Austin to Houston Passenger Rail Study

Final Report

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Texas Department of Transportation

Prepared by

HNTB

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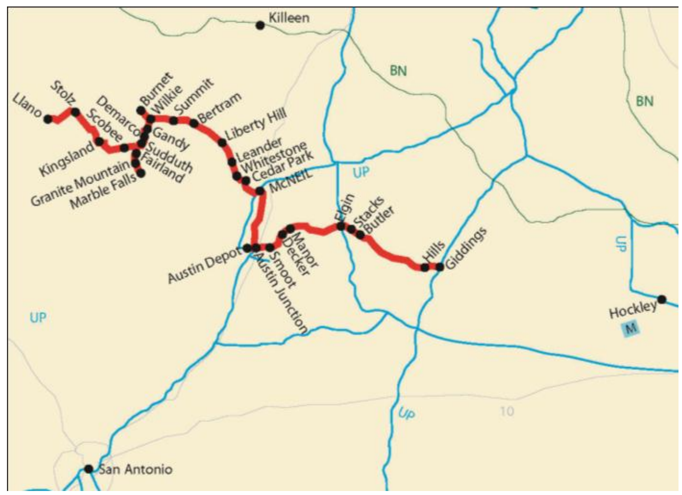
Executive Summary

The purpose of the Austin to Houston Passenger Rail Study is to analyze the feasibility of implementing 110 mph intercity passenger rail service between Austin and Houston including possible service to Bryan/ College Station. This feasibility analysis consisted of identifying the characteristics of existing rail infrastructure and operations in the study corridors, analyzing potential alternative alignments for the passenger rail operations, and determining required infrastructure and impacts for potential passenger rail service in the study area.

Background



The segment of rail line constructed from Giddings to Austin in 1871 was the first connection between Austin and other rail lines in Texas. The Giddings-to-Llano rail line was purchased by the City of Austin from Southern Pacific Railroad (SP) in 1986 for $9.4 million (equivalent to $17.5 million in 2010 dollars). Capital Metro purchased the rail line outright from the City of Austin in May 1998 and performs its obligation as a common carrier by contracting shortline rail operators to provide service to freight rail customers along the line. For the purpose of this study, only the East Subdivision portion of the line between Austin and Giddings is included in the Study Area. The East Subdivision of the rail line is currently only operational between Austin and Butler (just east of Elgin) with no existing service and inoperable track conditions between Butler and Giddings, although service by Union Pacific Railroad (UP) to the Lee County Cooperative is accessed via this line segment at Giddings.

In addition to obligations for the freight rail sector, Capital Metro's charge is to provide rapid transit services throughout its service area. The initial phase of transit service on Capital Metro's MetroRail transit system consists of the 32-mile Red Line that provides commuter rail service between Leander and Austin on Capital Metro's Central Subdivision. Capital Metro plans to extend transit service at a future date to the MetroRail Green Line on the East Subdivision between Austin Junction and Elgin.

Additionally, the potential intercity passenger rail corridors analyzed in this study connect to the Houston rail network at Hempstead via the UP Eureka Subdivision. The Gulf Coast Rail District (GCRD) is currently conducting an independent study for the implementation of commuter rail on the Eureka Subdivision rail line.

Train schedules for passenger rail service between Austin and Houston will require coordination with the potential Houston-to-Hempstead commuter trains, MetroRail train schedules established by Capital Metro on the existing Red Line and the future Green Line, and must not prevent the freight rail operator from executing its contract to fulfill Capital Metro's common carrier obligation.

Existing Conditions

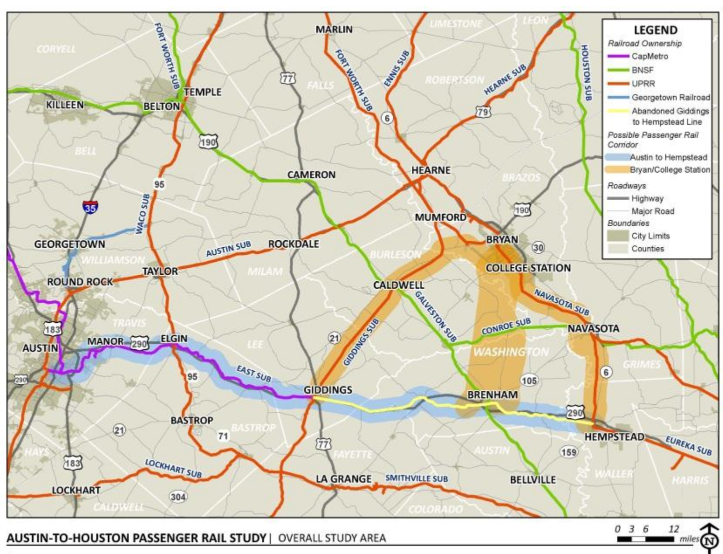
The Capital Metro East Subdivision consists of 57.8 miles of mainline track between Austin and Giddings, with 38 railroad bridges for a total length of nearly 5,000 feet, 118 drainage structures (e.g., culverts), three crossings with other rail lines (The Capital Metro Central Subdivision/ Red Line, the UP Waco Subdivision in Elgin, and the UP Giddings Subdivision in Giddings), and 99 at-grade roadway-railroad crossings, 63 of which are public. At Giddings, the East Subdivision meets the abandoned Southern Pacific (SP) right of way, which runs from Giddings to Hempstead. Although the abandoned right of way has been sold, large portions of the corridor remain undeveloped. The majority of the land use along the corridor is agricultural; however, portions of the abandoned right of way have been developed in the areas of Giddings, Burton, Brenham, and Chappell Hill. In particular, the abandoned right of way no longer exists where it runs through the city of Giddings. A grocery store, medical buildings, retail stores, and several other developments in downtown Giddings have been built within the original right-of-way.

Freight trains operating on the East Subdivision consist of approximately 10 train trips per week including ethanol trains that operate between Decker and Elgin, switch trains that operate between Decker and Robinson (near the McNeil interchange) on the Central Subdivision, and trains that operate between Butler and Summit on the West Subdivision.

The Hempstead to Houston segment of the corridor, although not analyzed in this study, was assumed to be comprised of an alignment along the UP Eureka Subdivision, which terminates in Houston near Loop 610 with a connection to the Houston rail network. The Eureka Subdivision consists of 54 miles of single mainline track with limited sidings between Navasota and Houston and currently averages approximately 5 to 10 freight trains per day.

Alternative Alignments Analysis

The rail corridors analyzed for potential passenger rail service include the Austin-to-Hempstead corridor, which would ultimately provide passenger service to Houston, as well as a corridor north to Bryan/ College Station. Rail lines to Bryan/ College Station consist of the UP Eureka and Navasota Subdivisions between Hempstead and Bryan as well as the UP Giddings Subdivision between Giddings and Hearne, with a connection to the UP Navasota



AUSTIN-TO-HOUSTON PASSENGER RAIL STUDY | OVERALL STUDY AREA

Subdivision to Bryan from Hearne.

Several alignments between Austin and Giddings, Giddings and Hempstead, Brenham to College Station, and Hempstead to College Station were analyzed to identify potential fatal flaws which centered on horizontal and vertical geometry as well as environmental issues. The alignments described as follows were identified based on the fatal-flaw analysis for the purposes of operational modeling and to determine order-of-magnitude cost estimates along the corridor and do not constitute preferred or chosen alignments, which would require further analysis including preliminary engineering, NEPA documentation, and public involvement.

Austin to Giddings

The existing alignment was modeled between Austin and Giddings with upgrades to horizontal geometry to increase the maximum allowable train speed. The revised alignment reduced the degree of curvature at several curves, eliminated curves (primarily between Elgin and Paige) and also reduced the distance along the route by approximately 3.4 miles. The revised alignment increased allowable train speeds to a minimum of 65 mph and up to 110 mph for the majority of the route, while the existing alignment had allowable speeds limited to a maximum of 25 mph.

Giddings to Hempstead

Two possible passenger rail corridors were evaluated between Giddings and Hempstead: the U.S. 290 corridor and the abandoned SP corridor. The alignment modeled follows the U.S. 290 corridor to Carmine and then along the abandoned SP corridor based on an analysis of track lengths, travel times, profile fatal-flaw analysis, environmental fatal-flaw analysis, and potential station locations. The modeled alignment has maximum allowable speeds of up to 110 mph with approximately 2 percent of the route limited to speeds of between 48 mph and 80 mph due to curves.

Hempstead to Houston

The Hempstead to Houston segment of the corridor, which consists of the UP Eureka Subdivision, was not analyzed in this study and is included in the independent GCRD study. The Eureka Subdivision currently has maximum allowable freight train speeds of up to 40 miles per hour, with several segments of the line limited to 25 mph. The GCRD study identifies improvements to the Eureka Subdivision that would increase allowable freight and passenger train speeds.

To Bryan/ College Station

The alternatives for a possible alignment to College Station consist of three general routes: Giddings to Bryan/ College Station, Brenham to Bryan/ College Station or Hempstead to Bryan/ College Station. The Giddings to Bryan/ College Station route would generally follow adjacent to the UP Giddings Subdivision right of way from Giddings to the Brazos River, and then follow along SH 21 and SH 47 to College Station. The Brenham to College Station route assumed a new greenfield alignment located east of FM 50. The alternative for a possible alignment from Hempstead to College Station would generally follow adjacent to the right of way along the UP

Eureka Subdivision from Hempstead to Navasota and the UP Navasota Subdivision to College Station with a new bypass route on the west side of Navasota.

The modeled alignments for each of the alternatives to College Station have maximum allowable speeds of up to 110 mph with a few locations along the routes limited to speeds of between 80 mph and 93 mph due to curves.

The modeled intercity passenger rail alignments are shown in the following figure. The intercity passenger routes include passenger rail station stops in downtown Austin, Elgin, Giddings, Brenham, Hempstead, and College Station. Although a ridership analysis was not performed, the preliminary passenger rail station locations were determined based on areas with the greatest population along the route between Austin and Hempstead. General locations for the stations were analyzed for the purpose of identifying conceptual passenger rail schedules and levels of on-time performance; specific sites for the stations were not identified. Although not modeled, passenger rail service would continue to Houston from Hempstead with a station stop at the existing Houston Amtrak station.

AUSTIN TO HOUSTON PASSENGER RAIL STUDY MODELED ALIGNMENTS

Improvements and Investments

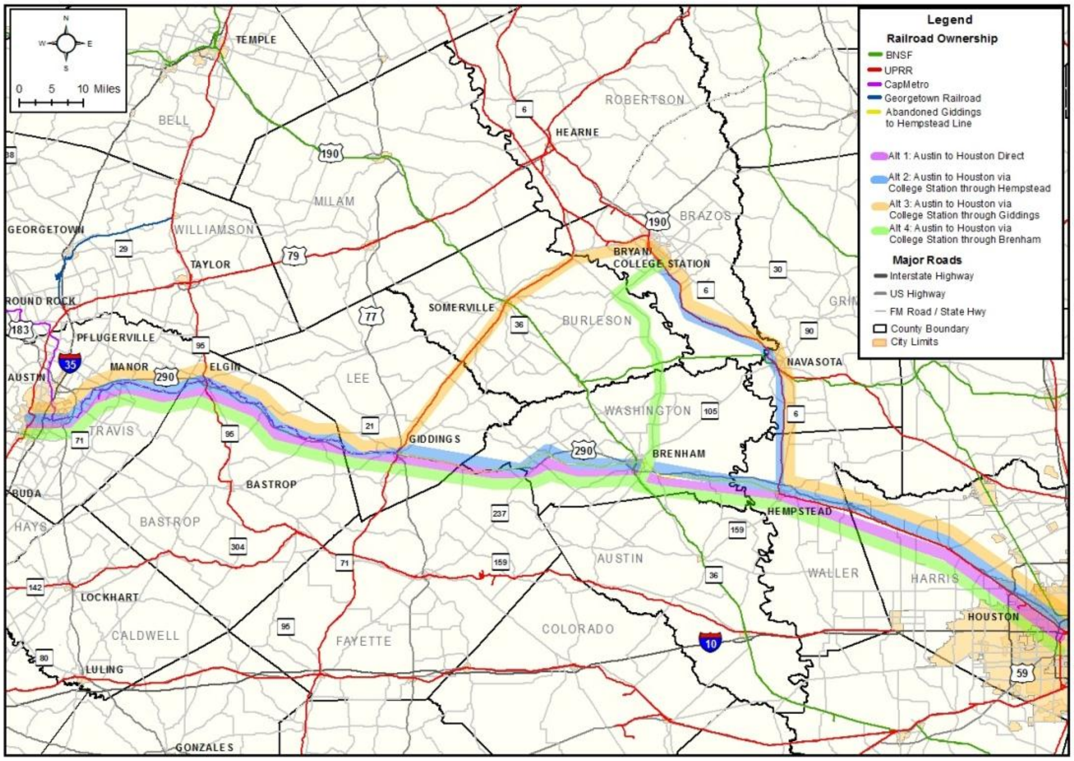
Corridor infrastructure improvements and associated costs required for passenger rail implementation were determined based on rail operations modeling using Rail Traffic Controller (RTC). The existing Capital Metro freight movements between Austin and Butler were modeled in the base case (current condition) and were also modeled in the planning cases with passenger rail operations to determine impacts to the freight operations. Intercity passenger rail operations were modeled to determine infrastructure improvements, such as mainline track and passing sidings, required to achieve a level of on-time performance that promotes service reliability to a level expected by the traveling public to sustain and grow ridership.

Start-up intercity passenger rail operations were defined as two round trips (one in each direction) with morning departures and evening returns daily between Austin and Houston. Weekday trip times as modeled were intended to accommodate business travel, while weekend trip times as modeled were intended to accommodate leisure activities including sporting events. Although the network and operations were not modeled between Hempstead and Houston, arrival and departure times of the passenger trains were planned to accommodate assumed peak demand times for Houston arrivals and departures, based on information obtained from the GCRD's independent study of commuter rail operations between Hempstead and Houston.

Start-up operations were modeled for four potential operating scenarios as listed below and shown in the following Figure:

- Option 1: Direct service between Austin and Houston with intermediate station stops in Elgin, Giddings, Brenham, and Hempstead
- Option 2: Service between Austin and Houston with intermediate station stops in Elgin, Giddings, Brenham, Hempstead, and College Station via a Hempstead-to-College Station route
- Option 3: Service between Austin and Houston with intermediate station stops in Elgin, Giddings, Hempstead, and College Station via a Giddings-to-College Station route
- Option 4: Service between Austin and Houston with intermediate station stops in Elgin, Giddings, Brenham, Hempstead, and College Station via a Brenham-to-College Station route

A total of 2 train sets would be required to operate the assumed start-up for each option listed above.



The build-out intercity passenger operations were assumed to double the initial operations along the direct route between Austin and Houston on weekdays with no change to the other service routes. The assumed schedule consisted of four round trips (two in each direction) with morning departures and evening returns between Austin and Houston on weekdays and two round trips (one in each direction) with morning departures and evening returns between Austin and Houston on weekend days. Similar to the assumed start-up operations, build-out operations were modeled for the 4 potential operating schedule scenarios listed above. A total of 4 train sets would be required to operate the assumed build-out schedules for each option listed above.

Infrastructure Requirements

The primary infrastructure improvements required for implementation of intercity passenger rail include modifications to the existing rail line between Austin and Giddings to allow for higher train speeds, new single mainline tracks east of Giddings to Hempstead via the routes previously described in Options 1 through 4 and shown in the previous figure, and a new Centralized Traffic Control (CTC) signal system along the passenger rail routes (including existing and new tracks). Improvements between Hempstead and Houston were not identified in this study and are being addressed in the study conducted by the Gulf Coast Rail District (GCRD).

Additionally, new sidings and extensions to existing sidings were identified at the locations listed as follows to allow the intercity passenger trains running in opposite directions to meet and pass each other. The lengths of the sidings would allow the passenger trains to pass each other without coming to a stop.

- Options 1 (direct) & 2 (via Hempstead)
  - Start-Up: One 3-mile-long siding approximately 12 miles west of Brenham
  - Build-Out: One additional 3-mile-long siding 15.4 miles west of Giddings
- Option 3 (via Giddings)
  - Start-Up: One 4-mile-long siding approximately 4 miles southwest of College Station on new Giddings-to-College Station alignment
  - Build-Out: Additional 3-mile-long siding located 0.75 miles north of Giddings on new Giddings-to-College Station alignment and 4-mile-long siding nearly 30 miles south of College Station on the line between Hempstead and College Station
- Option 4 (via Brenham)
  - Start-Up: One 3-mile-long siding approximately 2 miles southwest of College Station on new Brenham-to-College Station alignment
  - Build-Out: Additional 4-mile-long siding located 0.25 miles north of Brenham on new Brenham-to-College Station alignment and 3-mile-long siding 10 miles west of Brenham on the Giddings-to-Hempstead alignment

The following improvements were also included for all route options to allow existing freight trains to clear the mainline in a safe and timely manner and prevent delay to passenger trains. The improvements would also allow access into sidings to be dispatcher controlled versus the manual control by train and engine crews currently in place.

- #15 dual control power turnouts at all existing industry spur tracks (7 total)

- #15 dual control power turnouts at all existing freight sidings (6 total)

Additional infrastructure and ancillary facilities that may be required for passenger rail implementation, although not modeled or included in the cost estimates in this study, could include layover tracks, maintenance facilities, carwash/cleaning facilities, and crew and maintenance/operating personnel facilities.

Passenger and Freight Train Performance

The infrastructure improvements modeled provided a 99% level of on-time performance for the initial/ start-up and build-out schedules. The overall modeled average speed ranged from approximately 65 mph to 70 mph for passenger trains, depending on route option, and 24 mph for freight trains. The average passenger train speeds and travel times for each segment along the route are listed in the following table. The range in times and speeds depends on the direction of travel. The average speeds differ for eastbound versus westbound trains due to vertical grade as well as delay incurred at passing sidings. Grades are generally downhill from Giddings to Hempstead and from Giddings to College Station and generally uphill from Hempstead to College Station and from Brenham to College Station. Delay incurred at passing sidings may differ depending on direction of travel if trains in opposing directions do not reach the siding at the same time. Siding lengths and locations were determined in order to minimize such delays, although the siding locations could not be optimized in some instances due to infrastructure restrictions such as curve and major bridge locations.

Route Segment	Modeled Travel Time (includes station dwells)	Modeled Average Speed of Passenger Trains
Downtown Austin Station- Austin Junction/ Wye	9 min.	8 to 10 mph
Austin Junction-Elgin	24 to 25 min.	67 to 74 mph
Elgin-Giddings	19 to 21 min.	75 to 80 mph
Giddings-Brenham	28 to 30 min.	77 to 81 mph
Brenham-Hempstead	14 to 18 min.	61 to 75 mph
Hempstead-Houston*	65 min.	50 mph
Hempstead-College Station (Option 2)	31 to 34 min.	83 to 93 mph
Giddings-College Station (Option 3)	44 to 48 min.	66 to 72 mph
Brenham-College Station (Option 4)	24 to 29 min.	67 to 72 mph

Travel Times and Average Speeds by Segment
(*Hempstead-Houston data based on preliminary information available from the GCRD study)

The infrastructure improvements modeled provided a 99% level of on-time performance for the full build-out schedule. The overall modeled average speed was approximately 67 mph for passenger trains and 24 mph for freight trains. Average speeds and travel times by route segment were approximately the same for the build-out schedule as for the start-up schedule with minor differences of approximately 2 minutes on the total trip time due to additional train meets.

The existing freight trains from the base case were included in the planning cases, but with modified schedules to adjust for the passenger trains. Although the freight trains' origination times had to be modified in the planning cases, they were able to operate more efficiently and complete their schedules earlier as a result of the increased track speeds associated with the revised alignment and modeled infrastructure improvements. The intercity passenger rail schedule was determined to have very little impact on freight operations, although the freight train operations were shown to experience some delay due to being held to wait on passing passenger trains. This delay could be eliminated entirely if the operating hours of the freight trains were changed to operate completely outside of the passenger operating windows.

Estimated Costs

The estimated costs for the infrastructure improvements and rolling stock modeled for start-up and build-out intercity passenger operations, excluding ancillary facilities and equipment costs, are shown in the following table. The cost estimates for infrastructure improvements identified do not constitute the total costs associated with implementing intercity passenger rail between Austin and Houston. The cost estimates included in this study do not include operating and maintenance costs, projected revenues, or equipment costs other than rolling stock. No costs are included for requirements to bring the intercity passenger rail service from Hempstead to Houston.

As shown in the table, the direct service between Austin and Houston without a stop in College Station (Option 1) is the least expensive option. Of the routes that would provide service to College Station, the Giddings route is the least expensive.

The Hempstead-to-College Station segment has the lowest estimated cost (both overall and per mile) since it is the shortest segment and also has significantly fewer required railroad bridges, roadway crossings, and grade separations. The Austin-to-Giddings segment is relatively close in terms of the estimated cost per mile to the Giddings-to-Hempstead segment, even though it partially utilizes existing Capital Metro railroad infrastructure, since more than half of the corridor would require a new alignment in order to modify the geometry to increase allowable train speeds and the remaining portion of the existing alignment would require rehabilitation. Additionally, all existing timber bridges on Capital Metro would need to be replaced along the potential intercity passenger rail for improved ride quality.

Infrastructure Cost by Route Segment		
Route Segment	**Total Cost (w/o sidings)**	**Cost per Mile**
Austin to Giddings	$439,660,000	$8,123,799
Giddings to Hempstead	$461,710,000	$8,105,481
Hempstead to College Station	$283,010,000	$6,554,192
Giddings to College Station	$387,660,000	$8,666,667
Brenham to College Station	$276,450,000	$8,580,508
Summary of Total Costs		
Austin to Houston Route Option	**Start-Up**	**Build-Out**
Option 1 (Direct)	$936,710,000	$972,040,000
Option 2 (via Hempstead to College Station)	$1,219,720,000	$1,255,050,000
Option 3 (via Giddings to College Station)	$1,149,250,000	$1,199,510,000
Option 4 (via Brenham to College Station)	$1,213,160,000	$1,263,420,000

Summary of Estimated Costs by Segment

Conclusions

The following conclusions summarize the findings from the analysis conducted for this study:

- Use of the existing infrastructure between Austin and Giddings for intercity passenger rail requires several upgrades and rehabilitation, which result in the cost per mile along the existing Austin-to-Giddings segment to nearly equal the cost per mile along the new segment of track between Giddings and Hempstead.

- The alignment modeled between Giddings and Hempstead follows the U.S. 290 corridor to Carmine and then generally along the abandoned SP corridor based on an analysis of track lengths, travel times, profile fatal-flaw analysis, environmental fatal-flaw analysis, and potential station locations.
- The alignment modeled between Hempstead and College Station is adjacent to the UP Eureka and Navasota Subdivisions with a bypass west of Navasota.
- The alignment modeled between Giddings and College Station generally follows parallel to the existing UP Giddings Subdivision north to SH 47 and then generally alongside SH 47 to College Station.
- The alignment modeled from Brenham to College Station is a greenfield alignment that connects to the abandoned SP corridor on the east side of Brenham and connects to the existing UP Navasota Subdivision south of College Station.
- The assumed start-up schedules could be supported by single track mainline with a 3 to 4-mile-long passing siding.
    - One additional siding would be required for the build-out schedule for route options 1 and 2, while two additional 3 to 4-mile-long sidings would be required for the build-out schedules for route options 3 and 4.
- The approximate total travel times between Austin and Houston are listed below for each schedule option:
    - Option 1 (Austin to Houston Direct) - 2 hours and 45 minutes
    - Option 2 (Austin to Houston with Route to College Station via Hempstead) - 3 hours and 50 minutes
    - Option 3 (Austin to Houston with Route to College Station via Giddings) - 3 hours and 15 minutes
    - Option 4 (Austin to Houston with Route to College Station via Brenham) - 3 hours and 37 minutes
- The direct route (Option 1) is the least expensive route option and also has the shortest trip time. Of the route options that provide service to College Station, the Giddings route option (Option 2) is the least expensive and provides the shortest trip time.

Section 1: Introduction

Purpose

The purpose of the Austin to Houston Passenger Rail Study is to analyze the feasibility of implementing an intercity passenger rail system between Austin and Houston including possible service to Bryan/ College Station. The feasibility analysis, which is summarized in this report, consisted of identifying the characteristics of existing rail infrastructure and operations in the study corridors, analyzing potential alternative alignments for the passenger rail operations, and determining required infrastructure and impacts for potential passenger rail service in the study area.

Background

Merger and acquisition activities in the railroad industry have had a significant impact on existing operations and infrastructure conditions along the potential Austin-to-Houston passenger rail corridor. Characteristics exhibited by today's rail lines, such as abandonments, directional operations, and conversions of mainlines to industrial leads, are attributable to consolidations of the many railroad companies that constructed lines through Central Texas and the Gulf Coast in the late 1800s. As Austin's first link to the U.S. rail network, connection to the Southern Pacific (SP) mainline at Hempstead (now the UP Eureka Subdivision) served as a valuable means of moving local materials, such as rock and stone products, to outlying markets. Soon, mainlines were constructed through Austin and other towns (i.e., Elgin, Giddings, and Brenham) along the Austin-to-Hempstead corridor, which began to marginalize its role as an east-west branch line to SP's mainline and resulted in the eventual abandonment of most line segments.

Other than the development of these mainlines, the subsequent merger of UP and SP in 1996 has perhaps played a larger role in influencing conditions along the Austin to Houston corridor than any other single event. The geographic location of SP's rail network nationally did not provide it with the same volume of coal or grain business as UP and the Burlington Northern Santa Fe Railway (BNSF), but SP had dominated the region's lucrative petrochemical business as historically the most extensive railroad in Houston.

The UP/SP merger created two notable conditions that are favorable to the development of passenger rail service between Austin and Houston. First, parallel routes to Fort Worth were created in the Houston area, improving the possibility that UP would consider allowing passenger rail service on its Eureka Subdivision. Second, federal decisions on the allocation of post-merger rail service in Central Texas, by means of BNSF trackage rights and the location of shortline interchanges with Class I railroads, has provided the Capital Metropolitan Transportation Authority (Capital Metro) with greater flexibility in operating the Giddings to Llano line purchased from SP in 1986.

