** by developing service plans for each alternative as well as determining station locations and conceptual station designs, and the economic effects of implementing rail service;
- **Identify and evaluate existing and future potential passenger rail impacts on rail freight** operations in the corridor;
- **Assist with the development of model based ridership forecast** by estimating the size of the total person trip market in the corridor and the share of the market that would be captured by the proposed high capacity transit service;
- **Evaluate and rank the service options** by considering such factors as operations and service characteristics, ridership, institutional constraints and other key implementation-related issues, engineering feasibility and constructability, capital cost, operating cost, and major social, economic/or environmental constraints;
- **Provide public involvement assistance** by supporting H-GAC with performing outreach needs assessments, community workshops/meetings, newsletter/ fact sheet development and final brochure development.

2. EXISTING CORRIDOR CONDITIONS

2.1 Rail Operations

The study corridor is an existing railroad right of way. This right of way is currently owned by Union Pacific Railroad (UP) and is known as the Glidden Subdivision. The portion of the Glidden Subdivision under study begins at MP 9.5 in the City of Houston and ends at MP 34.8 in the City of Rosenberg, a total of approximately 25 miles.

This railroad corridor originally began as Buffalo Bayou, Brazo, & Colorado (1853 - 1870), became Galveston, Harrisburg & San Antonio (1870 - 1925), and then Texas & New Orleans (1925 - 1955) before taking the name of the parent company Southern Pacific (1955 - 1995). Southern Pacific was acquired by Union Pacific (UP), effective September 11, 1996. In addition to the UP operations, there are operating agreements in the corridor for Burlington Northern Santa Fe (BNSF), Texas Mexican Railway (Tex-Mex/KCS) and Amtrak.

Maximum speeds, due to track geometry or other conditions, in this section of the Glidden line are presented in Table 2-1.

Table 2-1
UP Glidden Subdivision Maximum Speed Table

Between Mileposts	Passenger (MPH)	Freight (MPH)
1.7 and 12.6	20	20
12.6 and 19.0	60	60
19.0 and 21.8	45	45
21.8 and 24.5	60	60
24.5 and 24.9	45	45
24.9 and 32.6	60	60
32.6 and 36.3	50	40

Figure 2-1 – UP grade crossing, Richmond

Figure 2-2 – UP crossing the Brazos River Bridge.

2.1.1 Existing Freight Operations

Tower 17 in Rosenberg is the last manned railroad interlocking tower in Texas. Several dozen train movements per day pass Tower 17. The tower protects the busy crossing of the BNSF (ex-ATSF) Galveston Subdivision between Temple and Galveston and the UP (ex-Southern Pacific) Glidden Subdivision between San Antonio and Houston. UP is the busier of the two lines. UP hauls a variety of both through freight movements and local freight traffic, ranging from transcontinental double stack trains to rock shuttles. BNSF commonly hauls freight and intermodal trains into and out of Houston/Galveston, grain trains bound for the Port of Houston, and coal trains destined for Reliant Energy's Smithers Lake power plant. UP and BNSF have numerous trackage rights to allow trains to operate on each other's tracks, permitting shortcuts over their own routes for certain train movements. Tex-Mex/KCS currently runs one to two trains a day each way through the corridor.

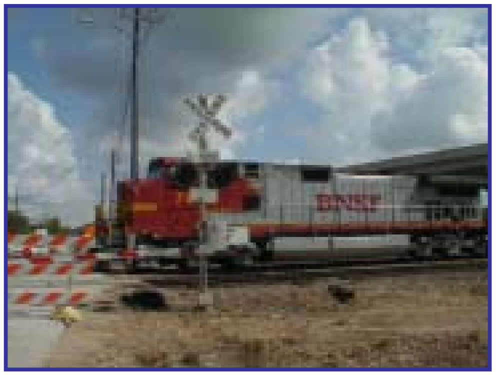

Figure 2-3 – BNSF train in Rosenberg.

2.1.2 Existing Passenger Operations

The only passenger service in the study corridor is operated by Amtrak. Amtrak operates the Sunset Limited passenger rail service out of a train station located at 902 Washington Avenue just north of Downtown Houston. The Sunset Limited travels between Los Angeles, California, and Orlando, Florida. On Tuesday, Friday and Sunday, the Sunset Limited traveling from Los Angeles, California to Orlando Florida is scheduled to arrive in Houston at 11:15 a.m. and depart at 11:25 a.m. On Monday, Wednesday and Friday, the Sunset Limited travels from Orlando, Florida, to Los Angeles, California, and is scheduled to arrive in Houston at 9:03 p.m. and depart at 9:18 p.m.

Figure 2-4 - The Sunset Limited train arrives at the Houston Amtrak Station.

2.2 Rail Infrastructure

This section of the report presents the major highlights of the existing track, structures, grade crossing and signals/communications. Detailed inventories of the existing rail corridor conditions can be found in Appendix A: Existing Corridor Infrastructure Feature Inventory Database, Appendix B: Existing Corridor Infrastructure Feature Inventory Photographs and Appendix C: Grade Crossing Inventory.

2.2.1 Right of Way Description

The UP right of way is typically 100 feet wide through the U.S. 90A corridor. The exceptions are in Richmond, where the right of way narrows to 20 feet, and in Rosenberg, where the right of way widens to approximately 250 feet.

The following is a description of the major features (tracks, sidings, structures, grade crossings) of the right of way in the U.S. 90A corridor, presented in segments. Grade crossings are single track and protected by gates, unless otherwise noted.

Fannin – Kirby (MP 9.5 – MP 10.25)

- The study corridor begins within the City of Houston and continues west through Harris County.
- The study corridor begins at approximately MP 9.5, Fannin Street. This location is where the METRORail terminates at a maintenance facility currently constructed at the northeast quadrant of the UP right of way and Fannin Road. The METRORail light rail had a test track from MP 9.5 to MP 11.2 on the north side of the right of way. The METRO lease for test track from UP expired August 23, 2003.
- UP is two-track (main track plus a passing siding) from MP 9.2 to MP 10.6.
- Fannin Street is an at-grade crossing (three track: two freight, one light rail), protected by 2-quad gates with median barriers (MP 9.5).
- Kirby Street (MP 10.10) is an at-grade crossing (three track: two freight, one light rail).

Kirby – West Junction (MP 10.25 – 12.90)

- There is an at grade private crossing, protected by a stop sign (MP 10.55), and two private crossings with cantilever gates and locks located 1,557 feet west of Kirby and 4,245 feet west of Kirby.

- The freight passing siding, on the south side of the right of way, ends just beyond Kirby Street (MP 10.6).
- The light rail test track ends approximately one mile west of Kirby Street (MP 11.2).
- A track diverts to the northwest at a turnout at Spence Junction (MP 11.30) towards Eureka.
- U.S. 90A/South Main Street northbound crosses the right of way overhead on a viaduct (MP 12.08).
- U.S. 90A/South Main Street southbound crosses the right of way overhead on a viaduct (MP 12.09).
- A track diverts to the northeast at a turnout at West Junction #2 (MP 12.59) and at West Junction #1 (MP 12.90) towards Eureka.
- This area is a very large wye, with the southwest leg coming from San Antonio, the north leg splitting toward Englewood Yard, and the east leg continuing through to the city. Movements through the wye were formerly at 10 mph, however, Union Pacific has made substantial investment into the wye, allowing track speeds in the range of 50 mph.

West Junction - Fort Bend County (MP 12.90 – MP 17.25)

- Post Oak frontage road northbound is an at-grade crossing (MP 13.60).
- Post Oak Road northbound crosses the right of way overhead on a viaduct (MP 13.61).
- Post Oak Road southbound crosses the right of way overhead on a viaduct (MP 13.62).
- Post Oak frontage road southbound is an at-grade crossing (MP 13.63).
- Chimney Rock Road is an at-grade crossing (MP 14.75).
- Hillcroft Road is an at-grade crossing (MP 15.55).
- A train defect detector is located at MP 15.6.[1]
- Haviland Street is an at-grade crossing (MP 15.80).
- Fondren Road is an at-grade crossing (MP 16.50).
- A bridge carries the right of way over the Sam Houston Tollway/Beltway 8 Northbound frontage road (MP 17.04).
- Sam Houston Tollway/Beltway 8 mainlanes cross the right of way overhead on a viaduct (MP 17.07).
- A bridge carries the right of way over the Sam Houston Tollway/Beltway 8 Southbound frontage road (MP 17.09).
- The alignment leaves Harris County at approximately MP 17.25.

Fort Bend County - Oyster Creek (MP 17.25 - MP 24.48)

- The alignment enters Fort Bend County at approximately MP 17.25.
- A freight siding begins on the north side from MP 17.3 to MP 18.8.
- Cravens Road is a two-track, at-grade crossing (MP 17.60).
- South Gessner Road is a two-track, at-grade crossing (MP 18.40).
- TXI plant entrance is an at-grade crossing (MP 18.90).
- There are two customer sidings to TXI - the #14 east siding turnout (MP 19.00) and the #10 west siding turnout (MP 19.50).
- Stafford-Bellaire Road is an at-grade crossing (MP 19.62).
- Siding turnout (#10) to spur, curving north to serve warehouses (Five Star, FDC Warehouses, Fire Trax) (MP 19.75).
- FM 1092 is an at-grade crossing (MP 20.00).
- Spur tracks in place but the connection to main track has been removed (MP 20.07).
- A train defect detector is located at MP 20.60.[2]
- Houston Shell (MP 20.80) and Kirkwood Drive (MP 21.50) are at-grade crossings.
- US 59/Southwest Freeway crosses the right of way overhead on a viaduct (MP 21.91).
- Dairy Ashford Road is an at-grade crossing (MP 22.50).
- Siding turnout (#10) to spur, National Oilwell (MP 22.70).
- Industrial Boulevard (MP 22.75), Schulmberger Drive (MP 23.02), Gillingham Road (MP 23.25), FM 1876/Eldridge Road (MP 23.50) and Wood Street (MP 24.20) are at-grade crossings.
- A second track begins on north side as part of the Imperial Sugar switching lead, but is not tied to the main track at the east end. (MP 24.20).
- An at-grade crossing is located at Main Street (MP 24.45).
- A bridge carries the rail right of way over Oyster Creek – timber, open deck (MP 24.48).

Oyster Creek – Brazos River (MP 24.48 – MP 32.42)

- Brooks Street (MP 24.52) and Ulrich Boulevard (MP 24.70) are at-grade crossings.
- A second freight track begins on north side - CP Sugar Land (MP 24.86 to MP 27.70).
- Spur track to Ondeo Nalco, Imperial Sugar (MP 25.00).
- Research Street is an at-grade crossing protected by flashers - double track crossing with spur track crossing slightly north of main tracks (MP 25.05).

[1] Includes a dragging equipment detector, hot box detector, and a signal box on the north side.

[2] Includes a detector signal box on the south side and AEI scanners on both sides.

- State Highway Route 6 is a two-track, at-grade crossing (MP 25.50).
- A bridge carries the rail right of way over Grand Parkway/State Highway Route 99 – concrete, ballasted deck (MP 27.82).
- A train defect detector is located at MP 28.10.
- A second track begins on north side - CP Harlem (MP 29.00 to MP 30.30).
- Prison Road (MP 26.25) and Harlem Road (MP 29.60) are two-track, at-grade crossings.
- A train defect detector is located at MP 30.31.[3]
- Pitts Road (MP 30.75) and FM 359 (MP 31.40) are at-grade crossings.
- A 1,132.5 foot, single-track bridge carries the rail right of way over the Brazos River – steel, open deck (MP 32.42.) A private road crosses under the bridge along the river.

Brazos River – State Highway 36 Bypass (MP 32.42 - MP 36.77)

- The right of way narrows coming over the Brazos River bridge into Richmond, where there are several at-grade crossings: Second Street (MP 32.75), Fourth Street (MP 32.8), Fifth Street (MP 32.82) (crossbucks only), Sixth Street (MP 32.84), Eighth Street (MP 32.86), Tenth Street (MP 33.03), Douglas Street (MP 33.10), and Collins Street/FM 3155 (MP 33.50.)
- A retaining wall runs on the on north side of the right of way from the Second Street crossing to Fourth Street crossing.
- A spur parallels the south side of main track to serve Cotton Oil (MP 33.70)
- A train defect detector is located at MP 34.50.[4]
- Entering Rosenberg, there are several at-grade crossings: Richwood Road (MP 34.55), Sixth Street (MP 35.75) and Third Street (MP 35.90).
- FM 723 crosses the right of way overhead on a viaduct (MP 36.10).
- There is a diamond crossing of the UP and BNSF main line tracks at Tower 17 in Richmond.
    - Track connection to BNSF on north side of main track (CPSA035) (MP 36.30)
    - Railroad crossing at shallow angle, UPRR-BNSF connection track in northeast quadrant (MP 36.34), BNSF west to Seeley, east to Houston.
    - An interlocking tower structure, known as Tower 17, is very close to south side of UPRR main track at the BNSF crossing (MP 36.35).
    - A second track begins on north side (MP 36.36 to MP 38.43)
    - UPRR Wharton Branch heads south from main (south) track just west of point where double track begins (MP 36.37)
    - A single-track spur connects to second (north) track, turnout on spur creates two tracks for servicing aggregate facility (MP 36.38).
- Just beyond the terminus of the area under study in this corridor, a double-track bridge carries the rail right of way over the SH36 Bypass – steel, open deck (MP 36.77).

2.2.2 Tracks

The existing UP corridor is a single-track railroad with passing sidings. Passing sidings are at the locations noted in Table 2-2.

Table 2-2
UP Glidden Line Passing Siding Locations

Between Mileposts	Siding Name	Siding Feet
9.2 and 10.6	Stella	6,341
17.3 and 18.8	Missouri City	6,236
24.9 and 27.7	Sugar Land	13,920
29.0 and 30.3	Harlem	6,477
36.4 and 38.4	Rosenberg	10,587

Business tracks (customer sidings) are at the following locations:

- Stafford TXI (MP 19.1)
- Stafford Greenbrier E (MP 19.8)
- Stafford Furman Lead E (MP 20.1)
- Hines Lead W (MP 22.7)

2.2.3 Structures

There are 26 bridges along the study corridor. Table 2-3 presents an overview of the existing bridges.

2.2.4 Signals and Communications

Dispatching on the railroad corridor is currently done by UP from Spring, Texas. Cab signals are used in the corridor and they are relatively new. There are flashers and gates at all grade crossings, except private grade- crossings.

[3] Includes a high-wide detector with signal box on south side of track.
[4] Includes a high-wide detector.

Table 2-3
Existing Study Corridor Bridges

MP	Crossing	Material	Deck Type	Current # of Tracks on Bridge	Possible # of Track(s) on Bridge
12.05	Stream	Timber	Open	1	1
16.92	Stream	Timber	Open	1	1
17.04	Loop 8 NB	Concrete	Ballasted	1	2
17.09	Loop 8 SB	Concrete	Ballasted	1	2
17.31	Stream	Concrete	Ballasted	1	2
20.52	Stream	Timber	Ballasted	1	1
20.98	Stream	Timber	Ballasted	1	1
21.07	Stream	Timber	Ballasted	1	1
24.48	Oyster Creek	Timber	Open	1	1
25.35	Stream	Concrete	Ballasted	2	2
25.75	Stream	Timber	Ballasted	2	2
26.50	Stream	Timber main, concrete 2nd	Open main, ballasted 2nd	2	2
27.82	SH99	Concrete	Ballasted	1	1
28.61	Stream	Timber	Open	1	1
28.89	Stream	Timber	Open	1	1
29.27	Stream	Timber	Open	2	2
29.45	Stream	Timber	Open	2	2
29.75	Stream	Timber	Open	2	2
30.07	Stream	Timber	Open main, ballasted 2nd	2	2
30.57	Stream	Timber	Open	1	1
31.07	Stream	Timber	Open	1	1
31.62	Stream	Timber	Ballasted	1	1
32.42	Brazos River	Steel	Open	1	1
33.01	Stream	Timber	Open	1	1
34.58	Stream	Concrete	Ballasted	1	1
34.74	Stream	Timber	Open	1	1

3. ALTERNATIVES CONSIDERED

3.1 Technologies Considered

Several types of rail technologies were examined for potential use in the U.S. 90A study corridor. The major features of each of the rail technologies considered are described in the sections that follow. A summary table of the principal characteristics of the rail technologies considered is presented at the end of Section 3.1 (Table 3-1).

3.1.1 Commuter Rail

Commuter rail is a mode of passenger rail service that utilizes diesel or electric locomotives, pushing or pulling passenger coaches. Push-pull operation eliminates the need to turn the train around or change the locomotive from one end of the train to the other end of the train. Service may use single-level or bi-level coaches. Single-level passenger cars can typically seat up to 120 people and bi-level coaches typically seat from 145 to 160 persons. Commuter rail train crews typically include a driver and a conductor. Commuter rail trains require long acceleration and deceleration distances due to the weight of the vehicles. Maximum speed on a Class IV railroad is 79 miles per hour.

Commuter rail lines typically range in length from 15 to 50 miles, with most connecting city centers to the surrounding suburban areas. Stations are usually widely spaced about every three to five miles apart and may have high- or ground-level platforms. Commuter rail service is typically found where there are high levels of peak-period demand. Passengers often have long commutes, therefore, passenger comfort is typically a priority for operators. Reduced fares are often provided for multiple rides. Fare collection is traditionally done by conductors, or a barrier-free proof-of-payment system can be used.

Commuter rail can utilize existing infrastructure and rights of way from existing active mainline freight and intercity rail lines or abandoned former rail lines. Commuter rail may share tracks with other users or may operate on dedicated tracks within the same right of way.

Commuter rail systems can be found in most major metropolitan areas in the United States, such as Baltimore, Boston, Chicago, Dallas, Los Angeles, Miami, New York, Philadelphia, San Diego, San Francisco, San Jose and Seattle. In addition, more than two dozen commuter rail systems are either being expanded or studied for future possible start-up.

Figure 3-1 – Trinity Railway Express operates diesel locomotive-hauled coaches.

3.1.2 Diesel Multiple Unit

Diesel Multiple Unit (DMU) is a mode of passenger rail service that is a hybrid between commuter rail and light rail. DMUs are typically used for rail services where medium-length trips are made, using fewer stops than light rail transit systems but more than commuter rail. DMUs typically accommodate more seated passengers than light rail transit (LRT) vehicles, but less than commuter rail. Single level DMUs can seat 98 people and double deck coaches can seat 185 people (412 with standees).[1]

DMU vehicles are self-propelled using multiple diesel units that can operate either individually or be linked together in multiple units of up to 10 cars. This means that one DMU is capable of driving itself without the need to be pushed/pulled by a locomotive. DMUs have a drive cab on each end of the bidirectional vehicle, allowing for a rapid change of direction because the operator does not have to turn the vehicle around. Rather, the operator walks from one end of the vehicle to the other. A benefit of using DMUs is that several units can easily and quickly be coupled together to make a longer train if a higher passenger capacity is needed.

A typical DMU train has several small diesel engines and a transmission propulsion system connected to the drive axle. These diesel engines are often the same ones used in buses or semi-trucks. Since diesel motors power DMUs, they are independent from any difficulties associated with catenary lines (e.g. storms, power outages). Technology has made these engines more powerful and fuel-efficient than diesel engines used previously. DMU diesel engines meet emission requirements, are much cleaner than in the past and

[1] Colorado Railcar Manufacturing.

quieter than engines used in passenger and freight locomotives. A DMU only uses slightly more fuel than buses, but it has the benefit of carrying many more people at a higher average rate of speed.

Like light rail vehicles, most standard DMU vehicles cannot operate on the same tracks as freight trains because they do not meet Federal Railroad Administration (FRA) safety (crashworthiness) requirements. However, in 2002, a new DMU being constructed by the Colorado Railcar Manufacturing became the first to pass the FRA structural test (49 CFR part 238 compression test). This FRA-compliant DMU can be run on the same tracks with freight service.

Figure 3-2: Colorado Railcar DMU

DMUs are most commonly used in Europe and Canada. Several metropolitan areas in the U.S. are currently studying the feasibility of implementing new DMU service, attracted by the opportunity to use new DMUs that have appealing features of a light rail vehicle, yet meet FRA standards for operation on the same tracks with freight.

3.1.3 Light Rail Transit

Light Rail Transit (LRT) is a mode of passenger rail service that utilizes LRT vehicles, which are small, light-weight vehicles powered from an overhead wire called a catenary. LRT can share street space with other vehicles, or operate within exclusive right of way, such as railroad corridors and freeways.

LRT can operate as a single vehicle or vehicles can be connected/articulated together. Articulated vehicles are constructed with a joint in the middle which allows them to negotiate curves with a short radius. Single-units are approximately 60 feet in length, and the average length of an articulated vehicle in 96 feet. Single LRT vehicles typically have a total capacity of up to 190 passengers per car and can seat about 50 passengers, while articulated vehicles can hold up to 170 passengers per car and can seat about 65 passengers. The Siemens S-70 light rail vehicle operated by METRO (Harris County Transit Agency) seats 72 passengers per car and has a standing capacity of 128 passengers, a maximum capacity of 200 passengers per car. Light rail operating speeds range up to a maximum of 66 miles per hour.

LRTs are not permitted to operate simultaneously on the same tracks with railroad equipment (freight or commuter rail) because the vehicles do not meet Federal Railroad Administration (FRA) strength requirements. Therefore, in corridors where there is both light rail and railroad operations, operations must be separated, either physically or through scheduling. In some corridors, the freight and light rail are limited to operating during separate times of the day but can share the same tracks; in other corridors, the light rail is operated within the same right of way, but uses tracks that are exclusively for light rail service. For safety reasons, it is typically recommended that exclusive LRT tracks that are located in an existing railroad right of way be separated by at least 25 feet from adjacent active freight tracks or that a crash wall is installed between the railroad and LRT tracks.

Figure 3-3 – METRORail's new light rail vehicle.

Table 3-1
Summary Description Of Rail Technologies Considered

TECHNOLOGIES	COMMUTER RAIL (Diesel Locomotive-Hauled Coaches) Single Level or Bi-Level	DIESEL MULTIPLE UNIT (DMUs) Single Level or Bi-Level	LIGHT RAIL (LRT) Single Unit (4-axle) Articulated (6-axle)
DIMENSIONS (LxWxH, Feet)	85x10.6x12.8 85x9.10x15.11	85x10x13.7 85x10x18	60x9x11 96x8 8x11.6
POWER SOURCE	Diesel engine	Diesel engine	Overhead electrical wire
OPERATING ENVIRONMENT	Separate right of way or can mix with freight rail	Separate right of way or can mix with freight rail using new FRA compliant vehicle	Mixed with vehicular traffic or separated (temporal or physical) right of way; (not compliant with FRA safety regulations; cannot operate with freight trains)
OPERATING SPEED (mph)	Up to 79 mph, average 50 mph	Up to 79 mph, average 50 mph	Up to 66 mph, average 30
CAPACITY (Seated)	120 - 160	98 - 185	50 - 65

Light rail stations are usually closer together in the central business district and farther apart in suburban areas. LRT vehicles have the ability to accelerate and decelerate rapidly because of their lighter weight and electric power. This allows the stations to be spaced at intervals of one-half mile if necessary. LRT stations range from the very simple to the very complex. Some stations are simply areas of the sidewalk that allow floor level boarding, with station platforms several inches above the track. Platform length is determined by train length. Platforms generally have a canopy covering portions of the platform.

Light rail is currently being operated in a variety of metropolitan areas in the U.S., including Baltimore, Boston, Cleveland, Dallas, Denver, Los Angeles, Newark/Jersey City, NJ, Philadelphia, Pittsburgh, Portland, Sacramento, Salt Lake City, San Francisco, San Jose San Diego and St. Louis. Houston is among several cities currently constructing a new light rail transit system, and many other metropolitan areas are studying the possibility of building light rail systems.

3.2 Alternative Definition and Configuration

Based on the existing rail right of way alignment considerations and potential rail technologies examined, five study alternatives were developed for consideration in the study:

- Alternative 1: Commuter Rail – Exclusive Operation
- Alternative 2: Diesel Multiple Unit – Exclusive Operation
- Alternative 3: Light Rail Transit – Exclusive Operation
- Alternative 4: Commuter Rail – Shared Operation
- Alternative 5: Diesel Multiple Unit – Shared Operation

Alternatives 1 and 4 assume commuter rail technology is used (diesel-locomotive hauled coaches); Alternatives 2 and 5 assume diesel multiple units (DMUs) are applied; and Alternative 3 assumes light rail transit (LRT) technology is operated in the corridor.

Independent of the vehicle technology applied, Alternatives 1, 2 and 3 assume that new passenger operations would occur on an entirely separate infrastructure within the right of way. Freight operations would be on separate track, as per current conditions.

Alternatives 4 and 5 assume, regardless of the vehicle technology used, that the new infrastructure to be constructed could be shared between the passenger and freight operations.

The following features are common to all alternatives:

- Existing Union Pacific (UP) mainline through track would remain as currently configured.
- All alternatives would involve construction of one or two additional tracks within the existing UP right of way from approximately Fannin Street in Houston to east of the SH 36 Bypass in Rosenberg.
- A passenger rail tail track would be provided at the terminus at the METRORail Station at Fannin Street.
- New bridge would be constructed to carry passenger rail tracks over the West Junction freight tracks.
- Passing sidings would also have to be constructed at various locations along the rail corridor, depending on the particular configuration of the alternative.
- Transit Centers would be located at: Fannin South METRORail Station, Westbury, Missouri City, Stafford, Stafford/Sugar Land, Sugar Land Airport, Richmond, and Rosenberg (see Chapter 4 for details on transit centers).
- Rail yard would be located in Rosenberg (see Chapter 4 for details on the yard).

Preliminary drawings showing details of the various alignment configurations for the rail alternatives are located in Appendix D: Study Alternative Schematic Track Layouts and Conceptual Alignment Drawings. The following section describes the individual features of the five study alternatives.

3.2.1 Alternative 1: Commuter Rail – Exclusive Operation

Locomotive-hauled coach commuter rail trains would be the technology used for passenger rail service in the U.S. 90A corridor under this alternative. The newly constructed single track with passing sidings would be used exclusively by the new passenger rail service. The commuter rail tracks would be located on the north side of the right of way. The existing UP tracks would be used exclusively by UP, as per current operations. These freight tracks would be located on the south side of the right of way. A new bridge would be constructed crossing the Brazos River.

The commuter rail service would begin at a new station at Fannin Street and would permit a transfer to the METRORail. A tail track would be located in the vicinity of Fannin Street to permit temporary storage of commuter rail trains. Service would continue on the single track to the other eight stations, terminating in Rosenberg. This alternative would have stations with a side platform located on the north side of the tracks. Beyond the Rosenberg station, there would be a yard facility for cleaning, maintenance and storage of equipment.

Three passing sidings for passenger rail service operations would be necessary at the following locations:

- West Junction (MP 12.50 – MP 13.50) on the new bridge to be constructed over the junction
- Stafford (MP 20.5 – MP 21.5)
- Sugar Land, just before the Brazos River bridge (MP 31.0 - MP 32.0)

Three current existing freight sidings would be relocated from the north side of the right of way to the south side to make room for the passenger tracks. One of these siding locations is in Missouri City (MP 17.4 – MP 18.8) and two are in Sugar Land.

3.2.2 Alternative 2: Diesel Multiple Unit – Exclusive Operation

Diesel multiple units (DMUs) would be the technology used for passenger rail service in the U.S. 90A corridor under this alternative. The newly constructed single track with passing sidings would be used exclusively by the new passenger rail service. The DMU tracks would be located on the north side of the right of way. The existing UP tracks would be used exclusively by UP as, per current operations. These freight tracks would be located on the south side of the right of way. A new bridge would be constructed crossing the Brazos River.

The DMU rail service would begin at a new station at Fannin Street and would permit a transfer to the METRORail. A tail track would be located in the vicinity of Fannin Street to permit temporary storage of DMU trains and also serve as a siding (MP 9.5 – MP 10.0). Service would continue on the single track to the other eight stations, terminating in Rosenberg. This alternative would have stations with a side platform located on the north side of the tracks. Beyond the Rosenberg station, there would be a yard facility for cleaning, maintenance and storage of equipment.

Three passing sidings for passenger rail service operations would be necessary at the following locations:

- Westbury, vicinity of Chimney Rock Road (MP 14.8 – MP 15.8)
- Sugar Land, just before the Oyster Creek bridge (MP 22.8 – MP 23.8)
- Rosenberg, in the vicinity of the transit center (MP 35.0 – 36.0)

Three existing freight sidings would be relocated from the north side of the right of way to the south side to make room for the passenger tracks. One of these siding locations is in Missouri City and two are in Sugar Land.

3.2.3 Alternative 3: Light Rail Transit – Exclusive Operation

Light rail transit trains would be the technology used for passenger rail service in the U.S. 90A corridor under this alternative. The proposed single track with passing sidings would be used exclusively by the new light rail service.[2] The light rail tracks would be located on the north side of the right of way. The existing UP tracks would be used exclusively by UP, as per current operations. These freight tracks would be located on the south side of the right of way. A new bridge would be constructed crossing the Brazos River. Light rail could permit a one-seat ride to the Houston central business district.

The light rail service would begin at a new station at Fannin Street and would permit transfer to the METRORail light rail. A tail track would be located in the vicinity of Fannin Street to permit temporary storage of light rail trains and also serve as a siding (MP 9.5 – MP 10.0). Service would continue on the single track to the other eight stations, terminating in Rosenberg. Stations in this alternative would have a side platform on the north side of the tracks. Beyond the Rosenberg station, there would be a small layover facility for storage of equipment. Cleaning and maintenance would take place at the existing METRORail facility, located at Fannin Street.

Three passing sidings for passenger rail service operations would be necessary at the following locations:

- Westbury Transit Center, vicinity of Chimney Rock Road (MP 14.6 – MP 15.8)
- Stafford Transit Center (MP 19.5 – MP 20.5)
- Sugar Land Airport Transit Center (MP 25.0 – MP 26.0)
- Sugar Land, vicinity of Harlem Road (MP 29.0 – MP 30.0)
- Rosenberg, in the vicinity of the transit center (MP 35.0 – 36.0)

Three existing freight sidings would be relocated from the north side of the right of way to the south side to make room for the passenger tracks. One of these siding locations is in Missouri City and two are in Sugar Land.

3.2.4 Alternative 4: Commuter Rail - Shared Operation

Locomotive-hauled coach commuter rail trains would be the technology used for passenger rail service in the U.S. 90A corridor under this alternative. The existing UP mainline track and two newly constructed tracks would be shared between passenger and freight operations. Locomotive-hauled Coach commuter rail trains are permitted to operate on tracks with mixed-passenger and freight traffic.

