Appendix D

Draft Texas-Oklahoma Passenger Rail Study Alternatives Analysis Report

Texas Department of Transportation

TEXAS-OKLAHOMA PASSENGER RAIL STUDY

In coordination with Oklahoma DOT

Alternatives Analysis Report - Draft

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1.0 Introduction

This report builds upon all of the previous major analysis work performed in this corridor, including a range of routing alignments and service-level alternative evaluations covering the entire corridor study area. After the completion of the Route Alternatives Analysis, which included an evaluation of the NEPA Service-level EIS scoping process, 12 initial route alternatives, four in each of the three geographic segments (defined below), were identified that would provide additional or new passenger rail service between Oklahoma City and south Texas. Each initial alternative included both a proposed route, some with minor route options, and two of three possible service-level operating features: conventional (emerging), higher speed rail (regional), or high-speed rail (core express) service. The geographic segments, which have significantly different population and travel characteristics, were defined as follows:

- Northern Section: Oklahoma City to Dallas and Fort Worth
- Central Section: Dallas and Fort Worth to San Antonio
- Southern Section: San Antonio to south Texas.

In addition, the Northern Section of the Program Corridor was extended north of Oklahoma City to Edmond, Okla., based on preliminary ridership information and stakeholder input. In the Southern Section, based on stakeholder input at Laredo and Harlingen, an option was added to extend the southern end of the Program Corridor across the U.S.-Mexico border to Monterrey, Mexico, to capture significant ridership generators. In the case of service to Monterrey, the evaluation considered the effect of ridership generated by potential extensions to Monterrey but not the route impact.

1.1 Report Structure

This report provides additional support for the alternatives analysis and evaluation processes adding specifically to the Final Route Alternatives Analysis Technical Memorandum (CH2M HILL; June 23, 2014). To build upon the previous and continuing efforts a summary of multiple and contributing disciplines is provided, each with both discrete and inter-related applicability to the alternatives analysis efforts. The evaluation and analysis efforts are reflected in the following summary sections:

Development of Initial Range of Alternatives – Using the iterative process associated with early alternatives development the focus was on generating, assessing, and refining potential alternatives for further consideration.

Route Alternatives Evaluation – Conduct a fatal flaw analysis of the initial alternatives based on fulfilling the purpose and need, consistency with local and regional objectives and policies, cost estimation, potentially unmitigable environmental impacts, community/agency support, interest, or opposition, and technical feasibility.

Initial Ridership Evaluation – Performing early evaluations the objective was to obtain rough order of magnitude ridership estimates sufficient to screen the initially developed alternatives through an approximate assessment of their demand and revenue levels.

Preliminary Station Location Evaluation – Based on initial ridership estimates, connectivity options, and GIS information and evaluation of broad-level station locations with a focus on accessibility and mobility, as well as engineering and urban planning feasibility criteria was conducted.

Preliminary Service Schedule and Initial Operations Plan – Maintaining a wide range of alternatives, screening-level evaluations/trade-offs among the critical elements, including frequency, speed, infrastructure investment and alternatives, support facilities, ridership, and schedule was developed.

Railroad Support Facilities – Understanding the interrelationships and dependencies, the objective was to develop a list of existing railroad support facilities for potential use in support, and identify potential locations where new facilities would be needed.

Railroad Simulation and Capacity Mitigation – Using a planning level model with track configuration, grade, curves, and speed restrictions focus on facilitating the capacity representation and generate the ability to provide a measure of aggregate and individual segment performances (average speed and hours of delay by train type and railroad).

Evaluation of Highway Crossings and Grade Separations – Based on the alternative alignments identified evaluate each in terms of highway crossing implications, including characterizing crossing roadway volumes and train frequencies, as well as engineering requirements associated with horizontal and vertical alignments.

Initial Capital Cost Estimates – Using a rough order of magnitude prepare a cost estimate of the initial alternatives based upon aggregated per-mile unit rates, and GIS level data for the corridor.

Public Outreach and Feedback – Develop a Public Involvement Plan (PIP) for use throughout all phases of the project development process. The PIP was and will be tailored to key stakeholders, affected communities, and representatives of potential environmental justice populations, and will include interviews, a website, printed materials, media outreach, meeting and briefings, and public open houses. All designed to fulfil procedural and regulatory requirements during the project's decision making processes.