The potential for gaining access to UP's Hempstead-to-Houston rail corridor would have been much smaller had the UP/SP merger not occurred. The merger provided UP with the SP

Houston & Texas Central line that extended from Houston, through Hempstead, to Navasota Junction, now called the UP Eureka Subdivision. Consequently, UP acquired an alternative means of moving freight between Houston and Navasota Junction to its own operations over the Palestine Subdivision between Houston and Spring and over the Navasota Subdivision between Spring and Navasota Junction.

Capital Metropolitan Transit Authority Rail Operations

The segment of rail line constructed from Giddings to Austin in 1871 was the first connection between Austin and other rail lines in Texas. In 1986, SP was given approval to abandon the Giddings-to-Llano rail line shown in Figure 1 by the Interstate Commerce Commission (ICC).[1] The Giddings-to-Llano rail line was purchased by the City of Austin from SP in 1986 for $9.4 million (equivalent to $17.5 million in 2010 dollars) funded largely by a federal grant with participation by Capital Metro as the anticipated future provider of passenger service over portions of the rail line.[2] Capital Metro purchased the rail line outright from the City of Austin in May 1998 and performs its obligation as a common carrier by contracting shortline rail operators to provide service to freight rail customers along the line. The extent of the 162-mile rail line, formerly the Western Branch of SP's Houston & Texas Central line, was redefined by the City of Austin as having a Giddings Branch, extending from milepost 0.00 near Giddings to milepost 154.07 at Llano, the 6.43-mile Marble Falls Branch, the 3.3-mile Scobee Spur, and the 0.93-mile Burnet Spur (Figure 1), divided into the following three segments:

- Western Segment – Llano to Scobee
- Middle Segment – Scobee to Smoot
- Eastern Segment – Smoot to Giddings

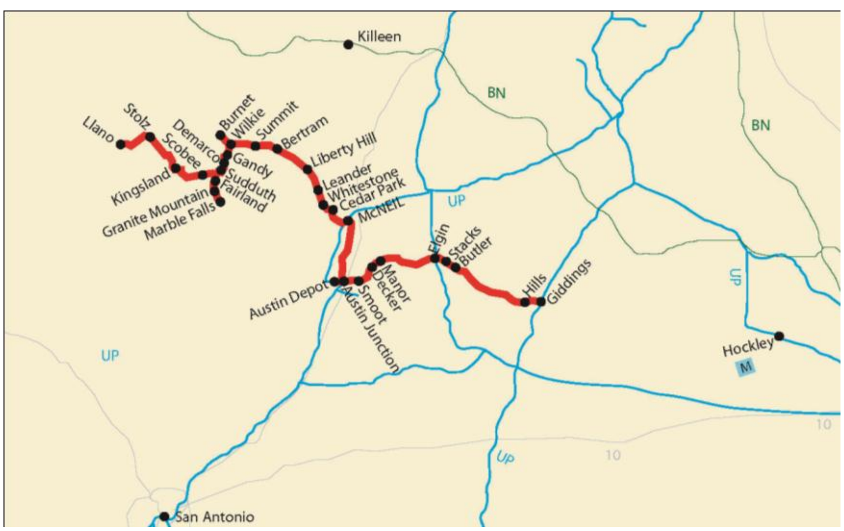


Figure 1: Limits of the Giddings-to-Llano Rail Line

[1] ICC Finance Docket No. 30861, June 30, 1986.

[2] Fair, J.R., "New Railroad at Austin, Texas," *Arkansas Railroader*, Vol. 18 (1), January 1987.

At the time of the purchase, the line provided interchange with the MKT at Elgin (now the UP Waco Subdivision) and connected to SP's Houston & Texas Central mainline at Giddings (now the UP Giddings Subdivision). Capital Metro purchased the rail line outright from the City of Austin in May 1998, and performs its obligation as a common carrier by contracting shortline rail operators to provide service to freight rail customers along the line. Today, Capital Metro defines segments of the rail line by subdivision rather than segments, consisting of:

- West Subdivision – Leander to Llano (including the Scobee and Burnet Spurs)
- Central Subdivision – 4th Street/Austin Convention Center to Leander
- East Subdivision – Giddings to Austin Junction
- Marble Falls Branch – Fairland to Marble Falls

The East Subdivision of the rail line is currently only operational between Austin Junction, where it connects to the Central Subdivision, and Butler (just east of Elgin) with no existing service and inoperable track conditions between Butler and Giddings. However, a primary function of Capital Metro is to manage the entire 162 miles of the Giddings-to-Llano rail right of way and fulfill its obligation as a common carrier to rail freight shippers along the line.[3] Since the Butler-to-Giddings segment has not been abandoned through STB proceedings, and is instead currently out of service, Capital Metro's common carrier obligation is inconsequential due to the absence of rail customers on this portion of the line.

When the City of Austin purchased the Austin-to-Giddings corridor in 1986, a primary role of the interchange at Giddings was to haul crushed stone from the Austin area for use in highway construction. Eventually, the economic infeasibility of maintaining the Elgin-to-Giddings section of the rail line for limited purposes contributed to Capital Metro's freight operator's decision to discontinue service on their eastern segment in 1995; although, rail service east of Austin Junction to Elgin was restored in 1997. Capital Metro now refers to track east of Elgin (MP 27.2) to the end of track at Giddings (MP -0.92) as the Giddings Industrial Spur. The Giddings Industrial Spur is out of service between MP 0.0 and MP 23.0, and the remaining 4.2 miles of track (MP 23.0 to MP 27.2) is classified as FRA Excepted Track.[4]

Despite obligations to the freight rail sector, Capital Metro's intended role is to provide rapid transit services throughout its service area. The initial phase of transit service on Capital Metro's MetroRail transit system consists of the 32-mile Red Line shown in Figure 2 on Capital Metro's Central Subdivision (4th Street in Austin to Leander). Capital Metro plans to extend

[3] Capital Metropolitan Transportation Authority Self-Evaluation Report, Submitted to the Texas Sunset Advisory Commission, September 2009.

[4] Train speeds must not be in excess of 10 mph and passenger service is prohibited. Capital Metro restricts train speeds to 5 mph between MP 23.0 and MP 25.0 on the Giddings Industrial Spur.

transit service at a future date to the proposed MetroRail Green Line (Figure 2) on the East Subdivision between Austin Junction and Elgin.

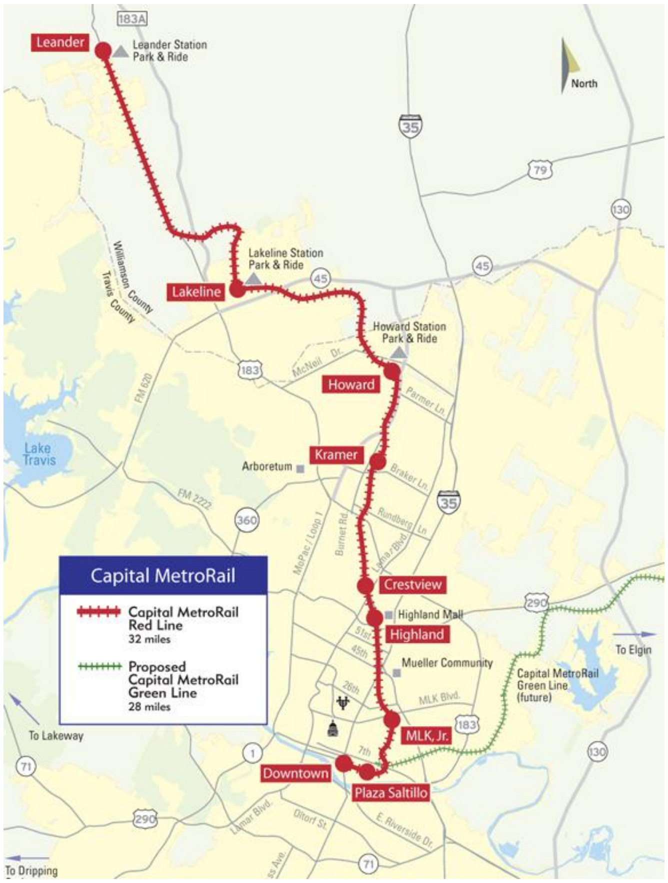


Figure 2: Capital Metropolitan Transportation Authority MetroRail System

Common Carrier Obligation

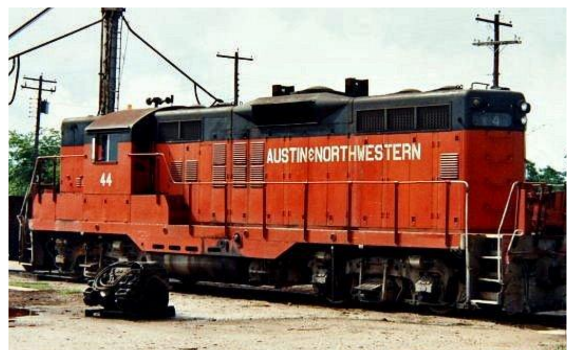
Through the acquisition of the 162-mile rail line, the City of Austin assumed the common carrier obligation[5] to rail shippers that rely on its freight services. The issue of common carrier obligations arose again in association with Capital Metro's purchase of the Giddings-to-Llano rail line from the City of Austin in 1998. In this instance, the Texas Attorney General offered an opinion on the legality of Capital Metro obligating itself as a common carrier to portions of the line outside of the Authority's service area (approximately 100 miles). Segments of the rail line outside of Capital Metro's service area were used strictly for non-transit operations, and Capital

[5] The Interstate Commerce Act of 1887 defines a common carrier as a carrier engaged in the transportation of passengers or property under a common control, management, or arrangement, for a continuous carriage or shipment from one State of the United States to any other place in the United States. This act requires every common carrier to afford all reasonable, proper, and equal facilities for the interchange of traffic between their respective lines, and for the receiving, forwarding, and delivering of passengers and property to and from their several lines and those connecting therewith.

Metro's service area could not be arbitrarily re-defined to encompass the entire Giddings-to-Llano line due to restrictions under Chapter 451 of the Texas Transportation Code.[6]

Shortline Freight Rail Operators

During its time as owner of the line from August 1986 to May 1998, the City of Austin entered into contracts with two shortline rail operators to provide service to freight rail customers. The Austin Railroad Company, doing business as (d.b.a.) Austin & Northwestern Railroad (AUNW), was chartered in 1986 and entered into a 10-year contract as the City of Austin's first freight rail operator on the Giddings-to-Llano line. The Austin Railroad Company itself was owned by RailTex, Inc. of San Antonio, which merged with RailAmerica, Inc. of Jacksonville, Florida in 1999.



AUNW discontinued rail service on the western segment (Llano-to-Scobee) of the line in 1994 and discontinued service on the eastern segment (Smoot-to-Giddings) of the line in 1995. AUNW continued to provide freight rail service over the middle segment, which was and remains the most heavily trafficked portion of the line, throughout the remainder of its contract with the City of Austin. Service on the western and eastern segments of the Giddings-to-Llano line was expected to resume shortly after a new freight rail operator was under contract in 1996.

Subsequent to the AUNW contract, the City of Austin entered into a contract in April 1996 with the Central of Tennessee Railway & Navigation Company, Inc., d.b.a. Longhorn Railroad (LHRR), for services as the new freight rail operator of the Giddings-to-Llano line.[7] LHRR restored service to Elgin by 1997.

In August 2000, Capital Metro awarded a new contract to Trans-Global Solutions, Inc., d.b.a. the Austin Area Terminal Railway (AUAR), as the replacement operator. Freight operations were transferred from Trans-Global Solutions, Inc. (d.b.a. Austin Area Terminal Railroad) to

[6] Texas Transportation Code, Title 6. Roadways, Subtitle K. Mass Transportation, Chapter 451. Metropolitan Rapid Transit Authorities.

[7] STB Finance Docket No. 32885 (Sub-No.1), Central of Tennessee Railway & Navigation Company Incorporated d/b/a The Longhorn Railway Company -- Change of Operator Exemption -- The City of Austin, TX.

the Austin Area Terminal Railroad, Inc. in December 2000.

In October 2007, Capital Metro entered into a contract with the Austin Western Railroad, Inc. (AWRR), a subsidiary of Watco Companies, Inc., to provide freight rail services on the Giddings-to-Llano line. This contract was extended an additional six years in December 2009, coincident with a five-year contract awarded to Herzog Transit Services for operation of Capital Metro's MetroRail passenger system. The Herzog contract replaced a contract awarded to Veolia Transportation Services, Inc. in 2007.

While the ability to set timetables and schedules is considered essential by transit operators, the STB made clear in AWRR's original filing for exemption to operate on the Giddings-to-Llano line that the transit operator will not provide, and does not have the ability to provide, common carrier freight services to customers.[8] The transit operations on the MetroRail Red Line (Figure 2) impose constraints (e.g., allowable operating windows) on AWRR's movement of freight on the Giddings-to-Llano line. However, there are currently limited numbers of freight rail customers in the Elgin area and no customers beyond this and the line's terminus at Giddings. In fact, the largest amount of AWRR traffic occurs within the vicinity of the UP Austin Subdivision and the AWRR rail yard at Austin Junction, located near the Red Line at Howard Lane.

Implications for Austin-to-Houston Passenger Rail Service

Train schedules for passenger rail service between Austin and Houston will require coordination with the MetroRail train schedules established by Capital Metro and must not prevent the freight rail operator from executing its contract to fulfill Capital Metro's common carrier obligation. Coordination of train schedules will be particularly important if the MetroRail Green Line becomes operational between Austin Junction and Elgin.

The 1998 STB award of a BNSF interchange at McNeil has added to the concentration of rail activity near the Austin Subdivision and proximity to most rail customers and has minimized the role of Elgin as an interchange location. There are currently no interchanges being made with the Class I railroads at Elgin, although switches are in place and there is some renewed interest by Capital Metro in the potential for Elgin to serve in this capacity. Not having to move carloads between rail customers and the Elgin interchange has reduced shortline operating costs and improves shortline viability. However, as the track east of Austin has begun to play a smaller role in railroad operating revenues over time, there has been less incentive to invest limited

[8] STB Finance Docket No. 35072, Austin Western Railroad, Inc. – Operation Exemption – Capital Metropolitan Transportation Authority.

capital in this segment of infrastructure. The consequence of deferred maintenance east of Austin to the development of the proposed MetroRail Green Line and the Austin-to-Houston passenger rail line will be a greater cost of implementation.

Austin-to-Hempstead Corridor

The rail line constructed between Austin and Hempstead in 1871 was the Austin area's first access to other rail lines in Texas, with the first mainline through the city not completed until four years later by the arrival of the International & Great Northern (IGN). Other railroad mainlines continued to be constructed through towns first served by the Austin-to-Hempstead line, diminishing its role as an east-west branch line over time. Over the next several decades, alternative rail service was provided to:

- Austin, 1875 – International & Great Northern (UP Austin Subdivision)
- Elgin, 1887 – Missouri-Kansas-Texas (UP Waco Subdivision)
- Brenham, 1881 – Gulf, Colorado & Santa Fe (BNSF Galveston Subdivision)
- Giddings, 1890 – San Antonio & Aransas Pass (UP Giddings Subdivision)

As alternative railroads began to serve these towns, segments of the Austin-to-Hempstead line became connectors between mainlines and local rail customers, justifying their abandonment as Class I rail lines. SP's Hempstead-to-Brenham segment (MP 0.00 to MP 20.86) was taken out of service following ICC abandonment proceedings in August 1961.[9] Rail service continued over the Brenham-to-Giddings segment (MP 20.86 to MP 55.78) through access by SP's San Antonio & Aransas Pass line (now the UP Giddings Subdivision) up to ICC abandonment proceedings for this segment in June 1980.[10] Finally, SP abandoned the track west of Giddings (west of MP 57.00) in 1986 that was purchased by the City of Austin soon thereafter.

Despite the abandonment of most SP track between Austin and Hempstead, UP retained, through the UP/SP merger, a small section of track at Giddings that connects with the UP Giddings Subdivision. This 1.22-mile segment of track in Giddings is now owned by Capital Metro, but operated by UP with access from the UP Giddings Subdivision to serve a local shipper (Lee County Co-Op). A segment of the SP line in Brenham also remains in use by local customers (e.g., Blue Bell Creameries) to receive shipments off of the BNSF Galveston Subdivision.

[9] ICC Finance Docket No. 21573, August, 17, 1961.

[10] ICC Finance Docket No. AB12 (Sub-No. 56), June 13, 1980.

Section 2: Existing Infrastructure and Operations

The rail corridors analyzed for potential passenger rail service include the Austin-to-Hempstead portion of the Austin-to-Houston corridor, as well as a corridor north to Bryan/ College Station as shown in Figure 3. The Hempstead-to-Houston portion of the corridor is under analysis by the Gulf Coast Rail District (GCRD) in an independent study. The Austin-to-Hempstead segment consists of an existing rail line owned by Capital Metro from Austin to Giddings as well as an abandoned rail corridor from Giddings to Hempstead, including a short existing rail line within Brenham. Rail lines to Bryan/ College Station consist of the UP Eureka and Navasota Subdivisions between Hempstead and Bryan as well as the UP Giddings Subdivision between Giddings and Mumford, with a connection to the UP Navasota Subdivision to Bryan from Mumford.

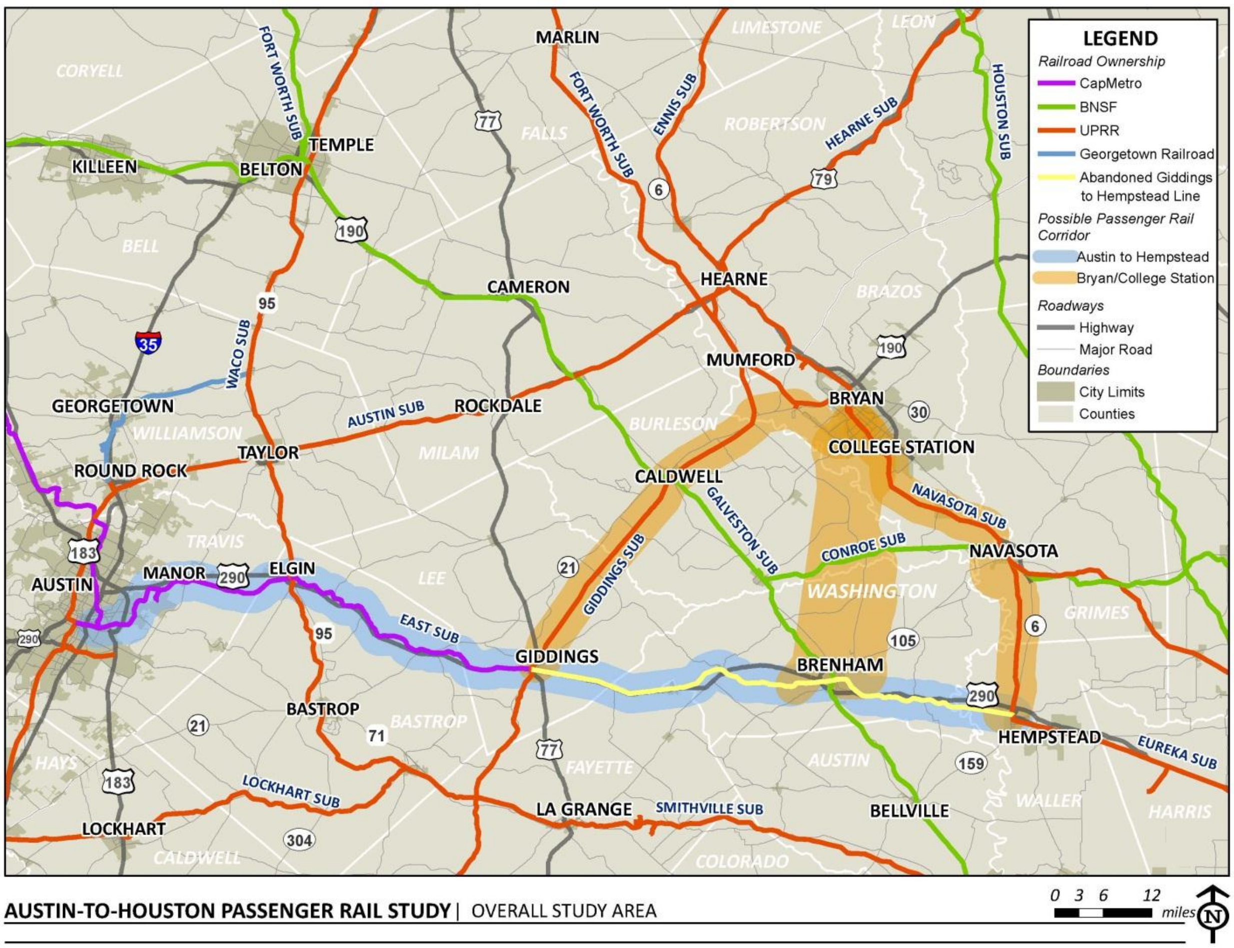


Figure 3: Austin to Houston Passenger Rail Study Area

Austin-to-Hempstead Corridor

Operations

The Capital Metro-owned rail lines are divided into subdivisions defined as follows:

- West Subdivision – Leander to Llano
- Central Subdivision – 4th Street/Austin Convention Center to Leander
- East Subdivision – Giddings to Austin Junction
- Marble Falls Branch – Fairland to Marble Falls

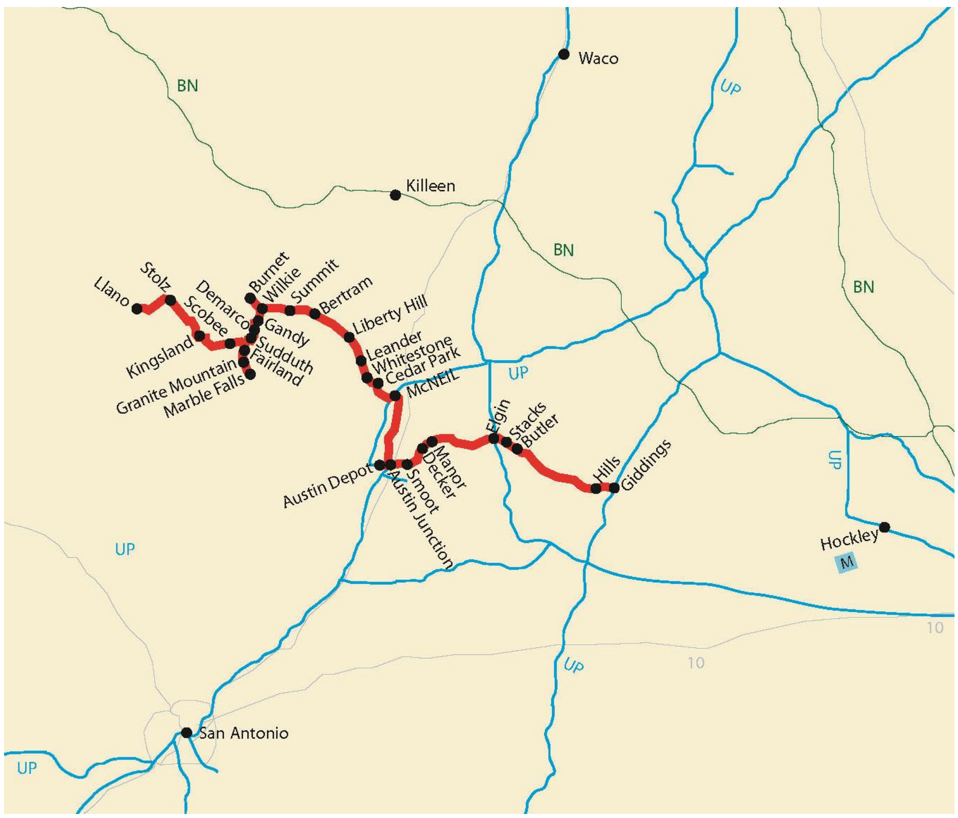


Figure 4: Limits of the Capital Metro Owned Rail Line

For the purpose of this study, only the East Subdivision is included in the Study Area. The East Subdivision of the rail line is currently operational only between Austin Junction and Butler (just east of Elgin), with no existing service and inoperable track conditions between Butler and Giddings. However, the UP serves a customer, the Lee County Co-Op, just west of Giddings along a small section of track (approximately 1.3 miles) that connects to the UP Giddings Subdivision.

Table 1 provides a list of rail spurs, switches, and industrial customers on the East Subdivision. With 90 percent of rail freight in the Capital Area Metropolitan Planning Organization (CAMPO) area consisting of exports of crushed stone, Portland cement, and lime originating along the Capital Metro West Subdivision, the remaining 10 percent of rail freight within the Austin area consists of imports of lumber, petroleum, wood products, and fabricated metal products that are more characteristic of commodities moved over the Capital Metro East Subdivision.[11] Table 1 describes this line as serving a petroleum tank farm (MP 47.80) and a lumber company (MP 55.44), as well as the construction materials business of Capitol Aggregates, all within 16 miles of Austin Junction.

Austin Junction (MP 56.21) comprises the western terminus of the East Subdivision and the southern terminus of the Central Subdivision and provides Downtown Austin with a connection to the MetroRail Red Line and proposed Green Line. The Katy Spur, which demarks the line's previous intersection with a former MKT line between Georgetown and Austin, is located near Austin Junction at MP 56.17. The eastern terminus of operations on the East Subdivision (MP 25.10) serves the Elgin Butler Brick Company, located east of the Elgin interchange (MP 30.72). However, this interchange is not currently being used by Capital Metro's freight rail operator, so rail freight from this facility is hauled over the Capital Metro East Subdivision into Austin.