There would be three tracks for most of the length of the study corridor. The existing UP track would remain in the center of the right of way. This track would continue to be used under this alternative primarily for freight operations. Two new tracks would be constructed for the length of the right of way - one on the north side and one on the south side of the right of way - for both passenger and freight use. A new bridge would be constructed crossing the Brazos River.

The commuter rail service would begin at a new station at Fannin Street and would permit a transfer to the METRORail light rail. Service would continue on either the north or south track to the other eight stations, terminating in Rosenberg. Stations in this alternative would have dual platforms on the outside of each of the north and south side tracks. Beyond the Rosenberg Station, there would be a yard facility for cleaning, maintenance and storage of equipment.

Crossovers would be necessary under this alternative to permit movement of both passenger and freight trains between the three tracks. Crossovers would be located at the following locations:

- Vicinity of Spence Junction (MP 11.30)
- Vicinity of West Junction (MP 13.0) – just beyond the new bridge to be constructed over the junction
- Vicinity of South Kirkwood Road (MP 21.7)
- Just beyond Oyster Creek Bridge (MP 24.5)
- Just before Route 99 overpass (MP 27.8)
- Vicinity of Richmond Station (MP 32.81)
- Vicinity of Rosenberg Station (MP 34.78)

The three-track section would end at the Brazos River Bridge because of right of way capacity constraints through Richmond. From the Brazos River, there would be two tracks - the passenger track on the north and the freight track on the south.

[2] Light rail service was only analyzed for exclusive operation. Federal Railroad Administration requirements mandate that light rail must be separated from freight, either on a separate track, or on a shared track operating at different times of the day. Due to the amount and frequency of freight service in this corridor, temporal separation was not a possibility. Commuter rail and DMU are permitted to operate in both an exclusive and a shared environment; therefore, both options were examined for those modes.

3.2.5 Alternative 5: Diesel Multiple Unit - Shared Operation

Diesel multiple unit trains would be the technology used for passenger rail service in the U.S. 90A corridor under this alternative. The existing UP mainline track and two newly constructed tracks would be shared between passenger and freight operations. DMUs are permitted to operate on tracks with mixed-passenger and freight traffic.

There would be three tracks along nearly the entire length of the study corridor. The existing UP track would remain in the center of the right of way. This track would continue to be used under this alternative primarily for freight operations. Two new tracks would be constructed for the length of the right of way - one on the north side and one on the south side of the right of way. These tracks would be for both passenger and freight use. A new bridge would be constructed crossing the Brazos River.

The DMU service would begin at a new station at Fannin Street and would permit a transfer to the METRORail light rail. Service would continue on either the north or south track to the other eight stations, terminating in Rosenberg. Stations in this alternative would have dual platforms on the outside of each of the north and south side tracks. Beyond the Rosenberg station, there would be a yard facility for cleaning, maintenance and storage of equipment.

Crossovers would be necessary under this alternative to permit movement of both passenger and freight trains between the three tracks. Crossovers would be at the following locations:

- Vicinity of Spence Junction (MP 11.30)
- Vicinity of West Junction (MP 13.0) – just beyond the new bridge to be constructed over the junction
- Vicinity of South Kirkwood Road (MP 21.7)
- Just beyond Oyster Creek Bridge (MP 24.5)
- Just before Route 99 overpass (MP 27.8)
- Vicinity of Richmond Station (MP 32.81)
- Vicinity of Rosenberg Station (MP 34.78)

The three-track section would end at the Brazos River Bridge because of right of way capacity constraints through Richmond. There would be two tracks - the passenger track on the north and the freight track on the south - from the Brazos River through Rosenberg.

4. TRANSIT CENTER AND YARD LOCATIONS

The selection of transit centers is a critical factor in the development of the operating plans for rail alternatives. It is necessary to determine the optimum number and location of intermediate stops for each alternative. While transit centers are generators of riders and can stimulate economic growth, they also lengthen travel times. Transit center locations that balance these complex operational and community issues must be selected in order to create feasible and efficient rail alternatives.

In a typical passenger rail system, the design of a rail transit center is dependent on the market to which it caters. For example, in rural, outlying areas, where ridership tends to be lower than that experienced in a more urban setting, rail transit centers are typically smaller in scale and provide fewer amenities. In contrast, a suburban transit center in a dense community, which will attract more patrons, would be larger in scale, with more parking, feeder bus service and amenities. Transit center stops are typically 3-5 miles apart. A significant question that each community considering new rail service must answer is what type of rail transit center it wishes to have in the future. While every community and transit center is unique, there are several examples that can be considered, depending on if the transit center is in a dense town center with little availability for parking and significant pedestrian activity, or a suburb with a need for a sizable park and ride facility. As the concept advances into engineering phases, the details of the transit center design would be a significant consideration.

Typical commuter rail and light rail transit centers are depicted in Figures 4-1, 4-2 and 4-3.

Figure 4-1 – Typical commuter rail transit center.

Figure 4-2 – Typical DMU transit center.

An inventory of the candidate transit centers for the rail alternatives under study are presented below. The eight rail transit centers being evaluated in the *U.S. 90A Corridor Commuter Rail Feasibility Study* (from west to east) are:

- Rosenberg Transit Center
- Richmond Transit Center
- Sugar Land Airport Transit Center
- Sugar Land/Stafford Transit Center
- Stafford Transit Center
- Missouri City Transit Center
- Westbury (Houston) Transit Center
- METRORail (Houston) Transit Center (at Fannin South Park & Ride)

As the rail plan evolves, additional transit centers may be added or locations modified due to operating conditions and community input.

Figure 4-3 – Typical light rail transit center.

4.1 Rosenberg Transit Center

This transit center is proposed between $3^{rd}/4^{th}$ Street and Avenue E/Union Pacific Railroad tracks in Rosenberg (MP 35.85). The platform would be on the north side of the right of way. A surface parking area would be provided on the south side of the right of way. Vehicular access to the parking area would be from 3rd Street. This site is currently vacant. It appears that this site is excess railroad property and able to accommodate a large parking area.

Figure 4-4 – Rosenberg Transit Center site

4.2 Richmond Transit Center

This transit center is proposed at $4^{th}/5^{th}$ Street and Preston Street/Union Pacific Railroad tracks in Richmond (MP 32.6). The platform would be on the north side of the right of way. A surface parking area would be provided on the north side of the right of way. This site is currently vacant and is owned by the City of Richmond. The site is adjacent to the former station building and appears to be able to accommodate a large parking area at this location. The site is within walking distance (less than a ¼ mile) of City Hall, the Fort Bend County complex and downtown Richmond.

Figure 4-5 – Richmond Transit Center Site

4.3 Sugar Land Airport Transit Center

This transit center is proposed in the vicinity of U.S. Highway 90A, opposite the Sugar Land Municipal Airport in Sugar Land (MP 25.9). The platform would be on the north side of the right of way. A surface parking area would be provided on the south of the right of way, south of U.S. 90A. Vehicular access to the parking area would be from U.S. 90A and the site appears to be able to accommodate a large parking area. Pedestrian access across US90A and the railroad would be provided. This site is currently vacant and is owned by the City of Sugar Land.

Figure 4-6 – Sugar Land Airport Transit Center Site (beyond runway)

4.4 Sugar Land / Stafford Transit Center

This transit center is proposed between Dairy Ashford Road and the Union Pacific Railroad tracks in Sugar Land (MP 22.1). The platform and parking would be on the north side of the right of way. Vehicular access to the parking area would be from Stiles Lane and Dairy Ashford Road. This site is currently vacant and is privately owned. The site appears to be able to accommodate a large parking area. This location is in the Stafford and Sugar Land business center area.

Figure 4-7 - Stafford/Sugar Land Transit Center Site

4.5 Stafford Transit Center

This transit center is proposed at Stafford Road and U.S. Highway 90A in Stafford (MP 20.0). This site is near the proposed Stafford Civic Center and the college campus. The parking and platform would be on the north side of the right of way. Vehicular access to the parking area would be through the Civic Center Development. This site is currently vacant and is privately owned. The site appears to be able to accommodate a large parking area.

4.6 Missouri City Transit Center

This transit center is proposed in the vicinity of Beltway 8 (Sam Houston Tollway) and the Union Pacific Railroad tracks in Missouri City (17.4). The platform would be on the north side of the right of way. Access to this transit center would be from U.S. 90A and the Sam Houston Tollway. This site is currently vacant and is privately owned. The site is being studied by the Missouri City as a transit-oriented development site. The site appears to be able to accommodate a large parking area.

4.7 Westbury (Houston) Transit Center

This transit center is proposed in the vicinity of Chimney Rock Road and the Union Pacific Railroad tracks in the Westbury neighborhood of Houston (MP 14.90) in an industrial area. The platform would be on the north side of the right of way. A surface parking area would be provided on the north side of the right of way. Vehicular access to the parking area would be from Chimney Rock Road. This site is currently vacant and is privately owned. The site appears to be able to accommodate a large parking area.

4.8 METRORail (Houston) Transit Center

This transit center is proposed at Fannin Street in Houston (MP 9.5) and would be a transfer facility with the METRORail light rail. The platform would be on the north side of the right of way. The site is within the Union Pacific rail right of way. Vehicular access to the transit center would be from Fannin Street and Holmes Road. This site on the east of Fannin and north of the right of way is currently owned by METRO and is a vehicle maintenance and storage facility.

Figure 4-8 – METRORail Transit Center Site vicinity

4.9 Rosenberg Yard (Vehicle Maintenance & Storage Facility)

An overnight vehicle maintenance and storage facility is proposed beyond the terminus transit center in Rosenberg, between Tower 17 and the Route 36 Bypass (MP 36.5). The proposed location is currently used by an extraction industry. This facility would provide space and structures for car cleaning and maintenance, in addition to overnight storage. Figure 4-9 presents a photograph of a sample vehicle maintenance and storage facility.

Routine maintenance plays an integral role in keeping a vast commuter network operational. All rail systems have maintenance facilities designed to provide efficient service and repair. Many of the facilities designed today accommodate the needs of new rail cars by providing wider and safer working aisles, better illumination, ventilation, moderately elevated posted rail, and shop-support facilities.

Light maintenance would typically be accomplished at the overnight equipment storage yard. The maintenance performed at the yard facility could include remedying minor air conditioning defects, making brake adjustments and repairing malfunctioning doors, as well as safety inspections. Heavy maintenance requires the equipment to be removed from service for repairs that are performed at a major shop facility. Heavy maintenance could include correcting for wheel truing defects, repairing equipment propulsion systems and remedying major air conditioning problems. The nature of heavy maintenance repair work will also require extensive shop apparatus.

Train length and peak-service headways were used to establish the overnight equipment storage requirements. These equipment storage requirements then establish a baseline to evaluate potential yard sites.

The optimal location for a rail yard site is just beyond the service terminus station. By locating the shop and maintenance facility near the morning start of service, the amount of "deadhead" or non-revenue hours and miles is reduced.

Characteristics of the site are also important in the yard location selection. The site should allow the efficient movement, with minimal conflicts, between the yard and main tracks. In addition to evaluating potential yard area, the configuration of the site also needs to be considered. Yard site size and configuration provide a footprint for the overall yard layout. For example, a long, narrow site might be available, but it might only accommodate two extended tracks to store several trainsets end-to-end. Thus, the equipment in the middle of these lengthy storage tracks would have to be delayed in leaving the yard to enter morning peak service.

The rail yard in Rosenberg can provide a flexible train operation, with additional trackage providing parallel train movements to and from the yard. The utilization of a double-ended yard, as opposed to a stub-end yard, would allow yard access and egress at either end of the storage facility. Additionally, the Rosenberg site would be located beyond the service terminus and would therefore minimize the number of deadhead train movements. All of these factors should be further examined in future analysis of this potential yard site.

Figure 4-9 – Typical rail yard, Metro-North Railroad, Wassaic, New York

5. OPERATING PLANS

5.1 Operations Planning Methodology

5.1.1 Passenger Rail Methodology

Information regarding the existing infrastructure and operations along the corridor was collected from the UP Railroad, field visits and other sources. Train movements through the corridor were identified and documented. Service guidelines or overall service standards were obtained. Physical data was collected, including the location of freight customers, quality of the track alignment, and the existence of sidings, crossovers, spur tracks, etc.

Engineering data (maximum track and curve speeds, grades, interlockings, etc.) and operating data were integrated as input to a Train Performance Calculator (TPC). The TPC model was run and output generated, including schedules/running time and stringline diagrams. Operating plans were developed for each proposed service options, for peak-and off-peak periods. These plans define basic operating parameters, such as:

- Service frequency
- Span
- Station served
- Operating patterns and variations
- Running times
- Cycle time
- Equipment type, capacity
- Train requirements
- Crew requirements
- Storage/maintenance needs
- Operating statistics

5.1.2 Freight Rail Methodology

For Alternatives 4 and 5, in which passenger rail and freight rail share the tracks within the right of way, a methodology was developed to perform the passenger rail operating analysis, intermingled with the freight. The following methodology and assumptions were used to integrate the freight train operating plan into the passenger train operating plan:

- Freight rail operating data was limited to a printout of all trains passing the Defect Detector Reader #595 located at MP 20.6. Since train dispatcher records were not available for this study, assumptions had to be made concerning the freight train operating characteristics beyond the simple train counts contained in the defect detector readouts.
- The entire railroad would be upgraded to provide 79 mph for passenger trains and 60 mph for freight trains. The Brazos River Bridge would be upgraded from current speeds to 70 mph for passenger trains and 50 mph for freight trains.
- Freight trains would enter the territory at a minimum speed of 30 mph, accelerate to 60 mph and diverge at 40 mph where necessary.
- Freight trains would have sufficient HP/Ton ratios that would allow achieving 60 mph. This results in a 30 minute run time from CP 2 to CP 34 without any stops.
- Freight trains would use Track 3 to the greatest extent possible. Passenger trains would operate on Tracks 1 and 2 in order to make the platforms. Amtrak could operate on any track.
- 80% of the freight trains enter/leave the territory at CP 12 (West Junction). The remaining 20% operate beyond the MetroRail transfer location at Fannin Street.

The defect detector readouts were analyzed to determine daily train counts between 6 a.m. and 10 p.m. for a period of 14 days. These train counts range from a low of 14 to a high of 28. These counts included the Amtrak trains, when they operated within the 6 a.m. to 10 p.m. window.

A matrix of the freight train movements was prepared and was loaded into the database used for the passenger operations model. Combined passenger and freight movements were then modeled to develop the operating plans for Alternatives 4 and 5.

5.2 Operations Planning Assumptions

Operating plans were prepared for each of the five alternatives analyzed in the U.S. 90A rail corridor. The following assumptions were common for all of the alternatives:

- The morning peak period is 6:00 a.m. to 10:00 a.m.
- The evening peak period is 4:00 p.m. to 8:00 p.m.
- Off-peak periods start at 5:00 a.m. and end at 12:00 a.m.
- The service will stop at eight rail transit centers (from west to east):
    - Rosenberg Transit Center (MP 35.8)
    - Richmond Transit center Transit Center (MP 32.6)
    - Sugar Land Airport Transit Center (MP 24.2)
    - Sugar Land/Stafford Transit Center (MP 22.1)
    - Stafford Transit Center (MP 20.0)
    - Missouri City Transit Center (MP 17.4)
    - Westbury (Houston) Transit Center (MP 14.9)
    - METRORail (Houston) Transit Center (MP 9.5)

- A vehicle storage yard and maintenance facility will be located west of the Rosenberg station between Tower 17 and the Route 36 Bypass (MP 36.5).

Figure 5-1 – A vehicle storage and maintenance yard would be located beyond Tower 17 in Rosenberg.

5.2.1 Alternative 1: Commuter Rail – Exclusive Operation

The following assumptions were used in developing operating plan for Alternative 1:

- Technology assumed is commuter rail.
- Push-pull train sets would be used, with each train assumed to include a diesel locomotive, four coaches and cab car.
- Dedicated passenger railroad (no freight service on the same track as passenger service).
- 79 mph maximum authorized speed (MAS) assumed.
- Two tracks are required at each terminal station.
- Single track over the Brazos River and through all stations.
- Headways are 30 minutes in the peak period, peak direction. (Memory schedules operating on the ½ hour in the peak direction.)
- Off-peak service operates hourly.

5.2.2 Alternative 2: Diesel Multiple Unit – Exclusive Operation

The following assumptions were used to develop an operating plan for Alternative 2:

- Technology assumed is diesel multiple units (DMUs). The vehicle assumed is the Colorado Rail Car Diesel Multiple Unit (DMU).
- Train consist is three bi-level powered DMU cab cars.
- Dedicated passenger railroad (no freight service on the same track as passenger service).
- 79 mph maximum authorized speed (MAS) assumed.
- Two tracks are required at each terminal station.
- Single track over the Brazos River and through all stations.
- Headways are 30 minutes in the peak period, peak direction. (Memory schedules operating on the ½ hour in the peak direction.)
- Off-peak service operates hourly.

5.2.3 Alternative 3: Light Rail Transit – Exclusive Operation

The following assumptions were used to develop an operating plan for Alternative 3:

- Technology assumed is light rail transit. The vehicle assumed is the METRORail vehicle, manufactured by Siemens Transportation.
- Light rail train consist is three cars.
- Dedicated passenger railroad (no freight service on the same track as passenger service).
- 60 mph maximum authorized speed (MAS) assumed
- Two tracks are required at each terminal station.
- Single track over the Brazos River and through all stations.
- Headways are 15 minutes in the peak period. (Memory schedules operating every 15 minutes in the peak direction)
- Headways are 30 minutes in the off peak period. (Memory schedules operating on the ½ hour in the off peak direction.)

5.2.4 Alternative 4: Commuter Rail - Shared Operation

The following assumptions were used to develop an operating plan for Alternative 4:

- Technology assumed is commuter rail.

- Push-pull train sets would be used, with each train assumed to include a diesel locomotive, four coaches and a cab car.
- Passenger service will operate concurrently with freight trains in an expanded version of the UP Glidden Subdivision, i.e., shared operation.
- 79 mph maximum authorized speed (MAS) assumed for commuter rail trains.
- 60 mph MAS assumed for freight service (50 MPH over Brazos River).
- Requires a three-track configuration with several intermediate interlockings.
- Requires two tracks at each terminal station.
- Requires a new two-track bridge over the Brazos River.
- Headways are 30 minutes in the peak period, peak direction. (Memory schedules operating on the ½ hour in the peak direction.)
- Off-peak service operates hourly.

5.2.5 Alternative 5: Diesel Multiple Unit - Shared Operation

The following assumptions were used to develop an operating plan for Alternative 5:

- Technology assumed is diesel multiple units (DMUs). The vehicle assumed is the Colorado Rail Car Diesel Multiple Unit (DMU).
- Train consist is 3 bi-level powered DMU cab cars.
- Passenger service will operate concurrently with freight trains in an expanded version of the UP Glidden Subdivision, i.e., shared operation.
- 79 mph maximum authorized speed (MAS) assumed for commuter rail trains.
- 60 mph MAS assumed for freight service (50 mph over Brazos River).
- Requires a three-track configuration with several intermediate interlockings.
- Requires two tracks at each terminal station.
- Requires a new bridge over the Brazos River.
- Headways are 30 minutes in the peak period, peak direction. (Memory schedules operating on the ½ hour in the peak direction.)
- Off-peak service operates hourly.

5.3 Operations Planning Results

Schedules for each of the five alternatives can be found in Tables 5-1 through 5-5 on the pages following Section 5.3. A stringline diagram depicting the details of the train movements can be found in Appendix E: Study Alternative Operating Plan Stringline Diagrams

5.3.1 Alternative 1: Commuter Rail – Exclusive Operation

The operation planning analysis yielded the following results for Alternative 1:

- Service requires four operating train sets, plus one spare set.
- Will require three, one-mile long passing sidings located at:
    - MP 12.5 – MP 13.5 (Houston)
    - MP 20.5 – MP 21.5 (Stafford)
    - MP 31.0 – MP 32.0 (Sugar Land)
- The 30-minute headway plan will handle 1,200 peak-direction riders per hour.
- Trip times range from 38 to 43 minutes, depending on the number of “meets” with trains in the opposite direction.

5.3.2 Alternative 2: Diesel Multiple Unit – Exclusive Operation

The operation planning analysis yielded the following results for Alternative 2:

- Service requires four operating train sets, plus one spare set.
- Will require three, one-mile long passing sidings located at:
    - MP 14.95 – MP 15.9 (Houston)
    - MP 22.8 – MP 23.8 (Sugar Land)
    - MP 34.0 – MP 35.0 (Rosenberg)
- The 30-minute headway plan will handle 1,110 peak direction riders per hour (seated).[1]
- Trip times range from 36 to 39 minutes, depending on the number of “meets” with trains in the opposite direction. If a trailer car is added to the DMU consist, the trip times will increase slightly.

5.3.3 Alternative 3: Light Rail Transit – Exclusive Operation

The operation planning analysis yielded the following results for Alternative 3:

- Service requires seven operating train sets, plus one spare set.

[1] A two-car (bi-level) DMU consist would accommodate 740 seated passengers in the peak hour on the 30-minute headway plan.

- Will require six, one-mile long passing sidings located at:
  - MP 9.5 – MP 10.5 (Houston)
  - MP 15.1 – MP 16.1 (Houston)
  - MP 19.3 – MP 20.3 (Stafford)
  - MP 23.2 – MP 24.2 (Sugar Land)
  - MP 28.2 – MP 29.2 (Sugar Land)
  - MP 33.8 – MP 34.8 (Rosenberg)
- The 15-minute peak headway plan will handle 864 seated (2,400 standing) peak-direction riders per hour using a three car consist.[2]
- Trip times range from 38 to 43 minutes, depending on the number of "meets" with trains in the opposite direction. Because each light rail vehicle is electrically powered, the performance specifications are the same for any car chosen, therefore the trips times will be the same for any size car consist.

5.3.4 Alternative 4: Commuter Rail - Shared Operation

The operation planning analysis yielded the following results for Alternative 4:

- Service requires four operating train sets, plus one spare set.
- The 30-minute headway plan will handle 1,200 peak direction riders per hour.
- Trip time is 39 minutes.
- The operations planning analysis found that this shared freight/passenger operating scenario was feasible under the assumptions described.

[2] A one-car LRT consist would accommodate 288 seated (800 standing) passengers in the peak hour on the 15-minute headway plan; a two-car consist 576 seated (1,600 standing) passengers.

5.3.5 Alternative 5: Diesel Multiple Unit - Shared Operation

The operation planning analysis yielded the following results for Alternative 5:

- Service requires four operating train sets, plus one spare set.
- The 30-minute headway plan will handle 1,110 peak direction riders per hour (seated).
- Trip time is 37 minutes.[3]
- The operations planning analysis found that this shared freight/passenger operating scenario was feasible under the assumptions described.

[3] The total trip time for Alternative 5 is 2 minutes less than Alternative 4 (37 minutes versus 39) because the DMU has better acceleration as compared to the diesel push pull commuter rail train set used in Alternative 4.

Table 5-1

Alternative 1: Commuter Rail - Exclusive Operation Operating Plan

U.S. 90A COMMUTER RAIL ALT 1 - Weekdays - Inbound

Departure Times	Train	C2 a.m.	C4 a.m.	C6 a.m.	C8 a.m.	C10 a.m.	C12 a.m.	C14 a.m.	C16 a.m.	C18 a.m.	C20 p.m.	C22 p.m.
34.8 Rosenberg		L6:00	L6:30	L7:00	L7:30	L8:00	L8:30	L9:30	L10:30	L11:29	L12:26	L1:26
32.6 Richmond		s6:04	s6:34	s7:04	s7:34	s8:04	s8:34	s9:34	s10:34	s11:33	s12:30	s1:30
24.2 Sugar Land Airport		s6:14	s6:44	s7:14	s7:44	s8:14	s8:44	s9:44	s10:44	s11:43	s12:42	s1:42
22.1 Sugarland/Stafford		s6:18	s6:48	s7:18	s7:48	s8:18	s8:48	s9:48	s10:48	s11:47	s12:46	s1:46
20.0 Stafford		s6:22	s6:52	s7:22	s7:52	s8:22	s8:52	s9:52	s10:52	s11:51	s12:50	s1:50
17.4 Missouri City		s6:27	s6:57	s7:27	s7:57	s8:27	s8:57	s9:57	s10:57	s11:56	s12:55	s1:55
14.8 Westbury		s6:32	s7:02	s7:32	s8:02	s8:32	s9:02	s10:02	s11:02	s12:01	s1:00	s2:00
9.5 MetroRail		A6:38	A7:08	A7:38	A8:08	A8:38	A9:08	A10:08	A11:08	A12:07	A1:09	A2:09
Total time:		:38	:38	:38	:38	:38	:38	:38	:38	:38	:43	:43

Departure Times	C24 p.m.	C26 p.m.	C28 p.m.	C30 p.m.	C32 p.m.	C34 p.m.	C36 p.m.	C38 p.m.	C40 p.m.	C42 p.m.	C44 p.m.
34.8 Rosenberg	L2:26	L3:26	L3:59	L4:26	L4:56	L5:26	L5:56	L6:26	L6:56	L7:56	L8:56
32.6 Richmond	s2:30	s3:30	s4:02	s4:30	5:00	5:30	6:00	6:30	7:00	8:00	9:00
24.2 Sugar Land Airport	s2:42	s3:42	s4:12	s4:42	5:12	5:42	6:12	6:42	7:12	8:12	9:12
22.1 Sugarland/Stafford	s2:46	s3:46	s4:16	s4:46	5:16	5:46	6:16	6:46	7:16	8:16	9:16
20.0 Stafford	s2:50	s3:50	s4:21	s4:51	5:21	5:51	6:21	6:51	7:21	8:21	9:21
17.4 Missouri City	s2:55	s3:55	s4:26	s4:56	5:26	5:56	6:26	6:56	7:26	8:26	9:26
14.8 Westbury	s3:00	s4:00	s4:31	s5:01	5:31	6:01	6:31	7:01	7:31	8:31	9:31
9.5 MetroRail	A3:09	A4:09	A4:40	A5:09	A5:39	A6:09	A6:39	A7:09	A7:39	A8:39	A9:39
Total time:	:43	:43	:42	:43	:43	:43	:43	:43	:43	:43	:43

U.S. 90A COMMUTER RAIL ALT 1 - Weekdays - Outbound

Departure Times	Train	C1 a.m.	C3 a.m.	C5 a.m.	C7 a.m.	C9 a.m.	C11 a.m.	C13 a.m.	C15 a.m.	C17 p.m.	C19 p.m.	C21 p.m.
9.5 MetroRail		L6:59	L7:29	L7:59	L8:29	L8:59	L9:59	L10:59	L11:59	L1:00	L2:00	L3:00
14.8 Westbury		s7:08	7:38	8:08	8:38	9:08	10:08	11:08	12:07	s1:07	s2:07	s3:07
17.4 Missouri City		s7:13	7:43	8:13	8:43	9:13	10:13	11:13	12:12	s1:12	s2:12	s3:12
20.0 Stafford		s7:18	7:40	8:18	8:48	9:10	10:18	11:18	12:17	s1:17	s2:17	s3:17
22.1 Sugar Land/Stafford		s7:23	7:53	8:23	8:53	9:23	10:23	11:22	12:21	s1:21	s2:21	s3:21
24.2 Sugar Land Airport		s7:27	7:57	8:27	8:57	9:27	10:27	11:26	12:25	s1:25	s2:25	s3:25
32.6 Richmond		s7:38	8:08	8:38	9:08	9:38	10:38	11:37	12:35	s1:35	s2:35	s3:35
34.8 Rosenberg		A7:41	A8:11	A8:41	A9:11	A9:41	A10:41	A11:40	A12:38	A1:38	A2:38	A3:38
Total time:		:42	:42	:42	:42	:42	:42	:41	:40	:38	:38	:38

Departure Times	C23 p.m.	C25 p.m.	C27 p.m.	C29 p.m.	C31 p.m.	C33 p.m.	C35 p.m.	C37 p.m.	C39 p.m.	C41 p.m.	C43 p.m.
9.5 MetroRail	L4:00	L4:30	L5:00	L5:30	L6:00	L6:30	L7:00	L7:30	L8:30	L9:30	L10:30
14.8 Westbury	s4:07	s4:37	s5:07	s5:37	s6:07	s6:37	s7:07	s7:37	s8:37	s9:37	s10:37
17.4 Missouri City	s4:12	s4:42	s5:12	s5:42	s6:12	s6:42	s7:12	s7:42	s8:42	s9:42	s10:42
20.0 Stafford	s4:17	s4:47	s5:17	s5:47	s6:17	s6:47	s7:17	s7:47	s8:47	s9:47	s10:47
22.1 Sugar Land/Stafford	s4:21	s4:51	s5:21	s5:51	s6:21	s6:51	s7:21	s7:51	s8:51	s9:51	s10:51
24.2 Sugar Land Airport	s4:25	s4:55	s5:25	s5:55	s6:25	s6:55	s7:25	s7:55	s8:55	s9:55	s10:55
32.6 Richmond	s4:35	s5:05	s5:35	s6:05	s6:35	s7:05	s7:35	s8:05	s9:05	s10:05	s11:05
34.8 Rosenberg	A4:38	A5:08	A5:38	A6:08	A6:38	A7:08	A7:38	A8:08	A9:08	A10:08	A11:08
Total time:	:38	:38	:38	:38	:38	:38	:38	:38	:38	:38	:38

Table 5-2
Alternative 2: Diesel Multiple Unit - Exclusive Operation

U.S. 90A COMMUTER RAIL ALT 2 - Weekdays - Inbound

Departure Times	Train	C2 a.m.	C4 a.m.	C6 a.m.	C8 a.m.	C10 a.m.	C12 a.m.	C14 a.m.	C16 a.m.	C18 a.m.	C20 p.m.	C22 p.m.
34.8 Rosenberg		L6:00	L6:30	L7:00	L7:30	L8:00	L8:30	L9:30	L10:30	L11:30	L12:38	L1:38
32.6 Richmond		s6:04	6:34	7:04	7:34	8:04	8:34	9:34	10:34	11:34	12:42	1:42
24.2 Sugar Land Airport		s6:13	6:43	7:13	7:43	8:13	8:43	9:43	10:43	11:43	12:51	1:51
22.1 Sugar Land/Stafford		s6:17	6:47	7:17	7:47	8:17	8:47	9:47	10:47	11:47	12:55	1:55
20.0 Stafford		s6:21	6:51	7:21	7:51	8:21	8:51	9:51	10:51	11:51	12:59	1:59
17.4 Missouri City		s6:25	6:55	7:25	7:55	8:25	8:55	9:55	10:55	11:55	1:03	2:03
14.9 Westbury		s6:30	7:00	7:30	8:00	8:30	9:00	10:00	11:00	12:00	1:09	2:09
9.5 MetroRail		A6:36	A7:06	A7:36	A8:06	A8:36	A9:06	A10:06	A11:06	A12:06	A1:15	A2:15
Total time:		:36	:36	:36	:36	:36	:36	:36	:36	:36	:37	:37