Working from this range of contributing elements, the analysis and evaluation conducted, and the corresponding summaries, the results of the Alternatives Analysis Report will be provided in a summary conclusion section. This report with also contribute to the comprehensive project development process and will be incorporated into the EIS in support of the alternative selection efforts.

2.0 Development of Initial Range of Alternatives

The purpose of the initial range of alternatives development and evaluation process was to identify a wide range of potential alternatives that could provide additional or new passenger rail service between Oklahoma City and south Texas, and then be included for further consideration in the Texas-Oklahoma Passenger Rail Study (TOPRS). This process also included an initial feasibility and fatal flaw analysis to determine the set of alternatives to be carried forward into the Route Alternatives Analysis (CH2M HILL 2013). The development of the initial range of alternatives is described in detail in the Initial Development of Alternatives Technical Memorandum (CH2M HILL 2013).

This section includes a description of the development of the alternatives included in the initial range of alternatives, the process involved in feasibility screening, and the results of the screening.

2.1 Development of Initial Range of Route Alternatives

The initial range of TOPRS route alternatives were based on three basic transportation networks that could be suitable for passenger rail operations: 1) the existing railroad network, 2) the existing interstate highway network, and 3) potential greenfield corridors.

Existing Railroad Network - Freight and passenger railroads in the study corridor are generally suitable for three types of intercity passenger rail use, shared track, shared right-of-way, and shared corridors. With shared track, passenger trains would interoperate with existing and proposed freight and commuter trains on existing, upgraded, and new tracks at speeds up to 90 mph. With shared right-of-way, intercity passenger trains would use their own tracks constructed along with existing and upgraded tracks for other uses in the same right-of-way at speeds up to 125 mph. With shared corridors, intercity passenger trains would use their own tracks constructed alongside the existing railroad corridors, and speeds could be faster than 125 mph depending on separation distance from other railroad operations and the civil alignment curve limiting speeds and the presence of any grade crossings.

Existing Interstate Highway Network - Two different route alternative concepts were developed following the Interstate 35 and 37 corridors, which parallel the Study corridor, a median-running right-of-way and a side-running right-of-way. The median running right-of-way would locate an intercity passenger rail line in the center of the roadway. This scenario has the benefit of allowing shared use of existing grade separations, but limits expansion of future roadway lanes and complicates maintenance and operations of both systems. The side-running right-of way, which would locate intercity passenger rail between the main driving lanes and frontage road or right-of-way fence, would complicate the design of highway on and off-ramps. Maximum rail speeds in both scenarios would also be limited to the engineered speed of the roadway. Due to urban median and right-of-way limitations, routes along interstate highways would use existing rail corridors to enter major cities.

Greenfield Corridors - The most flexible concept would involve constructing a new high speed passenger rail route capable of 220 mph maximum speed. Greenfield corridors may only be suitable outside of metropolitan areas and intercity passenger rail service may have to use other corridors described above to enter and leave downtown areas. Greenfield corridors typically have more environmental concerns than existing railroad or highway corridors.

2.2 Description of Route Alternatives

Each initial alternative included both a proposed route, and two of three possible service-level operating features: conventional (emerging), higher speed rail (regional), or high-speed rail (core express) service. Alternatives were developed for each of the Study geographic segments, which have significantly different population and travel characteristics. These initial alternatives are shown in Figure 2-1, taken from the Initial Development of Alternatives Technical Memorandum.

Northern Section: Oklahoma City to Dallas and Fort Worth – Four routes, beginning in Edmond, OK and continuing south to Ft. Worth were developed in the Northern Section, N1, N2, N3, and N4. N1 runs on a local railroad and the Union Pacific Railroad south through Chickasha and Bowie and on to Ft. Worth. N2 follows the BNSF railway south to Norman, OK, transitions to a greenfield alignment which continues south to Krum, TX, then follows BNSF to Ft. Worth and the KCS to Dallas Union Station (DUS). N3 follows the BNSF Railway south to Norman, OK, transitions to the IH-35 alignment continuing south to Krum, TX, then follows BNSF to Ft. Worth and the KCS to DUS. N4 runs on the BNSF Railway south to Ft. Worth then runs on the Trinity Rail Express (TRE) to DUS.