Facility	Description	MP	Landmark
Butler Spur		25.10	
Butler Siding	East Switch	25.15	FM 696 (MP 25.16)
Butler Siding	West Switch	25.75	
Elgin UP Tower 100	Automatic Interlocker	30.72	
Littig Siding	East Switch	39.05	
Littig Siding	West Switch	39.95	Littig Rd. (MP 39.99)
Capitol Aggregate Loop Track	East Switch	40.05	
Capitol Aggregate Loop Track	West Switch	40.52	
Manor Spur (removed from service)		43.10	
Decker Siding	East Switch	46.38	Decker Ln. (MP 46.25)
Decker Siding	West Switch	47.04	
Petroleum Tank Farm Spur		47.80	Daffan Ln. (MP 47.95)
Smoot Spur		52.94	US 183 (MP 53.54)
Guthrie Lumber Co. Spur		55.44	Tilerey St. (MP 55.58)
ABC Spur		55.62	Gonzales St. (MP 55.65)
Pleasant Valley Spur & Layover Yard		55.85	Pleasant Valley Rd. (MP 55.91)
Katy Spur	MoKan ROW	56.17	Pedernales St. (MP 56.18)
Austin Junction	East Wye	56.21	Robert Martinez St. (MP 56.49)

Table 1: Industry Tracks, Sidings, and Yards on the Capital Metro East Subdivision

Freight trains operating on the East Subdivision consist of ethanol trains that operate between Decker and Elgin, switch trains that operate between Decker and Robinson (near the McNeil interchange) on the Central Subdivision, and trains that operate between Butler and Summit on

[11] Bituminous coal is the largest single commodity imported to the CAMPO area (i.e., Bastrop, Caldwell, Hays, Travis, and Williamson Counties). However, coal shipments are made to industrial facilities in the outer region of the CAMPO area and no coal-fueled power plants exist along the Capital Metro line within the Austin area.

the West Subdivision. The loaded ethanol unit trains arrive on the UP Waco Subdivision in Elgin on Thursdays and travel westbound to Decker along the East Subdivision for unloading and then return to the UP in Elgin on Mondays. The switch trains travel westbound from Decker to Robinson in the mornings and return eastbound in the evenings on Tuesdays and Thursdays. Additionally, trains travel westbound from Butler in the evenings on Tuesdays, Thursdays, and Saturdays, progressing through several stations on the East and Central Subdivisions, and arriving at Summit on the West Subdivision in the early mornings. The trains then return eastbound from Summit in the evenings on Mondays, Wednesdays, and Fridays and arrive at Butler in the early mornings.

Infrastructure

The Capital Metro East Subdivision consists of 57.8 miles of mainline track between Austin and Giddings, with 38 railroad bridges for a total length of nearly 5,000 feet, 118 drainage structures (e.g., culverts), three crossings with other rail lines (the Capital Metro Central Subdivision/ Red Line, the UP Waco Subdivision in Elgin, and the UP Giddings Subdivision in Giddings), and 99 at-grade roadway-railroad crossings, 63 of which are public.

An inventory of track infrastructure between Giddings and Austin Junction is provided in Appendix B. The track inventory identifies the number of tracks, locations and geometry of curves, allowable train speeds, and size of rail along the corridor. Additionally, a photo inventory was conducted for the corridor and is included in Appendix B. The photos document all major at-grade crossings and bridges between Austin and Hempstead, as well as locations of potential right-of-way constraints along the abandoned corridor between Giddings and Hempstead. The existing Capital Metro East Subdivision alignment and right of way boundaries are shown in the exhibits in Appendix D.

Federal Railroad Administration (FRA) track classifications have been assigned to sections of track corresponding to the maximum allowable train speeds for freight rail prescribed in 49 CFR 213 – Track Safety Standards.[12] Speed restrictions in the Capital Metro freight rail operator timetables have been used to assign track classifications to East Subdivision track segments using the maximum freight train speed corresponding to each track class listed in Table 2. The portion of the East Subdivision that is out of service from Butler to Giddings (approximately 26.3 miles) is excepted track, while the majority of the rail line that is within service between Butler and Austin is Class 2 track (24.1 miles). Small portions of the line (7.3 miles), mostly located near Elgin and downtown Austin, are listed as Class 1 track due to reasons including track condition, bridge condition, track geometry, and operations through urban areas (i.e., downtown Austin). The track classifications define the maximum allowable speed of passenger trains according to Table 2 under current track conditions.

[12] Code of Federal Regulations, Title 49, Transportation, Part 213 (49 CFR 213), Subpart A – Classes of Track: Operating Speed Limits.

Track Class	Freight Train Speed (mph)	Passenger Train Speed (mph)
Excepted Track	10	not allowed
Class 1	10	15
Class 2	25	30
Class 3	40	60
Class 4	60	80
Class 5	80	90

Table 2: Maximum Allowable Train Speeds per FRA Track Class

The bridges on the existing line between Austin and Giddings are listed in the inventory in Appendix B by location, bridge type, and length along with photos of each bridge. Of the 38 bridges along the line, 32 are timber structures, 3 are steel, and 3 are concrete. A bridge at railroad milepost 43.35 near Manor requires a reduction in train speed through the area due to bridge condition. Several of the timber bridges would require repairs in order to allow for passenger rail service.

The rail crossings along the corridor consist of an interchange with the Capital Metro Central Subdivision at Austin Junction (see Figure 5), which is the western terminus of the East Subdivision, the UP Waco Subdivision in Elgin (see Figure 6), the UP Giddings Subdivision in Giddings (see Figure 7), the BNSF Galveston Subdivision in Brenham (see Figure 8), and the UP Eureka Subdivision in Hempstead (see Figure 9). The Capital Metro Central Subdivision is the route for the Capital Metro's MetroRail Red Line that provides commuter rail service between Leander and Austin. The Waco Subdivision runs between Smithville and Waco and the Giddings Subdivision runs between West Point (east of Smithville) and Hearne. The Eureka Subdivision runs from Houston through Hempstead to Navasota, where it connects to the Navasota Subdivision running north to Bryan.

The grade crossings along the existing line between Austin and Giddings are listed in the inventory in Appendix B by street name, location, DOT crossing ID number, and type (public, private, at-grade, overpass, underpass), along with photos of each major crossing.

Figure 5: Austin Junction, Capital Metro Central Subdivision

Figure 6: Waco Subdivision Crossing in Elgin

Figure 7: Giddings Subdivision Crossing in Giddings

Figure 8: BNSF Galveston Subdivision Crossing in Brenham

Figure 9: Eureka Subdivision in Hempstead

Abandoned Right of Way

As previously discussed, the abandoned Southern Pacific (SP) right of way runs from Giddings to Hempstead. Although the abandoned right of way has been sold, large portions of the corridor remain undeveloped. As shown in Figure 10, the majority of the land use along the corridor is agricultural. However, portions of the abandoned right of way have been developed in the areas of Giddings, Burton, Brenham, and Chappell Hill.

In particular, the abandoned right of way no longer exists where it runs through the city of Giddings. A grocery store, medical buildings, retail stores, and several other developments in downtown Giddings have been built within the original right of way as shown in Figures 11 and 12.

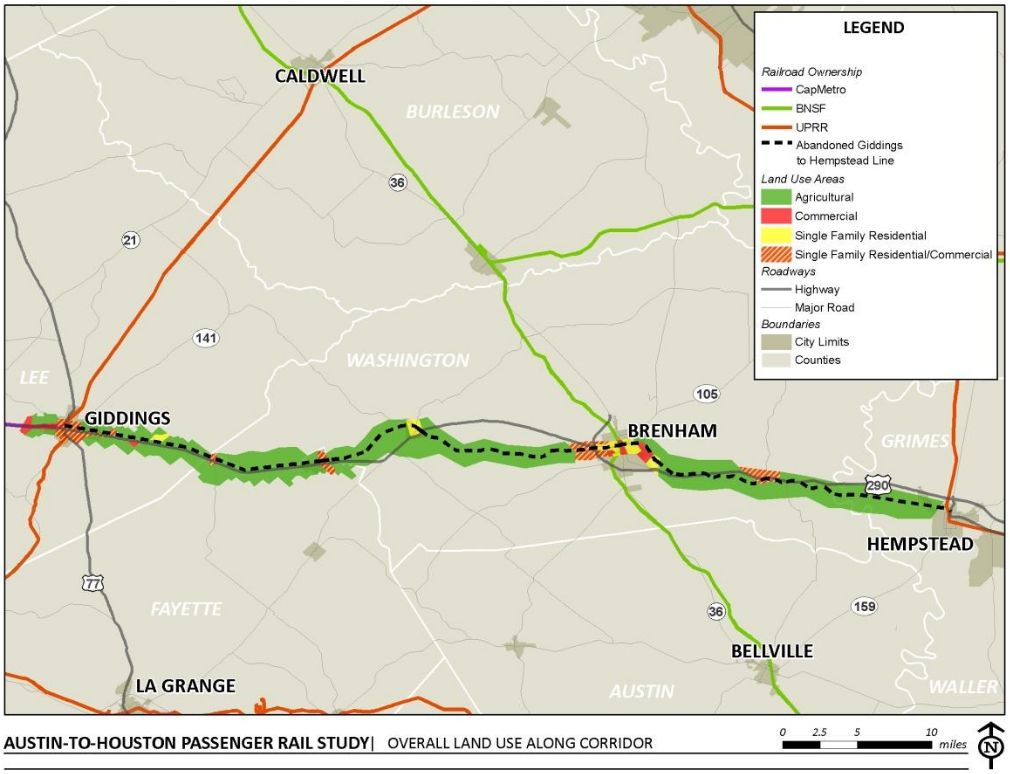


Figure 10: Land Use along Abandoned Corridor

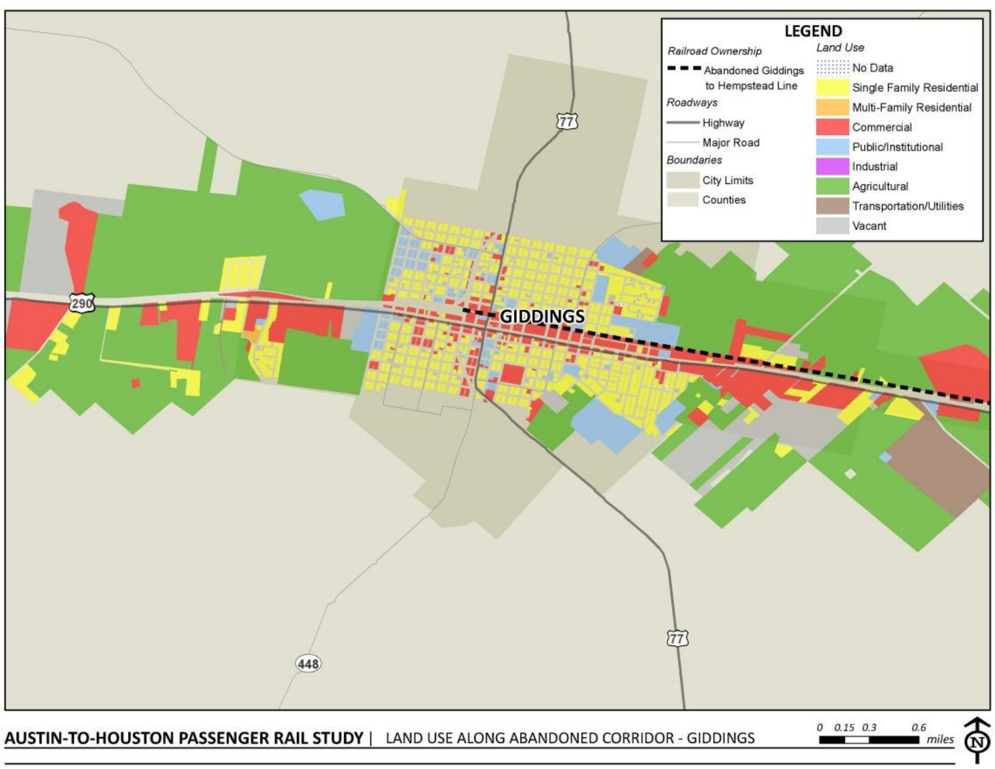


Figure 11: Land Use along Abandoned Corridor in Giddings

Figure 12: Development in Abandoned Right-of-Way in Giddings

Additionally, retail buildings and residential homes have been built either within or adjacent to the abandoned right-of-way boundaries in Burton as shown in Figures 13 and 14. Figure 15 shows the old bridge abutments where the rail line previously crossed U.S. 290, although the bridge has since been removed.

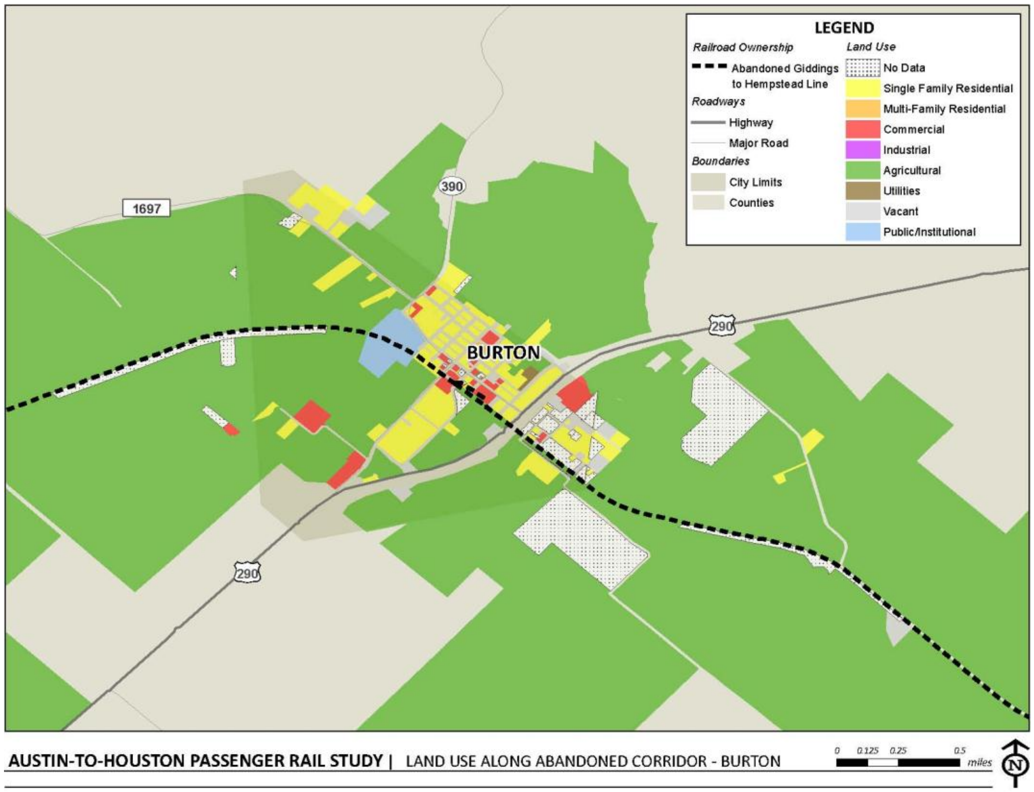


Figure 13: Land Use along Abandoned Corridor in Burton

Figure 14: Development in Abandoned Right-of-Way in Burton

Figure 15: Location of Removed Rail Bridge at U.S. 290 in Burton

Within Brenham some residential, commercial, and industrial developments have been built adjacent to or within the abandoned right-of-way corridor. Also, a single-track mainline exists and is in use today by BNSF from just west of the BNSF Galveston Subdivision through downtown Brenham to east of FM 577 near the Blue Bell Creameries. Figures 16 through 20 show the land use along the abandoned corridor through Brenham and Chappell Hill.

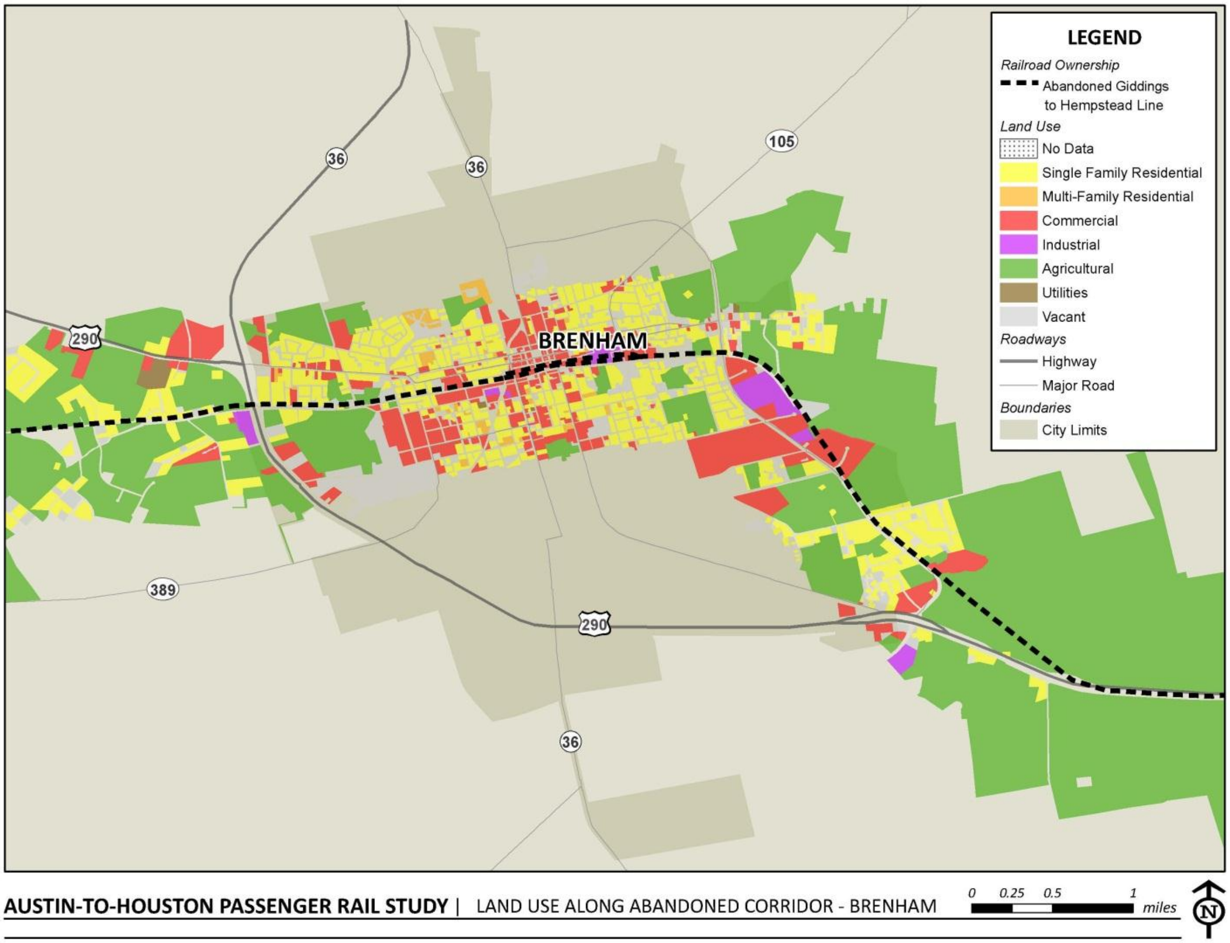


Figure 16: Land Use along Abandoned Corridor in Brenham (overall)

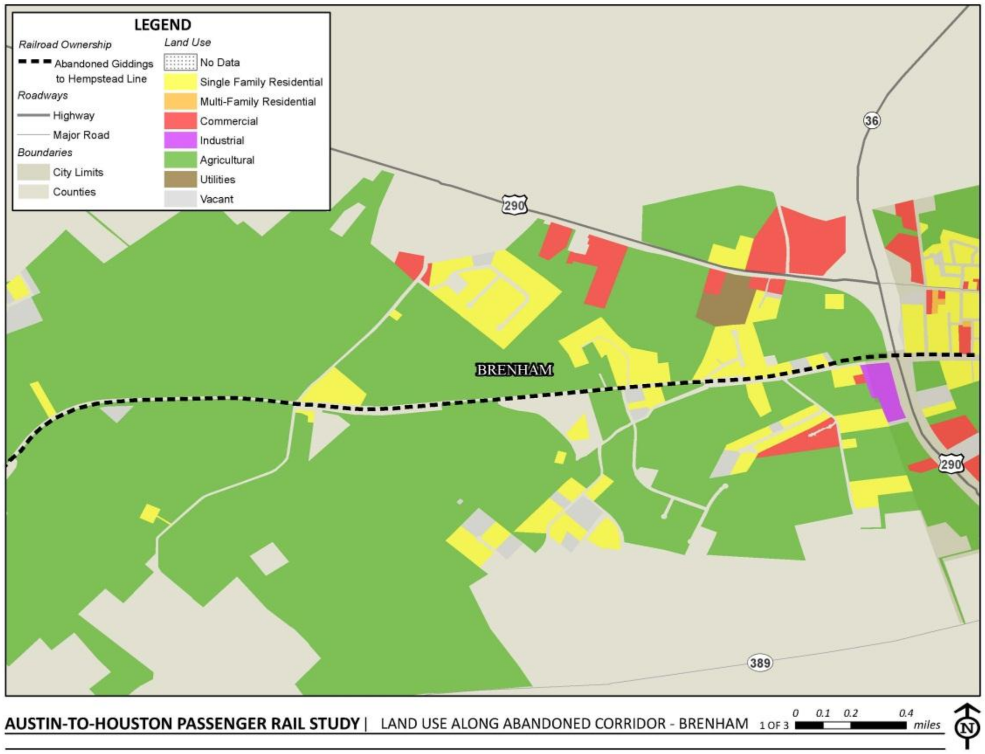


Figure 17: Land Use along Abandoned Corridor in Brenham (west)

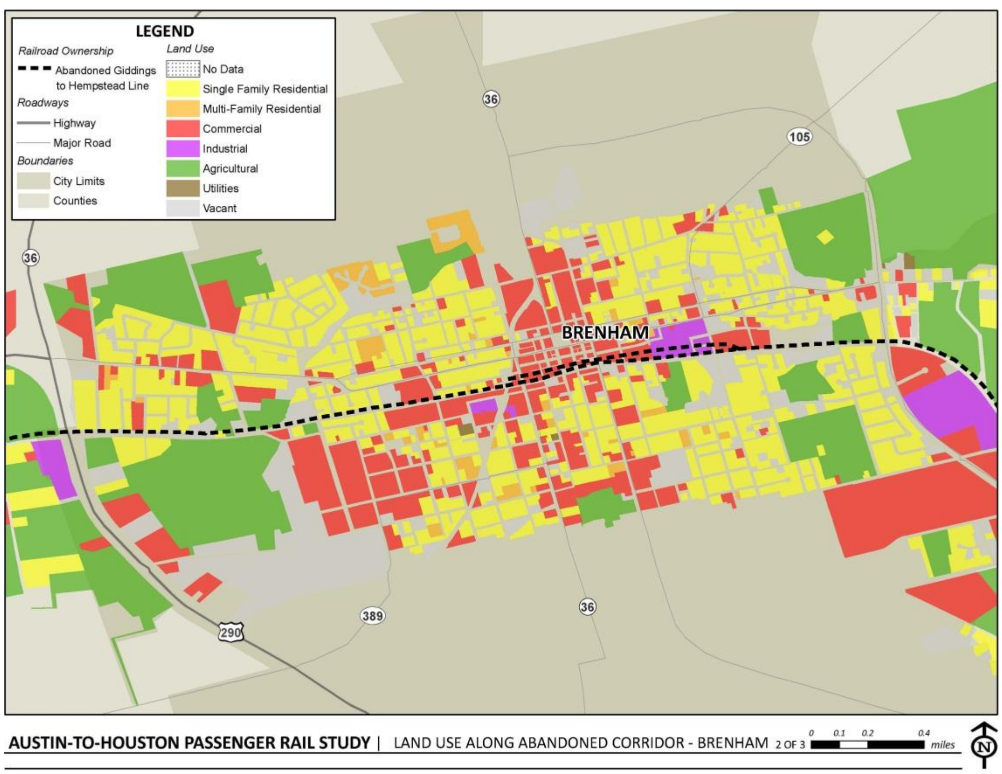


Figure 18: Land Use along Abandoned Corridor in Brenham (central)

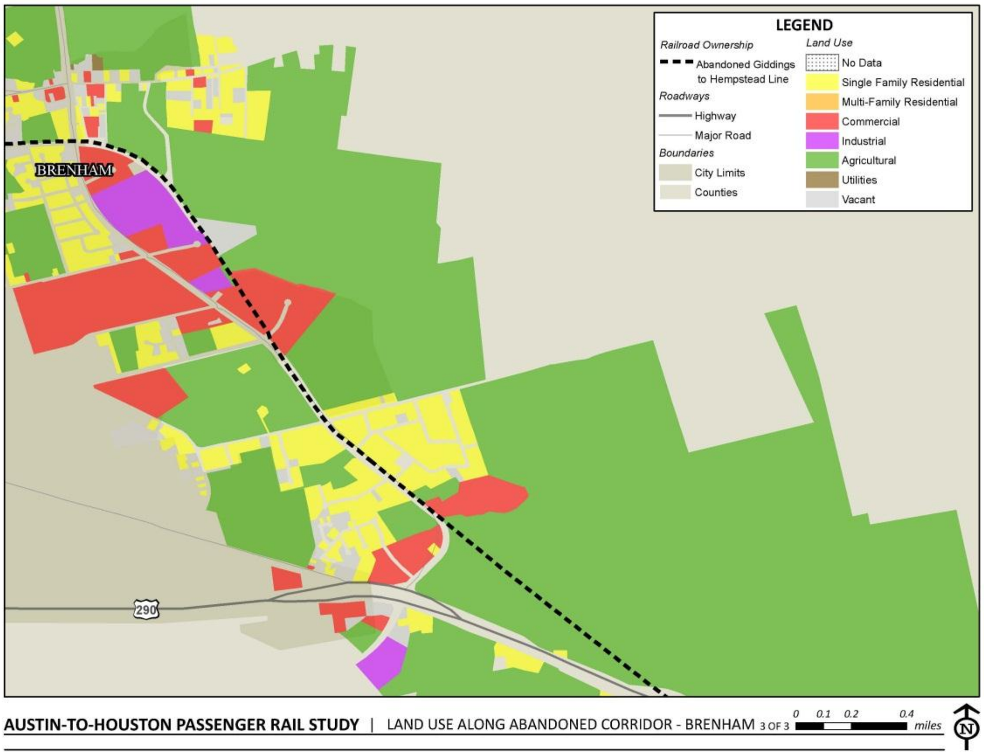


Figure 19: Land Use along Abandoned Corridor in Brenham (east)

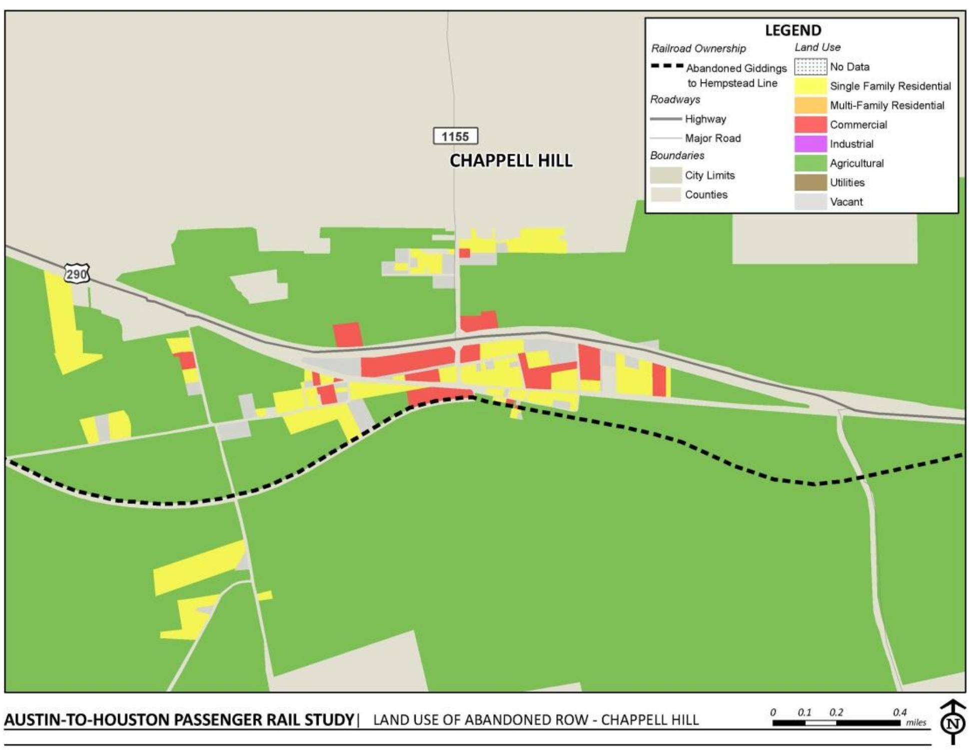


Figure 20: Land Use along Abandoned Corridor in Chappell Hill

Hempstead-to-Bryan/ College Station Corridor

The potential routes to Bryan/ College Station were not included in the detailed inventory conducted for the Austin-to-Hempstead corridor. Bryan/ College Station may be accessed by rail from the Austin-to-Hempstead corridor via the UP Giddings Subdivision or the UP Eureka and Navasota Subdivisions.