Departure Times	C24 p.m.	C26 p.m.	C28 p.m.	C30 p.m.	C32 p.m.	C34 p.m.	C36 p.m.	C38 p.m.	C40 p.m.	C42 p.m.	C44 p.m.
34.8 Rosenberg	L2:38	L3:38	L4:07	L4:37	L5:07	L5:37	L6:07	L6:37	L7:07	L8:07	L9:07
32.6 Richmond	2:42	3:42	4:11	4:41	5:11	5:41	6:11	6:41	7:11	8:11	9:11
24.2 Sugar Land Airport	2:51	3:51	4:20	4:50	5:20	5:50	6:20	6:50	7:20	8:20	9:20
22.1 Sugar Land/Stafford	2:55	3:55	4:25	4:55	5:25	5:55	6:25	6:55	7:25	8:25	9:25
20.0 Stafford	2:59	3:59	4:29	4:59	5:29	5:59	6:29	6:59	7:29	8:29	9:29
17.4 Missouri City	3:03	4:03	4:34	5:04	5:34	6:04	6:34	7:04	7:34	8:34	9:34
14.9 Westbury	3:09	4:09	4:40	5:10	5:40	6:10	6:40	7:10	7:40	8:40	9:40
9.5 MetroRail	A3:15	A4:15	A4:45	A5:15	A5:45	A6:15	A6:45	A7:15	A7:45	A8:45	A9:45
Total time:	:37	:37	:38	:38	:38	:38	:38	:38	:38	:38	:38

U.S. 90A COMMUTER RAIL ALT 2 - Weekdays - Outbound

Departure Times	Train	C1 a.m.	C3 a.m.	C5 a.m.	C7 a.m.	C9 a.m.	C11 a.m.	C13 a.m.	C15 a.m.	C17 p.m.	C19 p.m.	C21 p.m.
9.5 MetroRail		L6:51	L7:21	L7:51	L8:21	L8:51	L9:51	L10:51	L11:51	L1:00	L2:00	L3:00
14.9 Westbury		s6:57	7:27	7:57	8:27	8:57	9:57	10:57	11:57	s1:06	2:06	3:06
17.4 Missouri City		s7:03	7:33	8:03	8:33	9:03	10:03	11:03	12:03	s1:11	2:11	3:11
20.0 Stafford		s7:08	7:38	8:08	8:38	9:08	10:08	11:08	12:08	s1:16	2:16	3:16
22.1 Sugar Land/Stafford		s7:12	7:42	8:12	8:42	9:12	10:12	11:12	12:12	s1:20	2:20	3:20
24.2 Sugar Land Airport		s7:17	7:47	8:17	8:47	9:16	10:16	11:16	12:16	s1:24	2:24	3:24
32.6 Richmond		s7:26	7:56	8:26	8:56	9:25	10:25	11:25	12:25	s1:33	2:33	3:33
34.8 Rosenberg		A7:29	A7:59	A8:29	A8:59	A9:28	A10:28	A11:28	A12:28	A1:36	A2:36	A3:36
Total time:		:38	:38	:38	:38	:37	:37	:37	:37	:36	:36	:36

Departure Times	C23 p.m.	C25 p.m.	C27 p.m.	C29 p.m.	C31 p.m.	C33 p.m.	C35 p.m.	C37 p.m.	C39 p.m.	C41 p.m.	C43 p.m.
9.5 MetroRail	L4:00	L4:30	L5:00	L5:30	L6:00	L6:30	L7:00	L7:30	L8:30	L9:30	L10:30
14.9 Westbury	4:06	4:36	5:06	5:36	6:06	6:36	7:06	7:36	8:36	9:36	10:36
17.4 Missouri City	4:11	4:41	5:11	5:41	6:11	6:41	7:11	7:41	8:41	9:41	10:41
20.0 Stafford	4:16	4:46	5:16	5:46	6:16	6:46	7:16	7:46	8:46	9:46	10:46
22.1 Sugar Land/Stafford	4:20	4:50	5:20	5:50	6:20	6:50	7:20	7:50	8:50	9:50	10:50
24.2 Sugar Land Airport	4:24	4:54	5:24	5:54	6:24	6:54	7:24	7:54	8:54	9:54	10:54
32.6 Richmond	4:33	5:03	5:33	6:03	6:33	7:03	7:33	8:03	9:03	10:03	11:03
34.8 Rosenberg	A4:36	A5:06	A5:36	A6:06	A6:36	A7:06	A7:36	A8:06	A9:06	A10:06	A11:06
Total time:	:36	:36	:36	:36	:36	:36	:36	:36	:36	:36	:36

Table 5-3
Alternative 3: Light Rail Transit - Exclusive Operation

U.S. 90A COMMUTER RAIL ALT 3 - Weekdays - Inbound

Departure Times	Train	C2	C4	C6	C8	C10	C12	C14	C16	C18	C20	C22	C24
		a.m.	a.m.	a.m.	a.m.	a.m.	a.m.	a.m.	a.m.	a.m.	a.m.	a.m.	a.m.
34.8 Rosenberg		L6:00	L6:15	L6:30	L6:45	L7:00	L7:15	L7:30	L7:45	L8:00	L8:15	L8:30	L8:45
32.6 Richmond		s6:04	s6:19	s6:34	s6:49	s7:04	s7:19	s7:34	s7:49	s8:04	s8:19	s8:34	s8:49
24.2 Sugar Land Airport		s6:14[30]	s6:29[30]	s6:44[30]	s6:59[30]	s7:14[30]	s7:29[30]	s7:44[30]	s7:59[30]	s8:14[30]	s8:29[30]	s8:44[30]	s8:59[30]
22.1 Sugar Land/Stafford		s6:18[24]	s6:33[24]	s6:48[24]	s7:03[24]	s7:18[24]	s7:33[24]	s7:48[24]	s8:03[24]	s8:18[24]	s8:33[24]	s8:48[24]	s9:03[24]
20.0 Stafford		s6:23	s6:38	s6:53	s7:08	s7:23	s7:38	s7:53	s8:08	s8:23	s8:38	s8:53	s9:08
17.4 Missouri City		s6:27[36]	s6:42[36]	s6:57[36]	s7:12[36]	s7:27[36]	s7:42[36]	s7:57[36]	s8:12[36]	s8:27[36]	s8:42[36]	s8:57[36]	s9:12[36]
14.9 Westbury		s6:32[48]	s6:47[48]	s7:02[48]	s7:17[48]	s7:32[48]	s7:47[48]	s8:02[48]	s8:17[48]	s8:32[48]	s8:47[48]	s9:02[48]	s9:17[48]
9.5 MetroRail		A6:38[30]	A6:53[30]	A7:08[30]	A7:23[30]	A7:38[30]	A7:53[30]	A8:08[30]	A8:23[30]	A8:38[30]	A8:53[30]	A9:08[30]	A9:23[30]
Total time:		:38[30]	:38[30]	:38[30]	:38[30]	:38[30]	:38[30]	:38[30]	:38[30]	:38[30]	:38[30]	:38[30]	:38[30]

Departure Times	C26	C28	C30	C32	C34	C36	C38	C40	C42	C44	C46	C48
	a.m.	a.m.	a.m.	a.m.	a.m.	a.m.	a.m.	p.m.	p.m.	p.m.	p.m.	p.m.
34.8 Rosenberg	L9:00	L9:30	L10:00	L10:30	L11:00	L11:29	L11:58	L12:27	L12:56	L1:25	L1:54	L2:23
32.6 Richmond	s9:04	s9:34	s10:04	s10:34	s11:04	s11:33	s12:02	s12:31	s1:00	s1:29	s1:58	s2:27
24.2 Sugar Land Airport	s9:14[30]	s9:44[30]	s10:14[30]	s10:44[30]	s11:14[30]	s11:43[30]	s12:12[30]	s12:43[24]	s1:12[54]	s1:41[54]	s2:10[54]	s2:39[54]
22.1 Sugar Land/Stafford	s9:18[24]	s9:48[24]	s10:18[24]	s10:48[24]	s11:18[24]	s11:47[24]	s12:16[24]	s12:47[30]	s1:16[30]	s1:45[30]	s2:14[30]	s2:43[30]
20.0 Stafford	s9:23	s9:53	s10:23	s10:53	s11:23	s11:52	s12:21	s12:51[36]	s1:20[36]	s1:49[36]	s2:18[36]	s2:47[36]
17.4 Missouri City	s9:27[36]	s9:57[36]	s10:27[36]	s10:57[36]	s11:27[36]	s11:56[36]	s12:25[36]	s12:56[30]	s1:25[30]	s1:54[30]	s2:23[30]	s2:52[30]
14.9 Westbury	s9:32[48]	s10:02[48]	s10:32[48]	s11:02[48]	s11:32[48]	s12:01[48]	s12:30[48]	s1:01	s1:30	s1:59	s2:28	s2:57
9.5 MetroRail	A9:38[30]	A10:08[30]	A10:38[30]	A11:08[30]	A11:38[30]	A12:07[30]	A12:36[30]	A1:07	A1:36	A2:05	A2:34	A3:03
Total time:	:38[30]	:38[30]	:38[30]	:38[30]	:38[30]	:38[30]	:38[30]	:40	:40	:40	:40	:40

U.S. 90A COMMUTER RAIL ALT 3 - Weekdays - Inbound

Departure Times	Train	C50	C52	C54	C56	C58	C60	C62	C64	C66	C68	C70
		p.m.	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.
34.8 Rosenberg		L2:52	L3:20	L3:35	L3:50	L4:05	L4:20	L4:35	L4:50	L5:05	L5:20	L5:35
32.6 Richmond		s2:56	3:24[42]	s3:39[42]	s3:54[42]	s4:09[42]	s4:24[42]	s4:39[42]	s4:54[42]	s5:09[42]	s5:24[42]	s5:39[42]
24.2 Sugar Land Airport		s3:08[54]	3:37	s3:52	s4:07	s4:22	s4:37	s4:52	s5:07	s5:22	s5:37	s5:52
22.1 Sugar Land/Stafford		s3:12[42]	3:42	s3:57	s4:12	s4:27	s4:42	s4:57	s5:12	s5:27	s5:42	s5:57
20.0 Stafford		s3:16[54]	3:46[54]	s4:01[54]	s4:16[54]	s4:31[54]	s4:46[54]	s5:01[54]	s5:16[54]	s5:31[54]	s5:46[54]	s6:01[54]
17.4 Missouri City		s3:21[42]	3:51	s4:06	s4:21	s4:36	s4:51	s5:06	s5:21	s5:36	s5:51	s6:06
14.9 Westbury		s3:28	3:56[54]	s4:11[54]	s4:26[54]	s4:41[54]	s4:56[54]	s5:11[54]	s5:26[54]	s5:41[54]	s5:56[54]	s6:11[54]
9.5 MetroRail		A3:32	A4:03	A4:18	A4:33	A4:48	A5:03	A5:18	A5:33	A5:48	A6:03	A6:18
Total time:		:40	:43	:43	:43	:43	:43	:43	:43	:43	:43	:43

Departure Times	C72	C74	C76	C78	C80	C82	C84	C86	C88	C90	
	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.	
34.8 Rosenberg	L5:50	L6:05	L6:20	L6:35	L6:50	L7:05	L7:35	L8:05	L8:35	L9:05	
32.6 Richmond	s5:54[42]	s6:09[42]	s6:24[42]	s6:39[42]	s6:54[42]	s7:09[42]	s7:39[42]	s8:09[42]	s8:39[42]	s9:09[42]	
24.2 Sugar Land Airport	s6:07	s6:22	s6:37	s6:52	s7:07	s7:22	s7:52	s8:22	s8:52	s9:22	
22.1 Sugar Land/Stafford	s6:12	s6:27	s6:42	s6:57	s7:12	s7:27	s7:57	s8:27	s8:57	s9:27	
20.0 Stafford	s6:16[54]	s6:31[54]	s6:46[54]	s7:01[54]	s7:16[54]	s7:31[54]	s8:01[54]	s8:31[54]	s9:01[54]	s9:31[54]	
17.4 Missouri City	s6:21	s6:36	s6:51	s7:06	s7:21	s7:36	s8:06	s8:36	s9:06	s9:36	
14.9 Westbury	s6:26[54]	s6:41[54]	s6:56[54]	s7:11[54]	s7:26[54]	s7:41[54]	s8:11[54]	s8:41[54]	s9:11[54]	s9:41[54]	
9.5 MetroRail	A6:33	A6:48	A7:03	A7:18	A7:33	A7:48	A8:18	A8:48	A9:18	A9:48	
Total time:	:43	:43	:43	:43	:43	:43	:43	:43	:43	:43	

Edwards and Kelcey

Table 5-3
Alternative 3: Light Rail Transit - Exclusive Operation (contiunued)

U.S. 90A COMMUTER RAIL ALT 3 - Weekdays - Outbound

Departure Times	Train	C1 a.m.	C3 a.m.	C5 a.m.	C7 a.m.	C9 a.m.	C11 a.m.	C13 a.m.	C15 a.m.	C17 a.m.	C19 a.m.	C21 a.m.	C23 a.m.	C25 a.m.	C27 a.m.	C29 a.m.	C31 a.m.	C33 p.m.	C35 p.m.	C37 p.m.	C39 p.m.	C41 p.m.	C43 p.m.	C45 p.m.	C47 p.m.
34.8 Rosenberg		L6:50	L7:05	L7:20	L7:35	L7:50	L8:05	L8:20	L8:35	L8:50	L9:05	L9:20	L9:35	L10:05	L10:35	L11:05	L11:35	L12:05	L12:35	L1:04	L1:33	L2:02	L2:31	L3:00	L3:30
32.6 Richmond		s6:59	s7:14	s7:29	s7:44	s7:59	s8:14	s8:29	s8:44	s8:59	s9:14	s9:29	s9:44	s10:14	s10:44	s11:13	s11:42	s12:12	s12:42	s1:11	s1:40	s2:09	s2:38	s3:07	s3:37
24.2 Sugar Land Airport		s7:04	s7:19	s7:34	s7:49	s8:04	s8:19	s8:34	s8:49	s9:04	s9:19	s9:34	s9:49	s10:19	s10:49	s11:18	s11:46	s12:16	s12:46	s1:15	s1:44	s2:13	s2:42	s3:11	s3:41
22.1 Sugar Land/Stafford		s7:08	s7:23	s7:38	s7:53	s8:08	s8:23	s8:38	s8:53	s9:08	s9:23	s9:38	s9:53	s10:23	s10:53	s11:23	s11:51	s12:21	s12:51	s1:20	s1:49	s2:18	s2:47	s3:16	s3:46
20.0 Stafford		s7:13	s7:28	s7:43	s7:58	s8:13	s8:28	s8:43	s8:58	s9:13	s9:28	s9:43	s9:58	s10:28	s10:58	s11:27	s11:55	s12:25	s12:55	s1:24	s1:53	s2:22	s2:51	s3:20	s3:50
17.4 Missouri City		s7:17	s7:32	s7:47	s8:02	s8:17	s8:32	s8:47	s9:02	s9:17	s9:32	s9:47	s10:02	s10:32	s11:02	s11:32	12:00	s12:30	s1:00	s1:29	s1:58	s2:27	s2:56	s3:25	s3:55
14.9 Westbury		s7:29	s7:44	s7:59	s8:14	s8:29	s8:44	s8:59	s9:14	s9:29	s9:44	s9:59	s10:14	s10:45	s11:15	s11:44	s12:12	s12:41	s1:11	s1:40	s2:08	s2:37	s3:06	s3:35	s4:05
9.5 MetroRail		A7:33	A7:48	A8:03	A8:18	A8:33	A8:48	A9:03	A9:18	A9:33	A9:48	A10:03	A10:18	A10:48	A11:18	A11:48	A12:15	A12:44	A1:14	A1:43	A2:11	A2:40	A3:09	A3:38	A4:08
Total time		:43	:43	:43	:43	:43	:43	:43	:43	:43	:43	:43	:43	:43	:43	:43	:40	:39	:39	:39	:38	:38	:38	:38	:38

U.S. 90A COMMUTER RAIL ALT 3 - Weekdays - Outbound

Departure Times	Train	C49 p.m.	C51 p.m.	C53 p.m.	C55 p.m.	C57 p.m.	C59 p.m.	C61 p.m.	C63 p.m.	C65 p.m.	C67 p.m.	C69 p.m.	C71 p.m.	C73 p.m.	C75 p.m.	C77 p.m.	C79 p.m.	C81 p.m.
9.5 MetroRail		L4:00	L4:15	L4:30	L4:45	L5:00	L5:15	L5:30	L5:45	L6:00	L6:15	L6:30	L6:45	L7:00	L7:30	L8:00	L8:30	L9:00
14.9 Westbury		s4:07	s4:22	s4:37	s4:52	s5:07	s5:22	s5:37	s5:52	s6:07	s6:22	s6:37	s6:52	s7:07	s7:37	s8:07	s8:37	s9:07
17.4 Missouri City		s4:11	s4:26	s4:41	s4:56	s5:11	s5:26	s5:41	s5:56	s6:11	s6:26	s6:41	s6:56	s7:11	s7:41	s8:11	s8:41	s9:11
20.0 Stafford		s4:16	s4:31	s4:46	s5:01	s5:16	s5:31	s5:46	s6:01	s6:16	s6:31	s6:46	s7:01	s7:16	s7:46	s8:16	s8:46	s9:16
22.1 Sugar Land/Stafford		s4:20	s4:35	s4:50	s5:05	s5:20	s5:35	s5:50	s6:05	s6:20	s6:35	s6:50	s7:05	s7:20	s7:50	s8:20	s8:50	s9:20
24.2 Sugar Land Airport		s4:25	s4:40	s4:55	s5:10	s5:25	s5:40	s5:55	s6:10	s6:25	s6:40	s6:55	s7:10	s7:25	s7:55	s8:25	s8:55	s9:25
32.6 Richmond		s4:35	s4:50	s5:05	s5:20	s5:35	s5:50	s6:05	s6:20	s6:35	s6:50	s7:05	s7:20	s7:35	s8:05	s8:35	s9:05	s9:35
34.8 Rosenberg		A4:38	A4:53	A5:08	A5:23	A5:38	A5:53	A6:08	A6:23	A6:38	A6:53	A7:08	A7:23	A7:38	A8:08	A8:38	A9:08	A9:38
Total time		:38	:38	:38	:38	:38	:38	:38	:38	:38	:38	:38	:38	:38	:38	:38	:38	:38

Table 5-4
Alternative 4: Commuter Rail - Shared Operation

U.S. 90A COMMUTER RAIL ALT 4 - Weekdays - Eastbound

Departure Times / Train	C2	F2	F4	C4	F6	C6	C8	C10	F8	C12	F10	C14	F12	C16	F14	C18	F16	F18	C20	C22	A2	F20	C24	C26
	a.m.	a.m.	a.m.	a.m.	a.m.	a.m.	a.m.	a.m.	a.m.	a.m.	a.m.	a.m.	a.m.	a.m.	a.m.	a.m.	a.m.	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.
34.8 Rosenberg	L6:00	L6:05	L6:20	L6:30	L6:45	L7:00	L7:30	L8:00	L8:10	L8:30	L8:50	L9:30	L9:45	L10:30	L10:45	L11:30	L11:35	L12:10	L12:31	L1:31	L2:00	L1:56	L2:31	L3:31
32.6 Richmond	6:01	6:07	6:22	6:31	6:47	7:01	7:31	8:01	8:12	8:31	8:52	9:31	9:47	10:31	10:47	11:31	11:37	12:12	12:32	1:32	2:01	1:57	2:32	3:32
24.2 Sugar Land Airport	s6:04			s6:34		s7:04	s7:34	s8:04		s8:34		s9:34		s10:34		s11:34			s12:35	s1:35			s2:35	s3:35
22.1 Sugar Land/Stafford	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
20.0 Stafford	6:05	6:10	6:25	6:35	6:50	7:05	7:35	8:05	8:15	8:35	8:55	9:35	9:50	10:35	10:50	11:35	11:40	12:15	12:36	1:36	2:03	2:00	2:36	3:36
17.4 Missouri City	s6:13			s6:43		s7:13	s7:43	s8:13		s8:43		s9:43		s10:43		s11:43			s12:44	s1:44			s2:44	s3:44
14.9 Westbury	s6:17	↓	↓	s6:47	↓	s7:17	s7:47	s8:17	↓	s8:47	↓	s9:47	↓	s10:47	↓	s11:47	↓	↓	s12:48	s1:48	↓	↓	s2:48	s3:48
9.5 MetroRail	↓	6:23	6:38	↓	7:03	↓	↓	↓	8:28	↓	9:08	↓	10:03	↓	11:03	↓	11:53	12:28	↓	↓	2:11	2:13	↓	↓
20.0 Stafford	s6:21			s6:51		s7:21	s7:51	s8:21		s8:51		s9:51		s10:51		s11:51			s12:52	s1:52			s2:52	s3:52
17.4 Missouri City	s6:26			s6:56		s7:26	s7:56	s8:26		s8:56		s9:56		s10:56		s11:56			s12:57	s1:57			s2:57	s3:57
14.9 Westbury	s6:31	↓	↓	s7:01	↓	s7:31	s8:01	s8:31	↓	s9:01	↓	s10:01	↓	s11:01	↓	s12:01	↓	↓	s1:02	s2:02	↓	↓	s3:02	s4:02
12.0 CP 12	6:34	A6:40	A6:50	7:04	7:15	7:34	8:04	8:34	A8:40	9:04	A9:20	10:04	A10:15	11:04	11:15	12:04	A12:10	A12:40	1:05	2:05	2:18	A2:25	3:05	4:05
9.5 MetroRail	A6:39			A7:09	A7:19	A7:39	A8:09	A8:39		A9:09		A10:09		A11:09	A11:19	A12:09			A1:10	A2:10	A2:20		A3:10	A4:10
Total time	:39	:35	:30	:39	:34	:39	:39	:39	:30	:39	:30	:39	:33	:39	:34	:39	:35	:30	:39	:39	:38	:30	:39	:39

U.S. 90A COMMUTER RAIL ALT 4 - Weekdays - Eastbound

Departure Times / Train	F22	C28	C30	C32	C34	F24	C36	F26	C38	C40	F28	C42	C44	F30
	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.
24.8 Rosenberg	L3:27	L4:01	L4:31	L5:01	L5:31	L5:55	L6:01	L6:11	L6:31	L7:01	L7:30	L8:01	L9:01	L9:40
34.0 CP 34	3:39	4:02	4:32	5:02	5:32	5:57	6:02	6:13	6:32	7:02	7:32	8:02	9:02	9:42
32.6 Richmond		s4:05	s4:35	s5:05	s5:35		s6:05		s6:35	s7:05		s8:05	s9:05	
22.5 Brazos River	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
32.0 CP 32	3:42	4:08	4:38	5:08	5:38	6:00	6:08	6:16	6:38	7:08	7:35	8:08	9:08	9:45
24.2 Sugar Land Airport		s4:14	s4:44	s5:14	s5:44		s6:14		s6:44	s7:14		s8:14	s9:14	
22.1 Sugar Land/Stafford	↓	s4:18	s4:49	s5:18	s5:48	↓	s6:18	↓	s6:49	s7:18	↓	s8:19	s9:18	↓
21.0 CP 21	3:55	↓	↓	↓	↓	6:13	↓	6:29	↓	↓	7:48	↓	↓	9:58
20.0 Stafford		s4:22	s4:52	s5:22	s5:52		s6:22		s6:52	s7:22		s8:22	s9:22	
17.4 Missouri City		s4:27	s4:57	s5:27	s5:57		s6:27		s6:57	s7:27		s8:27	s9:27	
14.9 Westbury	↓	s4:32	s5:02	s5:32	s6:02	↓	s6:32	↓	s7:02	s7:32	↓	s8:32	s9:32	↓
12.0 CP 12	A4:12	4:35	5:05	5:35	6:05	6:26	6:35	A6:41	7:05	7:35	A8:00	8:35	9:35	A10:10
9.5 MetroRail		A4:40	A5:10	A5:40	A6:10	A6:29	A6:40		A7:10	A7:40		A8:40	A9:40	
Total time	:35	:39	:39	:38	:39	:34	:38	:30	:39	:38	:30	:39	:39	:30

Table 5-4
Alternative 4: Commuter Rail - Shared Operation (continued)

U.S. 90A COMMUTER RAIL ALT 4 - Weekdays - Westbound

Departure Times / Train	F1	F3	C1	F5	C3	C5	F7	C7	C9	F9	F11	C11	C13	F13	C15	F15	C17	F17	A1	C19	F19	C21	C23	F21
	a.m.	a.m.	a.m.	a.m.	a.m.	a.m.	a.m.	a.m.	a.m.	a.m.	a.m.	a.m.	a.m.	a.m.	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.
34.8 Rosenberg		L6:25	L6:59		L7:29	L7:59		L8:29	L8:59		L9:55	L9:59	L10:59		L11:59		L1:00		L1:55	L2:00		L3:00	L4:00	
32.6 Richmond	L6:00	6:29	↓	L7:26	↓	↓	L8:22	↓	↓	L9:30	9:59	↓	↓	L11:15	↓	L12:21	↓	L1:15	1:57	↓	L2:10	↓	↓	L4:26
24.2 Sugar Land Airport			s7:06		s7:36	s8:06		s8:36	s9:06			s10:06	s11:06		s12:05		s1:07			s2:07		s3:07	s4:07	
22.1 Sugar Land/Stafford			s7:11		s7:41	s8:11		s8:41	s9:11			s10:11	s11:11		s12:10		s1:12			s2:12		s3:12	s4:12	
20.0 Stafford	↓	↓	s7:16	↓	s7:46	s8:16	↓	s8:46	s9:16	↓	↓	s10:16	s11:16	↓	s12:15	↓	s1:17	↓	↓	s2:17	↓	s3:17	s4:17	↓
17.4 Missouri City	6:12	6:41	↓	7:38	↓	↓	8:34	↓	↓	9:42	10:11	↓	↓	11:27	↓	12:33	↓	1:27	2:04	↓	2:33	↓	↓	4:38
14.9 Westbury			s7:20		s7:50	s8:20		s8:50	s9:20			s10:20	s11:20		s12:19		s1:21			s2:21		s3:21	s4:21	
9.5 MetroRail	↓	↓	s7:24	↓	s7:54	s8:24	↓	s8:54	s9:24	↓	↓	s10:24	s11:24	↓	s12:23	↓	s1:25	↓	↓	s2:25	↓	s3:25	s4:25	↓
32.0 CP 32	6:25	6:54		7:51			8:47			9:55	10:24			11:40		12:46		1:40	2:12		2:41			4:51
32.5 Brazos River			↓		↓	↓		↓	↓			↓	↓		↓		↓			↓		↓	↓	
32.6 Richmond	↓	↓	s7:34	↓	s8:04	s8:34	↓	s9:04	s9:34	↓	↓	s10:34	s11:34	↓	s12:33	↓	s1:35	↓	↓	s2:35	↓	s3:35	s4:35	↓
34.0 CP 34	6:28	6:57	↓	7:54	↓	↓	8:55	↓	↓	9:58	10:27	↓	↓	11:43	↓	12:49	↓	1:43	2:14	↓	2:44	↓	↓	4:54
34.8 Rosenberg	A6:30	A6:59	A7:38	A7:56	A8:08	A8:38	A8:57	A9:08	A9:38	A10:08	A10:29	A10:38	A11:38	A11:45	A12:37	A12:51	A1:39	A1:45	A2:15	A2:39	A2:46	A3:39	A4:39	A4:56
Total time:	:30	:34	:39	:30	:39	:39	:35	:39	:39	:38	:34	:39	:39	:30	:39	:30	:39	:30	:20	:39	:36	:39	:39	:30

U.S. 90A COMMUTER RAIL ALT 4 - Weekdays - Westbound

Departure Times / Train	C25	C27	F23	C29	C31	F25	C33	C35	C37	F27	C39	F29	C41
	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.
9.5 MetroRail	L4:30	L5:00	L5:05	L5:30	L6:00		L6:30	L7:00	L7:30		L8:30		L9:30
12.0 CP 12	↓	↓	5:09	↓	↓	L6:15	↓	↓	↓	L8:15	↓	L8:55	↓
14.9 Westbury	s4:37	s5:07		s5:37	s6:07		s6:37	s7:07	s7:37		s8:37		s9:37
17.4 Missouri City	s4:42	s5:12		s5:42	s6:12		s6:42	s7:12	s7:42		s8:42		s9:42
20.0 Stafford	s4:47	s5:17	↓	s5:47	s6:17	↓	s6:47	s7:17	s7:47	↓	s8:47	↓	s9:47
21.0 CP 21	↓	↓	5:21	↓	↓	6:27	↓	↓	↓	8:27	↓	9:07	↓
22.1 Sugar Land/Stafford	s4:51	s5:21		s5:51	s6:21		s6:51	s7:21	s7:51		s8:51		s9:51
24.2 Sugar Land Airport	s4:55	s5:25	↓	s5:56	s6:25	↓	s6:55	s7:25	s7:55	↓	s8:55	↓	s9:55
32.0 CP 32			5:41			6:40				8:40		9:20	
32.5 Brazos River	↓	↓		↓	↓		↓	↓	↓		↓		↓
32.6 Richmond	s5:05	s5:35	↓	s6:05	s6:35	↓	s7:05	s7:35	s8:05	↓	s9:05	↓	s10:05
34.0 CP 34	↓	↓	5:44	↓	↓	6:43	↓	↓	↓	8:43	↓	9:23	↓
34.8 Rosenberg	A5:09	A5:39	A5:46	A6:09	A6:39	A6:45	A7:09	A7:39	A8:09	A8:45	A9:09	A9:25	A10:09
Total time:	:39	:39	:41	:39	:39	:30	:39	:39	:39	:30	:39	:30	:39

Table 5-6

Alternative 5: Diesel Multiple Unit - Shared Operation

U.S. 90A COMMUTER RAIL ALT 5 - Weekdays - Eastbound

Departure Times / Train	C2	F2	F4	C4	F6	C6	C8	C10	F8	C12	F10	C14
	a.m.	a.m.	a.m.	a.m.	a.m.	a.m.	a.m.	a.m.	a.m.	a.m.	a.m.	a.m.
34.8 Rosenberg	L6:00	L6:07	L6:20	L6:30	L6:43	L7:00	L7:30	L8:00	L8:10	L8:30	L8:48	L9:32
32.6 Richmond	6:01	6:09	6:22	6:31	6:45	7:01	7:31	8:01	8:12	8:31	8:50	9:33
24.2 Sugar Land Airport	s6:04			s6:34		s7:04	s7:34	s8:04		s8:34		s9:36
22.1 Sugar Land/Stafford												
20.0 Stafford	6:05	6:12	6:25	6:35	6:48	7:05	7:35	8:05	8:15	8:35	8:53	9:37
17.4 Missouri City	s6:14			s6:44		s7:14	s7:44	s8:14		s8:44		s9:46
14.9 Westbury	s6:18			s6:48		s7:18	s7:48	s8:18		s8:48		s9:50
9.5 MetroRail		6:25	6:38		7:01				8:28		9:06	
20.0 Stafford	s6:22			s6:52		s7:22	s7:52	s8:22		s8:52		s9:54
17.4 Missouri City	s6:26			s6:56		s7:26	s7:56	s8:26		s8:56		s9:58
14.9 Westburyt	s6:30			s7:00		s7:30	s8:00	s8:30		s9:00		s10:02
12.0 CP 12	6:33	A6:39	A6:58	7:03	7:13	7:33	8:03	8:33	A8:40	9:03	A9:18	10:05
9.5 MetroRail	A6:37			A7:07	A7:17	A7:37	A8:07	A8:37		A9:07		A10:09
Total time:	:37	:32	:38	:37	:34	:37	:37	:37	:30	:37	:30	:37