Metroplex: Connecting Dallas and Ft Worth (northern and central sections) – The northern and central section alternatives will serve both Dallas and Ft. Worth using one of three east-west routes between the Ft. Worth Intermodal Transportation Center (ITC) and DUS: M1, M2, or M3. M1 runs on the TRE with optional loops to the DFW airport and the Arlington entertainment district. M2 runs on a proposed aerial structure above the median of IH-30 with an intermediate stop in Arlington. M3 begins at Ft. Worth ITC then crosses Tower 55 to enter the Union Pacific Railroad and runs on it to DUS with an intermediate stop at Arlington.

Central Section: Dallas and Fort Worth to San Antonio – Four routes, beginning in the Dallas/Ft Worth Area and continuing south to San Antonio, TX were developed in the Central Section, C1, C2, C3, and C4. C1 runs on the BNSF Railway south from Ft Worth to Temple, then continues south running on the Union Pacific to Taylor, Austin and San Antonio. C2 runs on the Union Pacific south from Ft Worth to Hillsboro, and also provides service from Dallas by running south on the BNSF and then a restored disused line to Hillsboro. From Hillsboro, C2 continues south by running on the Union Pacific through Waco to Taylor, then it enters a greenfield alignment to the Austin Airport before transitioning back on to the Union Pacific to enter San Antonio. C3 follows the Union Pacific south from Ft. Worth to Burleson, where it transitions to the IH-35W alignment. The Dallas section follows the BNSF south to Red Oak where it transitions to the IH-35E alignment. They combine at Hillsboro to follow the IH-35 alignment south to San Antonio. C4 has three sub-alternatives. C4A begins at Ft. Worth and follows the Trinity Rail Express (TRE) to Dallas then transitions to a greenfield alignment roughly paralleling the BNSF and IH-35E to Hillsboro where it continues roughly paralleling the Union Pacific on a greenfield alignment to Taylor where it joins the greenfield alignment described in C2 above to San Antonio. C4B starts in both Ft. Worth and Dallas following a greenfield corridor along IH-30 to Arlington where the lines merge and continue south roughly along SR-360 to Hillsboro and then follow the C4A route to San Antonio. C4C is a loop route where