The UP Giddings Subdivision interchanges with the Capital Metro East Subdivision at Giddings and runs north to Hearne, where it connects to the Navasota Subdivision, which provides access to Bryan. The Giddings Subdivision also may also access Bryan via a connection with the Bryan Subdivision. The Giddings Subdivision is a single-track rail line with limited sidings and allowable freight train speeds of 60 mph to 70 mph on the mainline (Class 4 track). Approximately 15 to 20 trains per day operate on the UP Giddings Subdivision.

The Eureka Subdivision is a single track rail line with limited sidings and allowable freight train speeds of 40 mph on the mainline (Class 3 track) with several segments limited to 25 mph (Class 2). Currently, approximately 10 freight trains operate on the Eureka Subdivision per day. Both the Eureka Subdivision and Giddings Subdivision routes would require an interchange with the UP Navasota Subdivision to access Bryan/ College Station. The Navasota Subdivision is a single-track rail line with limited sidings and allowable freight train speeds of 50 mph to 60 mph on the mainline (primarily Class 4 track). Approximately 20 to 25 trains per day operate on the UP Navasota Subdivision.

The potential routes to Bryan/ College Station analyzed in this study consist of new dedicated passenger rail lines adjacent to the existing freight rail rights of way, and do not include shared use tracks. Evaluations for shared use options, although not included in this study, would need to consider impacts to existing freight operations, constraints associated with existing rail interchanges and yards, available capacity given current and projected train volumes, as well as allowable speeds on the existing freight lines.

Section 3: Alternative Alignments Analysis

The purpose of the Austin to Houston Passenger Rail Study is to identify the infrastructure requirements for passenger rail service with speeds up to 110 mph between Austin and Houston including alternatives for service to Bryan/ College Station. The Hempstead-to-Houston portion of the corridor is under analysis by the GCRD in an independent study. This section discusses the methodology used to determine the possible alignments, an overview of the possible alignments, a fatal-flaw analysis of environmental factors and vertical profile issues, travel times based on maximum allowable train speeds, and identification of the alignments modeled for intercity passenger rail operations for the Austin-to-Houston corridor.

Methodology

The possible alignments were developed based on track design criteria required to achieve passenger rail speeds of up to 110 mph as well as considerations for passenger station locations and infrastructure requirements.

Design Criteria

Maximum allowable train speeds for freight and passenger rail are prescribed according to track classification in 49 CFR 213 – Track Safety Standards.[13] Upgrades necessary to increase the class of track, and thereby increase the maximum allowable train speeds, may include railroad tie, rail, and ballast replacement, resurfacing and gauging the track, and changes to existing track geometry such as reducing the degree of horizontal curves. Actual operating train speeds would depend on line capacity, the acceleration/deceleration capabilities of passenger trains, and the distance between passenger stations in addition to the maximum allowable train speeds. Table 3 shows the class of track associated with the allowable passenger train speeds.

Track Class	Passenger Train Speed (mph)
Class 1	15
Class 2	30
Class 3	60
Class 4	80
Class 5	90
Class 6	110

Table 3: Maximum Allowable Train Speeds per Track Class

Line capacity is a measure of the maximum number of trains that can be operated over a rail line, or section of line, within a specified unit of time. Capacity is generally influenced by operational factors such as train speed restrictions, signal system design, and traffic at railroad

[13] Code of Federal Regulations, Title 49, Transportation, Part 213 (49 CFR 213), Subpart A – Classes of Track: Operating Speed Limits.

junctions.[14] Non-track issues that affect line capacity for passenger trains are the dwell times at passenger stations and meet/pass efficiency. In terms of passenger rail capacity on existing rail networks, capacity is further influenced by the volume of existing freight rail traffic and any other constraints imposed through shared-use agreements with the track owners. Line capacity issues will be discussed in Section 4 of this report.

The most fundamental components of long-range transportation plans for passenger rail service are the selection of station locations and the development of train schedules.[15] Passenger stations should be located to maximize total train ridership, or public value, by accommodating an optimal mix of business and non-business travel. In order to attract this mix of riders, sites should be selected in a way that major destination points are included in the passenger rail system while avoiding excessive numbers of stops that tend to lengthen trip times. The FRA recommends the following guidelines for locating passenger rail stations:

- Include the Central Business District (CBD)
- Select station locations within easy access to local roadways
- Configure station tracks to provide for the through movement of trains rather than using stub-end terminals
- Acquire enough land that will accommodate station platforms that are as long as the longest passenger train and interlocking spacing capable of holding the trains

Failure to locate passenger stations where there is sufficient land to expand parking facilities can limit a system’s capacity to serve the public. Potential locations for passenger stations should be determined through a ridership analysis, which is not a part of this study. However, potential areas for passenger stations have been analyzed for the purposes of identifying infrastructure requirements for the potential passenger rail line.

Potential passenger train schedules on an existing freight rail network are largely dependent on the terms under which track rights agreements are made with the owning railroad. The frequency of service needed on a rail network must be estimated according to factors such as residential population densities, volumes of daily passenger trips, and the accessibility of major destinations and connectivity to other transit modes from rail corridors. Potential passenger train schedules will be discussed in a separate section of this study. Additionally, passenger rail considerations such as issues associated with the shared use of freight rail lines (i.e., cost allocation methods, operating agreement negotiations, and accident liability) have not been analyzed as a part of this study.

[14] *Transit Capacity and Quality of Service Manual*, 2nd ed., TCRP Report 100, Transit Cooperative Research Program, Federal Transit Administration, Washington, D.C., 2003.

[15] Railroad Corridor Transportation Plans: A Guidance Manual, Federal Railroad Administration, U.S. Department of Transportation, Washington, D.C., July 2005.

Infrastructure Improvements

Infrastructure improvements along the existing Capital Metro track that are required for maximum allowable train speeds of up to 110 mph (Class 6) include rehabilitation of the existing track (new rail, new ties, new ballast, surfacing, etc), modifications of existing horizontal geometry, passing sidings, and possible passenger rail stations. Possible modifications to the existing geometry of the Capital Metro track from Austin to Giddings to meet Class 6 criteria are discussed in more detail later in this section in the overview of alternative alignments.

The possible alignments, including segments of new track, generally consist of a single mainline track with ditches on either side of the track as shown in the typical section detail in Figure 21.

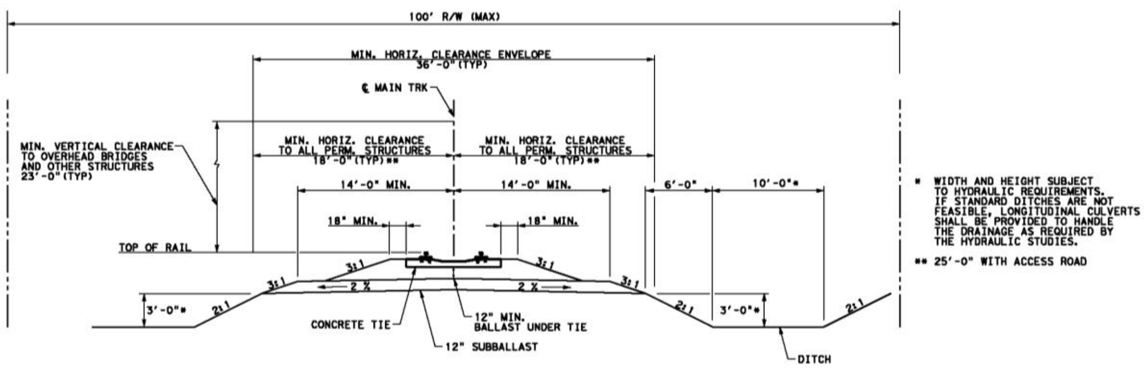


Figure 21: Possible Track Typical Section (single mainline)

Figure 22 shows a possible track configuration for segments of the possible passenger rail corridor that may follow and existing freight rail corridor such as the UP Giddings or Navasota Subdivisions. As shown in the figure, the passenger rail line would require 50 feet of separation from the freight rail line.

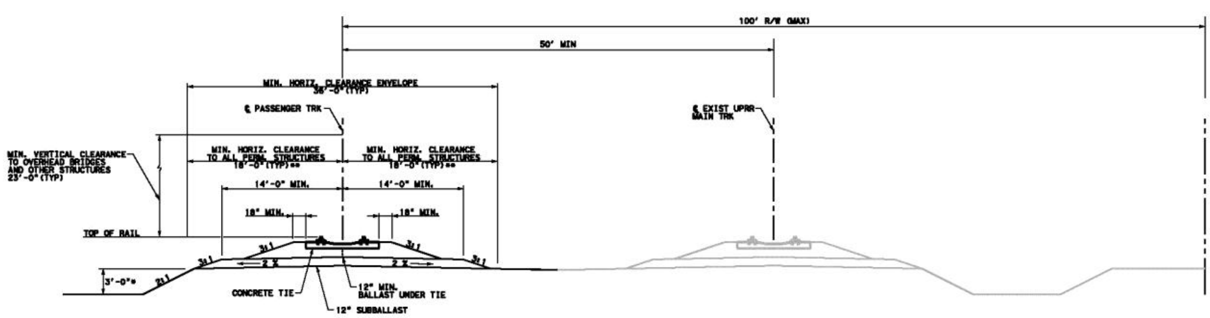


Figure 22: Possible Track Typical Section Along Existing Freight Corridor(single mainline)

Figure 23 details a track configuration for possible passing siding locations. Passing sidings needed for the potential passenger trains are identified in Section 4 the report based on an analysis of the corridor operations using Rail Traffic Controller (RTC) modeling software.

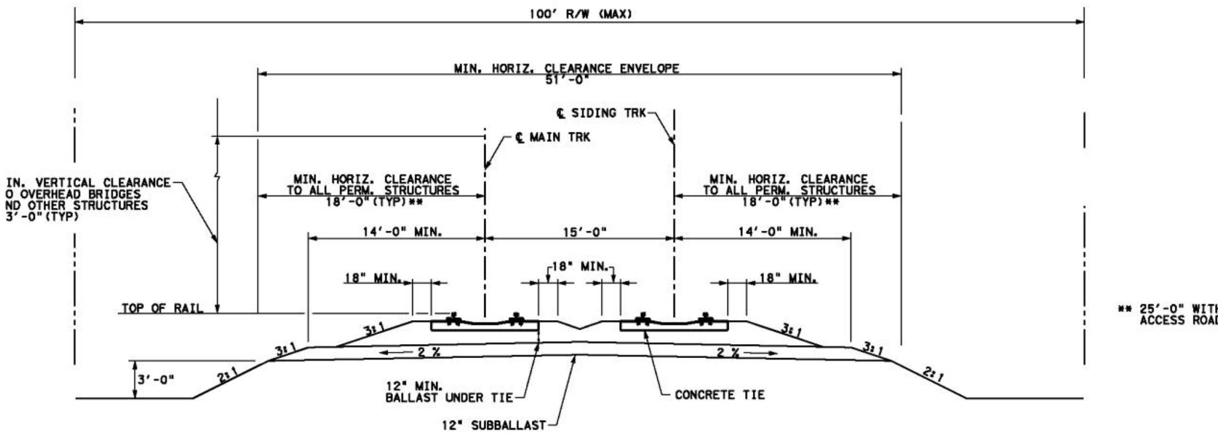


Figure 23: Possible Track Typical Section (single mainline with siding)

Figure 24 details a potential station platform for loading and unloading of passengers adjacent to the single mainline track. Although general passenger station locations will be assumed for this study, locations of station sites should be determined as part of a ridership analysis, which is not included as part of this study. Sidings would not be required for the level of passenger service modeled in this study; however, sidings may be required if future passenger rail service levels increase. Figure 25 shows a potential track configuration at a station with a center platform in between the mainline track and a siding, although this configuration is not assumed in the cost estimates in this study.

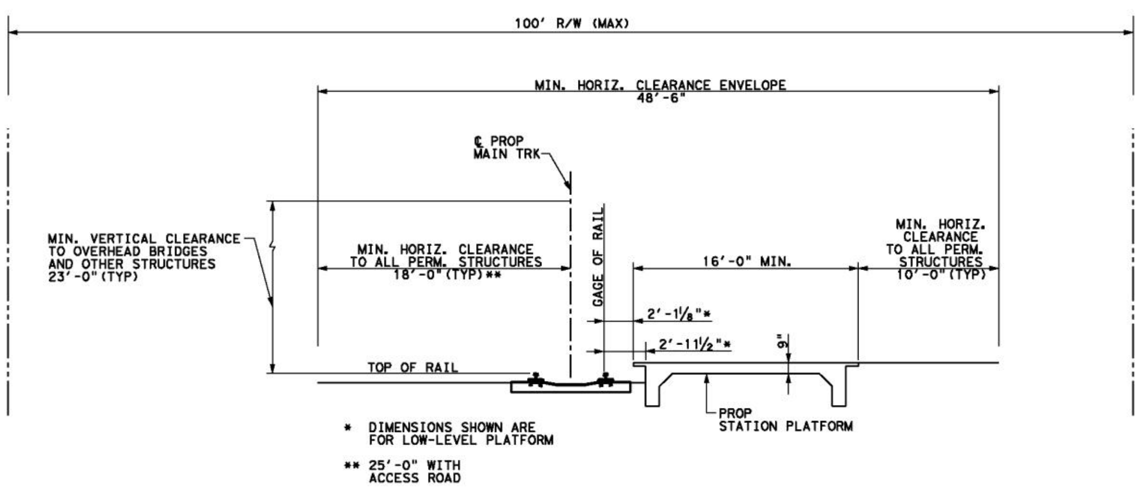


Figure 24: Possible Track Typical Section (station location without siding)

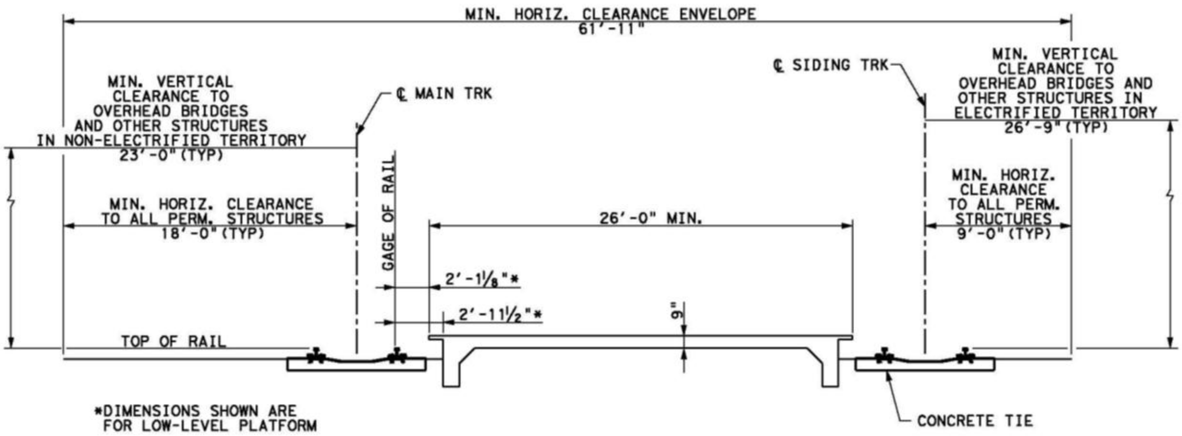


Figure 25: Possible Track Typical Section (station location with siding)

In certain locations within the possible passenger rail alignments, a minimum right-of-way width of 40 feet would likely need to be utilized to allow existing structures and features to remain in place. These instances would require adjustments to ditch system configurations as shown in Figures 21 through 23. Examples of locations where a minimum typical section may be utilized include the Ledbetter and Carmine town limits due to existing building and roadway features and in downtown Brenham due to potentially historic structures.

In addition, there are likely locations where additional embankment/excavation may be required due to the maximum vertical grades for Class 6 allowable train speeds. These locations, generally from Burton to the Brazos River west of Hempstead, may require additional right of way for the larger embankment/excavation areas or the use of retaining walls to limit right-of-way acquisition where applicable.

There are possible alignment alternatives which show track alignments adjacent to the existing U.S. 290 right of way. Along these segments of U.S. 290 there is a possibility that vehicular traffic using the side streets from U.S. 290 across the possible rail alignment may queue into U.S. 290 when passenger trains occupy the roadway-rail crossing. In these cases it may be determined that right-turn bays be utilized to allow vehicles to safely queue in a lane outside of the U.S. 290 main lanes and shoulder areas. In addition, use of signal preemption devices at certain locations along U.S. 290 may be warranted due to sight distances and other factors.

Assumptions

Existing reports and conceptual alignments for potential passenger and commuter rail facilities have been utilized as part of the possible Austin-to-Houston corridor alternatives alignment analysis. Reports for the City of Austin, Capital Metro, and the GCRD have been reviewed and incorporated where practicable as part of the possible alignments in this study. Coordination with ongoing studies was also conducted and information available at the time this study was completed was incorporated.

Initial evaluation of the possible alignments within the study limits utilized aerial photography to determine locations of existing residential and commercial land use and properties as well as existing contour data to validate the possible vertical grades along the passenger rail corridor. USGS quadrangle maps were also used to verify the locations of abandoned railroad corridors and potential major utility conflicts to avoid along the possible alignment routes.

An environmental fatal-flaw analysis was performed within a one-mile corridor of all of the possible alternative alignments. The analysis consists of identification of potential constraints that may preclude a possible alignment to be adjusted to accommodate the constraint or to no longer be considered. These environmental constraints are comprised of hazardous waste sites, wetlands and water bodies, threatened and endangered species, historic structures, cemeteries, and archeological sites. An environmental constraints report and constraints maps are provided in Appendix F.

Along the Capital Metro track, a possible alternative identifies locations where the existing alignment may be adjusted to reflect reductions in the degree of curves required to meet Class 6 criteria. In some cases this may affect rail connections into freight industry customers. Possible connections to freight customers have been evaluated and verified where connections may have been adjusted.

Although not part of the scope of services for the project, an identification of possible station locations is essential in determining a corridor route for the passenger rail system. Possible station locations within the corridor route include Austin, Elgin, Giddings, Brenham, and Hempstead as well as Navasota, Bryan, and College Station along the alignments to Bryan/ College Station. However, a ridership analysis should be used to ultimately determine locations for stations within the passenger rail corridor; a ridership study is not included as part of the scope of services for the project.

There are many locations where the possible alignments cross or are adjacent to existing railroad tracks and facilities. Major possible crossings at existing railroad corridors include the UP Waco Subdivision, the UP Giddings Subdivision, the BNSF Galveston Subdivision, the UP Eureka Subdivision, the BNSF Conroe Subdivision, and the UP Navasota Subdivision. Where possible, a grade separation at the existing railroad corridor has been suggested to eliminate any potential railroad operational conflicts.

It is assumed that use of existing UP and BNSF facilities would not be an acceptable option in most cases for a passenger rail route due to high freight volumes and operational conflicts. However, the existing Capital Metro rail corridor between Austin and Giddings (East Subdivision) has been evaluated for potential Class 6 passenger rail traffic due to the low freight volumes on the track.

Possible Alignment Alternatives

Alternative passenger rail routes analyzed for the segment between Austin and Hempstead for service between Austin and Houston included alternatives for a connection into the Austin central business district, alignments between Austin and Hempstead, and alternative routes to Bryan/ College Station.

Austin CBD Alignment Alternatives

The Austin central business district (CBD) is comprised of dense commercial land use with few open corridors for a passenger rail corridor connection. The Capital Metro commuter rail line to Leander terminates in the east end of the Austin CBD at 4th Street just west of I-35 and an existing Amtrak passenger station on the Texas Eagle route is located along the UP Austin Subdivision track on the west end of the CBD on North Lamar by West 3rd Street. Additionally, a potential intermodal hub may be placed just east of this station at the former Seaholm Power Plant property. A passenger rail alignment to the Austin CBD would be required to connect the west side to the east side of the CBD to provide connectivity with the Capital Metro commuter line to Leander (Red Line) as well as the Amtrak route that runs north-south through Austin.

The City of Austin has identified possible urban rail corridors within the city that may be utilized for connections with this study's possible rail alignment. The City currently has identified potential routes from Seaholm on the west side of the CBD to the Mueller Development east of I-35 and from the University of Texas campus to the Austin-Bergstrom International Airport. The rail plan also denotes a 700-foot extension of the existing Capital Metro Red Line commuter rail system west to Brazos Street. The possible City of Austin Urban Rail route is shown in Figure 26 along with a potential connection from the intercity passenger rail route analyzed in this study (shown in the Figure as the Green Line) to the Urban Rail route. The potential CBD connections shown in Figure 26 were not analyzed in detail or included in the cost estimates in this study.

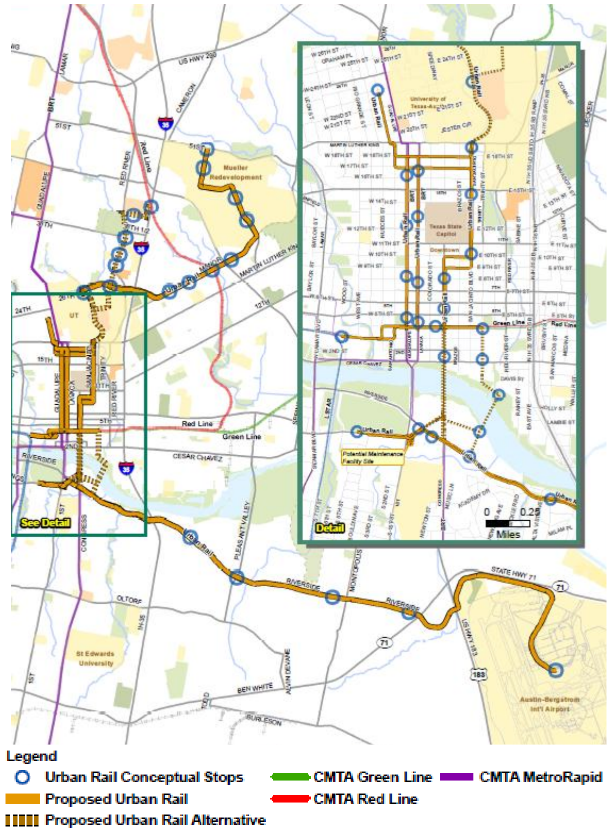


Figure 26: Possible Passenger Rail Corridor Downtown Austin Connections

Source: City of Austin Urban Rail Plan Update. Retrieved from www.austinstrategicmobility.com/resources/urban-rail-project.

Austin-to-Giddings Alignment Alternatives

The area between Austin and Giddings is moderately to densely populated with residential and commercial land use from Austin to Elgin and lightly populated between Elgin and Giddings, with the exception of Paige along U.S. 290. Capital Metro operates a segment of track which runs south of U.S. 290 between Austin and Elgin and north of U.S. 290 between Elgin and Giddings; a highway grade separation exists at U.S. 290 in Elgin. An existing UP track, the UP Waco Subdivision, travels through and crosses the Capital Metro track at-grade (crossing diamond) in downtown Elgin.

There are numerous existing curves along the Capital Metro track between Austin and Giddings that would need to be flattened in order to increase allowable train speeds to meet Class 6 criteria through the corridor for passenger rail operations. Potential modifications to existing curves are shown in Appendix D. In particular:

- The existing segment of track from U.S. 183 east of Austin to Manor contains multiple curves and travels through residential subdivisions and near an existing park. Generally, the segment of track utilizes four- to five-degree curves; some of the curves could be flattened to no less than three degrees without major impacts to a residential subdivision outside of existing right of way. In this segment maximum allowable train speeds would not reach Class 6 for the entire alignment without major modifications to the track geometry, which would require significant property acquisition. Potential modifications to existing curves, as shown in Appendix D, would result in approximately 76 percent of the 14 mile long alignment between Austin and Manor to have maximum allowable train speeds of 93 to 110 mph (Class 6). The curves that could not be modified to meet Class 6 design criteria without significant additional impacts and costs would limit approximately 24 percent of the alignment to maximum allowable speeds of between 65 mph 80 mph (Class 4).