Departure Times / Train	F12	C16	F14	C18	F16	F18	C20	C22	F20	A2	C24	C26
	a.m.	a.m.	a.m.	a.m.	a.m.	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.
34.8 Rosenberg	L9:45	L10:32	L10:45	L11:32	L11:36	L12:10	L12:32	L1:32	L1:55	L2:00	L2:32	L3:32
32.6 Richmond	9:47	10:33	10:47	11:33	11:38	12:12	12:33	1:33	1:57	2:01	2:33	3:33
24.2 Sugar Land Airport		s10:36		s11:36			s12:36	s1:36			s2:36	s3:36
22.1 Sugar Land/Stafford												
20.0 Stafford	9:50	10:37	10:50	11:37	11:41	12:15	12:37	1:37	2:00	2:03	2:37	3:37
17.4 Missouri City		s10:46		s11:46			s12:46	s1:46			s2:46	s3:46
14.9 Westbury		s10:50		s11:50			s12:50	s1:50			s2:50	s3:50
9.5 MetroRail	10:03		11:03		11:54	12:28			2:13	2:11		
20.0 Stafford		s10:54		s11:54			s12:54	s1:54			s2:54	s3:54
17.4 Missouri City		s10:58		s11:58			s12:58	s1:58			s2:58	s3:58
14.9 Westburyt		s11:02		12:02			s1:02	s2:02			s3:02	s4:02
12.0 CP 12	A10:15	11:05	11:15	12:05	A12:11	A12:40	1:05	2:05	A2:25	2:18	3:05	4:05
9.5 MetroRail		A11:09	A11:19	A12:09			A1:09	A2:09		A2:20	A3:09	A4:09
Total time:	:30	:37	:34	:37	:35	:30	:37	:37	:30	:20	:37	:37

U.S. 90A COMMUTER RAIL ALT 5 - Weekdays - Eastbound

Departure Times / Train	F22	C28	C30	C32	C34	F24	C36	F26	C38	C40	F28	C42	C44	F30
	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.
34.8 Rosenberg	L3:37	L4:02	L4:32	L5:02	L5:32	L5:55	L6:02	L6:11	L6:32	L7:02	L7:30	L8:02	L9:02	L9:40
34.0 CP 34	3:39	4:03	4:33	5:03	5:33	5:57	6:03	6:13	6:33	7:03	7:32	8:03	9:03	9:42
32.6 Richmond		s4:06	s4:38	s5:06	s5:38		s6:08		s6:38	s7:06		s8:06	s9:08	
32.5 Brazos River														
32.0 CP 32	3:42	4:07	4:37	5:07	5:37	6:00	6:07	6:16	6:37	7:07	7:35	8:07	9:07	9:45
24.2 Sugar Land Airport		s4:16	s4:48	s5:16	s5:48		s6:18		s6:48	s7:16		s8:16	s9:18	
22.1 Sugar Land/Stafford		s4:20	s4:50	s5:20	s5:50		s6:20		s6:50	s7:20		s8:20	s9:20	
21.0 CP 21	3:55					6:13		6:29			7:48			9:50
20.0 Stafford		s4:24	s4:54	s5:24	s5:54		s6:24		s6:54	s7:24		s8:24	s9:24	
17.4 Missouri City		s4:28	s4:58	s5:28	s5:58		s6:28		s6:58	s7:28		s8:28	s9:28	
14.9 Westburyt		s4:32	s5:02	s5:32	s6:02		s6:32		s7:02	s7:32		s8:32	s9:32	
12.0 CP 12	A4:12	4:35	5:05	5:35	6:05	6:25	6:35	A6:41	7:05	7:35	A8:00	8:35	9:35	A10:10
9.5 MetroRail		A4:39	A5:09	A5:39	A6:09	A6:29	A6:39		A7:09	A7:39		A8:39	A9:39	
Total time:	:35	:37	:37	:37	:37	:34	:37	:30	:37	:37	:30	:37	:37	:30



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Table 5-6
Alternative 5: Diesel Multiple Unit - Shared Operation (continued)

U.S. 90A COMMUTER RAIL ALT 5 - Weekdays - Westbound

Departure Times / Train	F1	F3	C1	F5	C3	C5	F7	C7	C9	F9	F11	C11	C13	F13	C15	F15	C17	F17	A1	C19	F19	C21	C23	F21
	a.m.	a.m.	a.m.	a.m.	a.m.	a.m.	a.m.	a.m.	a.m.	a.m.	a.m.	a.m.	a.m.	a.m.	a.m.	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.
34.8 Rosenberg		L6:25	L6:59		L7:29	L7:58		L8:29	L8:59		L9:52	L10:00	L11:00		L12:00		L1:00		L1:55	L2:00		L3:00	L4:00	
32.6 Richmond	L6:00	6:29	7:01	L7:25	7:31	8:01	L8:20	8:31	9:02	L9:30	9:56	10:03	11:03	L11:15	12:03	L12:21	1:03	L1:15	1:57	2:03	L2:10	3:03	4:03	L4:26
24.2 Sugar Land Airport	↓	↓	s7:05	↓	s7:35	s8:05	↓	s8:35	s9:06	↓	↓	s10:07	s11:07	↓	s12:07	↓	s1:07	↓	↓	s2:07	↓	s3:07	s4:07	↓
22.1 Sugar Land/Stafford	↓	↓	s7:09	↓	s7:39	s8:09	↓	s8:39	s9:10	↓	↓	s10:11	s11:11	↓	s12:11	↓	s1:11	↓	↓	s2:11	↓	s3:11	s4:11	↓
20.0 Stafford	↓	↓	s7:14	↓	s7:44	s8:14	↓	s8:44	s9:15	↓	↓	s10:16	s11:16	↓	s12:16	↓	s1:16	↓	↓	s2:16	↓	s3:16	s4:16	↓
17.4 Missouri City	6:12	6:41	7:15	7:37	7:45	8:15	8:32	8:45	9:16	9:42	10:09	10:17	11:17	11:27	12:17	12:33	1:17	1:27	2:04	2:17	2:22	3:17	4:17	4:38
14.9 Westbury	↓	↓	s7:17	↓	s7:47	s8:17	↓	s8:47	s9:18	↓	↓	s10:18	s11:19	↓	s12:19	↓	s1:19	↓	↓	s2:19	↓	s3:19	s4:19	↓
9.5 MetroRail	↓	↓	s7:21	↓	s7:51	s8:21	↓	s8:51	s9:22	↓	↓	s10:23	s11:23	↓	s12:23	↓	s1:23	↓	↓	s2:23	↓	s3:23	s4:23	↓
32.0 CP 32	6:35	6:54	7:29	7:50	7:59	8:29	8:45	8:59	9:30	9:55	10:21	10:31	11:31	11:40	12:31	12:46	1:31	1:40	2:12	2:31	2:41	3:31	4:31	4:51
32.5 Brazos River	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
32.6 Richmond	↓	↓	s7:31	↓	s8:01	s8:31	↓	s9:01	s9:32	↓	↓	s10:33	s11:33	↓	s12:33	↓	s1:33	↓	↓	s2:33	↓	s3:33	s4:33	↓
34.0 CP 34	6:38	6:57	7:33	7:53	8:03	8:33	8:53	9:03	9:35[18]	9:58	10:24	10:35	11:35	11:43	12:35	12:49	1:35	1:43	2:14	2:35	2:44	3:35	4:35	4:54
34.8 Rosenberg	A6:30	A6:58	A7:35	A7:56	A8:05	A8:35	A8:55	A9:05	A9:37	A10:00	A10:26	A10:37	A11:37	A11:45	A12:37	A12:51	A1:37	A1:45	A2:15	A2:37	A2:46	A3:37	A4:37	A4:56
Total time:	:30	:34	:37	:30	:37	:37	:35	:37	:38	:30	:34	:37	:37	:30	:37	:30	:37	:30	:20	:37	:36	:37	:37	:30

U.S. 90A COMMUTER RAIL ALT 5 - Weekdays - Westbound

Departure Times / Train	C25	F23	C27	C29	C31	F25	C33	C35	C37	F27	C39	F29	C41
	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.
9.5 MetroRail	L4:30	L5:05	L5:00	L5:30	L6:00		L6:30	L7:00	L7:30		L8:30		L9:30
12.0 CP 12	4:33	5:09	5:03	5:33	6:03	L6:15	6:33	7:03	7:33	L8:15	8:33	L8:55	9:33
14.9 Westbury	s4:37	↓	s5:07	s5:37	s6:07	↓	s6:37	s7:07	s7:37	↓	s8:37	↓	s9:37
17.4 Missouri City	s4:41	↓	s5:11	s5:41	s6:11	↓	s6:41	s7:11	s7:41	↓	s8:41	↓	s9:41
20.0 Stafford	s4:46	↓	s5:16	s5:46	s6:16	↓	s6:46	s7:16	s7:46	↓	s8:46	↓	s9:46
21.0 CP 21	4:47	5:21	5:17	5:47	6:17	6:27	6:47	7:17	7:47	8:27	8:47	9:07	9:47
22.1 Sugar Land/Stafford	s4:49	↓	s5:19	s5:49	s6:19	↓	s6:49	s7:19	s7:49	↓	s8:49	↓	s9:49
24.2 Sugar Land Airport	s4:53	↓	s5:23	s5:53	s6:23	↓	s6:53	s7:23	s7:53	↓	s8:53	↓	s9:53
32.0 CP 32	5:01	5:41	5:31	6:01	6:31	6:40	7:01	7:31	8:01	8:40	9:01	9:20	10:01
32.5 Brazos River	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
32.6 Richmond	s5:03	↓	s5:33	s6:03	s6:33	↓	s7:03	s7:33	s8:03	↓	s9:03	↓	s10:03
34.0 CP 34	5:05	5:44	5:35	6:05	6:35	6:43	7:05	7:35	8:05	8:43	9:05	9:23	10:05
34.8 Rosenberg	A5:07	A5:46	A5:37	A6:07	A6:37	A6:45	A7:07	A7:37	A8:07	A8:45	A9:07	A9:25	A10:07
Total time:	:37	:41	:37	:37	:37	:30	:37	:37	:37	:30	:37	:30	:37

5.4 Interface with METRORail Operations

METRO is the transit provider for the Houston Metropolitan area, currently providing bus service throughout the region. The METRORail is a new light rail transit (LRT) service operated by METRO. It opened in 2004 and is the first light rail service operating in the Houston region.

METRORail runs about 7.5 miles from the north end of Downtown to south of Loop 610. It follows Main Street to Wheeler, splits onto Fannin/San Jacinto, continues down Fannin through the Texas Medical Center to Braeswood, where it continues west/south on Greenbriar then back onto Fannin. The line terminates on Fannin at a maintenance facility located adjacent to the UP rail right of way. There are 16 stations in the METRORail system (Figure 5-2):

- UH Downtown (University of Houston)
- Preston
- Main St. Square
- Bell
- Downtown Transit Center
- McGowen
- Ensemble/HCC (Houston Community College)
- Wheeler
- Museum District
- Hermann Park/Rice University
- Memorial Hermann Hospital/Houston Zoo
- Dryden/Texas Medical Center
- Texas Medical Center Transit Center
- Smith Lands
- Reliant Park
- Fannin South Park and Ride

Figure 5-2 –METRORail Stations (Fannin South Park and Ride and Downtown Transit Center)

This busy corridor was selected for light rail because of the number of bus trips it carries and the variety of origins and destinations along its length. There are 245,000 employees working along the Main Street Corridor. Major nodes along the METRORail corridor include:

- Houston's Central Business District (140,000 employees)
- Texas Medial Center (60,000 employees, plus 75,000 visitors each day)
- Sports, Entertainment and the Arts (Houston Zoo, Museum District, Hermann Park, Minute Maid Park, Reliant Stadium)
- Colleges and Universities (University of Houston/Downtown, Houston Community College Central Campus, Rice University)
- Growing residential community

METRORail in the Main Street Corridor is a double-track alignment, which is in-street, semi-exclusive, at-grade right of way. The right of way is primarily in the median, with some sections in the curb lane of city streets (i.e., the train will be in its own lane, separated from other vehicles).

METRO's light rail cars run every 3-6 minutes in peak periods and every 12-15 minutes during off-peak periods. Because of heavy volumes in the Texas Medical Center during peak hours, trains run every three minutes between Hermann Park and the Smith Lands parking lot in the Texas Medical Center.

The approximate travel time for the length of the METRORail line – from the Fannin South Park & Ride lot to the University of Houston-Downtown – is 29 minutes. Light rail travels at posted speeds with priority at traffic signals. METRORail, therefore, moves through the corridor more quickly than other vehicles.

The METRORail fare is the same as local bus fare. A pre-payment method of fare collection is used. This means that riders buy the fare prior to boarding from machines at or near the station, or pre-purchased passes. Random proof of purchase checks are conducted to ensure compliance, with fines levied for violators. This proof-of-payment method ensures rapid boarding and keeps the trains running on schedule.

METRO has developed a bus operating plan that interfaces with light rail operations at each station, permitting seamless transfer between the bus and light rail services.

METRORail stations have standard design elements such as ticket vending machines, leaning rails, seats, wind screens and canopies. Each station also has unique features, design and artwork. In certain locations, community groups have secured additional funding for special enhancements like pavers, landscaping, sidewalk treatment, luminaries, banners, vicinity maps and other amenities.

METRORail cars, manufactured by Siemens Transportation Systems, are 95 feet long with seating for 72 passengers and a capacity of 200 with standees. Individual vehicles can be linked together into two-car trains, with a carrying capacity of 400. Trains will be limited to two-car consists, except during special events, to avoid blocking intersections in the Central Business District. Cars are low-floor (level with the platform) for 70 percent of their length. Level boarding means riders in wheelchairs or pushing strollers are able to board and exit quickly.

6. RIDERSHIP FORECAST

6.1 Ridership Forecast Procedures

The Houston-Galveston Area Council (H-GAC) used the traditional travel demand forecasting models to estimate the rail ridership on the proposed U.S. 90A corridor. The models were recently validated and calibrated to the base 1995 data using the travel surveys. These models have gone through an enhancement and updating from the original track zero models and are being worked towards the state of the art practice models. The mode choice model (the nested logit model), which estimates the mode split and predicts the transit ridership in the region, as well as the corridor, was revised and enhanced to estimate the commuter rail trips/ridership on the U.S. 90A corridor. The travel demand models that H-GAC uses apply the following sequential steps to estimate the rail (light and commuter) patronage/ridership:

1) The trip generation model estimated the productions and attractions of all the trips based on the year 2025 socioeconomic/demographics (household data – household size by income and employment data based on the 9 employment categories) forecasts. The demographic data/forecast for the year 2025 was based on 2000 census data and Urban-Sims model's aggressive forecasts.
2) The Atomistic model (an enhanced gravity model) was used for trip distribution to distribute the person trips to appropriate origin-destination pairs for the 7 trip purposes. The person trips are categorized mainly into the three broad trip purposes for home-based and non-home-based - home-based work (HBW) trip purposes; home-based, non-work (HBNW) trip purposes, which include school, shop and other trip purposes; and non-home-based (NHB) trip purposes. The other trip purposes produced in vehicle trips are the truck and taxi, and external local, while the external through-trips are factored and estimated from the 1995 external through base trips data
3) Pre-mode choice/split assignment was then run to estimate the assigned volumes and travel times based on the pre-mode choice daily trip tables for all eight-trip purposes on the network based on the skims.
4) The enhanced nested logit mode choice model for HBW, HBNW and NHB was run to estimate the number of transit passenger trips, which includes the rail patronage/ridership component.
5) The transit assignment, which is a part of the mode choice model procedure, assigns the number of passengers riding along the corridor route of U.S. 90A rail, which then estimates the boarding, alightings and the transfers by stations. The model also estimates the passenger miles of travel, as well as walk and drive access data by different modes, such as walk, bus (local, express and commuter), park and ride, kiss and ride, etc. The stochastic transit assignment procedure is used in the Emme/2 model that H-GAC uses.

The model was revised in 2003 to include special features to capture the commuter rail trips. The original mode choice model was developed to capture auto, bus and light rail trips, but was not designed to model the commuter rail trips. This study uses the most current commuter rail nest model that was added to the mode choice model. This commuter rail nest model is an enhancement to the original mode choice model.

On the modeling network side, the U.S. 90A rail corridor was coded with the proposed alignment from Rosenberg to the South Fannin Park-&-Ride. A total of eight stations with adjoining park and ride lots were then added to the year 2025 U.S. 90A corridor network. The rail stations were at Rosenberg, Richmond, Sugar Land Airport, Sugar Land, Stafford, Missouri City, Westbury and METRORail Fannin South. The proposed local and feeder buses were also coded with the same headways to correspond with that of U.S. 90A rail. The network already had the existing Draft (April 2003) version of the 2025 METRO Transit Plan bus routes while some of them were modified to feed into the rail stations along the U.S. 90A. Since the U.S. 90A rail and the feeder buses were coded on roads without previously planned bus routes, the percentage of potential transit passengers was re-estimated around the U.S. 90A corridor. It was assumed that people living within the half-mile radius along the bus lines would be able to take the feeder buses, and people living within 15 miles of a rail stations would consider driving to the park and ride facilities near the rail stations.

The options considered for this study were the light and commuter rail. The first was a light rail option with 15-minute peak and 30-minute off-peak headways. This operation was analyzed both as direct operation from the U.S. 90A corridor to the phase-1 of Downtown-to-Dome corridor to the CBD, and with a transfer to the METRORail light rail. The second option was the commuter rail/DMU alternative with 30-minute peak and 60-minute off-peak headways. The commuter rail was coded to end at the South Fannin Park-&-Ride station where passengers would be able to transfer to the CBD-to-Dome light rail line. The average operating rail speed of 30 miles per hour was assumed for both the options (light and commuter rail).

The HBW person trips are considered as peak-period trips and the HBNW and NHB trips as the off-peak trips. The highway and transit peak- and off-peak networks were also used for the specific purpose demand.

The methodology used for this his study was primarily for the commuter rail feasibility study. The other future rail corridor studies could possibly be under different assumptions and guidelines, and with other issues not considered in this study. The difference would result in a change of the model settings in the mode choice model, such as choice level constants, activity centers constants, fare impedances, rail speeds, headways, etc. The changes to the model overall could significantly impact the patronage/ridership forecasts.

6.2 Ridership Forecast Results

Ridership for the alternatives in the U.S. 90A corridor are estimated as follows:

- Alternatives 1, 2, 4, 5: **6,066** (or 12,132 daily person trips for commuter rail/DMU options)
- Alternative 3 (no transfer): **10,899** (or 21,798 daily person trips for Light/Urban rail option)
- Alternative 3 (transfer): **8,621** (or 17,242 daily person trips for Light/Urban rail option)

Details on the ridership are presented in Tables 6-1, 6-2 and 6-3.

The total trips for the light rail alternative (Alternative 3) only include those that either originate or terminate within the U.S. 90A corridor. The model produced some additional trips within the METRORail system (included in the subtotal), which are not included in the U.S. 90A rail feasibility analysis. These trips were removed from the total alternative ridership figures.

Based on the total ridership for the alternatives, the inbound two-hour a.m. peak-period demand figures are estimated as follows:

- Alternatives 1, 2, 4, 5: **4,797**
  (Commuter rail/DMU a.m. peak inbound ridership)
- Alternative 3 (no transfer): **9,003**
  (Light/Urban rail a.m. peak inbound ridership)
- Alternative 3 (transfer): **7,121**
  (Light/Urban rail a.m. peak inbound ridership)

Table 6-1
Alternatives 1, 2, 4, 5:
Ridership for Commuter Rail & DMU Alternatives (Average Weekday Totals)

	INBOUND		OUTBOUND		TOTAL RIDERS
Station	**Boardings**	**Alightings**	**Boardings**	**Alightings**	
Rosenburg	2,066	0	0	369	2,066
Richmond	1,277	45	18	478	1,295
Sugar Land Airport	311	6	35	32	346
Stafford/Sugar Land	778	729	231	324	1,009
Stafford	117	129	90	32	207
Missouri City	245	157	105	28	350
Westbury	3	809	168	6	171
METRORail	0	2,922	622	0	622
TOTAL	**4,797**	**4,797**	**1,269**	**1,269**	**6,066**

Table 6-2
Alternatives 3: Ridership for Light Rail Alternative, No Transfer
(Average Weekday Totals)

Station	INBOUND Boardings	INBOUND Alightings	OUTBOUND Boardings	OUTBOUND Alightings	TOTAL RIDERS
Rosenburg	2,131	0	0	297	2,131
Richmond	1,268	51	20	414	1,288
Sugar Land Airport	559	12	52	30	611
Stafford/Sugar Land	1,936	745	243	612	2,179
Stafford	1,026	209	118	193	1,144
Missouri City	800	196	140	85	940
Westbury	1,283	874	258	215	1,541
METRORail	0	206	99	50	99
Fannin South PnR	111	106	10	93	121
Reliant Park	382	159	94	137	476
Smith Lands	0	170	1	95	1
TMC Transit Center	323	560	178	196	501
Dryden	7	651	4	497	11
Memorial Hermann	11	13	32	3	43
Hermann Park	11	94	20	15	31
Museum District	38	96	15	79	53
Wheeler	159	383	321	93	480
Ensemble/HCC	4	64	24	12	28
McGowen	0	10	0	5	0
Dwtn Transit Center	46	602	175	57	221
Bell	0	352	40	6	40
Lamar/McKinney	0	4,388	1,085	0	1,085
Preston	0	0	0	2	0
UH Downtown	0	154	257	0	257
Subtotal	**10,095**	**10,095**	**3,186**	**3,186**	**13,281**
TOTAL	**9,003**		**1,896**		**10,899**

Table 6-3
Alternatives 3: Ridership for Light Rail Alternative, With Transfer
(Average Weekday Totals)

Station	INBOUND Boardings	INBOUND Alightings	OUTBOUND Boardings	OUTBOUND Alightings	TOTAL RIDERS
Rosenburg	2,016	0	0	290	2,016
Richmond	1,169	51	20	406	1,189
Sugar Land Airport	435	12	53	30	488
Stafford/Sugar Land	1,469	747	245	530	1,714
Stafford	771	211	120	146	891
Missouri City	618	203	140	70	758
Westbury	577	945	280	94	857
METRORail	0	284	146	0	146
Fannin South PnR	0	4,602	562	0	562
TOTAL	**7,055**	**7,055**	**1,566**	**1,566**	**8,621**

6.3 Rail / Automobile Comparison

Travel times for commuter rail were compared to those for the automobile in the U.S. 90A corridor. Note that travel times for the automobile are based on an average in the peak period.

Table 6-4
Commuter Rail Versus Automobile Travel Time Comparison

Auto travel time

From \ To	Rosenberg	Richmond	Sugar Land Airport	Sugar Land/ Stafford	Stafford	Missouri City	Westbury	Metro Rail	TMC	CBD
Rosenberg	---	6.8	16.6	20.1	23.5	31.1	34.0	45.3	48.4	57.1
Richmond	6.8	---	11.8	16.4	20.3	26.7	29.4	39.9	43.8	52.6
Sugar Land Airport	12.9	10.6	---	4.6	8.5	14.9	17.7	28.2	32.1	40.8
Sugar Land /Stafford	16.0	13.9	3.3	---	3.9	10.3	13.1	23.6	29.0	37.7
Stafford	16.4	16.8	6.2	2.9	---	6.4	9.1	19.6	23.5	31.7
Missouri City	24.5	22.4	11.8	8.5	5.6	---	2.8	13.2	17.2	25.3
Westbury	26.4	24.4	13.8	10.5	7.6	2.0	---	10.5	14.4	22.5
Metro Rail	34.8	32.7	22.1	18.7	15.9	10.3	8.3	---	4.9	13.0
TMC	36.6	35.0	24.4	21.1	18.9	13.3	11.3	4.1	---	10.2
CBD	33.3	31.8	26.6	24.3	25.0	20.9	18.9	11.6	10.6	---

Commuter Rail Travel Time

From \ To	Rosenberg	Richmond	Sugar Land Airport	Sugar Land/ Stafford	Stafford	Missouri City	Westbury	Metro Rail	TMC	CBD
Rosenberg	---	6.3	18.9	24.1	28.6	31.6	38.2	48.4	55.7	70.1
Richmond	6.3	---	12.6	17.8	22.3	25.3	31.9	42.2	49.5	63.8
Sugar Land Airport	18.9	12.6	---	5.2	9.7	12.7	19.3	29.6	36.9	51.2
Sugar Land /Stafford	24.1	17.8	5.2	---	4.5	7.5	14.1	24.4	31.7	46.0
Stafford	28.6	22.3	9.7	4.5	---	3.0	9.6	19.9	27.1	41.5
Missouri City	31.6	25.3	12.7	7.5	3.0	---	6.6	16.8	24.1	38.5
Westbury	38.2	31.9	19.3	14.1	9.6	6.6	---	10.3	17.6	31.9
Metro Rail	48.4	42.2	29.6	24.4	19.9	16.8	10.3	---	7.3	21.7
TMC Transit Ctr	55.7	49.5	36.9	31.7	27.1	24.1	17.6	7.3	---	14.4
Lamar/ McKinney	70.1	63.8	51.2	46.0	41.5	38.5	31.9	21.7	14.4	---

Commuter rail was also compared to the No Build scenario. The following table compares the a.m. vehicle miles traveled, a.m. traffic count, and a.m. peak-travel time for each scenario.

Table 6-5
Commuter Rail Versus No Build Comparison

AM VMT					
		commuter	no build	VMT reduced	%VMT reduced
US 59	Between Rosenberg and SH 6	254,179	259,060	4,881	1.88%
	Between SH 6 and BW 8	236,129	240,681	4,552	1.89%
	Between BW 8 and 610	395,425	398,192	2,767	0.69%
	Bewteen 610 and SH 288	309,004	309,699	695	0.22%
	total	1,194,737	1,207,633	12,896	1.07%
US 90	Between Rosenberg and SH 6	75,719	76,482	763	1.00%
	Between SH 6 and BW 8	111,024	112,069	1,045	0.93%
	Between BW 8 and Fannin	79,092	79,615	523	0.66%
	total	265,835	268,166	2,331	0.87%
AM Traffic Count		commuter	no build	Count reduced	%Count reduced
US 59	East of SH 99	28,344	28,864	519	1.80%
	East of SH 6	29,215	29,717	503	1.69%
	East of BW 8	43,197	43,612	415	0.95%
	East of 610	60,767	60,945	178	0.29%
	West of Spur 527	58,797	58,940	143	0.24%
US 90	East of SH 99	11,807	11,904	98	0.82%
	East of SH 6	12,558	12,674	116	0.91%
	West of Main	15,716	15,802	86	0.54%
AM Peak Travel Time					
		commuter	no build	Minute reduced	%time reduced
US 59	Between Rosenberg and SH 6	12.1	12.3	0.20	1.63%
	Between SH 6 and BW 8	10.3	10.6	0.27	2.56%
	Between BW 8 and 610	17.1	17.2	0.14	0.83%
	Bewteen 610 and Spur 527	7.9	8.0	0.05	0.58%
	Between Spur 527 and SH 288	1.8	1.8	0.00	0.06%
	total	49.2	49.9	0.66	1.33%
US 90	Between Rosenberg and SH 6	18.1	18.2	0.11	0.59%
	Between SH 6 and BW 8	13.7	13.8	0.10	0.75%
	Between BW 8 and Fannin	13.7	13.7	0.02	0.16%
	total	45.4	45.6	0.23	0.51%

7. CAPITAL, OPERATING AND MAINTENANCE COSTS

7.1 Capital Costs

7.1.1 Capital Cost Methodology

A capital cost model was developed by METRO for use in the transportation corridor studies being conducted throughout the Houston area. The model included spreadsheets for commuter rail and light rail modes. This model was chosen to estimate costs for the alternatives in the U.S. 90A corridor. The METRO base model was adapted to the conditions in the U.S. 90A corridor and the unit costs and quantities were adjusted where necessary. The commuter rail spreadsheet model was edited to create a new modal model for Diesel Multiple Unit (DMU) alternatives. These modifications to the model are documented in the Section on assumptions that follows.

The resulting capital cost model developed follows the guidance contained in *Procedures and Technical Method for Transit Project Planning*, Section II.3, Estimation of Capital Costs, Federal Transit Administration, September 1990, as revised. The following report presents the assumptions, cost line items, unit costs, and capital cost spreadsheets used for estimating capital costs of the alternatives under study in the *U.S. 90A Corridor Commuter Rail Feasibility Study*. As such, the capital cost model presented has been developed to a level of detail appropriate for the concept-level work performed in this study.

The capital cost model is limited by the level of design detail that was available at this stage of project development. Similarly, cost estimates are also limited in their accuracy to a conceptual level of detail. The level of detail is appropriate for comparative evaluation of the kind to be performed in the study. Should the study advance to the next phase, conceptual engineering would need to be performed and capital costs refined with the more detailed information developed.

In order to anticipate potential variances in assumptions made in the order-of-magnitude costs and actual implementation cost, a contingency cost is included. If the U.S. 90A rail project is further advanced and more detailed design work is prepared and available for use in capital cost estimating, the contingency, or risk, will decrease. More detailed information on environmental mitigation and right of way, station and yard property acquisition would need to be quantified in the next phase of design, as well.

Unit costs included in the model have been developed based on recent experience with the design and cost estimating of capital cost elements on other projects. Costs have been developed based on experience throughout the United States. This model cannot predict unforeseen future fluctuations that cannot be anticipated based on historic experience. The model has been prepared in 2002 dollars.

The capital cost model for rail alternatives for the U.S. 90A rail study is made up of the following cost category line items:

- Vehicles
- Stations
- Guideway
- Maintenance/Inspection Facilities
- Park and Ride
- Right of Way
- Project Contingency

7.1.2 Capital Cost Assumptions

Descriptions of the capital cost categories and details on the components of each category are presented in the following sections.