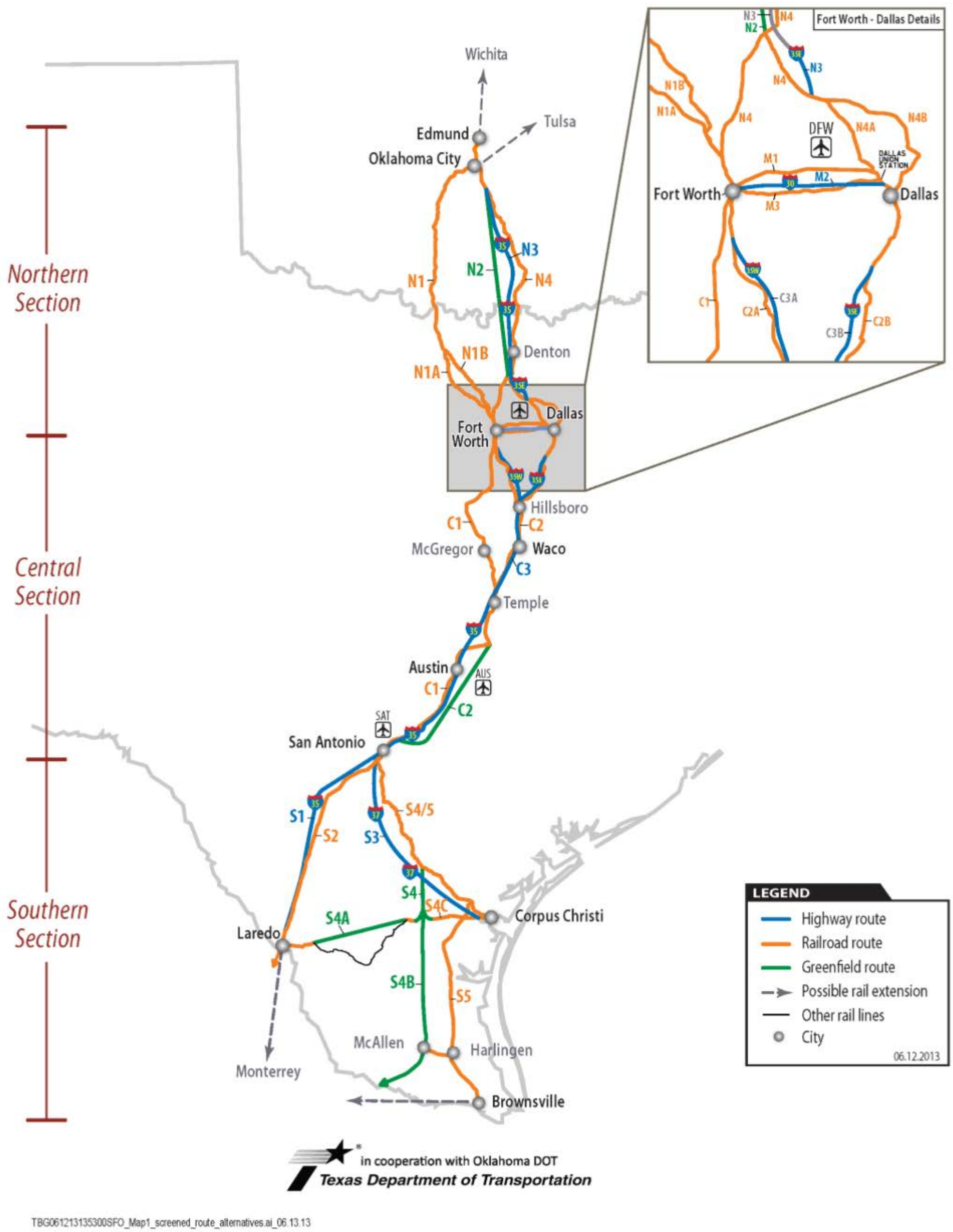

Figure 2-1: Route Alternatives Considered in Feasibility Analysis

trains would travel north from San Antonio along the C4A route to Hillsboro and then roughly follow the Union Pacific on a greenfield alignment to Ft. Worth, then run on the TRE to Dallas and then return south following the C4A alignment.

Southern Section: San Antonio to south Texas – Five routes, S1, S2, S3, S4, and S5, were originally developed beginning in San Antonio and ending in south Texas cities. S1 follows IH-35 southwest to Orvil, where it transitions to the Union Pacific for entry into Laredo. S2 runs on the Union Pacific southwest from San Antonio to Laredo. S3 follows the Union Pacific to Pleasanton, where it transitions to the IH-37 right-of-way to Corpus Christi. S4 follows the Union Pacific to Mikeska, where it would enter a greenfield right-of-way to Alice. In Alice, S4 divides into three sections, one following the KCS Railway then a greenfield alignment to Laredo, the second follows an abandoned railroad alignment south to McAllen, and the third would travel east along the KCS Railway to Corpus Christi. S5 would run on the Union Pacific to Odem, Corpus Christie, and Brownsville. Alternatives S1, S2, S4, and S5 could have the option of continuing south to Monterrey, Mexico. Subsequent to the route development, TxDOT was approached at one the South Texas public meetings on the TOPRS project and asked to consider another direct San Antonio – Laredo – Monterrey alignment that would cross the border near the Camino-Columbia bridge, about 20 miles northwest of Laredo, and would connect to a newly planned Mexican rail line that was just approved. This line, although originally planned for freight, could also host higher and high speed alignments in Mexico from the border to Monterrey. This alternative was added and designated S6.

2.3 Feasibility Screening of Initial Range of Route Alternatives

Routes were initially screened to determine overall feasibility by considering the following:

- Findings from the Oklahoma City to South Texas Infrastructure Analysis (Texas Department of Transportation [TxDOT] 2013a)
- Consent of railroads to continue studying routes that required use of existing railroad rights-of-way

The Oklahoma City to South Texas Infrastructure Analysis is a 2013 study of the possibility of operating high-speed or higher speed rail in the rights-of-ways of interstate highways within the Study area. The findings in this report established that interstate highways are designed with curve radii that are too small for high or higher speed railroad operation, that railroad vertical clearance needs are often higher than highway clearances at existing overpasses, and that many operational limitations of both highways and railroads make shared rights-of-way problematic for all but short stretches of a new rail alignment.