- The existing segment of track through downtown Manor contains three-degree curves. There does not appear to be adequate right of way to adjust existing track geometry for Class 6 allowable train speeds without major impacts to downtown Manor. The majority of the approximately 1.2 mile long alignment through Manor would be limited to maximum speeds of 65 mph.

- Between Manor and Elgin minor curve modifications to the existing track geometry to meet Class 6 criteria have been identified in the possible passenger rail alignments as shown in Appendix D. In some cases these modifications require minimal acquisition of right of way. Potential modifications to existing curves would result in the entire 10.8 mile long alignment between Manor and Elgin to meet Class 6 design criteria with maximum allowable speeds between 107 and 110 mph.

- Within Elgin there are two curves that would slow train speeds below the Class 6 criteria. There does not appear to be adequate right of way to adjust existing track geometry for Class 6 allowable train speeds without major impacts to downtown Elgin. Further, the Capital Metro track crosses the UP Waco Subdivision at-grade in downtown Elgin; the at-grade crossing may create operational conflicts with the UP track. The majority of the nearly 1 mile long alignment through Elgin would be limited to maximum speeds of 65 mph.

- From Elgin to west of Giddings the existing track alignment generally contains three- to five-degree curves through the track segment. Since there are multiple curves in close proximity with high degrees of curve, there does not appear to be an ideal solution to modify existing geometry and utilize existing right of way. This segment may require a new alignment to straighten out many of the curves to provide Class 6 allowable train speeds; this would require right-of-way acquisition for the new possible alignment not within the Capital Metro right of way. The potential new straightened alignment would result in result in the entire 26.8 mile long alignment between Elgin and Giddings to meet Class 6 design criteria with maximum allowable speeds between 107 and 110 mph.

Possible track corridors that would not utilize or would re-align the Capital Metro track include:

- Abandoned Missouri-Kansas-Texas (MoKan) Railroad corridor – The abandoned MoKan corridor is just east of U.S. 183 near Austin and west of the existing Capital Metro track. In this location the Capital Metro corridor traverses through residential areas with multiple higher-degree curves, decreasing allowable train speeds. The use of the MoKan corridor could allow increased allowable train speeds and remove interaction with residential and commercial land use. The possible segment of the MoKan corridor to be utilized would extend from near the U.S. 183/Capital Metro intersection to near U.S. 290.

- Bypass south of Manor – The existing Capital Metro track currently travels through downtown Manor and utilizes three-degree curves, which would decrease allowable train speeds for passenger rail operations. A bypass route south of downtown Manor may be utilized to increase allowable train speeds and shift train traffic outside of the town limits. This possible alignment may also require a grade separation with SH 130.

- Bypass south of Elgin – Currently the existing Capital Metro track runs through downtown Elgin and crosses the UP Waco Subdivision at-grade within the downtown area. A bypass route south of Elgin would increase allowable train speeds as well as impact fewer residents and businesses by shifting the track to less populated areas. The bypass route would require a grade separation at U.S. 290 as well as the UP Waco Subdivision to eliminate operational conflicts.

- Transmission easement corridor – The existing Capital Metro track contains multiple higher-degree curves between Elgin and Paige, which decreases allowable train speeds within this segment. An existing electric transmission easement and corridor lies northwest of Butler and McDade which is sparsely-populated within a ¼-mile vicinity. A possible passenger rail alignment may utilize acquired right of way adjacent and west of the transmission easement without impacting residential and commercial land use areas and allowing a straight segment with increased allowable train speeds. The possible alignment would have the opportunity to rejoin the existing Capital Metro alignment west of Paige, where the track contains fewer curves.

- U.S. 290 corridor – There is the possibility of utilization of right of way adjacent to the U.S. 290 corridor between Elgin and Giddings to provide higher train speeds than the existing Capital Metro track. Between Elgin and Paige the possible alignment follows adjacent to the southern right of way of U.S. 290 where feasible; near McDade, the alignment bypasses south of the town as well as south of Paige. East of Paige the possible alignment crosses over U.S. 290 with a grade separation and travels along the northern right of way of U.S. 290 where it rejoins the existing Capital Metro track.

A passenger rail station may potentially be located in the Elgin area. A station along the existing Capital Metro alignment would provide access to downtown Elgin. On the bypass route around Elgin, a station location is more difficult to define due to the lack of a destination area and would be complicated by the lack of public transportation services in the Elgin area.

Capital Metro is also considering a potential commuter rail line segment between Austin and Elgin. The 28-mile potential commuter rail line to the east of Austin, commonly called the Green Line, would use the existing Capital Metro track out to Elgin to provide riders access to downtown Austin locations. The intercity passenger rail line from Austin to Houston would be required to schedule passenger trains in concert with the Capital Metro Green Line if both lines are placed in operation and passenger trains intend to use the Capital Metro corridor.

Giddings Alignment Alternatives

The city of Giddings contains dense commercial land use along the U.S. 290 and U.S. 77 corridors and residential land use at least ½ mile in each direction from the U.S. 290/U.S. 77 interchange. In addition, the existing UP Giddings Subdivision runs in a north-south direction generally west of U.S. 77 through the city limits.

The Capital Metro corridor alignment exists west of the UP Giddings Subdivision and the abandoned SP corridor runs east of the UP Giddings Subdivision and generally following the U.S. 290 right of way outside of town. However, the abandoned SP right of way inside of town has been acquired and developed by multiple commercial properties. Due to the density of the residential and commercial land use and the lack of an apparent available corridor, implementing a passenger rail alignment through downtown Giddings does not seem like a viable option.

There are two possible corridors analyzed in the Giddings area:

- Bypass corridor north of Giddings – The first possible corridor would travel north from the existing Capital Metro track approximately two miles west of Giddings, travel around the main portion of the town, and connect to the abandoned corridor alignment north and adjacent to U.S. 290. A grade separation would be required at U.S. 77 and the UP Giddings Subdivision to eliminate operational conflicts. This alignment was chosen for operational modeling purposes.

- Bypass corridor south of Giddings – The second possible corridor would travel south from the existing Capital Metro track approximately two miles west of Giddings and connect to the abandoned corridor alignment north and adjacent to U.S. 290 east of Giddings. The possible alignment would be required to avoid the Lee County Airport west of town as well as a commercial complex south of the downtown area. Grade separations would be required at U.S. 290 both west and east of Giddings, at the UP Giddings Subdivision to eliminate operational conflicts, and potentially at U.S. 77.

There is the potential for a station location in the Giddings area. However, since the possible track alignments do not travel through downtown Giddings the station location would likely be outside of the downtown area. For both of these corridors it may be difficult for passengers to access destination locations within Giddings due to the lack of public transportation services in the area.

Exhibits defining these alternative alignments are located in Appendix E.

Giddings-to-Brenham Alignment Alternatives

The area between Brenham and Hempstead is lightly populated except for the towns of Ledbetter, Carmine, and Burton along U.S. 290. The abandoned SP corridor in this area generally travels north and adjacent to U.S. 290 between Giddings and Carmine. Between Carmine and Burton the abandoned SP alignment travels northeast and makes a turn to the southeast through Burton (near the current location of Burton High School) and across U.S. 290. East of Burton the abandoned corridor generally follows Old Mill Creek Road south of U.S. 290.

There are two possible corridors analyzed in the Giddings-to-Brenham area:

- Abandoned SP corridor – The first possible corridor would generally follow the abandoned SP alignment; however, there are curves along the existing alignment, in particular from west of Burton to Brenham, which would require adjustments in curvature to the abandoned SP alignment to provide Class 6 allowable passenger train speeds. Within Ledbetter and Carmine there is an abandoned right-of-way width between U.S. 290 and residential/commercial properties of approximately 40 feet; this would be a minimal segment of right of way for the passenger rail system and may require acquisition of certain properties or adjustments to U.S. 290 and adjacent roadways. West of Burton the possible alignment travels east away from the abandoned SP alignment and south of Burton to eliminate curvature that would slow train speeds and require additional grade crossings in Burton. A grade separation is required at U.S. 290 near Burton. The possible alignment utilizes one-degree curvature where necessary east of Burton and requires curve adjustments from the existing SP alignment to reach allowable train speeds. This alignment was chosen for operational modeling purposes.

- U.S. 290 corridor – A second possible corridor would utilize an alignment north and adjacent to the U.S. 290 right of way. Between Giddings and Carmine this is also the location of the abandoned SP corridor route; this would also include the minimal right of way through Ledbetter and Carmine and possible adjustments mentioned in the first possible alignment. East of Carmine the possible alignment continues to follow the north side of U.S. 290 through Burton; possible alignment routes through this area may impact a sports park and require acquisition of residential properties. Another option is to bypass Burton to the north; however, this brings the possible alignment near Burton High School and would require higher-degree curves, which decreases allowable track speeds. East of Burton the possible alignment continues north of U.S. 290 and impacts several residential properties and at least one commercial property. The alignment travels south and away from the U.S. 290 corridor west of Brenham and the U.S. 290/SH 36 interchange; a grade separation would be required at the U.S. 290 crossing.

Exhibits defining these alternative alignments are located in Appendix E.

Brenham Alignment Alternatives

The city of Brenham contains a historical downtown area, through which a segment of the old SP corridor remains as an industrial lead, now owned by BNSF, from the BNSF Galveston Subdivision to the Blue Bell facility on the eastern side of the city limits. The abandoned SP corridor crosses U.S. 290 just south of the U.S. 290/SH 36 interchange and travels east just north of the Blinn College campus. At the end of the Blue Bell Industrial Lead, the abandoned SP corridor travels southeast toward U.S. 290. The BNSF Galveston Subdivision runs in a north-south direction just west of the historical downtown area and generally through the center of the city limits. U.S. 290 bypasses Brenham to the west and south of the city.

There are two possible corridors analyzed within the Brenham area:

- Abandoned SP corridor – The first possible corridor would mainly follow the abandoned SP alignment and utilize the existing industrial lead alignment through town. A grade separation would be required over the U.S. 290/SH 36 facility (abutments currently exist from abandonment of the SP line) and potentially at the BNSF Galveston Subdivision to eliminate any potential railroad operating issues. Another potential solution to eliminate operating issues with the BNSF track is to relocate the track outside of the Brenham city limits; this would provide a quality-of-life improvement to the residents within Brenham as well as avoid more complex rail and roadway geometry around the historical downtown district. The corridor would follow the abandoned SP alignment, including along the existing BNSF industrial lead, until after the Blue Bell facility. At this point the alignment would veer in a more easterly path to stay east of an existing residential subdivision. From there it would head south toward U.S. 290. This alignment was chosen for operational modeling purposes.

- Bypass corridor south of U.S. 290 – A second corridor would potentially bypass Brenham to the west and south approximately one mile outside of the U.S. 290 bypass corridor. This corridor would remain south of existing large commercial properties along the U.S. 290/SH 36 corridors and would impact a few residential properties. Grade separations would be required at the BNSF Galveston Subdivision and SH 36 crossings.

A station may potentially be located in the Brenham area. On the abandoned SP corridor possible alignment, a station location could be placed either near the Blinn College campus area or in historical downtown area. On the bypass corridor possible alignment, a station location is more difficult to define due to the lack of a destination area and would be complicated by the lack of public transportation services in the Brenham area.

Additionally, the crossing with the BNSF Galveston in Brenham may require relocation, since a grade separation between the existing freight rail line and the potential new passenger rail line may not be feasible where the BNSF Galveston Subdivision would cross the modeled passenger rail line in downtown Brenham. A potential alternative would be to construct a bypass route for the BNSF around the city of Brenham, which would result in a crossing with the potential passenger rail line outside of the city where a grade separation would be possible. A bypass route to the west of town appears to be feasible in terms of horizontal geometry and undeveloped land; however, this bypass route would require further analysis and was not included in any of the cost estimates provided in this report. The existing BNSF line could be left in place in order to maintain service to the Blue Bell Creameries facility in Brenham and any other rail customers that BNSF currently serves. Another potential alternative would be to relocate the passenger rail line to the south of Brenham so that it would cross the BNSF Galveston Subdivision outside of town where a grade separation could be constructed; however, this alternative was not modeled.

Exhibits defining these alternative alignments are located in Appendix E.

Brenham-to-Hempstead Alignment Alternatives

The area between Brenham and Hempstead is lightly populated except for the town of Chappell Hill along U.S. 290. The abandoned SP corridor in this area generally travels south of U.S. 290 with multiple curves west of the Brazos River and a straight segment along Austin Branch Road to the east of the river (a bridge pier still exists within the Brazos River denoting the location of the abandoned corridor).

There are two possible corridors analyzed in the Brenham-to-Hempstead area:

- Abandoned SP corridor – The first possible corridor would generally follow the abandoned SP alignment; however, there are multiple curves along the existing alignment (in particular west of the river) with radii greater than a two-degree curve, limiting the allowable passenger train speeds. The possible alignment within this area concentrates on retaining a one-degree curve or less and following the abandoned corridor where possible. A grade separation would be required at U.S. 290 if the alignment utilizes the possible abandoned corridor through Brenham. A major bridge structure would also be required over the Brazos River. East of the Brazos River the possible alignment follows the abandoned SP alignment along Austin Branch Road. This would connect to the existing UP Eureka Subdivision. This alignment was chosen for operational modeling purposes.

- U.S. 290 corridor – A second possible corridor would utilize an alignment north and adjacent to the U.S. 290 right of way. The alignment would impact at least four commercial properties along the corridor, including a large gas station/convenience store within Chappell Hill, as well as some residential properties. A major bridge structure would also be required over the Brazos River; other bridge structures would be needed over a floodplain to the east of the river. A grade separation would be required at U.S. 290 to bring the possible alignment south to the UP Eureka Subdivision.

It is assumed that the potential Hempstead to Houston commuter rail service along the UP Eureka Subdivision currently being studied by the GCRD would utilize the same station as the potential intercity passenger rail service analyzed in this study.

Exhibits defining these alternative alignments are located in Appendix E.

Hempstead-to-Houston/Houston CBD

Ultimately, the objective of an intercity rail system would be to connect the Houston CBD to the Austin CBD to provide riders access to the both downtown areas. The previously mentioned GCRD study includes the analysis of a 40-mile commuter rail line from Hempstead to the U.S. 290/I-610 interchange in Houston along the UP Eureka Subdivision, which runs south of and parallel to the U.S. 290 corridor. The analysis is being coordinated with UP to potentially limit freight service to only local freight trains along the Eureka Subdivision in exchange for the GCRD providing additional improvements to UP's existing rail system. Identification of a connection into the Houston CBD from Loop 610 is not part of the GCRD study. One potential route would involve utilizing the UP Eureka Subdivision to the UP Terminal Subdivision and traveling east to the existing Amtrak station near downtown at I-45 or a potential intermodal terminal east of I-45 and north of I-10.

The area between Hempstead and Houston becomes more populated from west to east along the U.S. 290 corridor. In particular, the towns of Hempstead, Prairie View, Waller, Cypress, and Jersey Village reside in this area of the corridor.

Bryan/College Station Alignment Alternatives

The alternatives for a possible passenger rail alignment to College Station consist of three general routes: Giddings to Bryan/ College Station, Brenham to Bryan/ College Station or Hempstead to Bryan/ College Station. Possible station locations include Texas A&M University in College Station and the downtown Bryan area.

Giddings to Bryan/College Station

- Giddings-to-Bryan/College Station corridor (UP Giddings and Navasota Subdivisions) – The possible alignment would generally follow adjacent to the UP Giddings Subdivision right of way from Giddings to Mumford. The possible alignment presents few curve modifications in this segment; however, adjustments to track geometry would be needed in Caldwell near the intersection with the BNSF Galveston Subdivision. Multiple grade separations would also be required in this segment, including over the UP Giddings and BNSF Galveston Subdivisions to eliminate operational conflicts, U.S. 77, SH 36, SH 21, and other grade-separated county roads along the corridor. A major bridge structure would also be required over the Brazos River.

  From Mumford, the possible passenger rail alignment could follow parallel to the UP Navasota Subdivision to Bryan and south to College Station and Texas A&M University. Along the existing tracks of the UP Navasota Subdivision there are curves that do not meet Class 6 allowable train speeds and are not easily modified without major impacts to the surrounding commercial land use.

- A variation of this alignment was analyzed to turn east at SH 47, following generally parallel to the roadway to College Station. This alignment was chosen for operational modeling purposes.

Brenham to Bryan/College Station

Four alternatives, all of which are new greenfield alignments, were analyzed for the Brenham-to-Bryan/College Station corridor.

- Brenham-to-College Station Alignment 1 – The potential alignment connects to the abandoned SP corridor approximately 4 miles west of downtown Brenham and connects to the existing UP Navasota Subdivision approximately 1 mile north of FM 60 in Bryan. The alignment is approximately 35.4 miles long and would require approximately 20 railroad bridges, including a major bridge at the Brazos River, and 8 grade separations with major roadways. Additionally, the alignment may impact 2 cemeteries, 2 potentially eligible archeological sites, and approximately 25 property developments. The nearest potential location for a passenger station along the alignment would be approximately 3 miles outside of Brenham.

- Brenham-to-College Station Alignment 2 – The potential alignment connects to the abandoned SP corridor approximately 4 miles west of downtown Brenham and connects to the existing UP Navasota Subdivision approximately 3 miles south of FM 60 in College Station. The alignment is approximately 34.1 miles long and would require approximately 12 railroad bridges, including a major bridge at the Brazos River, and 6 grade separations with major roadways. Additionally, the alignment may impact approximately 16 property developments. The nearest potential location for a passenger station along the alignment would be approximately 3 miles outside of Brenham.

- Brenham-to-College Station Alignment 3 – The potential alignment connects to the existing spur track through Brenham within the abandoned SP corridor approximately 1.5 miles east of downtown Brenham and connects to the existing UP Navasota Subdivision approximately 1 mile north of FM 60 in Bryan. The alignment is approximately 36.7 miles long and would require approximately 10 railroad bridges, including a major bridge at the Brazos River, and 6 grade separations with major roadways. Additionally, the alignment may impact a landfill, 2 potentially eligible archeological sites, and approximately 12 property developments. The nearest potential location for a passenger station along the alignment would be approximately 1/2 mile outside of Brenham.

- Brenham-to-College Station Alignment 4 – The potential alignment connects to the existing spur track through Brenham within abandoned SP corridor approximately 1.5 miles east of downtown Brenham and connects to the existing UP Navasota Subdivision approximately 3 miles south of FM 60 in College Station. The alignment is approximately 34.2 miles long and would require approximately 10 railroad bridges, including a major bridge at the Brazos River, and 3 grade separations with major roadways. Additionally, the alignment may impact a landfill and approximately 8 property developments. The nearest potential location for a passenger station along the alignment would be approximately 1/2 mile outside of Brenham. This alignment was chosen for operational modeling purposes.

Hempstead to Bryan/College Station

Two alternatives were analyzed for the Hempstead-to-Bryan/College Station corridor.

- Hempstead-to-Bryan/College Station corridor (UP Eureka and Navasota Subdivisions) – The possible alignment would generally follow adjacent to the right of way along the UP Eureka Subdivision from Hempstead to south of Navasota. The possible alignment presents few curve modifications in this segment.

  Although there may be various potential alternative alignments, two possible alternative alignments were evaluated in the Navasota area. One possible alternative is to utilize the existing UP Eureka Subdivision at this location and use the existing crossovers within Navasota (which also intersect with the UP Navasota and BNSF Conroe Subdivisions) to travel through town; this option may create operational conflicts within the interlocking locations. Another alternative alignment would bypass Navasota to the south and west and rejoin the UP Navasota Subdivision corridor north of the Navasota River; this would require a grade separation over the BNSF Conroe Subdivision to eliminate operational conflicts.

  From Navasota to south of College Station the possible alignment would generally run adjacent to the right of way along the UP Navasota Subdivision. South of College Station, the possible alignment would utilize the existing UP Navasota Subdivision for College Station and Bryan station locations. This alignment, with the bypass alternative southwest of Navasota, was chosen for operational modeling purposes.

- Hempstead-to-Bryan/College Station corridor (abandoned corridor) – The potential alignment follows the same route from Hempstead to Navasota as the UP Navasota Subdivision possible alignment above. North and west of Navasota the possible alignment then utilizes an abandoned rail corridor to the north of the Navasota River and west of the UP Navasota Subdivision; the abandoned right of way appears to be undeveloped. This potential alignment then rejoins the UP Navasota Subdivision south of College Station and would utilize the existing UP Navasota Subdivision for potential College Station and Bryan station locations.

Exhibits defining these alternative alignments are located in Appendix E.

Maximum Allowable Passenger Train Speeds

Travel times are critical from a ridership standpoint, since passengers will likely choose the most expedient route. The travel time for a segment of a possible alignment is based on the maximum allowable train speeds along the track as well as operational factors including congestion as well as acceleration and deceleration requirements. The maximum allowable train speeds are derived from the class of track, which is based on the conceptual level horizontal and vertical geometry of the alignment. Track conditions, including gage and ties, that do not meet Class 6 criteria can be upgraded to produce the maximum allowable train speeds without any modifications to the alignment and are included in the cost estimates provided in Section 4 of this report.

The maximum allowable train speed only indicates the speed that could be permitted on a segment of track based on the design geometry, and does not account for operational issues such as deceleration prior to reaching a curve or short tangent segments between curves that would not allow time to accelerate to the allowable speed on the tangent track. Such acceleration and deceleration as well as congestion contribute to operational speeds being lower than maximum allowable speeds. The modeled operational speeds are discussed in Section 4.

Austin-to-Giddings Alignments

Table 4 details the distance and maximum allowable passenger train speeds for segments along the existing Capital Metro alignment from Austin to Giddings based on geometry. The existing condition of track, including track gage, condition and size of rails, and the number and spacing of good ties is not reflected in Table 4 and would require upgrades to maximum allowable train speeds listed as follows based solely on geometry.

Class of Track	Speed (mph)	Distance (mi)	% of Segment	Segment
3	51	0.5	3.3%	Austin Wye to west of Manor
	57	3.2	22.7%	
4	65	1.2	8.7%	
	80	0.7	4.7%	
6	107	0.2	1.3%	
	110	8.4	59.3%	
4	65	0.6	50.0%	Manor
	80	0.2	16.7%	
6	110	0.4	33.3%	
3	53	0.3	2.8%	East of Manor to west of Elgin
4	61	0.6	5.2%	
	65	0.7	6.3%	
	80	0.9	8.4%	
6	107	0.5	5.0%	
	110	7.8	72.4%	
4	65	0.5	55.6%	Elgin
	80	0.2	22.2%	
6	110	0.2	22.2%	
2	30	26.9	100.0%	East of Elgin to Giddings
Total		**54**		

Table 4: Maximum Allowable Train Speeds along Existing Capital Metro Alignment between Austin and Giddings (based only on geometry, not considering condition of track)

As discussed previously in this section of the report and as shown in Appendix D, geometric adjustments have been proposed for the existing Capital Metro alignment to increase maximum allowable train speeds. Table 5 denotes the distance and maximum allowable passenger train speeds that would result from these geometric changes between Austin and Giddings.

Class of Track	Speed (mph)	Distance (mi)	% of Segment	Segment
4	65	1.1	7.7%	Austin Wye to west of Manor
	80	2.3	16.2%	
6	107	2.4	16.9%	
	110	8.4	59.2%	
4	65	0.6	50.0%	Manor
6	107	0.2	16.7%	
	110	0.4	33.3%	
6	107	2.1	19.4%	East of Manor to west of Elgin
	110	8.7	80.6%	
4	65	0.5	55.6%	Elgin
	80	0.2	22.2%	
6	110	0.2	22.2%	
6	107	6.6	24.5%	East of Elgin to Giddings
	110	20.3	75.5%	
Total		**54**		

Table 5: Maximum Allowable Train Speeds with Proposed Adjustments to Capital Metro Alignment between Austin and Giddings

Giddings-to-Hempstead Alignments

Two possible alternative alignments have been defined between Giddings and Hempstead. Tables 6 and 7 provide the distance and maximum allowable passenger train speeds for the U.S. 290 corridor and abandoned SP corridor possible alignments between Giddings and Hempstead.

Class of Track	Speed (mph)	Distance (mi)	% of Segment	Segment
6	107	2.7	45.1%	Giddings
	110	3.3	54.9%	
6	107	0.5	5.4%	Giddings to Carmine
	110	8.6	94.6%	
6	107	0.8	27.4%	Carmine to Burton
	110	2.1	72.6%	
4	80	0.8	55.8%	Burton
6	110	0.6	44.2%	
6	107	0.4	9.1%	Burton to Brenham
	110	4.4	90.9%	
6	107	2.8	31.1%	Brenham
	110	6.1	68.9%	
6	107	4.7	28.4%	Brenham to Hempstead
	110	11.8	71.6%	
Total		**50**		

Table 6: Maximum Allowable Train Speeds along U.S. 290 Alignment between Giddings and Hempstead

Class of Track	Speed (mph)	Distance (mi)	% of Segment	Segment
6	107	2.7	45.1%	Giddings
	110	3.3	54.9%	
6	107	0.5	5.2%	Giddings to Carmine
	110	8.9	94.8%	
4	65	0.1	1.3%	Carmine to Burton
6	107	0.4	6.4%	
	110	6.1	92.3%	
4	72	0.2	2.9%	Burton to Brenham
	80	0.3	4.1%	
6	107	2.8	37.4%	
	110	4.1	55.6%	
4	65	0.4	10.2%	Brenham
6	93	0.9	20.3%	
	107	0.7	17.0%	
	110	2.2	52.5%	
3	48	0.2	1.4%	Brenham to Hempstead
6	107	3.0	18.9%	
	110	12.8	79.7%	
Total		**50**		

Table 7: Maximum Allowable Train Speeds along Abandoned SP Corridor Alignment between Giddings and Hempstead

Alignments to Bryan/ College Station

The maximum allowable speeds for the alternative alignments to Bryan/ College Station via the Giddings, Brenham, and Hempstead corridor alternatives are listed in Tables 8 through 10. The speeds shown are for the alignments chosen for operational modeling, since the various alignment alternatives within each corridor had negligible differences in terms of allowable speeds.