Vehicles

The unit costs used for commuter rail vehicles (locomotives, cab cars and coaches) were from recent U.S. procurements. Train consist assumed is a push-pull train set, with an AMD-103 diesel locomotive and five coaches with 200 seats per car. The 30-minute headway plan will handle 1,200 peak-direction riders per hour.

Unit costs for DMU vehicles are based on quoted rates for the Colorado Railcar (185-seat double deck low-floor trailer with cab.) The consist assumed is three bi-level DMU cab cars. The 30-minute headway plan will handle 1,110 peak-direction riders per hour.

Unit costs for light rail vehicles reflect vehicle cost assumptions used in other Houston studies that include light rail (METRO light rail Siemens vehicle, Avanto train sets with 72 seats per car and a total passenger capacity of 200 including standees.) The consist assumed is three-car, allowing for 864 seated passengers in the peak hour, using the 15-minute headway plan.

Quantities of rail vehicles required were based on the output of the operating plan (including adding a spare trainset), as well as the preliminary assumptions regarding ridership:

- Commuter rail alternatives assume four operating train sets, plus one spare set.
- DMU alternatives assume four operating train sets, plus one spare set.
- The light rail alternative assumes seven operating train sets, plus one spare set.

An add-on cost was also included that is a percentage of the vehicle cost to account for spare parts, manuals, training, engineering, and agency project management.

Stations

The METRO cost model included a line item for an at-grade station. A new line item was added to the U.S. 90A model for an at-grade station with a pedestrian overpass, including elevators. Because of the operating environment of the U.S. 90A rail corridor as a highly active freight line, stations were assumed to include pedestrian overpasses with elevators to provide safe movement of passenger rail passengers to the boarding platforms. The unit costs applied the commuter rail and light rail unit costs from the model used in other Houston studies, with an additional cost applied for the pedestrian overpass. Unit costs for DMU stations applied the same figures as light rail, as DMU stations would be of a comparable size, and would have comparable components.

Light rail and DMU stations assume:

- At-grade center platform 300' x 20' (6,000 square feet) – includes excavation, concrete slab, electrical, mechanical, finish and drainage
- Fare collection equipment
- Signs
- Canopy, 100' x 12' (1,200 square feet)
- Pedestrian overpass
- Elevators
- Landscaping

Commuter rail stations assume all of the above elements, however a longer platform would be required (500' x 20'.)

The quantity of stations was based on the assumption of station locations at:

- Rosenberg
- Richmond
- Sugar Land Airport
- Sugar Land
- Stafford
- Missouri City
- Houston/Westbury
- METRORail/ Fannin South

An add-on cost was also included as a percentage of the station cost to account for non-construction costs such as preliminary engineering, final design, art, construction management, design services during construction, insurance, testing and start-up, and agency project management.

Guideway

For exclusive alternatives, unit costs for commuter rail were not changed in the model; they reflect guideway cost assumptions used in other Houston studies. Unit costs for DMU guideway applied the same figures as commuter rail as the guideway (track, ballast, structures, signals and communications), since they are comparable. Unit costs for the light rail guideway in the model were applied using the "exclusive surface" figure as an existing railroad right of way. For shared alternatives (commuter rail and DMU) an additional line item was added and applied to reflect the higher cost of providing more signals and communications system necessary for the freight interface.

Quantities were developed based on the length of the corridor being 25.3 miles total for all alternatives (MP 9.5 to MP 34.8). Quantities for guideway were developed for each alternative as follows:

- *Alternative 1 – Exclusive Commuter Rail* and *Alternative 2 – Exclusive DMU* assume 22.3 miles of single track, and 3 miles of double track (for 3 passing sidings each 1 mile in length.)
- *Alternative 3 – Exclusive LRT* assumes 25.3 miles of exclusive surface.

- *Alternative 4 – Shared Commuter Rail* and *Alternative 5 – Shared DMU* assume 5.8 miles of single track, and 19.5 miles of double track (to accommodate a track for commuter rail and an additional track for shared between passenger rail and freight) The single track is located from MP 9.5 to MP 13.0 (from the METRORail Station to where most of the freight service leaves the alignment under study and heads north) and MP 32.5 to MP 34.8 (from the Brazos River in Richmond to the terminus in Rosenberg.)

Light rail guideway costs include:

- Concrete ties
- Ballast and subballast
- 115 # Rail
- Special trackwork
- Substations
- Catenary
- Signals
- Communications
- Civil elements
- Utility relocation
- Lighting
- Excavation
- Installation
- Traffic control
- Miscellaneous items

Commuter rail and DMU guideway costs include:

- Timber ties
- Ballast and subballast
- 139 # Rail
- Turnouts
- Signals
- Communications
- Civil elements
- Utility relocation
- Excavation
- Installation
- Miscellaneous items

An additional line item was added to cover the costs for reconstruction of two structures (Brazos River Bridge and Route 99 Bridge). Due to their significance and complexity they would not be included in the typical structure costs for the guideway figures (culverts, minor spans, etc.). Unit costs are based on current industry standards for one- and two-track ballasted deck railroad bridges.

- *Alternative 1 – Exclusive Commuter Rail, Alternative 2 – Exclusive DMU,* and *Alternative 3 – Exclusive LRT* assume construction of a new single-track railroad bridge over the Brazos River and Route 99.
- *Alternative 4 – Shared Commuter Rail* and *Alternative 5 – Shared DMU* assume construction of a new two-track railroad bridge over the Brazos River and Route 99.

An add-on cost was also included as a percentage of the guideway cost to account for non-construction costs, such as preliminary engineering, final design, art, construction management, design services during construction, insurance, testing and startup, and agency project management.

Maintenance / Inspection Facilities

Unit costs for commuter rail and light rail maintenance and inspection facilities were not changed in the model; therefore, it reflects cost assumptions used in other Houston studies. Unit costs for a DMU maintenance facility applied the same figures as commuter rail, as the DMU facility would be comparable. Quantities were based on the output of the operating plan, presented in the vehicles section.

Maintenance/inspection facility costs include:

- Yard and shop
- Equipment
- Site work
- Catenary and signals
- Storage
- Office furniture and movable equipment

An add-on cost was also included as a percentage of the maintenance/inspection facility cost to account for non-construction costs such as preliminary engineering, final design, art, construction management, design services during construction, insurance, testing and startup, and agency project management.

Park and Ride

Unit costs for were not changed in the model; therefore, it reflects per-parking-space cost assumptions used in other Houston studies. Surface parking assumes 280 square feet per parking space. Quantities of spaces are based on preliminary assumptions regarding ridership.

Park and ride costs include:

- Grading
- Curbing
- Pavement surface
- Drainage
- Striping
- Concrete wheel stops

An add-on cost was also included as a percentage of the park and ride cost to account for non-construction costs such as preliminary engineering, final design, art, construction management, design services during construction, insurance, testing and startup, and agency project management.

Right of Way

The Houston area model indicates that differing right of way unit costs should be assumed, depending on the individual study corridor. The model provides examples of the per-square-foot costs in several other study corridors. The U.S. 90A corridor was assumed to be typical of these other corridors. The number of square feet for right of way was estimated based on acquisition needs for parking (280 square feet per space for 3,500 spaces, or 980,000 square feet), a yard (7 acres, or 304,920 square feet), and rail right of way (25.3 miles at 40 feet wide, or 5,343,360 square feet.)

Right of way costs include:

- Land value
- Building value
- Closing cost
- Relocation cost
- Moving Expenses
- Legal fees
- Cost bonds
- Surveys
- Appraisals
- Environmental and demolition costs
- Agency staff labor costs

Project Contingency

The project contingency of 10 percent from the Houston area model was assumed.

7.1.3 Capital Cost Results

The following tables summarize the capital cost of the U.S. 90A Rail alternatives, as well as the detailed cost model for each alternative. The total capital cost of the alternative is:

- *Alternative 1 – Exclusive Commuter Rail:* $382.6 million
- *Alternative 2– Exclusive DMU:* $352.8 million
- *Alternative 3 – Exclusive LRT:* $756.3 million
- *Alternative 4 – Shared Commuter Rail:* $492.2 million
- *Alternative 5 – Shared DMU:* $462.3 million

Table 7-1
Capital Cost Summary

Cost Category	**Alternative 1 - Exclusive Commuter Rail** Total Cost Dollars	**Alternative 2 - Exclusive DMU** Total Cost Dollars	**Alternative 3 - Exclusive LRT** Total Cost Dollars	**Alternative 4 - Shared Commuter Rail** Total Cost Dollars	**Alternative 5 - Shared DMU** Total Cost Dollars
Vehicles	$ 64,125,000	$ 50,025,000	$ 67,620,000	$ 64,125,000	$ 50,025,000
Transit Center	$ 23,712,000	$ 22,339,200	$ 22,339,200	$ 23,712,000	$ 22,339,200
Guideway	$ 148,455,840	$ 148,455,840	$ 490,771,320	$ 248,041,440	$ 248,041,440
Maintenance Facility	$ 23,400,000	$ 11,700,000	$ 18,673,200	$ 23,400,000	$ 11,700,000
Park and Ride	$ 21,840,000	$ 21,840,000	$ 21,840,000	$ 21,840,000	$ 21,840,000
Right-of-Way	$ 66,327,800	$ 66,327,800	$ 66,327,800	$ 66,327,800	$ 66,327,800
Project Contingency	$ 34,786,064	$ 32,068,784	$ 68,757,152	$ 44,744,624	$ 42,027,344
Total Cost (2002 Dollars)	**$ 382,646,704**	**$ 352,756,624**	**$ 756,328,672**	**$ 492,190,864**	**$ 462,300,784**
Total Length in Miles	25.3	25.3	25.3	25.3	25.3
Cost per Mile (2002 Dollars)	$ 15,124,376	$ 13,942,950	$ 29,894,414	$ 19,454,184	$ 18,272,758

Table 7-2
Capital Cost Detail for Commuter Rail Alternatives

Cost Category	**Unit Cost**	**Unit Quantity**	**COMMUTER RAIL ALTERNATIVES CAPITAL COST MODEL** **Alternative 1 - Exclusive Commuter Rail**		**Alternative 4 - Shared Commuter Rail**	
			Input Quantity	Output Cost	Input Quantity	Output Cost
Vehicles		Vehicle		$ 64,125,000		$ 64,125,000
Locomotive	$ 3,500,000	Vehicle	5	$ 17,500,000	5	$ 17,500,000
Cab Car	$ 1,900,000	Vehicle	5	$ 9,500,000	5	$ 9,500,000
Coach	$ 1,500,000	Vehicle	20	$ 30,000,000	20	$ 30,000,000
Add-On Costs	15%	Percentage		$ 7,125,000		$ 7,125,000
Transit Center		Station		$ 23,712,000		$ 23,712,000
At-Grade	$ 900,000	Station	0	$ -	0	$ -
At-Grade with Pedestrian Overpass	$ 1,900,000	Station	8	$ 15,200,000	8	$ 15,200,000
Elevated	$ 3,440,000	Station	0	$ -	0	$ -
Add-On Costs	56%	Percentage		$ 8,512,000		$ 8,512,000
Guideway		Mile		$ 148,455,840		$ 248,041,440
At-Grade (1T) w/ Retaining Wall	$ 5,950,000	Mile	0	$ -	0	$ -
At-Grade (1T) w/o Retaining Wall	$ 2,980,000	Mile	22.3	$ 66,454,000	0	$ -
At-Grade (2 T) w/o Retaining Wall	$ 5,820,000	Mile	3	$ 17,460,000	0	$ -
At-Grade (1T) w/ Additional S&C	$ 3,480,000	Mile	0	$ -	5.8	$ 20,184,000
At-Grade (2T) w/ Additional S&C	$ 6,320,000	Mile	0	$ -	19.5	$ 123,240,000
Elevated (2T)	$26,760,000	Mile	0	$ -	0	$ -
Ballasted Bridge (1T)	$ 13,000	Linear Foot	1350	$ 17,550,000	0	$ -
Ballasted Bridge (2T)	$ 18,000	Linear Foot	0	$ -	1350	$ 24,300,000
Add-On Costs	56%	Percentage		$ 46,991,840		$ 80,317,440
Maintenance Facility		Vehicle		$ 23,400,000		$ 23,400,000
Maintenance/Inspection Facilities	$ 500,000	Vehicle	30	$ 15,000,000	30	$ 15,000,000
Add-On Costs	56%	Percentage		$ 8,400,000		$ 8,400,000
Park and Ride		Space		$ 21,840,000		$ 21,840,000
Surface	$ 4,000	Space	3,500	$ 14,000,000	3,500	$ 14,000,000
Structure	$ 10,000	Space	0	$ -	0	$ -
Add-On Costs	56%	Percentage		$ 7,840,000		$ 7,840,000
Right-of-Way		Square Foot		$ 66,327,800		$ 66,327,800
Right-of-Way	$ 10	Square Foot	6,632,780	$ 66,327,800	6,632,780	$ 66,327,800
Project Contingency	10%	Percentage		$ 34,786,064		$ 44,744,624
Total Cost (2002 Dollars)				**$382,646,704**		**$492,190,864**
Total Length in Miles				25.3		25.3
Cost per Mile (Constant Dollars)				$ 15,124,376		$ 19,454,184

Table 7-3
Capital Cost Detail for DMU Alternatives

Cost Category	Unit Cost	Unit Quantity	DMU ALTERNATIVES CAPITAL COST MODEL: Alternative 2 - Exclusive DMU		Alternative 5 - Shared DMU	
			Input Quantity	Output Cost	Input Quantity	Output Cost
Vehicles		Vehicle		$ 50,025,000		$ 50,025,000
DMU Double Deck Trailer with cab	$ 2,900,000	Vehicle	15	$ 43,500,000	15	$ 43,500,000
Add-On Costs	15%	Percentage		$ 6,525,000		$ 6,525,000
Transit Center		Station		$ 22,339,200		$ 22,339,200
At-Grade	$ 790,000	Station	0	$ -	0	$ -
At-Grade with Pedestrian Overpass	$ 1,790,000	Station	8	$ 14,320,000	8	$ 14,320,000
Elevated	$ 3,440,000	Station	0	$ -	0	$ -
Add-On Costs	56%	Percentage		$ 8,019,200		$ 8,019,200
Guideway		Mile		$148,455,840		$ 248,041,440
At-Grade (1T) w/ Retaining Wall	$ 5,950,000	Mile	0	$ -	0	$ -
At-Grade (1T) w/o Retaining Wall	$ 2,980,000	Mile	22.3	$ 66,454,000	0	$ -
At-Grade (2 T) w/o Retaining Wall	$ 5,820,000	Mile	3	$ 17,460,000	0	$ -
At-Grade (1T) w/ Additional S&C	$ 3,480,000	Mile	0	$ -	5.8	$ 20,184,000
At-Grade (2T) w/ Additional S&C	$ 6,320,000	Mile	0	$ -	19.5	$ 123,240,000
Elevated (2T)	$ 26,760,000	Mile	0	$ -	0	$ -
Ballasted Bridge (1T)	$ 13,000	Linear Foot	1350	$ 17,550,000	0	$ -
Ballasted Bridge (2T)	$ 18,000	Linear Foot	0	$ -	1350	$ 24,300,000
Add-On Costs	56%	Percentage		$ 46,991,840		$ 80,317,440
Maintenance Facility		Vehicle		$ 11,700,000		$ 11,700,000
Maintenance/Inspection Facilities	$ 500,000	Vehicle	15	$ 7,500,000	15	$ 7,500,000
Add-On Costs	56%	Percentage		$ 4,200,000		$ 4,200,000
Park and Ride		Space		$ 21,840,000		$ 21,840,000
Surface	$ 4,000	Space	3,500	$ 14,000,000	3,500	$ 14,000,000
Structure	$ 10,000	Space	0	$ -	0	$ -
Add-On Costs	56%	Percentage		$ 7,840,000		$ 7,840,000
Right-of-Way		Square Foot		$ 66,327,800		$ 66,327,800
Right-of-Way	$ 10	Square Foot	6,632,780	$ 66,327,800	6,632,780	$ 66,327,800
Project Contingency	10%	Percentage		$ 32,068,784		$ 42,027,344
Total Cost (2002 Dollars)				**$352,756,624**		**$462,300,784**
Total Length in Miles				25.3		25.3
Cost per Mile (Constant Dollars)				$ 13,942,950		$ 18,272,758

Table 7-4
Capital Cost Detail for Light Rail Alternatives

Cost Category	Unit Cost	Unit Quantity	LIGHT RAIL ALTERNATIVES: Alternative 3 - Exclusive LRT	
			Input Quantity	Output Cost
Vehicles		Vehicle		$ 67,620,000
Vehicles	$ 2,800,000	Vehicle	21	$ 58,800,000
Add-On Costs	15%	Percentage		$ 8,820,000
Transit Center		Station		$ 22,339,200
At-Grade	$ 790,000	Station	0	$ -
At-Grade with Pedestrian Overpass	$ 1,790,000	Station	8	$ 14,320,000
Elevated	$ 3,430,000	Station	0	$ -
Underground	$ 15,760,000	Station	0	$ -
Add-On Costs	56%	Percentage		$ 8,019,200
Guideway		Mile		$ 490,771,320
In-Street (single track)	$ 10,500,000	Mile	0	$ -
In-Street (double track)	$ 17,250,000	Mile	0	$ -
Exclusive Surface	$ 11,990,000	Mile	25.3	$ 303,347,000
Elevated	$ 32,140,000	Mile	0	$ -
Underground	$ 45,370,000	Mile	0	$ -
Ballasted Bridge (1T)	$ 13,000	Linear Foot	1350	$ 17,550,000
Ballasted Bridge (2T)	$ 18,000	Linear Foot	0	$ -
Add-On Costs	56%	Percentage		$ 169,874,320
Maintenance Facility		Vehicle		$ 18,673,200
Maintenance/Inspection Facilities	$ 570,000	Vehicle	21	$ 11,970,000
Add-On Costs	56%	Percentage		$ 6,703,200
Park and Ride		Space		$ 21,840,000
Surface	$ 4,000	Space	3,500	$ 14,000,000
Structure	$ 10,000	Space	0	$ -
Add-On Costs	56%	Percentage		$ 7,840,000
Right-of-Way		Square Foot		$ 66,327,800
Right-of-Way	$ 10	Square Foot	6,632,780	$ 66,327,800
Project Contingency	10%	Percentage		$ 68,757,152
Total Cost (2002 Dollars)				**$756,328,672**
Total Length in Miles				25.3
Cost per Mile (Constant Dollars)				$ 29,894,414

7.2 Operating and Maintenance Costs

7.2.1 Operating and Maintenance Cost Methodology

An Operating and Maintenance cost (O&M) model was developed for use in the U.S. 90A corridor. The O&M estimate has been prepared following the guidance contained in *Procedures and Technical Method for Transit Project Planning*, Section 2.4, Operating and Maintenance Cost, Federal Transit Administration, September 1990, as revised. The principals of this guidance were applied to prepare the O&M cost model for the U.S. 90A corridor, which was developed to a level of detail appropriate for the concept-level work performed in this study. This model was applied to estimate annual costs to operate and maintain the alternatives studied in the U.S. 90A corridor.

The following section presents the assumptions, cost-line items, unit costs and operating statistics used in the calculation of O&M Cost in the findings section. The output of the demand forecasts and operating plans were used as input to the O&M cost model, in the form of operating statistics. Development of the model involves identifying costs that vary with service levels, and then attributing each variable cost to the service characteristics to which it is most closely tied. Unit costs are applied for each variation in service characteristic to estimate O&M costs for the proposed service.

The O&M cost model for rail alternatives for the U.S. 90A Rail study is made up of the following cost-category line items:

- Train Operations
- Train Maintenance
- Maintenance of Way
- Transit Center Operations and Maintenance
- Administration

7.2.2 Operating and Maintenance Assumptions

Descriptions of these cost categories and details on the components of each category are presented in the following sections. To calculate annual O&M costs, the daily operating statistic output from the operations planning model was used. These daily operating statistics were annualized by a factor of 260. The O&M costs presented are, therefore, for weekday only service. An incremental additional cost would need to be added to provide rail service on weekends.

Train Operations

This cost category for rail operations includes crew costs (three-person crews are assumed, including an engineer, a conductor and an additional person) and motive power/propulsion cost. Crew cost is costed based on a cost per hour. Propulsion power cost is based on a cost per car mile.

Train Maintenance

This cost category for rail operations includes labor and materials for both mileage- and non-mileage-based equipment maintenance and equipment cleaning. Maintenance is costed on a per-car-mile basis.

Maintenance of Way

This cost category for rail operations includes labor, supervision and materials for the maintenance of right of way infrastructure, including track, signals and communication systems. Maintenance of way is costed on a per track mile basis.

Transit Center Operations and Maintenance

This cost category includes labor and materials for the operations and maintenance of new transit centers. These costs include operations, cleaning, maintenance, ticket vending machine servicing and utilities. A cost is included for safety and security including security officers, patrol car maintenance and operations. These items are costed on a per-station basis.

For all alternatives, O&M costs for eight transit centers have been included:

- Rosenberg
- Richmond
- Sugar Land Airport
- Sugar Land
- Stafford
- Missouri City
- Houston/Westbury
- METRORail

Administrative

This cost category includes any general operator administrative costs that would increase as a result of the U.S. 90A service, such as insurance, personnel, marketing, etc. Standard O&M cost estimating practice applies a percentage to the above cost factors to estimate additional administrative costs. Twenty percent is a commonly accepted percentage.

7.2.3 Operating and Maintenance Cost Results

The following tables summarize the annual operating and maintenance costs for the U.S. 90A Rail alternatives, as well as the detailed cost model for each alternative. The total O&M cost of the alternatives is:

- *Alternative 1 – Exclusive Commuter Rail:* $12.1 million
- *Alternative 2 – Exclusive DMU:* $8.4 million
- *Alternative 3 – Exclusive LRT:* $14.0 million
- *Alternative 4 – Shared Commuter Rail:* $13.5 million
- *Alternative 5 – Shared DMU:* $9.8 million

Table 7-5
Operating and Maintenance Cost Summary

Cost Category	Alternative 1 - Exclusive Commuter Rail Annual Cost Dollars	Alternative 2 - Exclusive DMU Annual Cost Dollars	Alternative 3 - Exclusive LRT Annual Cost Dollars	Alternative 4 - Shared Commuter Rail Annual Cost Dollars	Alternative 5 - Shared DMU Annual Cost Dollars
Train Operations	$ 1,171,560	$ 937,162	$ 3,252,392	$ 1,171,560	$ 937,162
Train Maintenance	$ 4,746,508	$ 1,846,244	$ 2,689,220	$ 4,746,508	$ 1,846,244
Maintenance of Way	$ 1,924,400	$ 1,924,400	$ 3,440,800	$ 3,046,400	$ 3,046,400
Transit Center Operations & Maintenance	$ 2,312,000	$ 2,312,000	$ 2,312,000	$ 2,312,000	$ 2,312,000
Administration	$ 2,030,894	$ 1,403,961	$ 2,338,882	$ 2,255,294	$ 1,628,361
Total Cost (2002 Dollars)	**$ 12,185,362**	**$ 8,423,768**	**$ 14,033,294**	**$ 13,531,762**	**$ 9,770,168**

Table 7-6
Alternative 1 – Exclusive Commuter Rail O&M Costs

Cost Item	Unit Cost (2003 dollars)	Unit of Service (annual)	Line Item
Train Operations			
Train Crew	$40.00 /Hour	14,820 Train Hours	$592,800
Propulsion	$2.00 /Train Mile	289,380 Train Miles	$578,760
Train Maintenance			
Locomotives	$3.40 /Loco Mile	289,380 Loco Miles	$983,892
Coaches	$2.60 /Car Mile	1,447,160 Car Miles	$3,762,616
Maintenance of Way			
Track, Signal & Communications	$68,000 /Track Mile	28.3 Track Mile	$1,924,400
Transit Center Operations & Maintenance			
Cleaning, Maintenance, TVM Servicing, Utilities	$106,000 /Transit Center	8 Transit Centers	$848,000
System Security (Officers, Patrols Car O&M)	$183,000 /Transit Center	8 Transit Centers	$1,464,000
Administration			$2,030,894
TOTAL O&M COST			$12,185,362

Table 7-7
Alternative 2– Exclusive DMU O&M Costs

Cost Item	Unit Cost (2003 dollars)	Unit of Service (annual)	Line Item Cost
Train Operations			
Train Crew	$40.00 /Hour	14,820 Train Hours	$592,800
Propulsion	$1.19 Train Miles	289,380 Train Miles	$344,362
Train Maintenance			
DMU Vehicle	$3.19 / Car Mile	578,760 Car Miles	$1,846,244
Maintenance of Way			
Track, Signal & Communications	$68,000 /Track Mile	28.3 Track Mile	$1,924,400
Transit Center Operations & Maintenance			
Cleaning, Maintenance, TVM Servicing, Utilities	$106,000 / Transit Center	8 Transit Centers	$848,000
System Security (Officers, Patrols Car O&M)	$183,000 / Transit Center	8 Transit Centers	$1,464,000
Administration			$1,403,961
TOTAL O&M COST			**$8,423,768**

Table 7-8
Alternative 3 – Exclusive LRT O&M Costs

Cost Item	Unit Cost (2003 dollars)	Unit of Service (annual)	Line Item Cost
Train Operations			
Train Crew	$40.00 /Hour	20,540 Train Hours	$821,600
Propulsion	$1.40 /Car Mile	1,736,280 Car Mile	$2,430,792
Train Maintenance			
LRT Vehicle Cleaning	$5,300 /Vehicle	16 Vehicles	$84,800
LRT Vehicle Maintenance	$1.50 /Car Mile	1,736,280 Car Mile	$2,604,420
Maintenance of Way			
Track, Signal & Communications, Catenary	$68,000 / Track Mile	51 Track Miles	$3,440,800
Transit Center Operations & Maintenance			
Cleaning, Maintenance, TVM Servicing, Utilities	$106,000 / Transit	8 Transit Centers	$848,000
System Security (Officers, Patrols Car O&M)	$183,000 / Transit	8 Transit Centers	$1,464,000
Administration			$2,338,882
TOTAL O&M COST			**$14,033,294**

Table 7-9
Alternative 4 – Shared Commuter Rail O&M Costs

Cost Item	Unit Cost (2003 dollars)	Unit of Service (annual)	Line Item
Train Operations			
Train Crew	$40.00 /Hour	14,820 Train Hours	$592,800
Propulsion	$2.00 /Train Mile	289,380 Train Miles	$578,760
Train Maintenance			
Locomotives	$3.40 /Train Mile	289,380 Train Miles	$983,892
Coaches	$2.60 /Car Mile	1,447,160 Car Miles	$3,762,616
Maintenance of Way			
Track, Signal & Communications	$68,000 /Track Mile	45 Track Miles	$3,046,400
Transit Center Operations & Maintenance			
Cleaning, Maintenance, TVM Servicing, Utilities	$106,000 /Transit Center	8 Transit Centers	$848,000
System Security (Officers, Patrols Car O&M)	$183,000 /Transit Center	8 Transit Centers	$1,464,000
Administration			$2,255,294
TOTAL O&M COST			**$13,531,762**

Table 7-10
Alternative 5 – Shared DMU O&M Costs

Cost Item	Unit Cost (2003 dollars)	Unit of Service (annual)	Line Item Cost
Train Operations			
Train Crew	$40.00 / Hour	14,820 Train Hours	$592,800
Propulsion	$1.19 Train Miles	289,380 Train Miles	$344,362
Train Maintenance			
DMU Vehicle	$3.19 /Car Mile	578,760 / Car Mile	$1,846,244
Maintenance of Way			
Track, Signal & Communications	$68,000 /Track Mile	45 Track Mile	$3,046,400
Transit Center Operations & Maintenance			
Cleaning, Maintenance, TVM Servicing, Utilities	$106,000 /Transit	8 Transit Centers	$848,000
System Security (Officers, Patrols Car O&M)	$183,000 /Transit	8 Transit Centers	$1,464,000
Administration			$1,628,361
TOTAL O&M COST			**$9,770,168**

8. ENVIRONMENTAL SCREENING

This section of the report identifies some of the environmental issues that will require more detailed information gathering and analysis should any of the alternatives under study advance into the next phase of study. During that next phase, an Environmental Assessment (EA) or Environmental Impact Statement (EIS) would be required. In addition, should any federal dollars be pursued for the service, the Federal Transit Administration (FTA) requires a detailed analysis of transportation, environmental and economic benefits and impacts as part of its preparation of the "New Starts" package prior to requesting preliminary engineering funding from the FTA. The follow section summarizes environmental conditions and identifies environmental topic areas for future study.

8.1 Land Use

8.1.1 Overview of Study Corridor

Land-use patterns within the 25-mile corridor from the City of Houston to Rosenberg consist of various degrees of development, from dense established residential, retail and commercial areas (downtown Rosenberg, Westbury neighborhood of Houston), to new suburban housing, commercial and retail developments (Sugar Land, Stafford, Missouri City), to undeveloped large-scale agricultural and ranching areas (surrounding areas of Rosenberg and Richmond) (Figures 8-1 and 8-2). Land-use types vary from light industrial and commercial along major arterials to residential areas located throughout the corridor. Between Loop 610 and Missouri City, land use is primarily commercial. Beginning in Missouri City and extending through Sugar Land, and in the cities of Richmond and Rosenberg, there are residential and light commercial uses. The land between Sugar Land and the cities of Richmond and Rosenberg is primarily used for agricultural and ranching.[1] Both Brazos Bend State Park and the country's largest public observatory – George Observatory - are also located within close proximity to many of the communities along the Fort Bend segment of the study corridor.

Over the past decade, many of the communities located along the study corridor, particularly those located in Fort Bend County, have experienced some of the highest rates of population and employment growth, not just within the study corridor and Houston Metropolitan area, but throughout the entire United States. Over the next 20 years, this pattern of rapid growth is expected to continue in Fort Bend County, emanating in a westward direction from Sugar Land toward Rosenberg, while underutilized parcels of land in more mature urbanized neighborhoods, such as the City of Houston and Missouri City, are likely to experience new development and continued redevelopment activities.

8.1.2 Study Corridor Community Profiles

Rosenberg

Rosenberg is located on U.S. 90A and U.S. 59 in central Fort Bend County, approximately 28 miles southwest of downtown Houston. Rosenberg consists of a historic downtown district that contains a dense mixture of residential, commercial and retail land uses, surrounded by vast tracts of open space - agricultural and grazing land. The Rosenberg area produces livestock, cotton, rice, sugar, sorghum, pecans, feed and some vegetables. A strong mineral and petroleum industry in Rosenberg produces petroleum, sulfur, natural gas and its derivatives-salt, clay, sand and gravel.[2]

[1] Houston-Galveston Area Council, *2022 Metropolitan Transportation Plan, Appendix C – Corridor and Sub-area Summaries*, March 22, 2002, page C-27.