The following routes were eliminated from further consideration because they use a shared highway right-of-way for most of their length:

- N3 (uses IH-35)
- C3 (uses IH-35)
- S1 (uses IH-35)
- S3 (uses IH-37)

A segment option between Dallas and Fort Worth included the possible use of Union Pacific Railroad (UPRR) track. During subsequent stakeholder meetings, UPRR advised TxDOT that they would not consider adding new intercity passenger trains to this corridor so that segment option, M3, was removed from the study.

The route alternatives eliminated from further consideration are shown in grey in Figure 2-2. A segment option for high-speed service over IH-30 between Dallas and Fort Worth was retained because although it uses a highway corridor, the Central Texas Council of Governments advised that they have reserved space on the highway for an elevated high-speed railway alignment (CH2M HILL, 2012) and requested that it be included in the study.

2.4 Continued Alternatives Development and Evaluation

Subsequent to the initial alternatives development and evaluation processes additional alternatives in each of the three defined segments have been identified, defined and considered for further evaluation. These new alternatives were created in concert with and in response to the screening processes and they represent additional options for providing the passenger rail connections across the corridor.

Northern Section, All alternatives extended to Edmond, OK

Central Section, Alternative C4C added with higher speed and high-speed service

Southern Section, Alternative S4 extended from McAllen to Brownsville and Alternative S6 added with higher speed and high-speed service