Class of Track	Speed (mph)	Distance (mi)	% of Corridor
4	80	4.8	9.1%
6	107	3.7	7.1%
	110	44.2	83.8%
Total		**53**	

Table 8: Maximum Allowable Train Speeds along Giddings to College Station Alignment

Class of Track	Speed (mph)	Distance (mi)	% of Corridor
6	110	34.2	100.0%
Total		**34**	

Table 9: Maximum Allowable Train Speeds along Brenham to College Station Alignment

Class of Track	Speed (mph)	Distance (mi)	% of Corridor
4	80	0.9	2.0%
6	107	12.2	28.8%
	110	29.2	69.1%
Total		**42**	

Table 10: Maximum Allowable Train Speeds along Hempstead to College Station Alignment

Profile Fatal-flaw Analysis

Preliminary profiles have been developed for the possible alignments described earlier in the section along the U.S. 290 corridor and the abandoned SP corridor from Giddings to Hempstead. The preliminary profiles are located in Appendix E.

Criteria for the profile fatal-flaw analysis have been developed to meet Class 6 allowable design speeds, including a maximum vertical grade of 1.50% for passenger trains. Vertical clearances for grade separations reference *TxDOT Roadway Design Manual* criteria. For situations where the roadway is grade separated over a railroad, a minimum vertical clearance of 23’-0” shall be used; for situations where the railroad is grade separated over a roadway, a minimum vertical clearance of 16’-6” shall be used.

Data for the existing ground of the profiles, as supplied by the Texas Natural Resources Information System (TNRIS), has been utilized to create a three-dimensional surface for use within the corridor limits.

Floodplain data has been evaluated as part of the profile fatal-flaw analysis. Federal Emergency Management Agency (FEMA) floodplain maps have been utilized to determine the location and depth of floodwaters during the 100-year storm event. Floodplain elevation data has been denoted in the preliminary profiles to develop top-of-rail and track subgrade elevations above the 100-year floodplains.

For each of the corridors, the preliminary profile fatal-flaw data is summarized as follows.

- U.S. 290 Corridor Possible Alignment – The preliminary profile shows grade separations at existing roadway and rail facilities along the U.S. 290 corridor possible rail alignment using the required vertical clearances. These locations are listed in Table 11.

Area	Location
Giddings	U.S. 77
Giddings	UP Giddings Subdivision
Burton	Spur 125
Brenham	U.S. 290
Brenham	BNSF Galveston Subdivision
Brenham	SH 36
Brenham	U.S. 290
Hempstead	U.S. 290

Table 11: Required Grade Separations for U.S. 290 Corridor Possible Alignment

Between Giddings and Burton the preliminary profile generally follows the existing U.S. 290 profile. In some cases modification to an existing roadway's profile may be required at the roadway-rail crossing due to the difference in elevation between the preliminary profile and the existing roadway.

From Burton to the Brazos River the existing ground becomes rolling terrain; thus, there is expected to be larger embankment areas as well as possible retaining walls in this area. A major bridge structure would be required at the Brazos River as well as either bridge structures or embankment areas over the low-lying areas east of the river. East of the river the terrain levels to Hempstead.

- Abandoned SP Corridor Possible Alignment – The preliminary profile shows grade separations along the abandoned SP corridor possible rail alignment using the required vertical clearances. These locations are listed in Table 12.

Area	Location
Giddings	U.S. 77
Giddings	UP Giddings Subdivision
Burton	U.S. 290
Brenham	BNSF Galveston Subdivision
Brenham	U.S. 290/SH 36
Brenham	U.S. 290

Table 12: Required Grade Separations for Abandoned SP Corridor Possible Alignment

Between Giddings and Burton the preliminary profile is the same as the U.S. 290 corridor possible alignment profile.

Similar to the U.S. 290 possible alignment profile, from Burton to the Brazos River the existing ground becomes rolling terrain. With the rolling terrain and flat grades there is expected to be larger embankment areas as well as possible retaining walls in this area. A major bridge structure would be required at the Brazos River. East of the river the terrain levels along Austin Branch Road, although there are a couple of locations where additional embankment may be required.

- Giddings-to-Bryan/College Station corridor possible alignment – The Giddings-to-Bryan/ College Station corridor generally follows the UP Giddings Subdivision alignment; therefore, it has been assumed that the preliminary profile for this possible alignment matches the existing profile for the UP Giddings Subdivision. Using this, grade separations have been identified based on existing grade separations along the existing railroad. These locations are listed in Table 13.

Area	Location
Giddings	UP Giddings Subdivision
Caldwell	Banks St
Caldwell	BNSF Galveston Subdivision
Caldwell	SH 36
Caldwell	FM 166
Caldwell	CR 208
Caldwell	SH 21

Table 13: Required Grade Separations for Giddings-to-Bryan/College Station Possible Alignment

In addition to these locations, a major bridge structure would be required at the Brazos River, and another bridge would be needed at the Little Brazos River.

- Brenham-to-Bryan/College Station corridor possible alignment – The Brenham-to-Bryan/ College Station corridor is a greenfield alignment located generally east of FM 50. Using USGS topographic maps and contours, locations that will likely require grade separations have been identified as listed in Table 14.

Area	Location
Brenham	SH 105
Brenham	FM 2621
Independence	CR 444 (due to topographic change in grade)

Table 14: Required Grade Separations for Giddings-to-Bryan/College Station Possible Alignment

In addition to these locations, a major bridge structure would be required at the Brazos River, and another bridge would be needed at the Little Brazos River. Several additional railroad bridges would be required along the alignment at various drainage and creek crossings.

- Hempstead-to-Bryan/College Station corridor possible alignment – The Hempstead-to-Bryan/College Station corridor generally follows the UP Eureka and Navasota Subdivision alignments and assumes the bypass route to the south and west of Navasota; therefore, it has been assumed that the preliminary profile for this possible alignment matches the existing profile for the UP Eureka and Navasota Subdivisions. Using this, grade separations have been identified based on existing grade separations along the existing railroad. These locations are listed in Table 15.

Area	Location
Navasota	SH 105
Navasota	BNSF Conroe Subdivision

Table 15: Required Grade Separations for Hempstead-to-Bryan/College Station Possible Alignments

In addition to these locations, a major bridge structure would be required to span the Navasota River near the town of Navasota.

The preliminary profile analysis did not reveal any fatal-flaws within the vertical alignment that would eliminate any of the possible alignment alternatives.

Modeled Alignment

As previously described, several alignments between Austin and Giddings, Giddings and Hempstead, and Hempstead to College Station were analyzed to identify any potential fatal flaws including horizontal and vertical geometry as well as environmental issues. The alignments described as follows were identified based on the fatal-flaw analysis for the purposes of operational modeling and to determine order-of-magnitude cost estimates along the corridor and do not constitute preferred or chosen alignments, which would require further analysis including preliminary engineering, NEPA documentation, and public involvement.

Austin to Giddings

The existing alignment was modeled between Austin and Giddings with upgrades to horizontal geometry to increase the allowable train speed. The revised alignment reduced the degree of curvature at several curves, eliminated curves (primarily between Elgin and Paige) and also reduced the distance along the route by approximately 3.4 miles. However, the revised alignment would not meet Class 6 criteria along the entire route even with the modifications as modeled. The revised alignment increased allowable train speeds to a minimum of 65 mph and up to 110 mph in some locations, while the existing alignment had allowable freight speeds limited to a maximum of 25 mph. The modeled alignment is shown in Appendix D. Additional modifications to geometry, as discussed previously in this section, could allow for further increased speeds; although, they would use very little of the existing alignment and would require all new right-of-way acquisition and as such, were not modeled.

Giddings to Hempstead

Two possible passenger rail corridors were evaluated between Giddings and Hempstead: the U.S. 290 corridor and the abandoned SP corridor. The U.S. 290 corridor generally requires acquisition of right of way adjacent to U.S. 290 and the abandoned SP corridor generally requires acquisition of right of way in the abandoned SP corridor and in some cases requires acquisition outside of the abandoned corridor in rural areas to remove curvature in the possible alignment. In some cases the U.S. 290 corridor requires acquisition of residential and commercial properties along U.S. 290, while in most cases the acquisition in the abandoned SP corridor requires acquisition of rural properties or previously-abandoned right of way.

The profile fatal-flaw analysis details possible floodplain locations and bridge areas for each alignment. East of the Brazos River the U.S. 290 corridor possible alignment is within a larger floodplain area, requiring either additional fill or a longer bridge length across the floodplain. Along the abandoned SP corridor the existing ground in this area appears higher and outside of an extended floodplain.

In terms of station locations, both possible alignments provide similar access except within the Brenham area. A potential station location for the abandoned SP possible alignment would be within the historic downtown area, which could likely be an ideal location for a stop in Brenham. The U.S. 290 possible alignment stays south and west of town and would have a potential station location a couple of miles outside of the Brenham CBD.

The environmental fatal-flaw analysis identified an area south of Chappell Hill that may require an adjustment to the south for the abandoned SP alignment if deemed to impact properties listed in the national register for historic places or parklands. Also, residential and commercial properties along the U.S. 290 corridor possible alignment have also been identified as possible environmental impacts.

The alignment modeled follows the U.S. 290 corridor to Carmine and then along the abandoned SP corridor based on an analysis of track lengths, travel times, profile fatal-flaw analysis, environmental fatal-flaw analysis, and potential station locations. There are several locations at which the modeled alignment deviates from the SP corridor due to required curve modifications or right of way impacts. For example, the modeled alignment deviates from the abandoned corridor through Burton due to the presence of a high school and recreational facilities that cross the abandoned right of way. The modeled alignment has maximum allowable speeds of between 93 and 110 mph (Class 6) with approximately 2 percent of the route limited to speeds of between 48 mph and 80 mph due to curves. The modeled alignment from Giddings to Hempstead along with adjacent land use is shown in Figure 27.

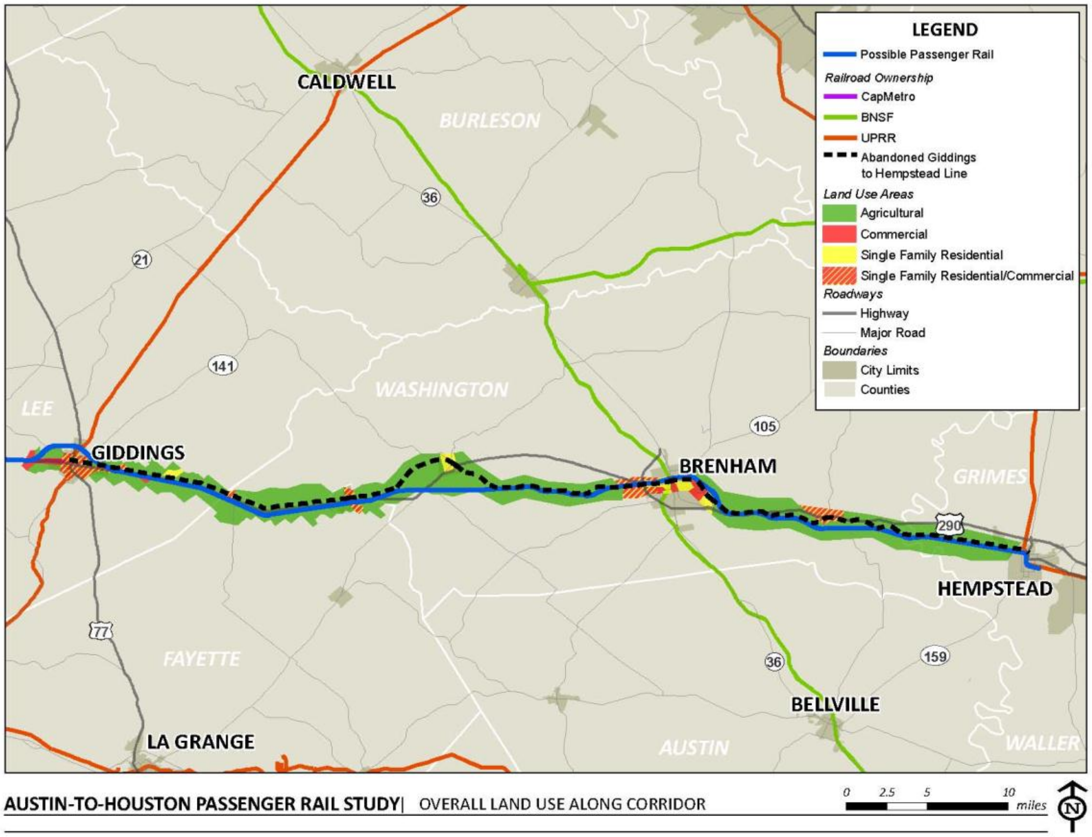


Figure 27: Modeled Route for Passenger Rail between Giddings and Hempstead

To Bryan/ College Station

The alternatives for a possible passenger rail alignment to College Station consist of three general routes: Giddings to Bryan/ College Station, Brenham to Bryan/ College Station or Hempstead to Bryan/ College Station. Each of the three alternative routes was modeled for the purpose of comparing trip times between Austin and Houston with a station stop in College Station.

Giddings to Bryan/College Station

The first alternative route would generally follow adjacent to the UP Giddings Subdivision right of way from Giddings to the Brazos River, and then follow along SH 21 and SH 47 to College Station.. The overall route length is approximately 54.8 miles. The Giddings route would then use the Hempstead-to-Bryan/College Station alignment departing toward or arriving from Houston to the east.

Brenham to Bryan/College Station

Four alternatives, all of which are new greenfield alignments, were analyzed for the Brenham-to-Bryan/College Station corridor. Based on an analysis of route lengths, potential station locations, required rail bridges and roadway grade separations, the number of impacts to developed properties, and environmental constraints, the 4th alignment that connects on the east side of Brenham and the south side of College Station was chosen for operational modeling. The alignment is approximately 34.2 miles long and would allow for maximum speeds of up to 110 mph along the entire route.

Hempstead to Bryan/College Station

The alternatives for a possible alignment from Hempstead to College Station would generally follow adjacent to the right of way along the UP Eureka Subdivision from Hempstead to Navasota and the UP Navasota Subdivision to College Station. There are at least two possible alternative alignments in the Navasota area. One possible alternative is to utilize the existing UP Eureka Subdivision at this location and use the existing crossovers within Navasota (which also intersect with the UP Navasota and BNSF Conroe Subdivisions) to travel through town; this option may create operational conflicts within the interlocking locations. Another alternative alignment would bypass Navasota to the south and west and rejoin the UP Navasota Subdivision corridor north of the Navasota River; this would require a grade separation over the BNSF Conroe Subdivision to eliminate operational conflicts. From Navasota to south of College Station the possible alignment would generally run adjacent to the right of way along the UP Navasota Subdivision. South of College Station, the possible alignment would utilize the existing UP Navasota Subdivision for the College Station station location. This route could potentially be adjusted to a bypass route to the west of town. The overall route length is approximately 47.8 miles.

A third alternative for a possible alignment to College Station follows the Eureka and Navasota Subdivisions to Navasota and then utilizes an abandoned rail corridor to the north of the Navasota River and west of the UP Navasota; the abandoned corridor possible alignment then rejoins the UP Navasota Subdivision south of College Station. The abandoned right of way appears to be undeveloped. The overall route length is approximately 48.9 miles.

The alignment modeled assumes a route adjacent to the UP Eureka and Navasota Subdivisions between Hempstead and College Station with a bypass around Navasota, since that route was the shortest of the routes analyzed and would have reduced construction, operations, and maintenance costs as compared to the other longer routes. The modeled alignment has maximum allowable speeds of between 93 and 110 mph (Class 6) with approximately 2 percent of the route limited to speeds of 80 mph due to curves.

The intercity passenger routes modeled are shown in Figure 28. The results of the operational modeling and the infrastructure requirements for implementing passenger rail along the alignments modeled are discussed in Section 4 of the report.

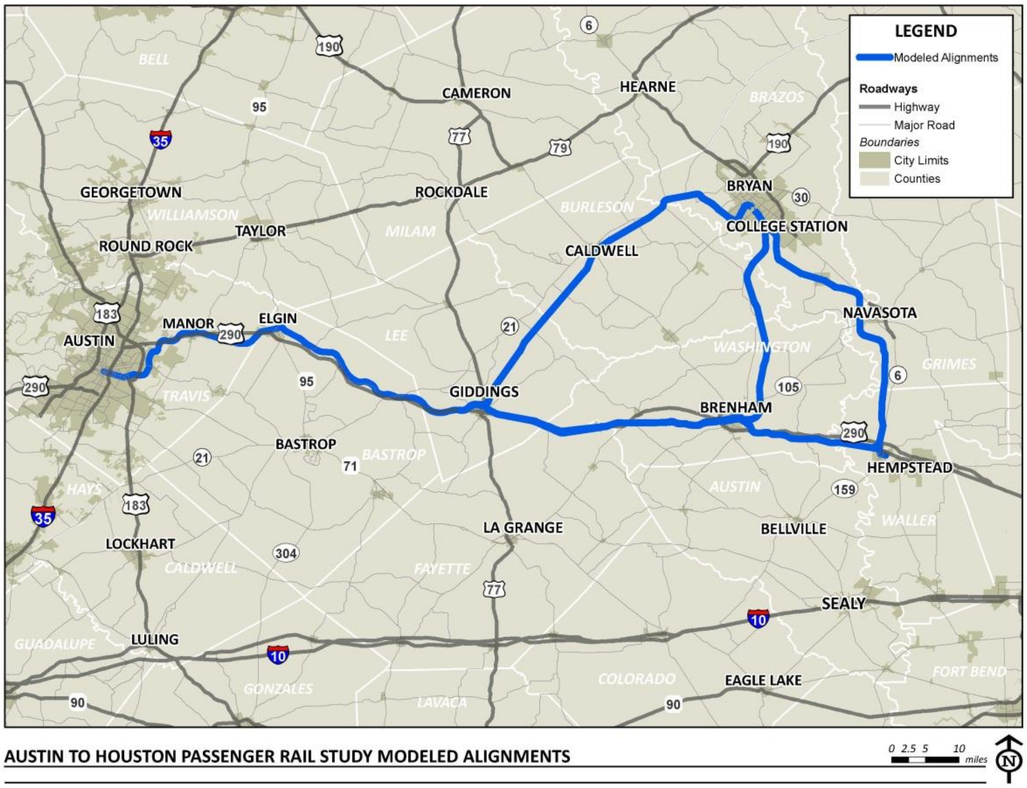


Figure 28: Modeled Routes for Passenger Rail

Section 4: Corridor Investments – Determination of Rail System Improvements

Corridor infrastructure improvements and associated costs required for passenger rail implementation were determined based on rail operations modeling using Rail Traffic Controller (RTC), as described below. The existing Capital Metro freight movements between Austin and Butler were modeled in the base case (current condition) and were also modeled in the planning cases with passenger rail operations to determine impacts to the freight operations. Intercity passenger rail operations were modeled to determine infrastructure improvements such as mainline track and passing sidings required to achieve a level of on-time performance that promotes service reliability to a level expected by the traveling public to sustain and grow ridership.

Rail Traffic Controller

RTC is a computer software program created by Berkeley Simulation Software, LLC, which simulates the operation of train movements over a railroad network. RTC allows the analysis of dispatching problems and capacity needs over large distances and long periods of time. Variations can be made in network track layouts, train consists (make-up of a train by types of cars and their contents) and schedules, and operating rules and constraints, which allows the testing of such changes before they are implemented. RTC is used by almost all North American Class I railroads including Amtrak to evaluate and plan their operations and capital expenditures.

RTC Files

The simulation model consists primarily of two kinds of files:

- *Network files* – include track, signals, grades, curves, bridges, road crossings, and railroad junctions or interlocking for existing and new alignments.
- *Train files* - include all information related to individual trains: their identity, type, weight, length, locomotives, time and day of operation, relative priority, origin and destination, route, railroad carrier, and intermediate work, if any.

RTC Dispatching Logic

As the simulation "dispatcher" sends trains across the railroad network, it resolves conflicts between trains in the same manner as an actual railroad dispatcher according to the priority of each train. Unless a train is significantly delayed, or the crew is nearing the federally-mandated 12-hours-of-continuous-service limit, both the actual railroad dispatchers and the simulation program "dispatcher" will generally give preference to passenger trains over expedited freight trains, to expedited freight trains over lower priority manifest freight trains, and to through manifest trains over local freight trains or yard engines.

However, there are times when the RTC model makes an incorrect or poor decision, just as human dispatchers. The RTC decisions are analyzed, and if they are realistic or have no significant impact, then they are left standing. Other decisions are rejected in the "resolution" process, which is the RTC user (or the Chief Dispatcher, in railroad terms) intervening to change an initial RTC decision for a better or more realistic one.

RTC Performance Measures

The measures used in the analysis of infrastructure requirements and schedules for intercity passenger rail operations are as follows:

- *Average Speed* – the average operating speed, in miles per hour, of the measured trains operating across the entire network, or across a specific part of the network (i.e., a railroad subdivision or district).

- *Delay Minutes/100 Train-miles* – A significant reduction in delay minutes per 100 train miles will suggest a significant improvement in asset and labor productivity. These ratios often will be extremely high in terminals because switch engines seldom travel over long distances.

- *On-Time Performance (OTP)* – the ratio of the number of on-time trips to total trips. On-time is defined within a specified threshold, such as 5 minutes for passenger trains.

The RTC Base Case

Before the simulation model can be used to test alternative operating or investment plans, a "base" case in the model that represents the real world under current conditions must be built. The base case simulation network was constructed largely from railroad "track charts" supplied by Capital Metro. These schematic maps show the physical rail infrastructure in sections (sheets showing five miles at a time). The detail on these charts allows the proper milepost location of signals, switches, grade crossings, sidings, and yard tracks; and conveys the correct distances between points. These charts, along with railroad timetables, also show the allowable operating speed limits for trains on various parts of the network.

The Base Case modeled for this study consists of nearly 57 miles of track, called the East Subdivision, between Austin Junction and Giddings owned by Capital Metro. The East Subdivision of the rail line is currently operational only between Austin Junction and Butler (just east of Elgin) with no existing service and inoperable track conditions between Butler and Giddings. However, the UP serves a customer, the Lee County Co-Op, just west of Giddings along a small section of track (approximately 1.3 miles) that connects to the UP Giddings Subdivision.

The base case train files were constructed from records and data (i.e., identity of the train, its consist, its route, and the day and time when it passed certain key recording points) as received from Capital Metro. As described in Section 2 of this report, freight trains operating on the East Subdivision consist of ethanol trains that operate between Decker and Elgin, switch trains that operate between Decker and Robinson (near the McNeil interchange) on the Central Subdivision, and trains that operate between Butler and Summit on the West Subdivision for a total of approximately 10 trains per week. Additional sidings currently under design, and the associated increase in freight train traffic to support the growth of the ethanol plant at Decker were not included in the base model.

The Base Case runs without any delay due to conflicts between trains, since there is currently minimal freight traffic on the line. The only delays experienced by freight trains are due to speed restrictions along the line that are due to existing geometry constraints and/or track conditions.

RTC Planning Cases

Planning cases were modeled to analyze passenger rail operations between Austin and Hempstead, with an ultimate origin/ destination in Houston, and between Austin and College Station for initial start-up and build-out operations. The modeled passenger train equipment consists of high performance passenger trains capable of operating speeds of up to 110 mph.

Planning Case Modeled Network

The planning cases extended the base case alignment west from Austin Junction (located at the connection with Capital Metro's Red Line) to the Capital Metro's downtown Austin commuter rail station located on 4th Street at the Austin Convention Center. Speeds from Austin Junction to the downtown Austin station were limited to 10 mph in the model for several reasons including existing track geometry, the presence of Capital Metro commuter rail trains, the location of the route through an urban area, and required deceleration to approach and stop at the station.

Additionally, the base case network was modified along the East Subdivision to allow for passenger trains to travel at higher speeds than currently allowed due to track geometry. Under current conditions, the maximum authorized freight train speed along the line is 25 mph, with certain locations where the authorized speed is reduced to 10 mph. The revised alignment would eliminate sharp curves and allow for operating speeds up to 110 mph for most of the route, although locations still exist where operating speeds are limited to 65 mph due to curvature. The revised alignment also reduces the length of the route between Austin and Giddings by 3.4 miles.

The planning case networks include new track along the following routes:

- Giddings to Hempstead, generally following an abandoned rail alignment
- Hempstead to College Station, generally following parallel to the existing UP Eureka and Navasota Subdivision freight rail lines
- Giddings to College Station, generally following parallel to the existing UP Giddings Subdivision
- Brenham to College Station, along a new greenfield alignment

The intercity rail line modeled to College Station terminates near the Texas A&M University campus. All of the existing and new track alignments would require installation of a Centralized

Train Control (CTC) signal system for passenger rail implementation, which was modeled using a standard rule of thumb for signal spacing (1.5 to 2 mile-long signal blocks) and characteristics. A Positive Train Control (PTC) overlay was included in the cost estimates as well. The new track alignments would allow for maximum speeds of passenger trains of up to 110 mph.

The planning cases include a connection to the UP Eureka Subdivision at Hempstead, at which point some trains would continue on to Houston. Train operations from Hempstead to Houston were not modeled in RTC as part of this study and will be modeled by UP independently. Freight traffic currently on the Eureka Subdivision was not modeled at Hempstead, since it is assumed these operations would be modified to have temporal separation (i.e., operate freight service outside of the windows for passenger operations). Additionally, potential commuter trains coming into Hempstead were not modeled since these are being studied independently by the Gulf Coast Rail District (GCRD) and did not yet have an identified schedule at the time this report was completed. The intercity trains modeled in this report would take dispatching priority over any commuter and freight traffic on the Eureka Subdivision between Hempstead and Houston, meaning that they should experience minimal delays due to conflicting traffic so long as sufficient infrastructure (e.g., passing sidings) is provided along the route.

The planning cases did not include connections to other intersecting rail lines consisting of the UP Waco Subdivision at Elgin, the UP Giddings Subdivision at Giddings, and the BNSF Galveston Subdivision at Brenham, since it is assumed that these rail crossings would need to be grade separated from the intercity passenger rail line. Grade separated crossings would prevent delays to existing freight operations and would eliminate safety risks associated with the interaction of freight and passenger trains at the intersections.