[2] The General Libraries at the University of Texas at Austin and the Texas State Historical Association, *Handbook of Texas Online*, www.tsha.utexas.edu/handbook/online/articles/view/RR/her2.html, January 2, 2003.

Over the next 20 years, it is expected that the vast open space tracts of agricultural and ranch land will experience some form of residential, commercial, light industrial and retail development. Development pressure will become more and more pronounced once the construction of the West Park Tollway to Grand Parkway (also known as State Highway 99) is completed, thus enabling the traveling public to obtain a faster and more convenient way to reach Rosenberg. This will especially be the case if the West Park Tollway is expanded toward the Rosenberg.

Richmond

Richmond is the county seat of Fort Bend County, approximately 26 miles southwest of downtown Houston. Richmond is located on the Brazos River and U.S. 90A and U.S. 59. Similar in character to Rosenberg, but on a much smaller scale of development, Richmond is characterized as having a small historic downtown consisting of residential, commercial and retail establishments, surrounded by numerous agricultural and ranch lands.

Richmond experienced rapid development from the 1950s through the 1980s. As is the case with Rosenberg, increasing development of agricultural and ranch open space is expected in the future in Richmond, once the construction of the West Park Tollway is completed to the Grand Parkway, and possibly expanded toward Richmond.

Figure 8-1
Land Use

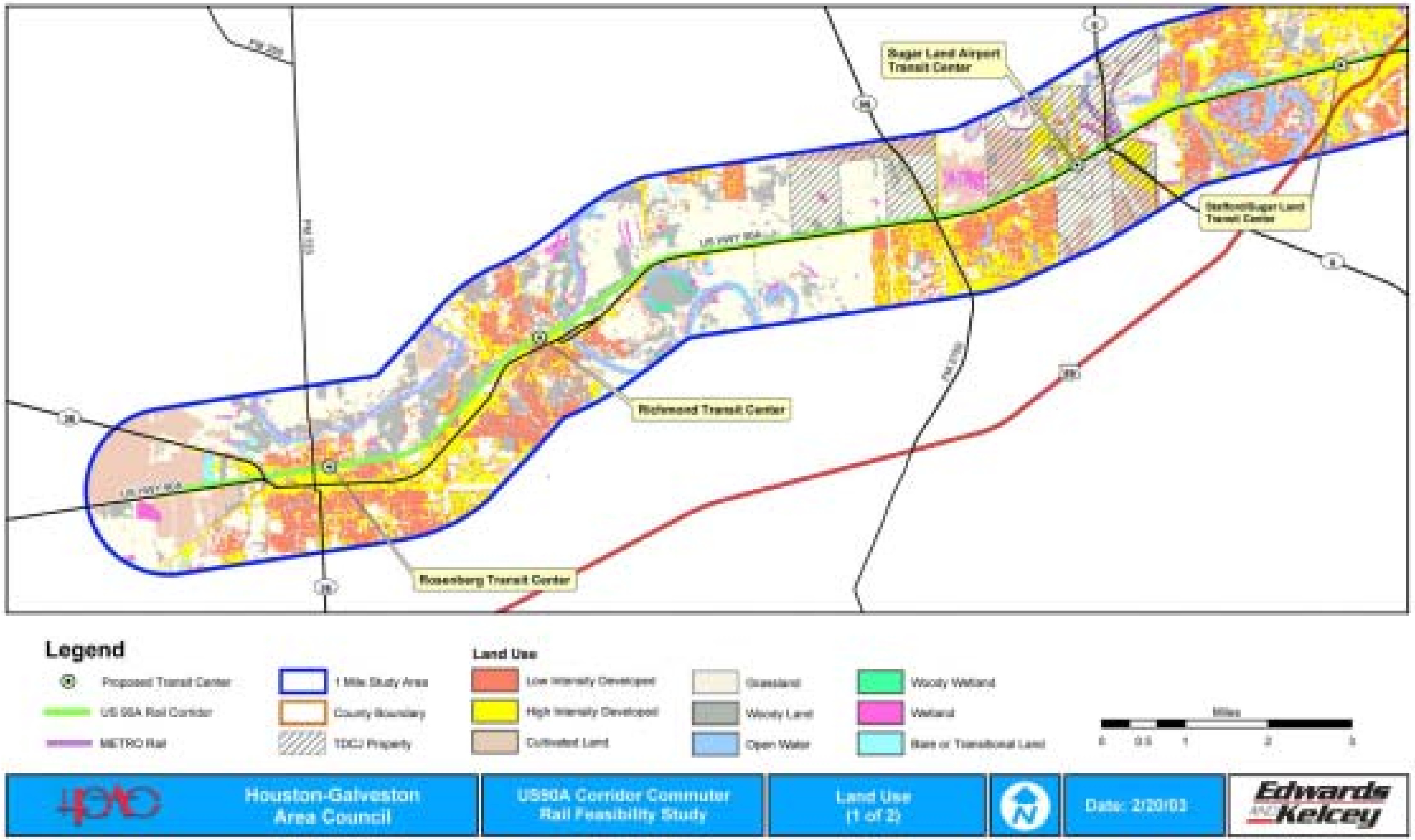
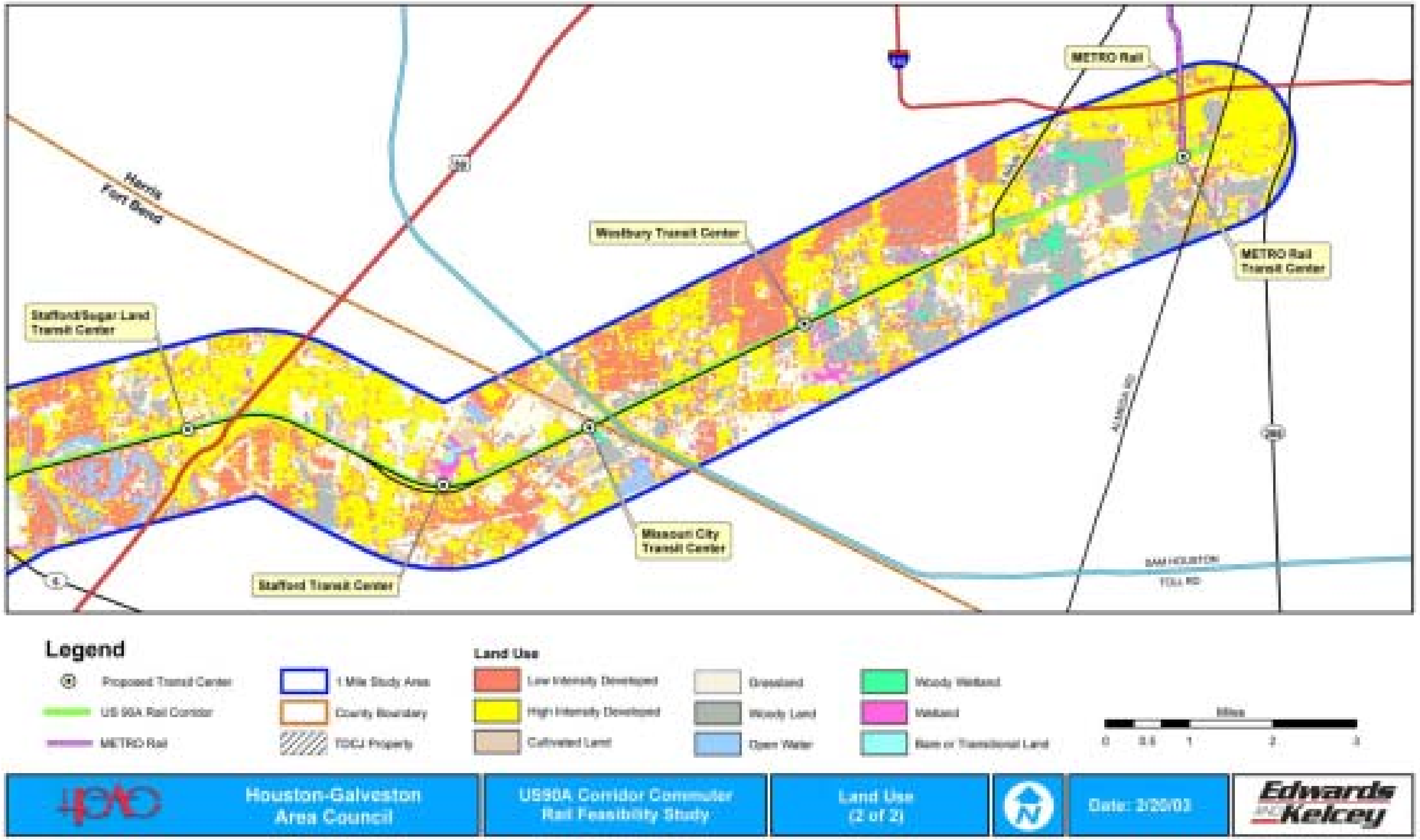


Figure 8-2
Land Use (continued)



Sugar Land

Sugar Land is located in Fort Bend County off of U.S. 90A and U.S. 59, and SH 6, approximately 20 miles southwest of downtown Houston. According to the 2000 Census, Sugar Land was not only the fastest growing community in the Houston metropolitan area, but also the fastest growing community out of the largest 45 cities in the State of Texas. As is the case with many of the Fort Bend County communities within the study corridor, this suburban municipality contains many large-scale master planned communities, such as Avalon, First Colony, Hall Lake, Sugar Lakes, Sugar Mill, and Venetian Estates. Many of these developments contain amenities such as public/private golf courses, retail and commercial stores, community parks, tennis courts, playgrounds and pools.

One of the most highly anticipated developments in Sugar Land is the construction of the Town Square project, located due south and west of the intersection of U.S. 59 and SH 6. Town Square is a 32-acre mixed-use, pedestrian-oriented development modeled after successfully developed mixed-used communities like the Reston Town Center in Virginia. Town Square will contain 200,000 square feet of retail space, 750,000 square feet of Class A office space, 300-room Marriott Hotel, Conference Center, apartments and a new Sugar Land City Hall. Once completed, this mixed-use development is expected to serve as the new downtown for Sugar Land and Fort Bend County.

The Sugar Land Regional Airport is a vital component of the local community. This airport is the fourth largest facility in the greater Houston metropolitan area and the only general reliever airport in the southwest sector. Many corporate business jets utilize the airports 100-foot wide by 8,000-foot long runway. Some of the recently completed infrastructure improvement projects include: air traffic control tower and radar system, corporate hangar/office facility, Western Airways Hangar and new runway lights. In addition, 62 acres of land were recently acquired for a new general aviation center.

Meadows Place

Meadows Place is located off U.S. 59 in northeastern Fort Bend County, approximately 20 miles southwest of downtown Houston. The city began as the Meadows Municipal Utility District, which was established in 1967, and the first homes were constructed in 1968. In order to avoid annexation by Houston, Meadows Place incorporated on November 14, 1983. In the 1990s Meadows Place had a number of stores and a theater located in a large shopping center.[3] Today, much of this small municipality is built out and it is not expected to grow any larger in the near future.

Stafford

Stafford is on Farm Road 1092 and the boundary between Fort Bend and Harris counties, just north of the junction of U.S. 90A and U.S. 59, approximately 19 miles southwest of downtown Houston. Like many municipalities in close proximity to the City of Houston, Stafford has experienced rapid development since the 1960s and was considered to be suburban in character by the 1980s with many of its residents commuting to jobs in Houston.[4] Stafford has a diverse economy, with a significant amount of light manufacturing complexes located throughout the community. One of the more anticipated openings in Stafford will be the Stafford Center convention center and performing arts theater. This facility will consist of a 50,000-square-foot convention center (20,000-square-foot ballroom and up to six meeting rooms) and a 40,000-square-foot theater containing (1,100 permanent seats, a large stage, orchestra pit and other amenities).

Missouri City

Missouri City is located off of U.S. 90A and SH 6, and is primarily in Fort Bend County, with a small section located in Harris County, approximately 17 miles southwest of downtown Houston. Roughly half the land of Missouri City has been zoned for residential use, with the single-family home the predominate type of residence inhabited by its residents. Missouri City has never had a commercial or industrial base large enough to support the local population. Most of the income earned by the residents had traditionally been from ranching and farming. As of 1989, most of the commercial development contained retail stores. The medical segment of the service industry is also very important to the local community, as is the local petrochemical industry, which produces compression and drilling products.[5]

One of the ways in which Missouri City balances its growth and development is through the application of municipal zoning, and planning rules and regulations. In the late 1980s, the City Council and Planning and Zoning Commission of Missouri City established a comprehensive planning process to develop a 30-year (1990 to 2020) comprehensive plan. The end result was the preparation of "The Comprehensive Plan For The City of Missouri City," released in 1990. The actual development of the plan was done by a steering committee that sought to clarify and achieve the proper balance of development by developing several goals, objectives and strategies.

One of several Missouri City Comprehensive Plan goal topics linked to improving transportation mobility was to provide support for "evaluating the feasibility and inter-connectivity of rail and transit with other forms of

[3] The General Libraries at the University of Texas at Austin and the Texas State Historical Association, *Handbook of Texas Online*, www.tsha.utexas.edu/handbook/online/articles/view/MM/hlmkv.html, January 2, 2003.
[4] Ibid
[5] Ibid

transportation throughout the region." Other items stressed the "need to improve local, state and federal roadways, develop multi-modal transportation systems, and to work in a cooperative way with other adjacent cities, the County, H-GAC and other agencies to address regional transportation, air and water quality, and other federal mandates." [6] At the time of this study the original Comprehensive Plan was is in the process of being updated.

Westbury (Houston)

The Westbury neighborhood of Houston is located in Harris County, approximately 12 miles southwest of downtown Houston. The Westbury neighborhood can best be described as a well-established, mixed-use community, consisting of urban - and suburban – style, single - and multi-family - residences, and commercial, industrial, park and vacant land uses. During the 1950s and 1960s, much of the housing stock in this neighborhood was constructed around the Westbury Square shopping district, which was one of the main attractions to the area. [7]

Westbury has the advantage of excellent access to numerous roadways (South Main, Beltway 8, freeways, city roadways) enabling area residents, employees and visitors to reach various major destinations within the City of Houston in a relatively short period of time. It is anticipated that over the next few years, Westbury will grow by another seven percent growth. To facilitate this growth and update the existing facilities, many of the community facilities are undergoing renovation, including the Westbury High School.[8]

[6] City of Missouri City Planning Department, *The Comprehensive Plan for the City of Missouri City,* August 1990.
[7] City of Houston Department of Planning and Development, *Super Neighborhood Resource Assessment,* February 1999, page 1.
[8] Greater Southwest Houston Chamber of Commerce, *Profile of Communities*, www.gswhcc.org/westbury.asp, December 10, 2002.

METRORail (Houston)

The METRORail light rail terminus at the Fannin South Park & Ride Station, located about seven miles from downtown Houston, off of Holmes Road and Fannin Street, began operating January 2004. The surrounding neighborhood in the vicinity of this station primarily consists of commercial, industrial, institutional and vacant land uses.

Reliant Park is a major trip generator to this neighborhood and is expected to draw millions of visitors a year to its numerous entertainment and convention center facilities. Reliant Park includes Reliant Stadium, Reliant Astrodome, Reliant Arena, Reliant Hall and Reliant Center. Currently, more than 2.1 million square feet of exhibition space exists at Reliant Park, with additional space available to possibly expand these facilities if the future demand justifies the need.

8.2 Demographics

8.2.1 Population

Data obtained from the 1990 U.S. Census and the 2000 U.S. Census shows that over the past decade, the population of the Houston-Galveston eight-county region has increased by 25 percent, representing almost one-quarter of the total population growth in Texas.[9] At the county level of analysis, the population of Fort Bend County increased more than twice the rate of the H-GAC eight-county region, 57 percent compared to 25 percent, respectively (Table 8-1).

Table 8-1
Fort Bend County, Harris County and Houston-Galveston 8-County Region
Population, 1990 to 2000

Study Area	1990	2000	Percent Change
Fort Bend County	225,421	354,452	57%
Harris County	2,818,199	3,400,578	21%
Houston-Galveston 8-County Region	3,731,131	4,669,571	25%

Source: 1990 and 2000 US Census

During the 1990s, the study corridor population increased by 26 percent and grew to nearly 390,000 people by the year 2000 (Table 8-2). Forty-four percent (44 percent) of the study corridor population was in Fort Bend County and 56 percent in the City of Houston. However, the population growth throughout the study corridor was not evenly distributed. From 1990 to 2000 the population of the study corridor segment in Fort Bend County increased by 66 percent, compared to 6 percent in the City of Houston.

[9] The Houston-Galveston eight-county region consists of the following counties: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery and Waller.

When comparing the percent change of population along the study corridor segments to their respective Counties (Harris and Fort Bend), it is apparent that the rates of growth did not always occur in the same direction. From 1990 to 2000 the population of the Fort Bend County segment of the study corridor grew more rapidly at 66 percent than Fort Bend County at 57 percent. The opposite situation occurred in Harris County; the percentage change of population in the City of Houston segment of the study corridor increased by 6 percent, compared to Harris County's population increase of 21 percent.

Table 8-2
Study Corridor Population, 1990 To 2000

Study Area	1990	2000	Percent Change
Fort Bend County	103,692	171,958	65.84%
Houston	205,080	217,677	6.14%
TOTAL	308,772	389,635	26.19%

Source: 1990 and 2000 U.S. Census

In the 1990s, a slight majority of the population growth in Fort Bend County occurred within the communities located in the study corridor. From 1990 to 2000, more than 53 percent of the population growth in Fort Bend County was concentrated in the incorporated Fort Bend County study corridor communities located adjacent to U.S. 90A. The Fort Bend County communities of Sugar Land, Stafford and Missouri City had the greatest percentage change in population from 1990 to 2000, increasing by 158 percent, 87 percent and 46 percent, respectively (Table 8-3). In fact, during the 1990s, Sugar Land had the second largest percent change in population growth throughout Texas.

Table 8-3
Fort Bend County Study Area Population, 1990 To 2000

Study Area	1990	2000	Percent Change
Rosenberg	20,183	24,043	19%
Richmond	9,801	11,081	13%
Sugar Land	24,529	63,328	158%
Stafford	8,397	15,681	87%
Missouri City	36,176	52,913	46%
Meadows Place	4,606	4,912	7%
TOTAL	103,692	171,958	66%

Source: 1990 and 2000 U.S. Census

Within the City of Houston segment of the study corridor, the population did not grow as rapidly as it did within Harris County, 6 percent compared to 21 percent, nor was population growth evenly distributed. The population of the Houston neighborhoods of Fondren Gardens and Fort Bend/Houston increased at a faster rate than Harris County, 30 percent and 23 percent, versus 21 percent, respectively, whereas the Greater Fondren South West and Sunnyside neighborhoods experienced a decline in population (Table 8-4).

Table 8-4
Houston Study Area Population, 1990 To 2000

Study Area	1990	2000	Percent Change
Greater Fondren S.W.	54,022	49,436	-8.49%
Fort Bend / Houston	26,673	32,867	23.22
Fondren Gardens	1,717	2,229	29.82%
Westbury	18,631	22,090	18.57%
Central Southwest	36,596	41,820	14.27%
Willow Meadows/Willowbend	11,302	12,402	9.73%
South Main	4,642	4,849	4.46%
Astrodome Area	13,039	13,832	6.08%
Sunnyside	19,092	18,629	-2.43%
OST / South Union	19,366	19,523	0.81%
TOTAL	205,080	217,677	6.14%

Source: City of Houston, Super Neighborhood resource assessment profiles, April 2003

As was shown on the land-use map, there is a decreasing intensity of development along the study corridor emanating outward in a southwest direction from the City of Houston, in the east, to the City of Rosenberg, in the west. Data compiled from the 2000 U.S. Census and the City of Houston Department of Planning and Development shows that the 153-square-mile study corridor has a population density of 2,547 people per square mile. The City of Houston segment of the study corridor has a higher population density at 3,376 persons per square mile compared to the Fort Bend County segment of the study corridor, which has a population density of 1,944 people per square mile. The range of population densities within the Fort Bend County study corridor varied from a high of 5,226 people per square mile in Meadows Place to 1,131 people per square mile in Rosenberg (Table 8-5). Within the City of Houston study corridor, population densities ranged from 6,250 people per square mile in Greater Fondren South West to 1,732 people per square mile in South Main (Table 8-6).

Table 8-5
Fort Bend County Study Corridor
Area And Population Density, 2000

Study Area	Area (Square Miles)	Density (People Per Square Mile)
Rosenberg	21.26	1,131
Richmond	3.94	2,812
Sugar Land	24.92	2,541
Stafford	6.98	2,247
Missouri City	30.41	1,740
Meadows Place	0.94	5,226
TOTAL / AVERAGE	88.45	1,944

Source: 2000 U.S. Census

Table 8-6
Houston Study Corridor
Area And Population Density, 2000

Study Area	Area (Square Miles)	Density (People Per Square Mile)
Greater Fondren S.W.	7.91	6,250
Fort Bend / Houston	7.54	4,359
Fondren Gardens	1.22	1,827
Westbury	3.7	5,970
Central Southwest	23.75	1,761
Willow Meadows/Willowbend	3.19	3,888
South Main	2.8	1,732
Astrodome Area	3.76	3,679
Sunnyside	6.3	2,957
OST / South Union	4.3	4,540
TOTAL / AVERAGE	64.47	3,376

Source: 2000 U.S. Census

8.2.2 Households

The percentage change in households from 1990 to 2000 was relatively similar to the percentage change in population (Table 8-7, Table 8-8, Table 8-9). The greatest difference in the percentage change of population and households occurred in the Greater Fondren South West neighborhood of Houston, which experienced a 17 percent decline in the number of households and an 8 percent decline in population (Table 8-10).

Table 8-7
Fort Bend County, Harris County And Houston-Galveston 8-County Region
Households, 1990 to 2000

Study Area	1990	2000	Percent Change
Fort Bend County	70,424	110,915	58%
Harris County	1,026,448	1,205,516	17%
Houston-Galveston 8-County Region	1,338,775	1,639,401	22%

Source: 1990 and 2000 U.S. Census

Table 8-8
Study Corridor Households, 1990 To 2000

Study Corridor	1990	2000	Percent Change
Fort Bend County	33,888	56,393	66%
Houston	75,007	77,668	4%
TOTAL	108,895	134,061	23%

Source: 1990 and 2000 U.S. Census

Table 8-9
Fort Bend County Study Corridor Households, 1990 to 2000

Study Area	1990	2000	Percent Change
Rosenberg	6,804	7,933	17%
Richmond	3,077	3,413	11%
Sugar Land	8,100	20,515	153%
Stafford	2,909	5,865	102%
Missouri City	11,544	17,069	48%
Meadows Place	1,454	1,598	10%
TOTAL	33,888	56,393	66%

Source: 1990 and 2000 U.S. Census

Table 8-10
Houston Study Corridor Households, 1990 to 2000

Study Area	1990	2000	Percent Change
Greater Fondren S.W.	21,584	17,859	-17%
Fort Bend / Houston	7,892	9,595	22%
Fondren Gardens	540	646	20%
Westbury	6,824	7,846	15%
Central Southwest	10,582	12,231	16%
Willow Meadows/Willowbend	4,566	5,165	13%
South Main	2,628	2,573	-2%
Astrodome Area	6,966	7,878	13%
Sunnyside	6,658	6,839	3%
OST / South Union	6,767	7,036	4%
TOTAL	75,007	77,668	4%

Source: City of Houston Department of Planning and Development, Super Neighborhood resource assessment profiles, April 2003.

8.2.3 Income

Annual median household incomes varied from community to community (Table 8-11). Incomes were higher in the Fort Bend County communities studied compared to those in Harris County. Median household incomes in some Fort Bend County communities were as much as 50 percent greater than the communities in Harris County (City of Houston). According to the 2000 U.S. Census, the 1999 annual median household income in the Fort Bend County study corridor varied from the mid-$30,000 range in the cities of Rosenberg and Richmond to the low-$80,000 range in Sugar Land. In the City of Houston segment of the study corridor, annual median household incomes varied from the low $20,000 range in the neighborhoods of OST/South Union and Sunnyside to the mid-$40,000 range in Willow Meadows/Willowbend Area and Fort Bend/Houston. Refer to Figure 8-3 for a graphical depiction of the study corridor 1999 median household incomes.

Table 8-11
Median Household Income, 1999

Study Area	Median Household Income ($)
Fort Bend County	64,000
Harris County	43,000
City of Houston	37,000
Meadows Place	73,000
Missouri City	72,000
Stafford	50,000
Sugar Land	82,000
Richmond	35,000
Rosenberg	36,000
Greater Fondren S.W.	36,000
Fort Bend / Houston	44,000
Fondren Gardens	26,000
Westbury	40,000
Central Southwest	40,000
Willow Meadows/ Willowbend Area	47,000
South Main	25,000
Astrodome Area	31,000
Sunnyside	20,000
OST / South Union	21,000

Source: 2000 U.S. Census

8.2.4 Housing Values

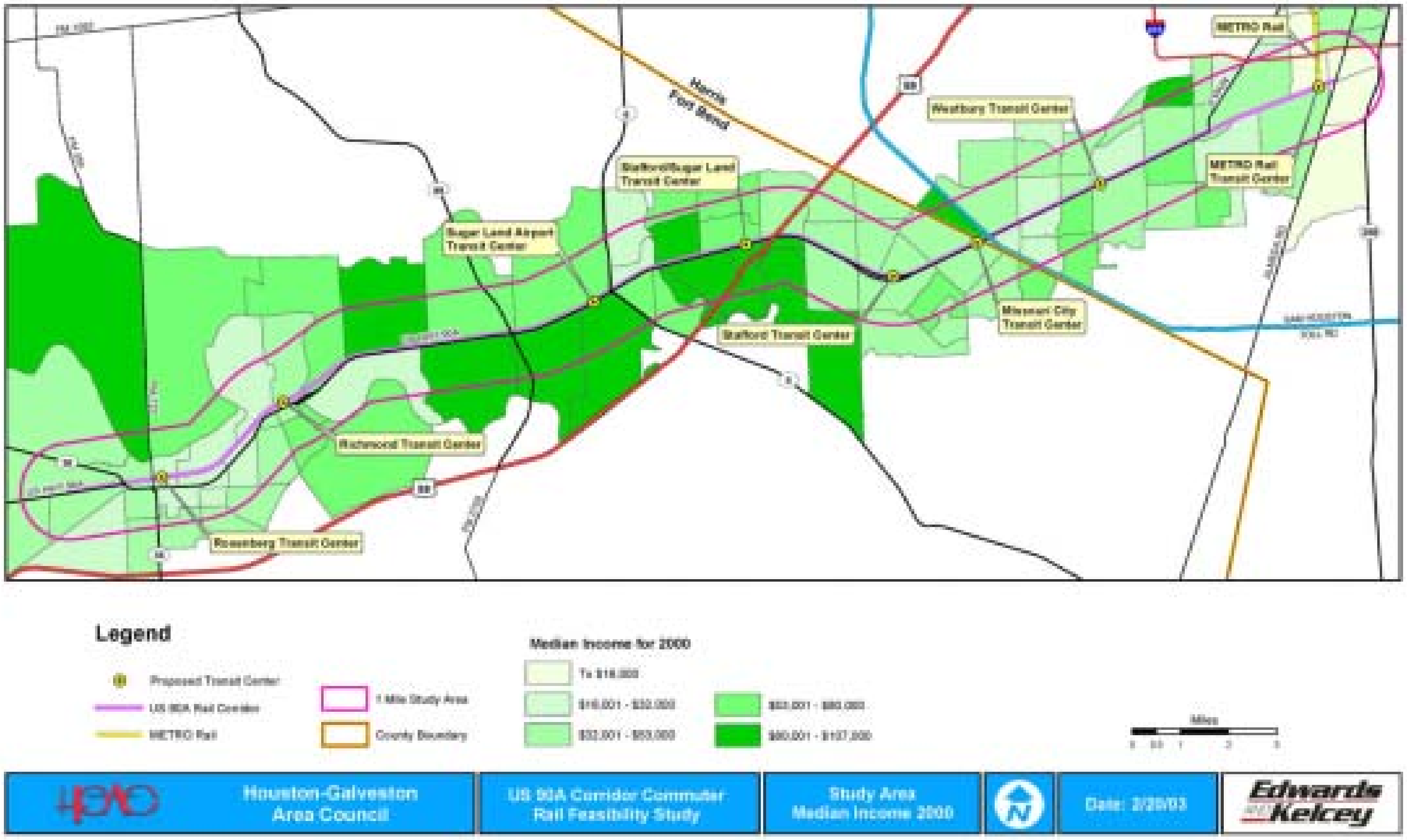
The Houston metropolitan region of Texas continues to provide a broad range of housing values to meet the diverse needs of its population. Median housing values in the communities studied mirrored the respective median household income of the communities themselves (i.e. both the $158,000 median home value and $82,000 median household income in Sugar Land are higher than the respective study corridor medians). According to the 2000 U.S. Census, the median home value in Fort Bend County was $111,000, Harris County was $84,000 and City of Houston was $79,000. Within the Fort Bend County segment of the study corridor, median home values ranged from $68,000 in Rosenberg to $158,000 in Sugar Land (Table 8-12).

Table 8-12
Median Home Values, 2000

Study Area	Median Home Value ($)
Fort Bend County	111,000
Harris County	84,000
City of Houston	79,000
Meadows Place	99,000
Missouri City	112,000
Stafford	100,000
Sugar Land	158,000
Richmond	79,000
Rosenberg	68,000

Source: 2000 U.S. Census

Figure 8-3
Median Household Incomes



8.2.5 Home Ownership Patterns

The 2000 U.S. Census data shows that the percentage of owner-occupied housing along the study corridor varies by county and municipality. Fort Bend County has a higher percentage of owner-occupied housing at 81 percent, than Harris County at 55 percent (Table 8-13).

Table 8-13
County Ownership Patterns, 2000

Study Area	% Owner Occupied	% Renter Occupied
Fort Bend County	81%	19%
Harris County	55%	45%

Source: 2000 U.S. Census

Homeownership rates in the study corridor also vary from community to community. The percentage of owner occupied housing in the communities along the Fort Bend County segment of the study corridor varied from 94 percent in Meadows Place to 48 percent in Stafford, with an average of 72 percent (Table 8-14). Within the City of Houston segment of the study corridor, the percentage of owner-occupied housing varied from 79 percent and 75 percent, in Fort Bend/Houston and Central Southwest, respectively, to 8 percent in South Main, with a Houston study corridor average of 48 percent (Table 8-15). When compared to their respective county rates of homeownership, both the Fort Bend County and City of Houston study corridor segments have lower rates of homeowners (Table 8-16).

Table 8-14
Fort Bend County Study Corridor
Ownership Patterns, 2000

Study Area	% Owner Occupied	% Renter Occupied
Rosenberg	57%	43%
Richmond	57%	43%
Sugar Land	84%	16%
Stafford	47.5%	52.5%
Missouri City	91%	9%
Meadows Place	94%	6%
AVERAGE	72%	28%

Source: 2000 U.S. Census

Table 8-15
Houston Study Corridor
Ownership Patterns, 2000

Study Area	% Owner Occupied	% Renter Occupied
Greater Fondren S.W.	36%	64%
Fort Bend / Houston	79%	21%
Fondren Gardens	38%	62%
Westbury	60%	40%
Central Southwest	75%	25%
Willow Meadows / Willowbend Area	55%	45%
South Main	8%	92%
Astrodome Area	18%	82%
Sunnyside	54%	46%
OST / South Union	53%	47%
AVERAGE	48%	52%

Source: City of Houston Planning and Development Dept.

Table 8-16
Ownership Patterns, 2000

Study Area	Owner Occupied	Renter Occupied
Fort Bend County - Total	81%	19%
Fort Bend County -Study Corridor	72%	28%
Harris County – Total	55%	45%
City of Houston - Study Corridor	48%	52%

Source: 2000 U.S. Census

8.2.6 Employment

The Houston-Galveston eight-county region's economic growth and productivity has increased more than 4 percent a year over the last 30 years, tripling since 1970. In fact, the Houston-Galveston region accounts for 23 percent of the state's employment. From 1990 to 2000 the number of employees in the eight-county region increased by 31 percent, from 1,810,000 to 2,373,000 (Table 8-17). During this same period of time, the number of employees working in Harris County increased by 27 percent, from 1,538,000 to 1,950,000. The number of employees in Fort Bend County increased by 120 percent, from 50,000 to 110,000. These figures also indicate that most of the Houston Consolidated Metropolitan Statistical Area (CMSA) employment growth took place in Fort Bend and Harris counties. In total, both Fort Bend and Harris counties accounted for 84 percent (472,000) of the Houston CMSAs 563,000 new jobs that were created from 1990 to 2000.

Table 8-17
Employment, 1990 to 2000

Study Area	1990	2000	Percent Change
Fort Bend County	50,214	110,483	120%
Harris County	1,537,833	1,949,749	27%
H-GAC 8 County Region	1,809,856	2,372,593	31%

Source: 1990 and 2000 U.S. Census

8.2.7 Journey to Work

According to the 2000 U.S Census Journey to Work data, 6 percent of City of Houston residents, 4 percent of Harris County residents, and 2 percent of Fort Bend County residents used public transit to travel to work - with 1 percent or less utilizing public transit from the community of Sugar Land westward past Rosenberg (Table 8-18). Within the City of Houston segment of the study corridor, travel by transit to work varied from 0 to 3 percent (Fondren Gardens and Fort Bend/Houston, respectively) to 10 percent – 13 percent (Sunnyside and OST/South Union and South Main, respectively.) In the Fort Bend County segment of the study corridor, transit usage in the study area communities was comparable to the county average.

The 2000 U.S. Census indicates that 32,000 commuters a day travel in a reverse commute direction from Harris County to Fort Bend County, whereas 97,000 commuters a day travel from Fort Bend County to Harris County. The most utilized travel mode to work for many of the study corridor commuters heading to and from work is the automobile, which accounted for 95 percent and 88 percent of the respective journey to work trips by the residents of Fort Bend County and the City of Houston. In Fort Bend County and the City of Houston, 82 percent and 72 percent of the respective residents traveling to work did so alone in their own vehicle, and 13 percent and 16 percent carpooled to work. Carpooling to work was higher than average in Rosenberg and Richmond, compared to the Fort Bend County average. In the Houston study corridor, carpooling to work was higher than the city average in neighborhoods of Fondren Gardens, Greater Fondren Southwest, Westbury and Central Southwest. One neighborhood of particular note is Fondren Gardens where 33 percent of work trips were made by carpooling.

Table 8-18
Study Area Journey To Work, 2000

Study Area	SOV [1]	Carpool	Public Transit	Walked	Worked at Home	Other	Avg. Time to Work (Min.)
Fort Bend County	82%	13%	2%	< 1%	3%	< 1%	32
Harris County	76%	15%	4%	2%	2%	1%	28
City of Houston	72%	16%	6%	2%	2%	2%	27
Meadows Place	86%	10%	2%	< 1%	1%	0%	26
Missouri City	84%	11%	2%	< 1%	2%	< 1%	32
Stafford	82%	13%	2%	< 1%	2%	< 1%	27
Sugar Land	84%	9%	1%	< 1%	4%	< 1%	30
Richmond	71%	22%	< 1%	3%	1%	2%	27
Rosenberg	76%	20%	< 1%	< 1%	1%	2%	27
Greater Fondren S.W.	67%	21%	7%	1%	3%	1%	-
Fort Bend / Houston	81%	13%	3%	1%	1%	1%	-
Fondren Gardens	61%	33%	0%	3%	3%	0%	-
Westbury	69%	20%	6%	2%	1%	1%	-
Central Southwest	72%	19%	6%	<1%	1%	1%	-
Willow Meadows/Willowbend	76%	13%	7%	1%	3%	1%	-
South Main	73%	10%	13%	2%	<1%	2%	-
Astrodome Area	74%	12%	8%	2%	1%	3%	-
Sunnyside	66%	14%	13%	3%	3%	1%	-
OST / South Union	68%	16%	10%	2%	2%	2%	-

Source: 2000 U.S. Census
[1] SOV is an abbreviation for single occupancy vehicle

8.2.8 Future Growth and Conditions

The 1999 to 2025 H-GAC demographic forecast completed in 1999 was utilized to show future population, household and employment growth projections. The production of this forecast involved three primary steps: 1) the generation of regional control totals for population and employment, 2) the allocation of population to the Regional Analysis Zone (RAZ) level, and 3) the allocation of employment to the RAZ level.

H-GAC forecasts for the year 2025 projects that the eight-county Houston-Galveston region will be home to nearly 6.5 million residents with an employment base exceeding 3.1 million people (Tables 8-19 and 8-20). Figures 8-4 and 8-5 show a snapshot of the year 2000 population and employment, and the 2025 forecast. The forecast predicts that Fort Bend County will continue to have one of the highest population, household and employment growth rates within the eight-county Houston-Galveston region. From 2000 to 2025, the Fort Bend County population is projected to grow to 650,000 (an increase of 83 percent), households are projected to grow 231,000 (an increase of 108 percent), and employment is projected to grow to 193,000 (an increase of 74 percent). This would mean that 296,000 more people would be residing in Fort Bend County, resulting in 120,000 additional households and the generation of 82,000 more jobs. Although Harris County was not forecasted to have as robust a growth rate as Fort Bend County, it will still continue to be the economic engine driving growth throughout the entire eight-county region. Over a half-million more jobs are projected to be created in Harris County by 2025. The 2025 forecast also estimates that Harris County's population will grow to 4,339,000, households will grow to 1,745,000 and employment will grow to 539,000.

Table 8-19
Population Growth Forecast, 2000 To 2025

Study Area	2000	2025 Projected	Change 2000 to 20025	Percent Change
Fort Bend County	354,452	650,069	295,617	83%
Harris County	3,400,578	4,339,022	938,444	28%
H-GAC 8 County Region	4,670,000	6,464,199	1,794,199	38%

Source: 2000 U.S. Census. H-GAC year 2025 forecast completed in 1999

Table 8-20
Household Growth Forecast, 2000 To 2025

Study Area	2000	2025 Projected	Change 2000 to 2025	Percent Change
Fort Bend County	110,915	230,793	119,878	108%
Harris County	1,205,516	1,744,887	539,371	45%
H-GAC 8 County Region	1,639,401	2,556,252	916,851	56%

Source: 2000 U.S. Census. H-GAC year 2025 forecast completed in 1999

Table 8-21
Employment Forecast, 2000 To 2025

Study Area	2000	2025 Projected	Change 2000 to 2025	Percent Change
Fort Bend County	110,483	192,691	82,208	74%
Harris County	1,949,749	2,461,605	511,856	26%
H-GAC 8 County Region	2,372,593	3,106,671	734,078	31%

Source: 2000 U.S. Census. H-GAC year 2025 forecast completed in

According to the *Southern Houston Study* that was recently produced by the City of Houston Planning and Development Department, there are opportunities for population, household and employment growth in the Holmes Area, which includes the super neighborhoods of Astrodome, South Main, Fondren Gardens, Central Southwest and Sunnyside. The study forecasted that by the year 2020, if improvements were made to the transportation, water and sewer infrastructure, as well as environmental mitigation of contaminated land uses and floodplains, then the forecast made could become a reality. This would mean that the population of these super neighborhoods would grow between 78 percent and 99 percent and employment would grow by 51 percent to 81 percent.

As with the southern section of Houston, the continued growth of Fort Bend County through and beyond 2020 will require additional investments in infrastructure. The construction of thousands of new residential units, an additional 40 million square feet of commercial space, numerous retail centers and improved transportation infrastructure will be necessary to meet the future demand. If the Fort Bend County toll road is extended across the Brazos River, then there will be an enormous amount of land beyond Greatwood that will be open to development. The George Ranch area is also another large area that is subject to development. Substantial growth within Fort Bend County is likely to occur west of the Grand Parkway, once it is connected to the West Park Tollway, and could move the economic center of the county from Sugar Land further west toward Richmond and Rosenberg. In addition, continued improvements to U.S. 59 could have the potential to lead to more development pressure along the Grand Parkway.[1]

[1] Barbara Fulenwider, *The Fort Bend / Southwest STAR*, "Galloping growth still forecast for Fort Bend County," November 30, 2002.

Figure 8-4
Population, 2000-2025

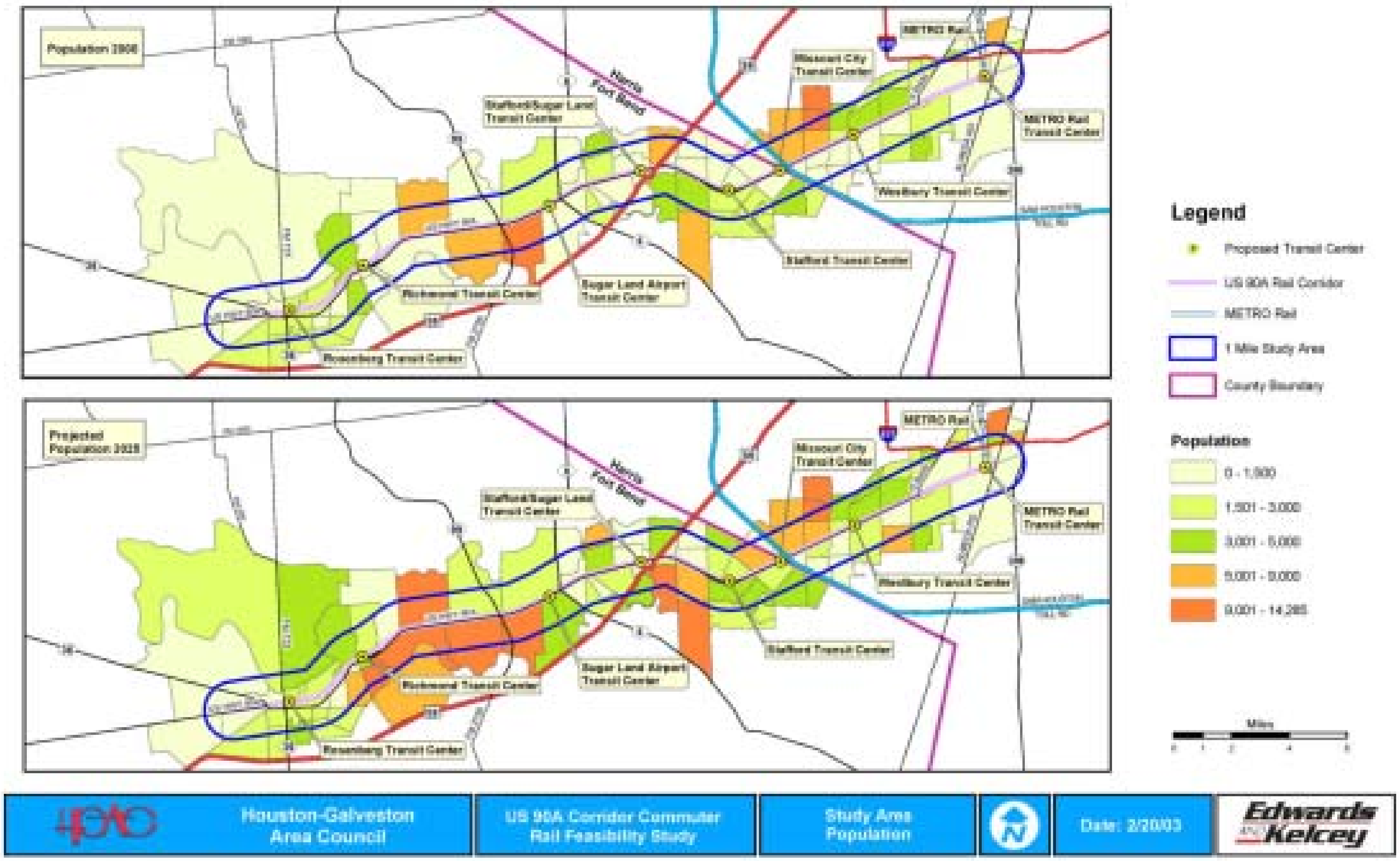
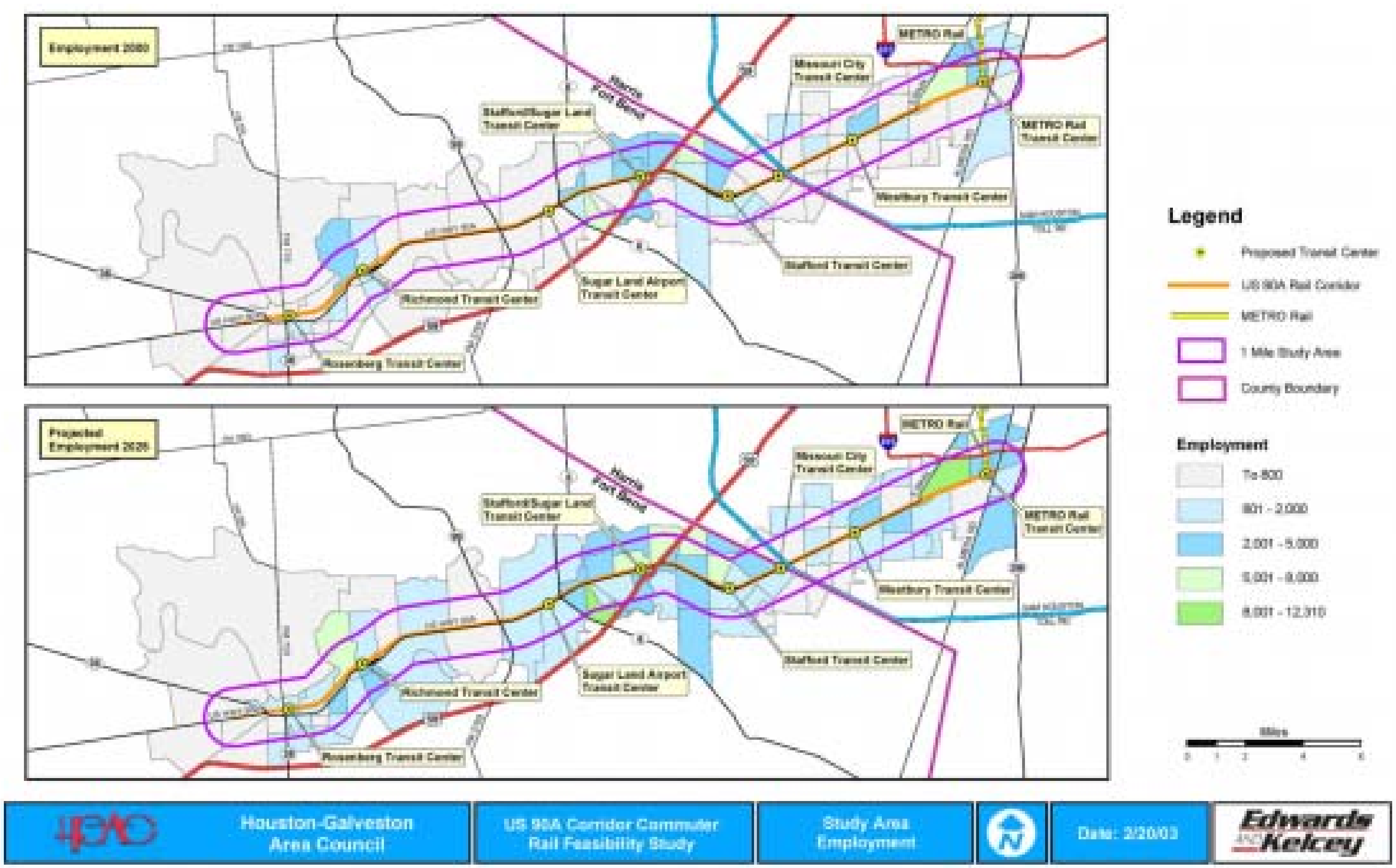


Figure 8-5
Employment, 2000-2025



8.3 Economic Development

The economy of the study area could benefit from transportation improvements, such as the implementation of a new rail service. The categories of such benefits include:

- Regional Accessibility and Attractiveness
- Local Business Enhancement
- Residential Property Values
- Employment

8.3.1 Regionwide Accessibility and Attractiveness

The availability of passenger rail services is a factor that can add to the economic activity attraction and growth of an area. Improved transportation can enable the U.S. 90A study area to better compete for economic activities and attract businesses and residents to the local economy.

Improved rail service has the potential to increase productivity by increasing the pool of workers who live within a reasonable travel vicinity of business centers. Rail also indirectly generates jobs in supporting industries, such as office, retail and hotel establishments. Major firms often look to locate along rail lines to provide their employees with better access. Retail establishments also often desire rail access for patrons. Industrial parks often desire rail accessibility for workers and shipping.

As part of the overall economic goals of Fort Bend and Harris counties, passenger rail services could serve as catalysts to achieve other economic development goals. Rail service could be a significant boost to the economy in terms of further increasing the U.S. 90A corridor's profile and visibility within the region, and enhancing its competitive position statewide.

8.3.2 Local Business Enhancement

Business communities near rail lines often learn quickly that rail is good for local business, increasing gross sales for existing businesses and attracting new businesses. In the areas surrounding stations, opportunities for redevelopment may occur. Particularly in town center areas, new land uses often develop around stations including commercial use and residential use. Many rail systems have also found that spending increases in the areas directly surrounding a rail station. For example, the public transportation agency for the State of New Jersey (NJ TRANSIT) found that each rail user spends approximately $1,800 - $3,000 annually at businesses surrounding a station.

8.3.3 Residential Property Values

The areas served by rail become more attractive places to live, increasing housing and property values, and tax revenues, as well as improving access to jobs, stores, institutions and recreation. Recent research has found that residential values increase in the vicinity of rail stations because of improved accessibility. In New Jersey, residential and commercial real estate in towns with a rail station have an average value that is 10 percent to 30 percent higher, than similar towns without rail stations. These increased values can translate into increased property tax revenues for the municipality.

8.3.4 Employment

Rail employs a significant number of workers during the construction stage. Once implemented, employees are needed to operate and maintain the facilities and equipment. Rail systems purchase materials and services as part of their daily operations, which also create employment.

The construction and operation of a new rail service to Fort Bend County will create jobs through both the impact of the public investment funds and the economic activity those investments will attract. The two categories of impacts from rail service are:

- Direct and indirect impacts from capital expenditures
- Direct and indirect impacts from operating expenditures

Employment impacts from capital expenditures include money spent in the study area for railroad improvements, such as tracks, signal/communications systems, bridge/tunnel reconstruction, stations, parking lots, and yards, has economic value to the region in terms of jobs and wages directly created by capital investment in transportation construction projects (direct - on-site) and for the construction industry suppliers (indirect - off-site).

Employment impacts from operating expenditures include direct effects of mass transit operations, as well as indirect jobs created because of the availability of transit services.

8.4 Land Acquisitions and Displacements

Land acquisition and displacement requirements would be determined in alternatives analysis and conceptual design should any of these alternatives be advanced for further analysis. If land acquisitions are required, the existing characteristics of each property would be identified and documented in an environmental impact statement, including size, shape, ownership, value, assessment, location, use (tax code), number and condition of structures, status as occupied or vacant.

Land would be needed to construct transit centers, parking lots, rail maintenance and storage facility, and other ancillary facilities. Visual- and access-related issues would be experienced in developed areas. Decreases in farmland acreage and open space lands would be the primary issue in rural areas. It is likely that the construction of high capacity transit centers would spur the development of residential and commercial developments in adjacent parcels of land.

Possible locations analyzed in this study that could require land acquisition and displacement of the existing use include:

- Rosenberg Vehicle Storage and Maintenance Facility (Underutilized)
- Rosenberg Transit Center (Vacant)
- Richmond Transit Center (Vacant)
- Sugar Land Airport Station (Vacant)
- Stafford / Sugar Land Station (Vacant)
- Stafford Station (Vacant)
- Missouri City Station (Vacant)
- Westbury Station (Vacant)
- METRORail Station

Most of the land necessary to construct rail alternative-related facilities is vacant or already in rail-related use, which minimizes the likelihood that displacements of businesses or residents would be necessary. A more detailed analysis would be conducted in subsequent studies.

8.5 Transportation

8.5.1 Roadway Network

The eastern part of U.S. 90A in the study corridor is under construction to make it fully grade separated, but not controlled access, at all intersections. The median will have a few widely spaced breaks to allow left turns. All overpasses will have six lanes, and between the overpasses, the roadway will generally have eight lanes. Since the railroad track is on the north side of the right of way, the westbound lanes will effectively be access-controlled since there is no property access over the railroad tracks except in one location that is just west of Hillcroft. The western part of U.S. 90A in the study corridor is typically a four-lane roadway with traffic lights at intersections and curbcuts to access businesses along the roadway.

U.S. 59 is a major arterial roadway through the Houston area that carries approximately 250,000 vehicles per day (vpd) and is one of the primary southwest-northeast routes through Fort Bend and Harris counties. U.S. 59 is being considered as the corridor alignment for the proposed Interstate 69, slated to run between Indianapolis, Indiana, and Laredo, Texas. The U.S. 59 roadway segments in Fort Bend County are currently being expanded from a four-lane divided freeway, with non-contiguous frontage roads, to eight lanes, with two-way high-occupancy vehicle (HOV) lanes and dual three-lane frontage roads along the entire segment. This project stretches four miles from west of SH 6 in Sugar Land to east of FM 2759.

In 1998, the Texas Department of Transportation completed a 28-mile *U.S. 59 Major Investment Study* from SH 6 to the Fort Bend/Wharton County line. Average daily traffic volumes citied on U.S. 59 in Fort Bend County ranged from 20,000 vpd at the Fort Bend/Wharton County line to more than 75,000 vpd at SH 6. Traffic volumes are projected to increase by more than 50,000 vpd at the Wharton County line and approximately 150,000 vpd at SH 6 by the year 2020. This represents traffic volumes that will be nearly three times greater at the Fort Bend/Wharton County line and two times greater at SH 6 compared to those in 1998.[2] The preferred alternative for the major investment study (MIS) consists of a total of four to five general-purpose, single-occupancy vehicle travel lanes and one HOV lane in each direction between FM 762 and the Fort Bend/Wharton County line; and two- to three-lane frontage roads on both sides of U.S. 59 between SH 6 and SH 99.[3] Another planned transportation improvement proposed for U.S. 59 is a 500-space park and ride lot in Sugar Land that is in H-GAC's long-range transportation plan.

The construction of the six-mile, four-lane Fort Bend Parkway Toll Road is under way. Once completed, this divided toll road will extend from the Sam Houston Toll Road South (near Hillcroft) to SH 6 (near Knight Road) and contain major interchanges at Highway 6, Lake Olympia Parkway and FM 2234. This road will eventually parallel U.S. 90A up to Post Oak Road, connecting to Loop 610.

H-GAC forecasted that, by the year 2025, areas of severe congestion will remain on U.S. 90A located near Fondren and Beltway 8, and from U.S. 59 South to just west of SH 99. [4] By the year 2025, traffic on SH 6 will become serious from FM 1093 to Sugar Land, and will increase to severe conditions past Sugar Land.

SH 99 (Grand Parkway) is currently a partially completed four4-lane, limited-access, greenbelt roadway that could be built out to six lanes in the future. If all the segments of this parkway ever be completed, it would form the third loop-highway around the City of Houston. A final environmental impact statement (FEIS) is in the process of being prepared for Segment C, which would run from U.S. 59 to SH 288 through Fort Bend and Brazoria counties. If Segment C is built, areas of increased development, along with increased traffic congestion, could potentially occur in the western half of Fort Bend County.

8.5.2 Transit Network

Limited commuting options exist throughout the study corridor and in Fort Bend County. U.S. 90A currently does not have HOV lanes. There are HOV lanes on U.S. 59 (at Southwest Freeway / south of West Airport) that are being expanded southwest past SH 6. Four commuter bus routes and eight local and other bus routes operate along the 41-mile length of U.S. 90A or

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[2] Texas Department of Transportation, *U.S. Highway 59 Major Investment Study*, Executive Summary, page 2, 1998.
[3] Ibid, page 5.
[4] Houston-Galveston Area Council, *2022 Metropolitan Transportation Plan, Appendix C – Corridor and Sub-area Summaries*, March 22, 2002, page C-36.

serve transit facilities within the U.S. 90A corridor for portions of their trip. These bus routes have total combined weekly boardings of 42,789 passengers.[5] Additionally, there are two park and ride facilities located within the study corridor. While these transportation modes provide options to combat the traffic congestion throughout the study corridor, they will not be able to meet the future employment and population growth that is forecasted to occur. The lack of available public transit is becoming an issue that must be addressed. In addition to commuter issues, transit is needed for those who are low-income, elderly, physically impaired, mentally challenged or too young to drive. The creation of a high-capacity transit system within the study corridor would help to improve these other important mobility needs as well.

8.5.3 Impact Potential

The critical issues to be examined regarding traffic, parking and pedestrian impacts relate to the increased activities that will result from this project. Trips generated at the proposed stations for commuters who drive, get dropped off, or walk to and from the stations add to existing flows in the vicinity of the stations. Similarly, the increased frequency of the new commuter rail traversing at-grade crossings will also affect the existing levels of service. Initial field reconnaissance of the alignments revealed that there are 35 at-grade crossings along the proposed rights of way. The combination of the increased frequency of rail use and hours of activity will require a detailed analysis of the potential impacts at grade crossings. Additionally, activity at proposed support facility locations (i.e., yards and maintenance facilities) will likely change mobility in the immediate surrounding area. Traffic and pedestrian issues related to access, egress and circulation at the station sites and in the town centers will require the evaluation of adequate signal timing at adjacent intersections, signing and pavement markings. Additional mitigation may result in new traffic lights, pedestrian overpasses, landscaping treatments, fencing or crossing guards to prevent unsafe crossing of the right of way.

8.6. Noise and Vibration

Noise and vibration impacts at the station areas and along the alignment would need to be evaluated in an EIS document if any of the alternatives are pursued for further study. Noise monitoring locations will need to be considered in the project corridor where noise-sensitive land uses, such as residences, parks, schools, hospitals, schools, libraries, churches, wildlife sanctuaries and other sensitive areas identified in the natural and built environment, adjoin the proposed alignment. Predicted sound levels would be determined through noise analysis, possibly determining if mitigation measures are recommended to minimize impacts. Sensitive receptors to vibration impacts include research, manufacturing, hospitals and universities with vibration-sensitive equipment, residences and any buildings where people sleep, and schools, churches and other institutions.

The noise and vibration analysis would be based on guidance provided by the FTA's "Transit Noise and Vibration Impact Assessment" Final Report prepared by the U.S. Department of Transportation (April 1995). The FTA criteria for noise are expressed in terms of A-weighted sound pressure levels (dBA). The guideline limits are expressed for the three land-use categories:

Category 1: Tracts of land where quiet is an essential element in their intended purpose. This category includes tracts of land set aside for serenity and quiet, and land uses such as outdoor concert pavilions and National Historical Landmarks with significant outdoor use. The noise metric L_{eq} is used for the noisiest hour during hours of noise sensitivity.

Category 2: All residential land uses and any buildings where people sleep, such as hotels and hospitals. The noise metric used is L_{dn}.
Category 3: Institutional land uses with primarily daytime and evening use. This category includes schools, libraries, churches and active parks where it is important to avoid interference with activities, such as speech, meditation and concentration on reading. The noise metric L_{eq} is used for the noisiest hour of transit-related activity during hours of noise sensitivity.

The FTA vibration guidelines are based on the maximum velocity levels by land-use categories (Table 8-22).

[5] Houston-Galveston Area Council, *2022 Metropolitan Transportation Plan, Appendix C – Corridor and Sub-area Summaries*, March 22, 2002, page C-27.

Table 8-22
FTA Ground-Borne Vibration and Noise Impact Criteria

Land Use Category	Vibration Impact Levels (VdB re 1 micro inch/sec)		Ground-Borne Noise Impact Levels	
	Frequent Events[1]	Infrequent Events[2]	Frequent Events[1]	Infrequent Events[2]
Category 1: Buildings where low ambient vibration is essential for interior operations	65 VdB[3]	65 VdB[3]	--[4]	--[4]
Category 2: Residents and buildings where people normally sleep	72 VdB	80 VdB	35 dBA	43 dBA
Category 3: Institutional land uses with primarily daytime use	75 VdB	83 VdB	40 dBA	48 dBA

1. "Frequent Events" are defined as more than 70 vibration events per day. Most rapid transit projects fall into this category.
2. "Infrequent Events" are defined as fewer than 70 vibration events per day. This category includes most commuter rail systems.
3. This criterion limit is based on levels that are acceptable for most moderately sensitive equipment, such as optical microscopes. Vibration-sensitive manufacturing or research will require detailed evaluation to define acceptable vibration levels.
4. Vibration sensitive equipment is not sensitive to ground-borne noise.

Noise radiated to the community from the operation of a rail system is a function of the noise generated by the locomotive and cars, the frequency of train pass-bys, their consist (number of locomotives and cars), their speeds, and train and track configuration and condition.

In their "Transit Noise and Vibration Impact Assessment," FTA provides reference noise levels for various types of locomotives, railcars and guideway configurations. Using the FTA guidelines and methodology, Table 8-23 shows the estimated impact area for each component of the project.

Table 8-23
Impact and Severe Impact Areas

Project Component	L_{eq} at 50'	L_{dn} at 50'	Impact Area Distance (assuming existing L_{eq} and L_{dn} is 55 dBA)		
			Cat. 1 (L_{eq})	Cat. 2 (L_{dn})	Cat. 3 (L_{eq})
Wayside Noise	57.5	51.5	63'	36'	40'
Stations and Parking Areas	60.2	54.2	81'	46'	51'
Layover Tracks	88	84.2	1045'	736'	659'
Access Roads	52.9	46.9	41'	24'	26'

* Measured from the center line of guideway/roadway for mobile sources; from center of noise-generating activity for stationary sources.