The intercity passenger routes include potential passenger rail station stops in downtown Austin, Elgin, Giddings, Brenham, Hempstead, and College Station. Additionally, although not modeled, passenger rail service would continue to Houston from Hempstead with a station stop at the existing Houston Amtrak station. Although a ridership analysis was not performed, the preliminary passenger rail station locations were determined based on areas with the greatest population along the route between Austin and Hempstead. General locations for the stations were analyzed for the purpose of identifying conceptual passenger rail schedules and levels of on-time performance; specific sites for the stations were not identified. Stations were assumed to consist of passenger platforms 800 feet in length located adjacent to the mainline track (Figure 24 in Section 3). Station siding tracks were determined to not be necessary for the modeled level of passenger rail service, but could be added in the future if needed to prevent trains from stopping on the mainline.

The networks modeled for each of the planning cases differed depending on the schedule route for the passenger trains, including the route alternatives to College Station as well as locations and lengths of required passing sidings, which also differed for start-up and build-out operations as described in further detail in the discussion of each planning case as follows.

Each planning case was run with randomization to test whether the passenger trains would be able to operate with 90%, or better, on-time performance. Randomization parameters were assigned by train type, which are summarized in Table 16. The values of the randomization parameters dictate the maximum amount of time that the operation of a train can vary from the coded operating schedule while still being considered on-time. A random number generator in RTC randomly determines final operating times within the assigned parameters. Randomization parameters for freight trains are larger than passenger trains to represent the greater variability of operating times of freight trains.

Randomization Parameter	Passenger	Freight
Early Departure	0:00:00	0:30:00
Late Departure	0:04:00	1:30:00
Dwell Extension	0:01:00	0:30:00

Table 16: Randomization Parameters by Train Type

The early departure is the limit time that a train can leave its station of origin before its scheduled time. Late departure is the limit to how late a train can leave its station of origin after its scheduled time. Dwell extension is the limit to how long a dwell can be extended beyond its scheduled time.

Initial/ Start-Up Operations

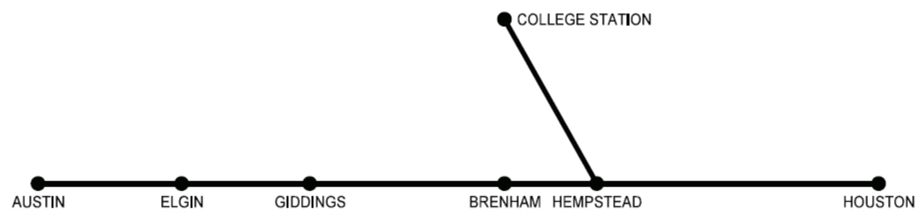
The start-up planning cases were tested to identify what infrastructure requirements would be required to support initial start-up operations for intercity passenger rail in addition to the existing freight traffic. Freight rail traffic growth between Austin and Butler was not modeled, nor was expanding existing freight rail operations to Giddings and/or Hempstead.

Start-up intercity passenger rail operations were defined as two round trips (one in each direction) with morning departures and evening returns daily between Austin and Houston. Weekday trip times as modeled were intended to accommodate business travel, while weekend trip times as modeled were intended to accommodate leisure activities including sporting events. Although the network and operations were not modeled between Hempstead and Houston, arrival and departure times of the passenger trains were planned to accommodate assumed peak demand times for Houston arrivals and departures, based on information obtained from the GCRD's independent study of commuter rail operations between Hempstead and Houston.

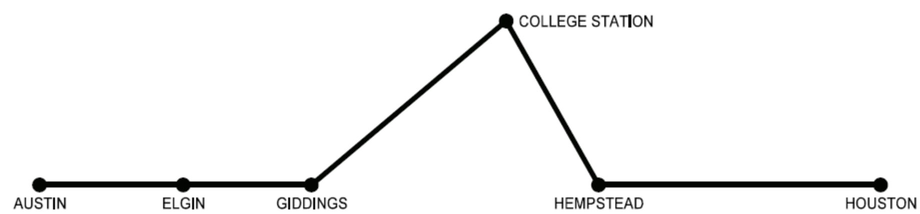
Start-up operations were modeled for four potential operating scenarios as listed below:

- **Option 1**: Direct service between Austin and Houston with intermediate station stops in Elgin, Giddings, Brenham, and Hempstead

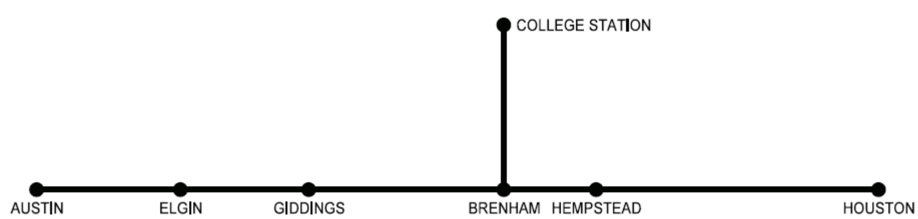
- **Option 2**: Service between Austin and Houston with intermediate station stops in Elgin, Giddings, Brenham, Hempstead, and College Station via a Hempstead-to-College Station route



- **Option 3**: Service between Austin and Houston with intermediate station stops in Elgin, Giddings, Hempstead, and College Station via a Giddings-to-College Station route



- **Option 4**: Service between Austin and Houston with intermediate station stops in Elgin, Giddings, Brenham, Hempstead, and College Station via a Brenham-to-College Station route

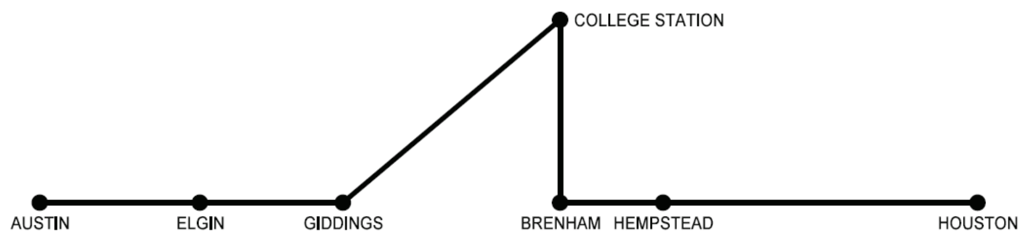


As was previously mentioned, a ridership analysis was not conducted as part of this study and would be required to determine the optimal locations of passenger rail stations and subsequently a refined schedule. Adding a station stop in College Station along the route between Austin and Houston would increase the total trip time by thirty minutes to over an hour, depending on which route option is taken. The station stops and schedules as modeled for this study are shown in Tables 17 through 20 for the four potential operating scenarios.

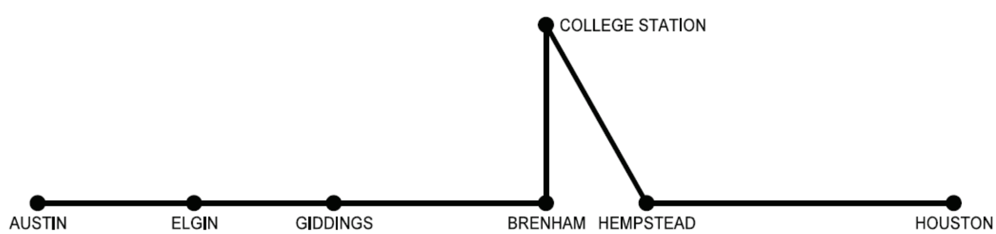
A total of 2 train sets would be required to operate the assumed schedules shown in Tables 17 through 20, although these are not included in the estimate shown in Table 26. Each train set, as modeled, consisted of one locomotive, 3 passenger cars (one with a cab car), and one diner/lounge car.

Although not included in the schedules or cost estimates, additional route options were considered in the analysis as described below:

- Option 1a: Direct service between Austin and Houston with intermediate station stops in Elgin, Giddings, Brenham, and Hempstead with an additional train, should future ridership studies warrant this service, to provide service between Austin and College Station with intermediate station stops in Elgin, Giddings, Brenham, and Hempstead.
    - The addition of an Austin-to-College Station train would require an additional 43 miles of new track construction between Hempstead and College Station, a 4-mile extension to the existing Milby siding for passing trains and would require an additional train set.
    - The Austin-to-College Station train would have a one-way approximate trip time of 2 hours and 10 minutes
- Option 3a: Service between Austin and Houston with intermediate station stops in Elgin, Giddings, Brenham, Hempstead, and College Station via a Giddings-to-College Station route and a Brenham-to-College Station route
    - Using a Brenham-to-College Station alignment rather than a Hempstead-to-College Station alignment between College Station and Houston would add 7 route miles and nearly 10 minutes to the trip time



- Option 4a: Service between Austin and Houston with intermediate station stops in Elgin, Giddings, Brenham, Hempstead, and College Station via a Brenham-to-College Station route
    - Using a Hempstead-to-College Station alignment rather than a Brenham-to-College Station alignment between College Station and Houston would reduce the route by 7 route miles and would reduce the trip time by nearly 10 minutes, though it would require an additional 25 miles of new track construction



EASTBOUND	Austin to Houston Service (Direct)				
Station	Dwell (m:ss)	101 (h:mm)	105 (h:mm)	701 (h:mm)	703 (h:mm)
Austin	----	7:03	17:38	8:00	20:00
Elgin	3:00	7:37	18:12	8:34	20:34
Giddings	2:00	7:56	18:31	8:53	20:53
Brenham	2:00	8:24	18:59	9:21	21:21
Hempstead	3:00	8:40	19:15	9:37	21:37
Houston	----	9:45	20:20	10:42	22:42
Total Trip Time		2:42	2:42	2:42	2:42
Operating Days		M-F	M-F	Sa, Su	Sa, Su

WESTBOUND	Houston to Austin Service (Direct)				
Station	Dwell (m:ss)	102 (h:mm)	106 (h:mm)	702 (h:mm)	704 (h:mm)
Houston	----	6:42	17:17	7:39	19:39
Hempstead	3:00	7:50	18:25	8:47	20:47
Brenham	2:00	8:07	18:42	9:04	21:04
Giddings	2:00	8:36	19:11	9:33	21:33
Elgin	3:00	8:57	19:32	9:54	21:54
Austin	----	9:30	20:05	10:27	22:27
Total Trip Time		2:48	2:48	2:48	2:48
Operating Days		M-F	M-F	Sa, Su	Sa, Su

Table 17: Start-Up Intercity Passenger Rail Schedule Modeled for Austin to Houston Direct Service (Option 1)

EASTBOUND	Austin to Houston Service through College Station via Hempstead				
Station	Dwell (m:ss)	101 (h:mm)	105 (h:mm)	701 (h:mm)	703 (h:mm)
Austin	----	7:03	17:38	8:00	21:00
Elgin	3:00	7:37	18:12	8:34	21:34
Giddings	2:00	7:56	18:31	8:53	21:53
Brenham	2:00	8:24	18:59	9:21	22:21
Hempstead	3:00	8:40	19:15	9:37	22:37
College Station	3:00	9:14	19:49	10:11	23:11
Hempstead	3:00	9:45	20:20	10:42	23:42
Houston	----	10:50	21:25	11:47	0:47
Total Trip Time		3:47	3:47	3:47	3:47
Operating Days		M-F	M-F	Sa, Su	Sa, Su

WESTBOUND	Houston to Austin Service through College Station via Hempstead				
Station	Dwell (m:ss)	102 (h:mm)	106 (h:mm)	702 (h:mm)	704 (h:mm)
Houston	----	5:42	16:17	6:39	19:39
Hempstead	3:00	6:50	17:25	7:47	20:47
College Station	3:00	7:24	17:59	8:21	21:21
Hempstead	3:00	7:55	18:30	8:52	21:52
Brenham	2:00	8:12	18:47	9:09	22:09
Giddings	2:00	8:41	19:16	9:38	22:38
Elgin	3:00	9:02	19:37	9:59	22:59
Austin	----	9:35	20:10	10:32	23:32
Total Trip Time		3:53	3:53	3:53	3:53
Operating Days		M-F	M-F	Sa, Su	Sa, Su

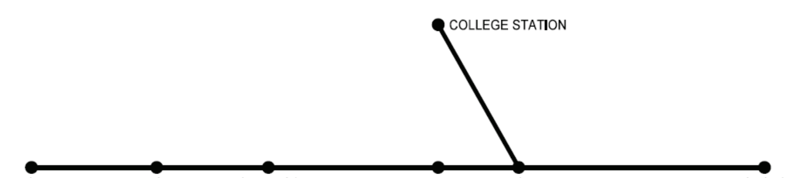


Table 18: Start-Up Intercity Passenger Rail Schedule Modeled for Austin to Houston Service through College Station via Hempstead (Option 2)

EASTBOUND	Austin to Houston Service through College Station via Giddings			
Station	**Dwell (m:ss)**	**101 (h:mm)**	**105 (h:mm)**	**701 (h:mm)**	**703 (h:mm)**
Austin	----	7:05	17:35	8:05	21:05
Elgin	3:00	7:39	18:09	8:39	21:39
Giddings	2:00	7:58	18:28	8:58	21:58
College Station	3:00	8:46	19:16	9:46	22:46
Hempstead	3:00	9:15	19:45	10:15	23:15
Houston	----	10:20	20:50	11:20	0:20
Total Trip Time		3:15	3:15	3:15	3:15
Operating Days		M-F	M-F	Sa , Su	Sa , Su

WESTBOUND	Houston to Austin Service through College Station via Giddings				
Station	**Dwell (m:ss)**	**102 (h:mm)**	**106 (h:mm)**	**702 (h:mm)**	**704 (h:mm)**
Houston	----	6:45	17:15	7:45	20:45
Hempstead	3:00	7:53	18:23	8:53	21:53
College Station	3:00	8:25	18:55	9:25	22:25
Giddings	2:00	9:09	19:39	10:09	23:09
Elgin	3:00	9:30	20:00	10:30	23:30
Austin	----	10:00	20:30	11:00	0:00
Total Trip Time		3:15	3:15	3:15	3:15
Operating Days		M-F	M-F	Sa , Su	Sa , Su

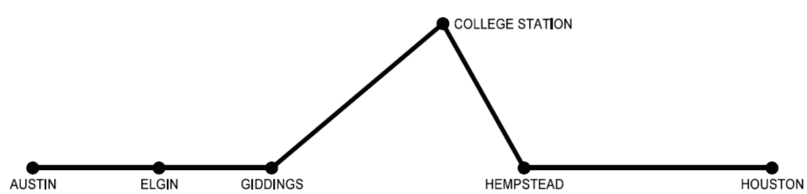


Table 19: Start-Up Intercity Passenger Rail Schedule Modeled for Austin to Houston Service through College Station via Giddings (Option 3)

EASTBOUND	Austin to Houston Service through College Station via Brenham				
Station	Dwell (m:ss)	101 (h:mm)	105 (h:mm)	701 (h:mm)	703 (h:mm)
Austin	----	7:00	17:30	8:00	21:00
Elgin	3:00	7:34	18:04	8:34	21:34
Giddings	2:00	7:53	18:23	8:53	21:53
Brenham	2:00	8:21	18:51	9:21	22:21
College Station	3:00	8:50	19:20	9:50	22:50
Brenham	2:00	9:14	19:44	10:14	23:14
Hempstead	3:00	9:29	19:59	10:29	23:29
Houston	----	10:34	21:04	11:34	0:34
Total Trip Time		3:34	3:33	3:33	3:33
Operating Days		M-F	M-F	Sa , Su	Sa , Su

WESTBOUND	Houston to Austin Service through College Station via Brenham				
Station	Dwell (m:ss)	102 (h:mm)	106 (h:mm)	702 (h:mm)	704 (h:mm)
Houston	----	6:50	17:20	7:50	20:50
Hempstead	3:00	7:58	18:28	8:58	21:58
Brenham	2:00	8:15	18:45	9:15	22:15
College Station	3:00	8:42	19:12	9:42	22:42
Brenham	2:00	9:06	19:36	10:06	23:06
Giddings	2:00	9:35	20:05	10:35	23:35
Elgin	3:00	9:56	20:26	10:56	23:56
Austin	----	10:29	20:59	11:29	0:29
Total Trip Time		3:39	3:39	3:39	3:39
Operating Days		M-F	M-F	Sa , Su	Sa , Su

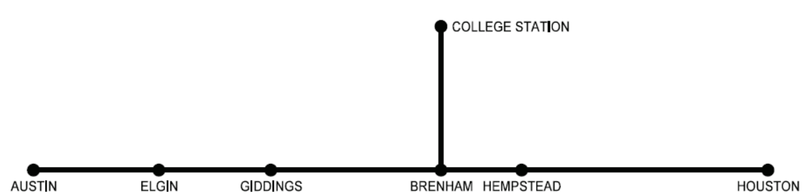


Table 20: Start-Up Intercity Passenger Rail Schedule Modeled for Austin to Houston Service through College Station via Brenham (Option 4)

Build-Out Operations

The build-out planning cases were tested to identify what infrastructure requirements would be required to support build-out operations for intercity passenger rail in addition to the existing freight traffic. The build-out intercity passenger operations were assumed to double the initial operations between Austin and Houston on weekdays with no change to the weekend service routes. As with the first planning case (start-up operations), freight rail traffic growth between Austin and Butler was not modeled, nor was expanding existing freight rail operations to Giddings and/or Hempstead.

The build-out scenario for intercity passenger rail operations is defined as four round trips (two in each direction) with morning departures and evening returns between Austin and Houston weekdays and two round trips (one in each direction) with morning departures and evening returns between Austin and Houston on weekend days.

Build-out operations were modeled for the same four potential operating routes as modeled in the start-up operations as listed below:

- Option 1: Direct service between Austin and Houston with intermediate station stops in Elgin, Giddings, Brenham, and Hempstead
- Option 2: Service between Austin and Houston with intermediate station stops in Elgin, Giddings, Brenham, Hempstead, and College Station via a Hempstead-to-College Station route
- Option 3: Service between Austin and Houston with intermediate station stops in Elgin, Giddings, Brenham, Hempstead, and College Station via a Giddings-to-College Station route
- Option 4: Service between Austin and Houston with intermediate station stops in Elgin, Giddings, Brenham, Hempstead, and College Station via a Brenham-to-College Station route

The station stops and schedule as modeled for each option listed above are shown in Tables 21 through 24. A total of 4 train sets would be required to operate the assumed schedules shown in Tables 21 through 24, although these are not included in the estimate shown in Table 26. Adding a station stop in College Station along the route between Austin and Houston would increase the total trip time by thirty minutes to over an hour, depending on which route option is taken.

EASTBOUND	Austin to Houston Service						
Station	Dwell (m:ss)	101 (h:mm)	103 (h:mm)	105 (h:mm)	107 (h:mm)	701 (h:mm)	703 (h:mm)
Austin	----	7:03	8:03	17:38	18:38	8:00	20:00
Elgin	3:00	7:37	8:37	18:12	19:12	8:34	20:34
Giddings	2:00	7:58	8:58	18:33	19:33	8:55	20:55
Brenham	2:00	8:26	9:26	19:01	20:01	9:23	21:23
Hempstead	3:00	8:42	9:42	19:17	20:17	9:39	21:39
Houston	----	9:47	10:47	20:22	21:22	10:44	22:44
Total Trip Time		2:44	2:44	2:44	2:44	2:44	2:44
Operating Days		M-F	M-F	M-F	M-F	Sa , Su	Sa , Su
WESTBOUND	Houston to Austin Service						
Station	Dwell (m:ss)	102 (h:mm)	104 (h:mm)	106 (h:mm)	108 (h:mm)	702 (h:mm)	704 (h:mm)
Houston	----	6:42	7:42	17:17	18:17	7:39	19:39
Hempstead	3:00	7:50	8:50	18:25	19:25	8:47	20:47
Brenham	2:00	8:07	9:07	18:42	19:42	9:04	21:04
Giddings	2:00	8:36	9:36	19:11	20:11	9:33	21:33
Elgin	3:00	8:57	9:57	19:32	20:32	9:54	21:54
Austin	----	9:30	10:30	20:05	21:05	10:27	22:27
Total Trip Time		2:48	2:48	2:48	2:48	2:48	2:48
Operating Days		M-F	M-F	M-F	M-F	Sa , Su	Sa , Su

Table 21: Build-Out Intercity Passenger Rail Schedule Modeled for Austin to Houston Direct Service (Option 1)

EASTBOUND	Austin to Houston Service via College Station						
Station	Dwell (m:ss)	101 (h:mm)	103 (h:mm)	105 (h:mm)	107 (h:mm)	701 (h:mm)	703 (h:mm)
Austin	----	7:03	8:03	17:38	18:38	8:00	21:00
Elgin	3:00	7:37	8:37	18:12	19:12	8:34	21:34
Giddings	2:00	7:58	8:58	18:33	19:33	8:55	21:55
Brenham	2:00	8:26	9:26	19:01	20:01	9:23	22:23
Hempstead	3:00	8:42	9:42	19:17	20:17	9:39	22:39
College Station	3:00	9:16	10:16	19:51	20:51	10:13	23:13
Hempstead	3:00	9:47	10:47	20:22	21:22	10:44	23:44
Houston	----	10:52	11:52	21:27	22:27	11:49	0:49
Total Trip Time		3:49	3:49	3:49	3:49	3:49	3:49
Operating Days		M-F	M-F	M-F	M-F	Sa, Su	Sa, Su

WESTBOUND	Houston to Austin Service via College Station						
Station	Dwell (m:ss)	102 (h:mm)	104 (h:mm)	106 (h:mm)	108 (h:mm)	702 (h:mm)	704 (h:mm)
Houston	----	5:42	6:42	16:17	17:17	6:39	19:39
Hempstead	3:00	6:50	7:50	17:25	18:25	7:47	20:47
College Station	3:00	7:24	8:24	17:59	18:59	8:21	21:21
Hempstead	3:00	7:55	8:55	18:30	19:30	8:52	21:52
Brenham	2:00	8:12	9:12	18:47	19:47	9:09	22:09
Giddings	2:00	8:41	9:41	19:16	20:16	9:38	22:38
Elgin	3:00	9:02	10:02	19:37	20:37	9:59	22:59
Austin	----	9:35	10:35	20:10	21:10	10:32	23:32
Total Trip Time		3:53	3:53	3:53	3:53	3:53	3:53
Operating Days		M-F	M-F	M-F	M-F	Sa, Su	Sa, Su

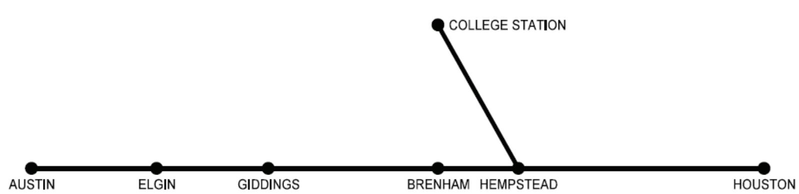


Table 22: Build-Out Intercity Passenger Rail Schedule Modeled for Austin to Houston Service via College Station (Option 2)

EASTBOUND	Austin to Houston Service through College Station via Giddings					
Station	Dwell (m:ss)	101 (h:mm)	103 (h:mm)	105 (h:mm)	107 (h:mm)	701 (h:mm)	703 (h:mm)
Austin	----	7:05	8:05	17:35	18:35	8:05	21:05
Elgin	3:00	7:39	8:39	18:09	19:09	8:39	21:39
Giddings	2:00	7:58	8:58	18:28	19:28	8:58	21:58
College Station	3:00	8:46	9:46	19:16	20:16	9:46	22:46
Hempstead	3:00	9:15	10:15	19:45	20:45	10:15	23:15
Houston	----	10:20	11:20	20:50	21:50	11:20	0:20
Total Trip Time		3:15	3:15	3:15	3:15	3:15	3:15
Operating Days		M-F	M-F	M-F	M-F	Sa, Su	Sa, Su

WESTBOUND	Austin to Houston Service through College Station via Giddings						
Station	Dwell (m:ss)	102 (h:mm)	104 (h:mm)	106 (h:mm)	108 (h:mm)	702 (h:mm)	704 (h:mm)
Houston	----	6:45	7:45	17:15	18:15	7:45	20:45
Hempstead	3:00	7:53	8:53	18:23	19:23	8:53	21:53
College Station	3:00	8:25	9:25	18:55	19:55	9:25	22:25
Giddings	2:00	9:11	10:11	19:41	20:41	10:11	23:11
Elgin	3:00	9:31	10:31	20:01	21:01	10:31	23:31
Austin	----	10:01	11:01	20:31	21:31	11:01	0:01
Total Trip Time		3:16	3:16	3:16	3:16	3:16	3:16
Operating Days		M-F	M-F	M-F	M-F	Sa, Su	Sa, Su

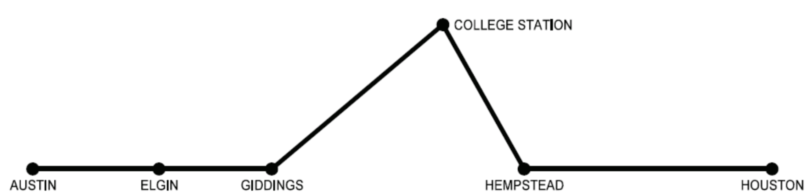


Table 23: Build-Out Intercity Passenger Rail Schedule Modeled for Austin to Houston Service through College Station via Giddings (Option 3)

EASTBOUND	Austin to Houston Service through College Station via Brenham						
Station	Dwell (m:ss)	101 (h:mm)	103 (h:mm)	105 (h:mm)	107 (h:mm)	701 (h:mm)	703 (h:mm)
Austin	----	7:00	8:10	17:30	18:30	8:00	21:00
Elgin	3:00	7:34	8:44	18:04	19:04	8:34	21:34
Giddings	2:00	7:53	9:03	18:23	19:23	8:53	21:53
Brenham	2:00	8:20	9:30	18:50	19:50	9:20	22:20
College Station	3:00	8:50	10:00	19:20	20:20	9:50	22:50
Brenham	2:00	9:18	10:28	19:48	20:48	10:18	23:18
Hempstead	3:00	9:34	10:44	20:04	21:04	10:34	23:34
Houston	----	10:39	11:49	21:09	22:09	11:39	0:39
Total Trip Time		3:39	3:39	3:39	3:39	3:39	3:39
Operating Days		M-F	M-F	M-F	M-F	Sa , Su	Sa , Su

WESTBOUND	Austin to Houston Service through College Station via Brenham						
Station	Dwell (m:ss)	102 (h:mm)	104 (h:mm)	106 (h:mm)	108 (h:mm)	702 (h:mm)	704 (h:mm)
Houston	----	6:50	7:55	17:20	18:20	7:50	20:50
Hempstead	3:00	7:58	9:03	18:28	19:28	8:58	21:58
Brenham	2:00	8:13	9:18	18:43	19:43	9:13	22:13
College Station	3:00	8:38	9:43	19:08	20:08	9:38	22:38
Brenham	2:00	9:04	10:09	19:34	20:34	10:04	23:04
Giddings	2:00	9:36	10:41	20:06	21:06	10:36	23:36
Elgin	3:00	9:56	11:01	20:26	21:26	10:56	23:56
Austin	----	10:27	11:32	20:57	21:57	11:27	0:27
Total Trip Time		3:37	3:37	3:37	3:37	3:37	3:37
Operating Days		M-F	M-F	M-F	M-F	Sa , Su	Sa , Su

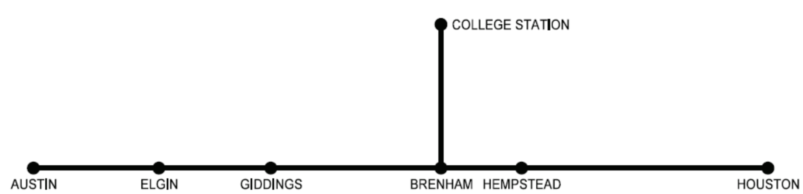


Table 24: Build-Out Intercity Passenger Rail Schedule Modeled for Austin to Houston Service through College Station via Brenham (Option 4)

Passenger and Freight Train Performance

The infrastructure improvements modeled provided a 99% level of on-time performance for the initial/ start-up and build-out schedules. The overall modeled average speed ranged from approximately 65 mph to 70 mph for passenger trains, depending on route option, and 24 mph for freight trains. The average passenger train speeds and travel times for each segment along the route are listed in the Table 25. The average travel times and speeds differ for eastbound versus westbound trains due to vertical grade as well as delay incurred at passing sidings. Grades are generally downhill from Giddings to Hempstead and from Giddings to College Station and generally uphill from Hempstead to College Station and from Brenham to College Station. Delay incurred at passing sidings may differ depending on direction of travel if trains in opposing directions do not reach the siding at the same time. Siding lengths and locations were determined in order to minimize such delays, although the siding locations could not be optimized in some instances due to infrastructure restrictions such as curves and major bridges.

Route Segment	Modeled Travel Time (includes station dwells)	Modeled Average Speed of Passenger Trains
Downtown Austin Station- Austin Junction/ Wye	9 min.	8 to 10 mph
Austin Junction-Elgin	24 to 25 min.	67 to 74 mph
Elgin-Giddings	19 to 21 min.	75 to 80 mph
Giddings-Brenham	28 to 30 min.	77 to 81 mph
Brenham-Hempstead	14 to 18 min.	61 to 75 mph
Hempstead-Houston*	65 min.	50 mph
Hempstead-College Station (Option 2)	31 to 34 min.	83 to 93 mph
Giddings-College Station (Option 3)	44 to 48 min.	66 to 72 mph
Brenham-College Station (Option 4)	24 to 29 min.	67 to 72 mph

Table 25: Travel Times and Speeds by Route Segment (not including station dwells)
(*Hempstead to Houston data based on preliminary information available from the GCRD study)

The existing freight trains from the base case were included in the planning cases, but with modified schedules to adjust for the passenger trains. Although the freight trains' origination times had to be modified in the planning cases, they were able to operate more efficiently and complete their schedules earlier as a result of the increased track speeds associated with the revised alignment. The intercity passenger rail start-up schedule was determined to have very little impact on freight operations, although the freight train operations were shown to experience some delay on the Tuesday and Thursday evening trips due to being held to wait on passing passenger trains. This delay could be eliminated entirely if the operating hours of the freight trains were shifted to operate completely outside of the passenger operating windows.

Average speeds and travel times by route segment were approximately the same for the build-out schedule as for the start-up schedule with minor differences of approximately 2 minutes on the total trip time due to additional train meets.

The freight train operations were shown to experience a total of approximately 35 minutes of delay over 100 train miles, which could be eliminated if the operating hours of the freight trains were changed to operate outside of the passenger operating windows. The eastbound ethanol train, as modeled, has to wait 14 minutes at the Littig siding for the eastbound passenger train to pass while en route from Decker to Elgin on Mondays. The westbound ethanol train also has to wait 14 minutes at the Littig siding for the eastbound passenger train while en route from Elgin to Decker on Thursdays. The westbound gravel train was modeled to experience a short (less than 5 minute) delay departing from the Butler aggregate yard waiting for a passenger train to pass on Tuesdays and Thursdays.

Infrastructure Improvements

The primary infrastructure improvements required for implementation of intercity passenger rail include modifications to the existing rail line between Austin and Giddings to allow for higher train speeds, new single mainline tracks east of Giddings to Hempstead via the routes previously described in Options 1 through 4, and a new Centralized Traffic Control (CTC) signal system along the passenger rail routes (including existing and new tracks). Improvements between Hempstead and Houston were not identified in this study and are being addressed in the study conducted by the Gulf Coast Rail District (GCRD).

Additionally, new sidings and extensions to existing sidings were identified at the locations listed as follows and shown in Figures 29 through 32 to allow the intercity passenger trains running in opposite directions to meet and pass each other. The lengths of the sidings would allow the passenger trains to pass each other without coming to a stop.

- Options 1 (direct) & 2 (via Hempstead)
    - Start-Up: One 3-mile-long siding approximately 12 miles west of Brenham
    - Build-Out: One additional 3-mile-long siding 15.4 miles west of Giddings
- Option 3 (via Giddings)
    - Start-Up: One 4-mile-long siding approximately 4 miles southwest of College Station on new Giddings-to-College Station alignment
    - Build-Out: Additional 3-mile-long siding 0.75 miles north of Giddings on new Giddings-to-College Station alignment and a 4-mile-long siding nearly 30 miles south of College Station on the line between Hempstead and College Station
- Option 4 (via Brenham)
    - Start-Up: One 3-mile-long siding approximately 2 miles southwest of College Station on new Brenham-to-College Station alignment
    - Build-Out: Additional 4-mile-long siding located 0.25 miles north of Brenham on new Brenham-to-College Station alignment and a 3-mile-long siding 10 miles west of Brenham on the Giddings-to-Hempstead alignment

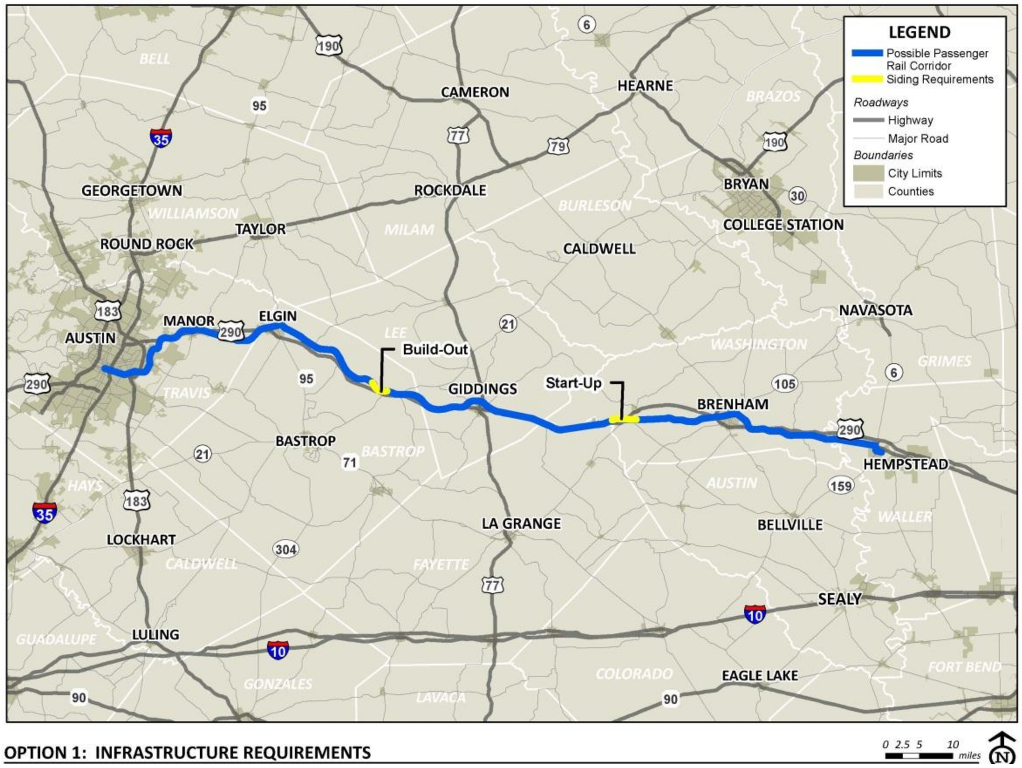


Figure 29: Option 1 Infrastructure Requirements

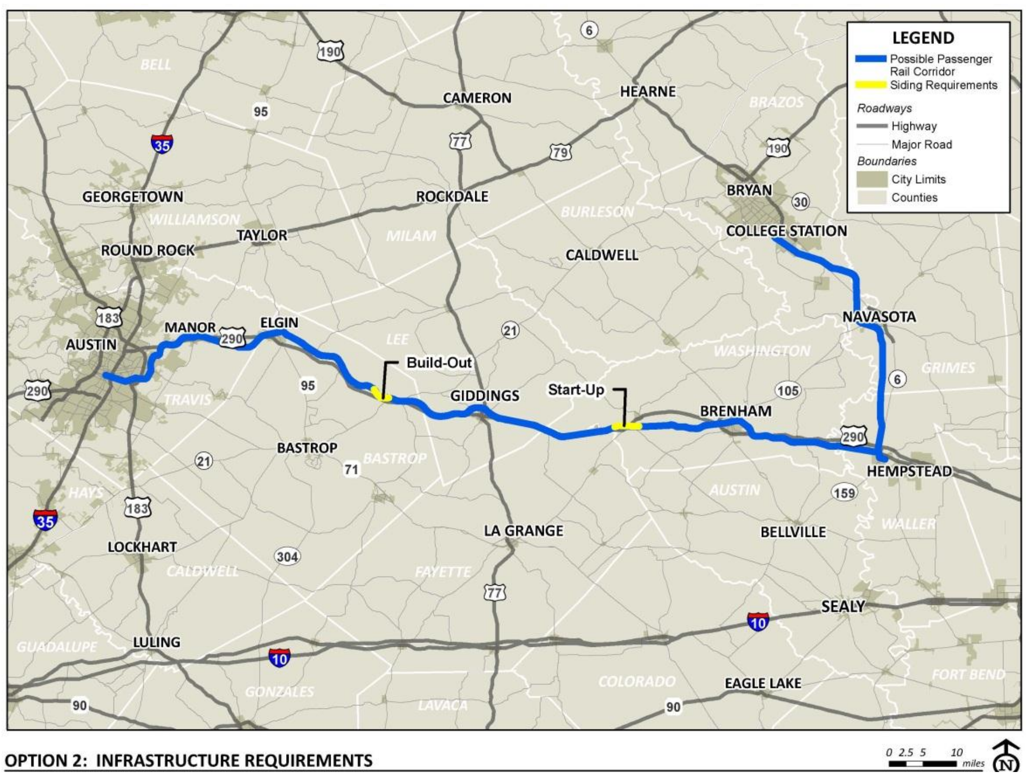


Figure 30: Option 2 Infrastructure Requirements

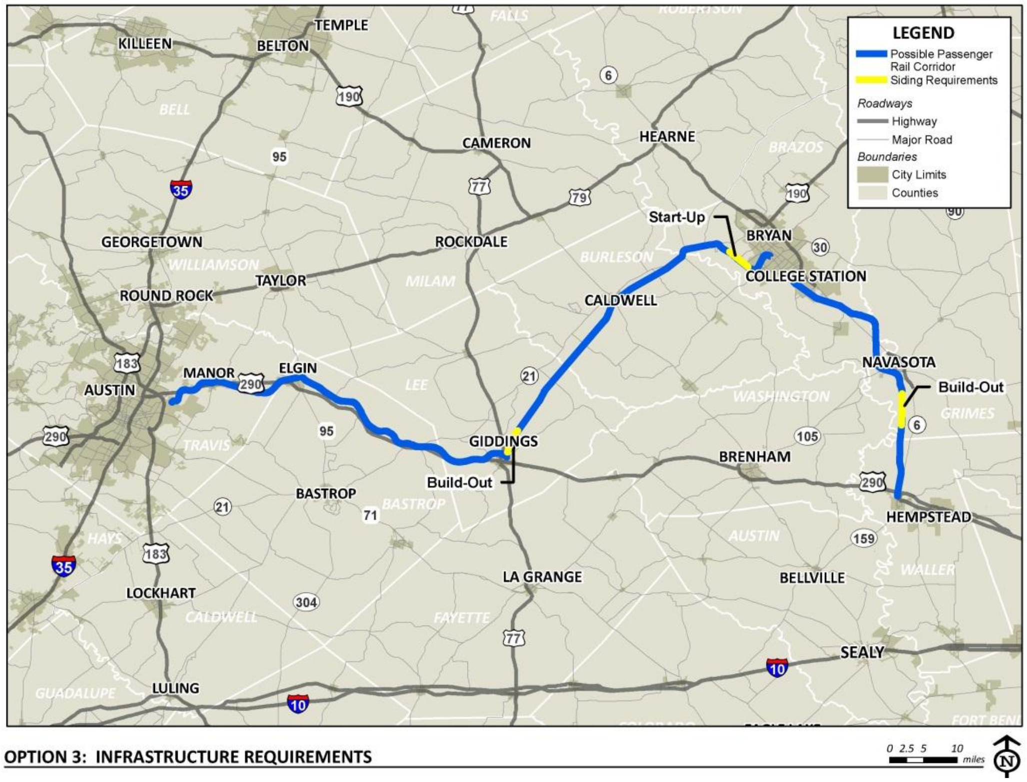


Figure 31: Option 3 Infrastructure Requirements

Figure 32: Option 4 Infrastructure Requirements

The following improvements were also included along the existing Austin-to-Giddings segment for all route options to allow existing freight trains to clear the mainline in a safe and timely manner and prevent delay to passenger trains. The improvements would also allow access into sidings to be dispatcher controlled versus the manual control by train and engine crews currently in place.

- #15 dual control power turnouts at all existing industry spur tracks (7 total)
- #15 dual control power turnouts at all existing freight sidings (6 total)

Additional infrastructure and ancillary facilities that may be required for passenger rail implementation, although not modeled or included in the cost estimates in this study, could include layover tracks, maintenance facilities, carwash/cleaning facilities, and crew and maintenance/operating personnel facilities.

Estimated Costs

The estimated costs for the infrastructure improvements and rolling stock modeled for start-up and build-out operations, excluding ancillary facilities, are shown in Table 26. The cost estimates for infrastructure improvements identified do not constitute the total costs associated with implementing intercity passenger rail between Austin and Houston. The cost estimates included in this study do not include operating and maintenance costs, projected revenues, or equipment costs other than rolling stock. Rolling stock costs were estimated to be $12 million per train set. No costs are included for the requirements for intercity passenger rail service in the Hempstead to Houston segment.

As shown in the table, the direct service between Austin and Houston without a stop in College Station (Option 1) is the least expensive option. Of the routes that would provide service to College Station, the Giddings route is the least expensive.

The Hempstead-to-College Station segment has the lowest estimated cost (both overall and per mile) since it is the shortest segment and also has significantly fewer required railroad bridges, roadway crossings, and grade separations. The Austin-to-Giddings segment is relatively close in terms of the estimated cost per mile to the Giddings-to-Hempstead segment, even though it partially utilizes existing Capital Metro railroad infrastructure, since more than half of the corridor would require a new alignment in order to modify the geometry to increase allowable train speeds and the remaining portion of the existing alignment would require rehabilitation. Additionally, all existing timber bridges on Capital Metro would need to be replaced along the potential intercity passenger rail for improved ride quality. More detailed estimates for each segment of the potential intercity passenger rail corridor are provided in Appendix G.

Infrastructure Cost by Route Segment		
Route Segment	**Total Cost (w/o sidings)**	**Cost per Mile**
Austin to Giddings	$439,660,000	$8,123,799
Giddings to Hempstead	$461,710,000	$8,105,481
Hempstead to College Station	$283,010,000	$6,554,192
Giddings to College Station	$387,660,000	$8,666,667
Brenham to College Station	$276,450,000	$8,580,508
Summary of Total Costs		
Austin to Houston Route Option	**Start-Up**	**Build-Out**
Option 1 (Direct)	$936,710,000	$972,040,000
Option 2 (via Hempstead to College Station)	$1,219,720,000	$1,255,050,000
Option 3 (via Giddings to College Station)	$1,149,250,000	$1,199,510,000
Option 4 (via Brenham to College Station)	$1,213,160,000	$1,263,420,000

Table 26: Summary of Estimated Costs

The following section describes what items are included in Table 26 and lists the primary assumptions used in estimating the costs.

Track

The estimated costs for track work include new continuously welded rail (CWR), concrete ties, ballast, sub ballast, surfacing and other track materials (OTM) for all new track alignments between Giddings and Hempstead, between Hempstead and College Station, and along the segments of revised alignment between Austin and Giddings. The Austin-to-Giddings segment would also require replacement of the existing jointed rail and timber ties with continuously welded rail and concrete ties for the portions of the existing alignment that may be used by the intercity passenger service. Additionally, the cost estimate includes the removal of existing turnouts at existing freight sidings and industry access tracks and replacement with #15 power turnouts as well as #24 power turnouts at new connections to Eureka Subdivision at Hempstead and Navasota Subdivision at College Station. The cost estimates include new sidings required for passing intercity passenger rail trains as previously discussed for the potential operating schedule options.

Signals

The estimated costs for signals include the costs for railroad signalization as well as grade crossing warning devices for at-grade roadway crossings within the intercity passenger rail corridor. The costs include 4-quadrant gates with bells and flashing lights at all public at-grade crossings and 2-quadrant gates with bells and lights at all private at-grade crossings. The estimate also includes centralized train control (CTC) signalization along the entire passenger rail route, including potential new alignments as well as the portions of the existing rail line between Austin and Giddings that may be used for the intercity passenger rail service. Positive Train Control (PTC) overlay was included for all portions of the route.

Structures

The estimated costs for structures include railroad grade separations, roadway grade separations, railroad bridges, and miscellaneous drainage structures. Railroad grade separations were assumed at all crossings with existing freight lines (UP Waco, UP Giddings, and BNSF Conroe Subdivisions) and roadway grade separations were assumed at at-grade crossings with high volume roadways (typically with AADT> 5,000). Approximate locations and lengths of new railroad bridges were identified along segments of new track between Austin and Hempstead using aerial photography, FEMA floodplain elevations, USGS quadrangle maps showing topography as well as profile alignments. Locations and lengths of railroad bridges along the segment between Hempstead and College Station were based on existing bridges on the UP Eureka and Navasota Subdivisions, since the intercity passenger rail alignment is assumed to parallel those rail lines. Additionally, the cost estimate for the Austin-to-Giddings segment includes replacing all existing timber railroad bridges located along the revised alignment in order to provide improved ride quality as would be desired for intercity passenger service. Bridges that have been recently replaced by Capital Metro or are included in Capital Metro’s near-term capital plan for replacement were not included in the cost estimate. Miscellaneous drainage structures, such as culverts, were included as a unit cost per mile of new track.

Earthwork

Earthwork quantities were produced using an assumed typical section and were not based on detailed vertical profile alignments and existing ground line elevations.

Passenger Stations

The passenger station cost estimates were based on the costs of passenger stations constructed on the Capital Metro Red Line passenger rail route between Leander and Austin and include a covered 800-foot platform and parking facilities. The passenger station at Hempstead is assumed to be a larger station, since it may also serve as the end of line station for potential commuter trains between Hempstead and Houston as currently being studied by the GCRD.

Miscellaneous

Additional miscellaneous costs include clearing, grubbing, landscaping, utility relocation, storm water pollution prevention, contractor mobilization, design/ engineering/ permitting/ construction management, and contingency. All of the miscellaneous items are based on a percentage of the construction cost.

Right of Way

Currently, the two competing approaches to appraisal are the corridor valuation (CV) method and the at-the-fence (ATF) method. The CV method is an approach that sets price according to the market sales price of similar linear corridors, whereas the ATF method measures value according to the market sales price of properties adjacent to the corridor.[16]

Using the CV method of appraising railroad right of way, the 2010 value of the City of Austin's original 1986 purchase of the Giddings-to-Llano line is $17.5 million, or $108,000 per mile for the 162-mile corridor. Whether $108,000 per mile actually reflects the cost of a comparable corridor in 2010 depends on the 24-year price escalation of the property relative to that of the general economy. The 1986 Giddings-to-Llano purchase will differ from a Hempstead-to-Giddings corridor to some degree by their proximities to a major city such as Austin and by the total mileage within urban areas. However, this price does provide a comparison to the value of the Giddings-to-Hempstead segment of the same original corridor obtained using the ATF method and an enhancement factor ranging from 1.1 to 1.2.

The right-of-way acquisition costs shown in Table 26 were based on the ATF method for the Giddings-to-Hempstead segment, which produced a higher cost than using the CV method with a cost of $108,000 per mile. The acquisition costs were developed based on information obtained from the respective counties' central appraisal districts along the corridor. In those instances where market value information was not available for a particular property from an appraisal district, value estimates were used based on the highest value per square foot for adjacent or nearby properties of similar land use. Market adjustment factors were applied to adjust the appraisal district values to more closely represent what the current market may be experiencing based on discussions with representatives of each of the counties' appraisal districts. Additionally, legal fees and transaction fees were included per property acquisition to account for legal review of the contract, title conditions, property surveys, and closing costs.

Such a detailed review of potential property acquisitions was not conducted for the Austin-to-Giddings, Giddings-to-College Station, Brenham-to-College Station, and Hempstead-to-College Station segments of the potential intercity passenger rail route. As a result, a typical cost per acre was used to estimate right of way costs for the Austin-to-Giddings, Giddings-to-College Station, and Brenham-to-College Station segments based on the detailed property value information obtained for the Giddings-to-Hempstead segment using comparable land use types. The right-of-way acquisition for the Hempstead-to-College Station corridor, however, was estimated using the CV method with a cost of $108,000 per mile since the property

[16] These market-based appraisal methods are subsets of the market approach, whereby a market value is established, as compared to the cost approach or the income approach to valuation. The cost approach considers investments that have been made to improve the functionality of property and the income approach considers revenue that is being generated by the property, neither of which applies to the acquisition of abandoned rail corridors or other least cost right of way alternatives.

generally followed an existing railroad corridor owned by UP and may not require as many individual land owners.

Conclusions

The following conclusions summarize the findings from the analysis conducted for this study:

- Use of the existing infrastructure between Austin and Giddings for intercity passenger rail requires several upgrades and rehabilitation, which result in the cost per mile along the existing Austin-to-Giddings segment to nearly equal the cost per mile along the new segment of track between Giddings and Hempstead.
- The alignment modeled between Giddings and Hempstead follows the U.S. 290 corridor to Carmine and then generally along the abandoned SP corridor based on an analysis of track lengths, travel times, profile fatal-flaw analysis, environmental fatal-flaw analysis, and potential station locations.
- The alignment modeled between Hempstead and College Station is adjacent to the UP Eureka and Navasota Subdivisions with a bypass west of Navasota.
- The alignment modeled between Giddings and College Station generally follows parallel to the existing UP Giddings Subdivision north to SH 47 and then generally alongside SH 47 to College Station.
- The alignment modeled from Brenham to College Station is a greenfield alignment that connects to the abandoned SP corridor on the east side of Brenham and connects to the
- The assumed start-up schedules could be supported by single track mainline with a 3 to 4-mile-long passing siding.
    - One additional siding would be required for the build-out schedule for route options 1 and 2, while two additional 3 to 4-mile-long sidings would be required for the build-out schedules for route options 3 and 4.
- The approximate total travel times between Austin and Houston are listed below for each schedule option:
    - Option 1 (Austin to Houston Direct) - 2 hours and 45 minutes
    - Option 2 (Austin to Houston with Route to College Station via Hempstead) - 3 hours and 50 minutes
    - Option 3 (Austin to Houston with Route to College Station via Giddings) - 3 hours and 15 minutes
    - Option 4 (Austin to Houston with Route to College Station via Brenham) - 3 hours and 37 minutes
- The direct route (Option 1) is the least expensive route option and also has the shortest trip time. Of the route options that provide service to College Station, the Giddings route option (Option 2) is the least expensive and provides the shortest trip time.

Next Steps

Building upon the information contained in this report, a ridership analysis should be conducted to determine refined station locations and train operating schedules for intercity passenger rail operations between Austin and Houston and to determine if a stop in College Station would be viable based on the revenue to cost ratio. Additionally, further study of passenger rail between Austin and Houston should identify the improvements necessary to bring the passenger rail service to the central business districts of both cities. In particular, a preferred route and required infrastructure should be determined to bring passenger trains from the end of the Eureka Subdivision at Loop 610 into the core of Houston. Potential sites for ancillary facilities such as layover tracks, maintenance facilities, carwash/cleaning facilities, and crew and maintenance/operating personnel facilities should also be identified.

The last step required to complete the planning phase for this project would be to proceed with an environmental impact study for the proposed corridor. Coordination with the City of Austin Urban Rail plans, Capital Metro MetroRail operations (both the existing Red Line and the potential future Green Line), Houston Metro light rail operations, and the GCRD Hempstead to Houston commuter rail plans should be maintained for all potential future phases of this study. Additional coordination would be required with UP and BNSF regarding potential impacts to existing freight lines that need to be mitigated.