Sensitive uses in the following areas may be impacted by the project and would need further analysis in an EIS.

- Wayside Noise – Residential areas exist throughout the corridor that would require more detailed evaluation.
- Station and Parking Areas
  - Rosenberg Station (Vacant)
  - Richmond Station (Vacant)
  - Sugar Land Airport Station (Vacant, to be municipally owned)
  - Stafford / Sugar Land Station (Vacant)
  - Stafford Station (Vacant)
  - Missouri City Station (Vacant)
  - Westbury Station (Vacant)
  - METRORail Station (Light Rail Station/Yard)
- Layover Tracks
  - Rosenberg Yard (Underutilized)
  - Various Siding Locations
- Access Roads

8.7 Air Quality

The United States Environmental Projection Agency (EPA) National Ambient Air Quality Standards (NAAQS) and Texas State Standards have been established for six major pollutants. The primary standards are intended to prevent adverse health effects, while the secondary standards are intended to protect the public welfare by minimizing material damage and maximizing visibility. The EPA has six air pollutants collectively referred to as criteria pollutants that are of nationwide concern: carbon monoxide, nitrogen dioxide, ozone, particulate matter, sulfur dioxide and lead.

The eight-county Houston-Galveston region is designated as an area in non-attainment of federal ozone air quality standards. The Federal Clean Air Act (CAA) and Amendments of 1990 define a non-attainment area as a locality where air pollution levels persistently exceed NAAQS. Designating an area as non-attainment is a formal rulemaking process and the EPA normally takes this action only after air quality standards have been exceeded for several consecutive years. The CAA classifies the air quality problem in the Houston-Galveston area as severe (the second highest of five area classes) and requires the area to meet national ozone standards. Meeting these standards will be especially challenging to the Houston-Galveston region because of the meteorological conditions that affect the region, the magnitude of reductions required, and the shortage of readily available control options. The Environmental Protection Agency not only designated the Houston-Galveston area as a non-attainment area, but it also required Texas to submit a State Implementation Plan (SIP) describing the actions that would be taken to meet air quality standards by the deadline.[6]

[6] Texas Natural Resource Conservation Commission, "Houston/ Galveston SIP Revision Fact Sheet," Last updated October 18, 2002, www.tnrcc.state.tx.us/oprd/sips/HGA_fact_sheet.pdf, page 1.

As compared to the 1993 on-road vehicle emissions inventory, a 62 percent reduction in nitrogen oxides and a 74 percent reduction in volatile organic compound emissions are required to meet the 2007 motor vehicle budget. These goals are particularly challenging, since the vehicle miles of travel are expected to increase 36% between 1993 and 2007.[7]

No substantial effects on air quality are expected to result from the construction and operation of these rail alternatives under study in the U.S. 90A corridor. Rail projects of this type usually result in regional air quality improvements that could be applied to the SIP. Transit improvements have a beneficial effect on air quality because of the reduction in the amount of trips by private automobiles that are diverted to mass transit. The relative ambient air quality standards established by EPA would need to be examined in the next phase of study, since they relate to mobile - and rail - source emissions for the study area. If impacts are identified, ways to avoid or mitigate the adverse impacts will be recommended.

8.8 Water Quality

Of special importance to the region are its waterways, which are regulated by the Texas Commission on Environmental Quality (TCEQ). It is important to include the continued maintenance of water quality in any development plan. For example, during the construction phase of the project, the correct installation of siltation barriers and spill prevention needs to be properly monitored to maintain the effectiveness of these measures and prevent the silting of waterways. Significant waterways that fall within the study area include Oyster Creek and the Brazos River.

[7] Houston-Galveston Area Council, *2022 Metropolitan Transportation Plan*, March 22, 2002, page 12.

8.9 Natural Resources

8.9.1 Floodplains

The rail corridor traverses rivers and streams, as well as areas that are designated within 500- or 100-year floodplains. However, many of the rail embankments along this corridor are high enough to avoid being damaged by a 100-year flood. Since the proposed rail line would be constructed parallel to the existing rail freight line, floodplain impacts are not likely to occur. Figure 8-6 highlights known parks and floodplains that are located in the vicinity of the study corridor.

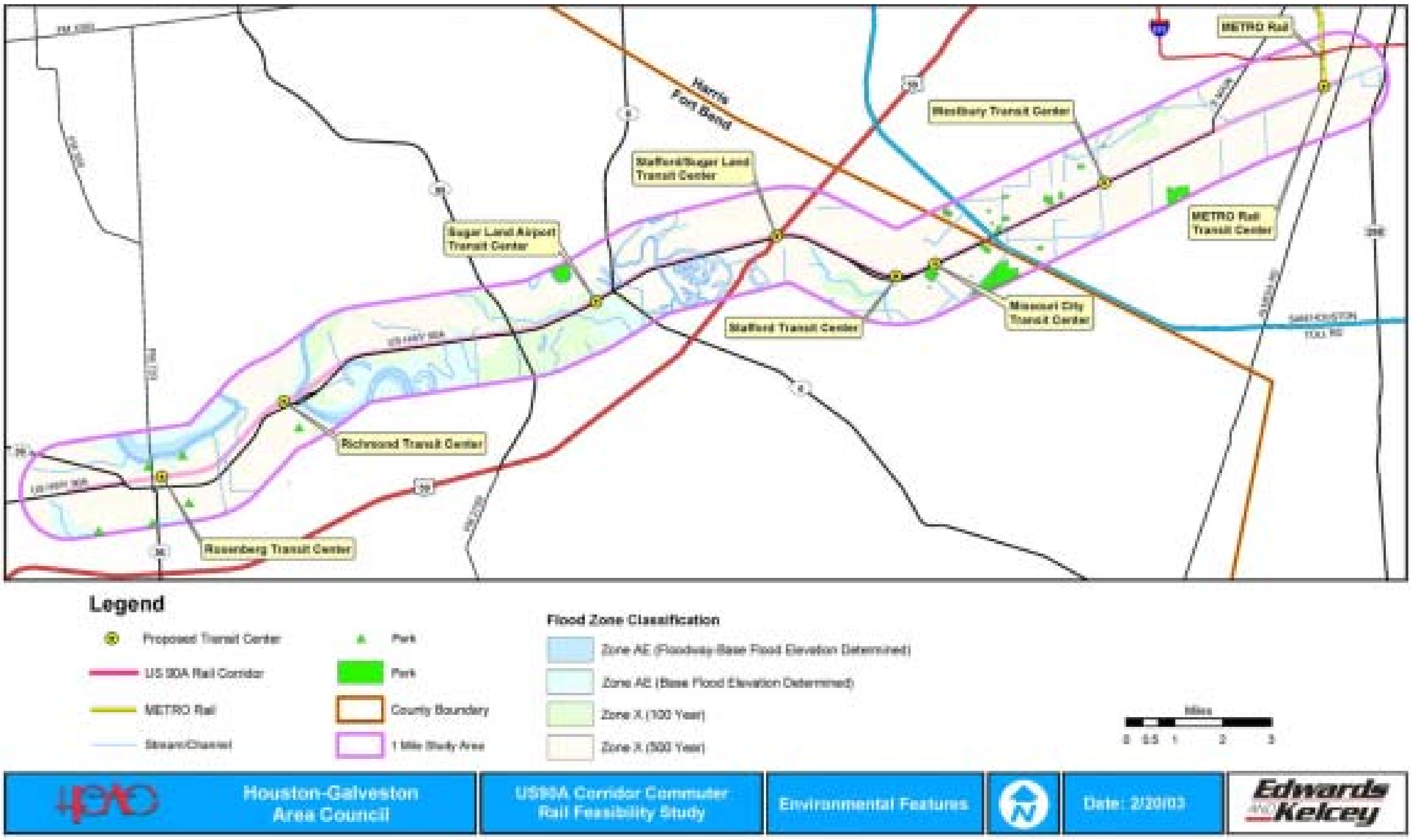
8.9.2 Wetlands

Jurisdictional wetlands will be assessed in an EIS document if the alternative is pursued for further study. Precise wetland boundaries are unknown at this time and cannot be determined until a formal wetland delineation is conducted for each area in which there will be ground disturbance. The TCEQ and National Wetlands Institute maps should be gathered and wetland limits identified to ensure that these areas remain undisturbed. Station locations for each alternative have the potential of impacting wetlands. Adjacent wetlands along the existing railroad right of way may also be impacted. The effort to identify wetland areas should also be augmented with field reconnaissance where necessary.

8.9.3 Ecologically Sensitive Areas

The development of parking lot and transit centers has the potential to displace wildlife and destroy wildlife habitat areas. The location of ecologically sensitive areas, such as woodlands, wildlife habitats, marshes, lakes, streams, scenic areas, land forms, bogs, geological formations and pristine natural areas, will need to be reviewed in the EIS. The TCEQ will need to be contacted regarding critical environmental areas.

Figure 8-6
Environmental Features



8.10 Endangered Species

The latest list of threatened and endangered flora and fauna published by the U.S. Department of the Interior and U.S. Fish and Wildlife Service (USFWS) will be reviewed in the EIS, as will information from appropriate state agencies, such as the Wildlife Diversity Program (WDP) of the Texas Parks and Wildlife Department (TPWD). If an endangered or threatened species or habit is found to exist in the vicinity of the rail corridor, the potential for negative impacts will need to be analyzed to determine if new yard and transit center locations or any temporary construction activities will impact the species or habitat.

8.11 Historic Resources

Station locations and parking lots identified in this study do not appear to directly impact any historic structures or places. A search of the National Register of Historic Places (NRHP), State Archeological Landmarks, Official State Historical Markers and the Texas Historical Commission should be conducted to further determine if any historic resources are in the vicinity of the proposed project. Archeological studies will also need to be conducted as part of the environmental review process.

8.12 Hazardous Materials

Potential station sites will be evaluated in the EIS to identify the presence or likely presence of any hazardous substances on or near the subject property under conditions that would indicate an existing release, a past release, or a potential release of a hazardous substance into structures on the property or into ground, ground water or surface water of the property. The Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) contains a list of reported superfund sites. One of the known federal superfund sites in the vicinity of the study area is the former Sol Lynn Industrial Transformer property, located between King Street and David Street, and South Loop West Feeder Street and Mansard Street. This site is located about one block south and east from the METRORail station. Therefore, special care and attention will have to be taken to ensure that this site remains undisturbed.

A Phase I Environmental Site Assessment will be necessary prior to the acquisition of any property for the proposed station sites. A Phase I Environmental Site Assessment is intended to comply with the standard practice for Environmental Site Assessment/Phase I Site Assessment Process as promulgated by the American Society for Testing Materials (ASTM) dated May 10, 2000. This ASTM document establishes standards for determining good commercial real estate with respect to the range of contaminates within the scope of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

9. PUBLIC INVOLVEMENT

H-GAC, as the lead public agency for the U.S. 90A Corridor Commuter Rail Feasibility Study, developed and implemented a public involvement program throughout the duration of the study process. The public involvement program was designed to provide a variety of formal and informal opportunities to: inform the public and elected officials about the purpose of the study, describe the transportation alternatives being considered, explain the benefits and impacts of each of the alternatives, develop station locations and describe the evaluation of the alternatives.

9.1 Steering Committee Meetings

A steering committee composed of several transportation agencies, county officials and study corridor mayors was formed to communicate with regularly, review the progress of the U.S. 90A Corridor Rail Feasibility Study and address any issues raised. The steering committee helped to connect the study staff to the public through their local elected officials. Steering committee meetings enabled elected officials to keep abreast of the progress of the study, so that they could keep their constituents informed of the latest available information. In addition, steering committee members assisted with formulating the public presentations by vocalizing specific questions and concerns that their constituents were likely to raise.

The initial steering committee included the following members/individuals:

- Houston-Galveston Area Council - Alan Clark, Kari Hackett and Earl J. Washington
- Texas Department of Transportation - Rakesh Tripathi
- Metropolitan Transit Authority of Harris County - Cyndi Robinson
- City of Meadows Place - Mayor Jim McDonald
- City of Missouri City - Mayor Allen Owen
- City of Stafford - Mayor Leonard Scarcella
- City of Sugar Land - Mayor Dean Hrbacek and City Engineer Dale Rudick
- City of Richmond - Commissioner Jim Gonzalez
- City of Rosenberg - Mayor Joe Gurecky
- Union Pacific Railroad – Joe Adams

Over time, and as a result of local elections or other changes made, the following members/individuals were added to the steering committee:

- Metropolitan Transit Authority of Harris County - Thomas Gray
- City of Houston Department of Planning and Development - David Manuel
- Harris County - Charles Dean
- Fort Bend County - Judge Bob Hebert
- Fort Bend County - Commissioner James Patterson
- Fort Bend County - Commissioner Grady Prestage
- Fort Bend County - Commissioner Tom Stavinoha
- Fort Bend County - Commissioner Andy Meyers
- City of Meadows Place - Mayor Mark McGrath

The steering committee convened on the following six dates:

- June 21, 2002
- August 19, 2002
- September 20, 2002
- December 13, 2002
- February 14, 2003
- March 14, 2003

9.2 Town Official Meetings

Town meetings were held with local elected officials and their professional staff to update them on the status of the project, involve them in station planning process and address any questions or concerns that they might have about the project. The following town meetings were held:

- Missouri City on October 15, 2002
- Sugar Land on October 16, 2002
- Richmond on October 17, 2002
- Stafford on November 11, 2002
- Rosenberg on November 12, 2002.

A meeting was held with the Fort Bend County Mayors and Councilmen at their monthly meeting in May 2003. In addition to these meetings, elected officials in each of the study corridor cities of Houston, Meadows Place, Missouri City, Stafford, Sugar Land, Richmond and Rosenberg had the opportunity to participate in the study process by attending any of the six steering committee meetings that were held from June 2002 through March 2003.

9.3 H-GAC Meetings

In addition to the meetings that were convened with local elected officials and municipal employees who were involved with the steering committee, presentations were also made to H-GACs Transportation Policy Council and Technical Advisory Committee.

- H-GAC Transportation Policy Council in December 2002
- H-GAC Technical Advisory Committee in April 2003

9.4 Public Information Meetings

Public information meetings were held at the Stafford Civic Center on March 25, 2003, and the Rosenberg Civic and Convention Center on March 27, 2003 to: provide area residents and business owners with the opportunity to learn more about the study, express their views and address any questions the attendees might have about the project. The two public informational meetings consisted of a PowerPoint slide presentation (Appendix F), display boards (Figure 9-1), handouts and an informal question and answer period. These meetings were also carried live on cable television for all those who could not attend the meeting or wanted to watch from their own home. More than 125 people attended the two public informational meetings (Figure 9-2).

The two community information meetings were publicized throughout the study corridor communities in a variety of ways, including:

- Public informational meeting notices were distributed to various public and private community facilities along the study corridor, such as town halls, libraries, medical centers and community organizations (Figure 9-3).
- Informational meeting advertisements were placed in local newspapers.
- A meeting notice was posted on the H-GAC web site.
- Press releases were forwarded to various local and regional news media.

Attendees at the information meetings offered a variety of questions and comments. An overview of typical comments received include the following:

- Operational issues about how freight and commuter trains can co-exist on the same track and/or right of way.
- Travel time comparison of passenger rail and automobile.
- Concerns about the interval and length of time when grade crossings will be closed due to commuter and freight rail train movements.
- Noise and safety concerns at grade crossings.
- Length of time to construct the rail project.
- Questions about the sources of capital and operational funding for a rail line.
- Level of support for commuter rail alternatives by local, state and federal elected officials.
- Coordination with other transit studies/projects to enhance the benefits of passenger rail in the U.S. 90A corridor.
- Acquisition of properties to support passenger rail service.
- Continued inclusion of women and minority owned businesses in future work efforts.
- Rail yard noise concerns.
- Cost/fare to ride the passenger rail and park a vehicle.

Figure 9-1: Presentation Materials Used at Community Information Meetings, March 2003.

Figure 9-2: Attendees view materials at a Community Meetings at the Rosenberg Civic Center on March 27, 2003.

9.5 Business Group Meetings

An overview of the U.S. 90A study was also provided at meetings of area business groups. A presentation was made to the Greater Houston Partnership on August 21, 2002. On October 22, 2002, a PowerPoint presentation was made before the Fort Bend County Chamber of Commerce. At these meetings, a description of the project was provided, and a substantial amount of time was devoted to open discussion, permitting questions and responses.

Figure 9-3
Community Information Meeting Notice

US90A Corridor Commuter Rail Feasibility Study

COMMUNITY INFORMATION MEETING NOTICE

Tuesday, March 25, 2003
Stafford Civic Center
1415 Constitution
Stafford, Texas 77477
281-499-5763

Thursday, March 27, 2003
Rosenberg Civic and Convention Center
3825 Highway 36 South
Rosenberg, Texas 77471
832-595-3520

Time: 6:30 PM to 8:30 PM
Presentation to Begin at 7:00 PM

Meeting sponsored by the: METRO

For more information, please contact Mr. Earl Washington at (713) 627-3200.

10. EVALUATION OF ALTERNATIVES

Using technical analyses prepared in the previous chapters, the alternatives are evaluated against one another and the trade-offs between them identified. The strengths and weaknesses of the various alternatives are identified in terms of the technical factors evaluated, which include:

- Travel time
- Ridership
- Costs
- Community Issues
- Institutional Issues

10.1 Summary of Alternative Features

The following features are common to all rail alternatives in the U.S. 90A Rail study:

- The right of way used is the existing Union Pacific (UP) Glidden Line, from Milepost 9.5 to Milepost 36.5.
- Existing UP mainline through track would remain as currently configured.
- All alternatives would involve construction of an additional track within the existing UP right of way from approximately Fannin Road in Houston, to just before the State Highway 36 Bypass in Rosenberg.
- A passenger rail tail track would be provided at the terminus at the METRO Station at Fannin Street.
- New bridge would be constructed to carry passenger rail tracks over the West Junction freight tracks.
- Transit Centers were assumed at the following locations:
    - Rosenberg Transit Center (MP 35.85)
    - Richmond Transit center Transit Center (MP 32.6)
    - Sugar Land Airport Transit Center (MP 25.9)
    - Sugar Land/Stafford Transit Center (MP 22.1)
    - Stafford Transit Center (MP 20.0)
    - Missouri City Transit Center (MP 17.4)
    - Westbury (Houston) Transit Center (MP 14.90)
    - METRORail (Houston) Transit Center (MP 9.5) (transfer to the METRORail light rail)
- A yard for vehicle maintenance and storage assumed in Rosenberg, past Tower 17 before the Route 36 Bypass (MP 36.5.)

In addition to these common features, each of the alternatives has a variety of unique features creating differing strengths and weaknesses.

10.1.1 Alternative 1: Commuter Rail – Exclusive Operation

- Assumes commuter rail technology is used (diesel-locomotive hauled coaches, push-pull train sets)
- The newly constructed, single-track with passing sidings would be for the exclusive use of the new passenger rail service. The commuter rail tracks would be located on the north side of the right of way. Three passing sidings for passenger rail service operations would be necessary.
- The existing UP tracks would be used exclusively by UP, as per current operations. These freight tracks would be located on the south side of the right of way.
- A new, single-track bridge over the Brazos River would be required for passenger track.
- Train consist would include a diesel locomotive and five coaches.
- Service requires four operating train sets plus one spare set.
- Headways are 30 minutes in the peak period, 60 minutes off-peak.
- Sample trip times from Rosenberg to METRORail Fannin range from 38 to 43 minutes.

10.1.2 Alternative 2: Diesel Multiple Unit – Exclusive Operation

- Assumes diesel multiple units (DMUs) are used (Colorado Rail Car bi-level powered cab cars).
- The newly constructed, single-track with passing sidings would be for the exclusive use of the new passenger rail service. The commuter rail tracks would be located on the north side of the right of way. Three passing sidings for passenger rail service operations would be necessary.
- The existing UP tracks would be used exclusively by UP, as per current operations. These freight tracks would be located on the south side of the right of way.
- A new, single-track bridge over the Brazos River would be required for passenger track.
- Train consist is three bi-level powered DMU cab cars.
- Service requires four operating train sets plus one spare set.
- Headways are 30 minutes in the peak period, 60 minutes off-peak.
- Sample trip times from Rosenberg to METRORail Fannin range from 36 to 39 minutes.

10.1.3 Alternative 3: Light Rail Transit – Exclusive Operation

- Assumes light rail transit vehicles (LRTs) are used (METRORail vehicle, manufactured by Siemens Transportation).
- The newly constructed, single-track with passing sidings would be for the exclusive use of the new passenger rail service. The commuter rail tracks would be located on the north side of the right of way. Six passing sidings for passenger rail service operations would be necessary.
- The existing UP tracks would be used exclusively by UP, as per current operations. These freight tracks would be located on the south side of the right of way.
- A new, single-track bridge over the Brazos River would be required for passenger track.
- Light rail train consist is three cars.
- Service requires seven operating train sets plus one spare set.
- Headways are 15 minutes in the peak period, 30 minutes off-peak.
- Sample trip times from Rosenberg to METRORail Fannin range from 38 to 43 minutes.

10.1.4 Alternative 4: Commuter Rail - Shared Operation

- Assumes commuter rail technology is used (diesel-locomotive hauled coaches, push-pull train sets).
- There would be three tracks along the entire length of the study corridor. The existing UP track would remain in the center of the right of way. This track would continue to be used under this alternative, primarily for freight operations. Two new tracks would be constructed for the length of the right of way, one on the north side and one on the south side of the right of way. These tracks would be for both passenger and freight use.
- A new, two-track bridge over the Brazos River would be required for shared passenger and freight operation.
- Train consist would include a diesel locomotive and five coaches.
- Service requires four operating train sets plus one spare set.
- Headways are 30 minutes in the peak period, 60 minutes off-peak.
- Sample trip time from Rosenberg to METRORail Fannin is 39 minutes.

10.1.5 Alternative 5: Diesel Multiple Unit - Shared Operation

- Assumes diesel multiple units (DMUs) are used (Colorado Rail Car bi-level powered cab cars).
- There would be three tracks along the entire length of the study corridor. The existing UP track would remain in the center of the right of way. This track would continue to be used under this alternative, primarily for freight operations. Two new tracks would be constructed for the length of the right of way, one on the north side and one on the south side. These tracks would be for both passenger and freight use.
- A new, two-track bridge over the Brazos River would be required for shared passenger and freight operation.
- Train consist is 3 bi-level powered DMU cab cars.
- Service requires four operating train sets plus one spare set.
- Headways are 30 minutes in the peak period, 60 minutes off-peak.
- Sample trip time from Rosenberg to METRORail Fannin is 37 minutes.

10.2 Comparison of Alternatives

Table 10-1 shows a comparison of the operations, ridership and financial data between the various study alternatives.

Table 10-1
Comparison of Alternatives

	Alternative 1: Commuter Rail – Exclusive Operation	Alternative 2: Diesel Multiple Unit – Exclusive Operation	Alternative 3: Light Rail Transit – Exclusive Operation	Alternative 4: Commuter Rail - Shared Operation	Alternative 5: Diesel Multiple Unit - Shared Operation
Operations					
Headways (peak/off peak)	30/60	30/60	15/30	30/60	30/60
Travel Time, Rosenberg to METRORail/ Fannin	38 - 43	36 – 39	38 – 43	39	37
Equipment Needs	5 Locomotives 5 Cab Cars 20 Coaches	15 DMUs (double deck with cab)	21 LRTs	5 Locomotives 5 Cab Cars 20 Coaches	15 DMUs (double deck with cab)
Maximum Passengers in Peak Hour (seated)	1,200	1,110	864	1,200	1,110
Ridership					
Daily Riders	6,066 riders (or 12,132 daily trips)	6,066 riders (or 12,132 daily trips)	10,899 (or 21,798 daily trips)	6,066 riders (or 12,132 daily trips)	6,066 riders (or 12,132 daily trips)
Annual Riders	1,577,160 riders 3,154,320 trips	1,577,160 riders 3,154,320 trips	2,833,740 riders 5,667,480 trips	1,577,160 riders 3,154,320 trips	1,577,160 riders 3,154,320 trips
Financial					
Capital Costs	$383 million	$353 million	$756 million	$492 million	$462 million
O&M Costs (annual)	$12.2 million	$8.4 million	$14.0 million	$13.5 million	$9.8 million

10.3 Evaluation

Using the technical work tasks performed for the U.S. 90A Commuter Rail Feasibility Study and the comparison of alternatives in the pervious section, Table 10-2 presents a qualitative analysis of the alternatives against the study objectives.

Table 10-2: Comparison of Alternatives Against Study Objectives

	Alternative 1: Commuter Rail – Exclusive Operation	Alternative 2: Diesel Multiple Unit – Exclusive Operation	Alternative 3: Light Rail Transit – Exclusive Operation	Alternative 4: Commuter Rail - Shared Operation	Alternative 5: Diesel Multiple Unit - Shared Operation
Maximizes Ridership					
Minimizes Capital Costs					
Minimizes O&M Costs					
Improves infrastructure for freight, increasing flexibility and safety.					
Efficiently moves volumes of riders					
Minimizes institutional barriers to implementation					
Integrates with METRO services (bus and rail)					
Provides mobility, economic and environmental benefits to communities					

= Meets/Exceeds Criteria
= Neutral for Criteria
= Does Not Meet Criteria

10.4 Summary of Findings

The U.S. 90A Corridor Rail Feasibility Study has demonstrated that a potential rail service in this corridor is feasible. Among the alternatives analyzed, each has strengths and weaknesses, described below.

10.4.1 Alternative 1: Commuter Rail – Exclusive Operation

Strengths

- Capital costs minimized due to fewer infrastructure needs.
- Will provide mobility, economic and environmental benefits to communities.
- This mode can be operated with freight service.
- Efficiently moves high volumes of passengers.

Weaknesses

- New mode for region; will require all new facilities (storage, maintenance).
- Operating entity for mode not established.

10.4.2 Alternative 2: Diesel Multiple Unit – Exclusive Operation

Strengths

- Capital costs minimized due to fewer infrastructure needs.
- Will provide mobility, economic and environmental benefits to communities.
- This mode can be operated with freight service.
- Efficiently moves high volumes of passengers.

Weaknesses

- Federal Railroad Administration (FRA)-compliant DMU technology is not currently in operation or production, therefore there could be a degree of risk associated with it.
- New mode for region; will require all new facilities (storage, maintenance).
- Operating entity for mode not established.

10.4.3 Alternative 3: Light Rail Transit – Exclusive Operation

Strengths

- High potential ridership due to frequency.
- Will provide mobility, economic and environmental benefits to communities.
- Potential for integration with METRORail service.

Weaknesses

- Institutional barriers to implementation because of the required separation from freight operations.
- High capital costs due to unique infrastructure needs.
- Lower volumes of passengers moved per train, relative to other modes.
- High operating cost due to frequency.

During the later stages of the study analysis, interest increased in the opportunity to modify Alternative 3: Light Rail – Exclusive Operation. The proposed modification would create a new suboption – Alternative 3a: Light Rail – Exclusive Operation, Through-Service. This option would permit U.S. 90A light rail trains to operate directly onto the METRORail system via a new rail connection between the U.S. 90A corridor and the light rail line. The need for a transfer would be removed under this option. More detailed analysis is required to examine the benefits, impacts and costs of this option. Integration with METRO's light rail service is a significant consideration under this option. Their operating plans would need to be examined in detail in relation to U.S. 90A trains to understand the feasibility of this extension. The scheduling of trains over their system and the recycling of equipment is a complicated matter that must not be compromised by proposed new service extensions. Should light rail in the U.S. 90A corridor be further advanced, more work on operating plans, operating cost and capital costs will be necessary to understand the feasibility of this suboption.

10.4.4 Alternative 4: Commuter Rail - Shared Operation

Strengths

- Improves infrastructure for freight by providing an additional track, as well as an improved signalization and communication system, increasing benefits to freight operators in terms of flexibility and safety.
- Will provide mobility, economic and environmental benefits to communities.
- This mode can be operated with freight service.
- Efficiently moves high volumes of passengers.

Weaknesses

- New mode for region; will require all new facilities (storage, maintenance).
- Operating entity for mode not established.

10.4.5 Alternative 5: Diesel Multiple Unit - Shared Operation

Strengths

- Improves infrastructure for freight by providing an additional track, as well as an improved signalization and communication system, increasing benefits to freight operators in terms of flexibility and safety.
- Will provide mobility, economic and environmental benefits to communities.
- This mode can be operated with freight service.
- Efficiently moves high volumes of passengers.

Weaknesses

- FRA-compliant DMU technology is not currently in operation or production, therefore there could be a degree of risk associated with it.
- New mode for region; will require all new facilities (storage, maintenance).
- Operating entity for mode not established.

10.5 Recommendations

Based on this conceptual analysis, preliminary discussions have been conducted with Union Pacific Railroad, the owner and operator of freight rail service in the corridor. UP has indicated that the most favorable service options in the U.S. 90 Corridor are the exclusive operating scenarios. UP has indicated that it feels that these scenarios have less potential for impact on their current and future freight operations in the corridor.

The steering committee for the U.S. 90A Corridor Commuter Rail Feasibility has also made the following statement:

> *The steering committee for the U.S. 90A Corridor Commuter Rail Feasibility Study accepts the findings of the draft report and requests that the planning consultant finalize the report by completing the adjustments and revisions submitted by committee members.*
>
> *The steering committee concurs with providing an opportunity for public review and comment on the completed Feasibility Study.*
>
> *The steering committee requests the support of the H-GAC Transportation Policy Council to define the need, purpose and scope of a locally preferred investment, including the possibility of taking no action. This study of transit alternatives in the U.S. 90A Corridor should be conducted in cooperation with the Texas Department of Transportation, the Metropolitan Transit Authority, the Houston-Galveston Area Council, Harris and Fort Bend counties, and the Cities of Houston, Meadows Place, Missouri City, Richmond, Rosenberg, Stafford and Sugar Land. For each of the alternatives identified, the study will detail operating and capital investment, transportation and mobility benefits as well as the compatibility with regional and local plans. The factors examined include alternative transit technologies, alignments, station or park and ride locations, supporting local and express transit service and yard or maintenance facility locations. This study effort, commonly referred to as an Alternatives Analysis, would build upon the feasibility study and examine at a more detailed level the community wide impacts related to mobility, safety, noise, and expanded freight capacity.*
>
> *Assuming the "no action" alternative is not the locally preferred investment strategy, the study will identify financial and institutional strategies for implementing the preferred alternative.*
>
> *The steering committee encourages each of the participating local governments and state and local transportation agencies to consider continued financial support for this "Alternatives Analysis."*