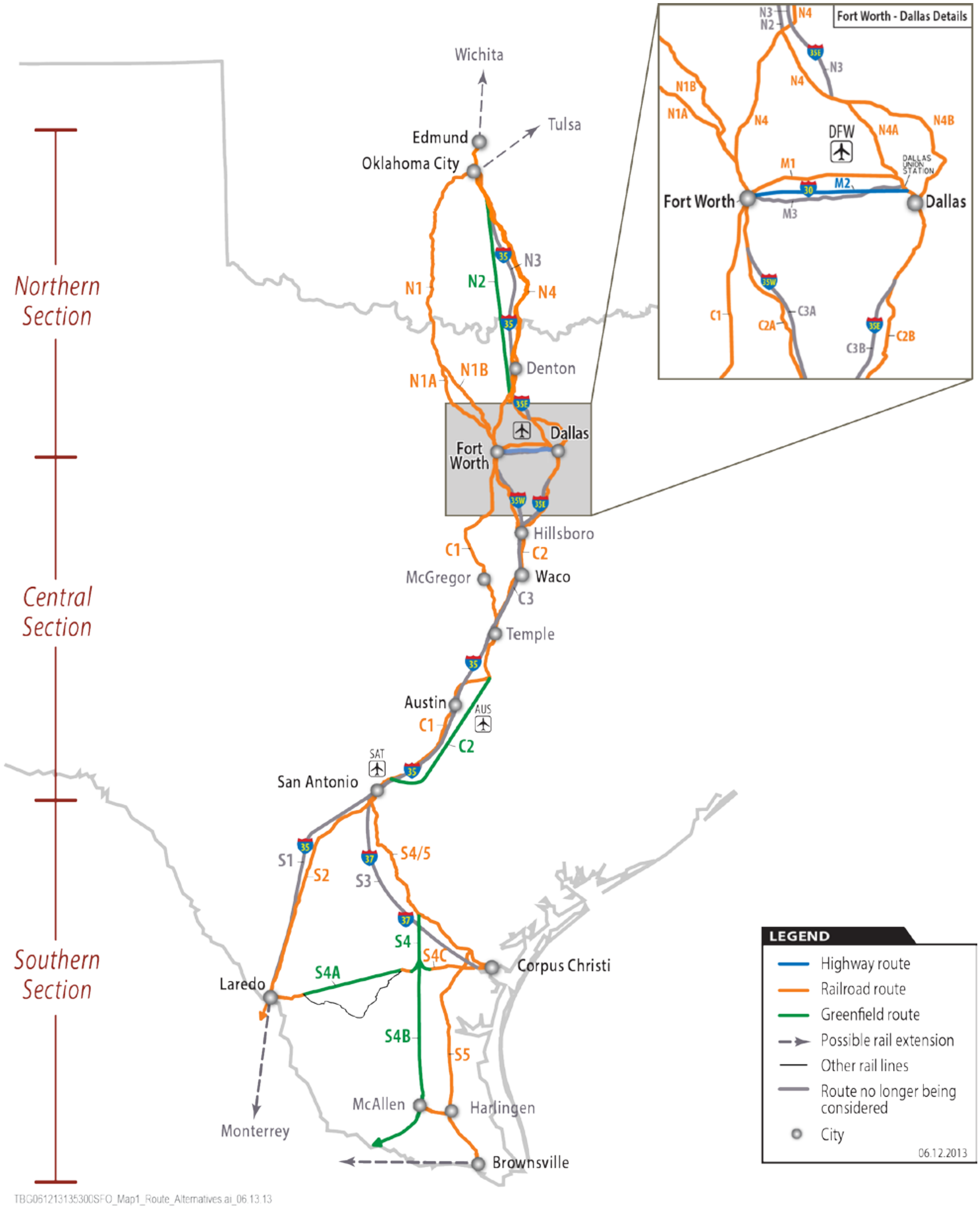

Figure 2-2: Screened Route Alternatives

3.0 Initial Ridership Evaluation

The purpose of this evaluation was to create a comparison between route alternatives based on initial ridership estimates and related ticket revenue. The Ridership estimates are a component of a number of the criteria evaluated in the Route Alternatives analysis. In addition to ridership and ticket revenue, ridership is incorporated into estimates of capital cost, reduction in travel time (compared to cars), and rail mode share. Ridership estimates were calculated using FRA's CONNECT Model, a high-level rail modelling tool.

This section includes a description of the methodology used to evaluate ridership-related criteria, presents tables including the results of the ridership evaluation, and explains how the results relate to the project Purpose and Need. In addition, the methods used to evaluate ridership-related criteria used in the Routes Alternative Analysis are discussed, and the resulting values are listed.

3.1 Ridership Evaluation Objectives

The ridership analysis helped to determine the extent to which the route alignments and service types considered in the Route Alternatives Analysis support several of the Study's Purpose and Need elements (Table 3-1).

Table 3-1: TOPRS Purpose and Need Elements Addressed by Ridership Estimates

No.	Elements of Purpose and Need
Purpose	
Overall	To enhance intercity mobility by providing new, improved, and, where feasible, high-speed passenger rail service as a transportation alternative that is competitive with automobile, bus, and/or air travel.
P1	Provide infrastructure for a **high-quality** intercity rail **service** that will reduce travel times, increase schedule reliability, and increase traveler comfort.
P3	Provide an **equitable and affordable** intercity **travel alternative** to automobile, bus, and air service.
P6	**Enhance interregional access** to employment, entertainment, recreation, health, and shopping opportunities for existing and future residents in the Program corridor.
P8	Be a **cost-efficient** investment where the projected train service revenue meets or exceeds operations and maintenance costs, based on service level.
Need	
N1	Population and economic growth will increase travel demand, generate additional **congestion**, and reduce automobile and transit **reliability** and thereby require regional mobility alternatives.
N2	Limited intercity passenger rail service and capacity restrict both mobility and **economic development.**

3.2 Ridership Metrics

Criteria were developed as part of the TOPRS Route Alternatives Analysis to support each of the Purpose and Need elements. The following table (Table 3-2) summarizes the Route Alternative Analysis criteria that were based all or in part on ridership estimates, and indicates which of the Purpose and Need elements is supported by each. A description of each of the criteria is included below.

Table 3-2: Route Alternatives Analysis Criteria Incorporating Ridership Estimates

Route Alternatives Analysis Criterion No.	Criterion	Units	Data Source	Associated Purpose/Need
2	Ridership	Annual passenger trips	CONNECT	P3, P6, N1, N2
4	Capital Cost	USD 2010	CONNECT with local data	P8
5	Revenue / Operating Cost Ratio	%	CONNECT	P8
6	Reduce Travel Times	Savings compared to automobile in minutes	CONNECT	P1, P6
7	Enhance Mode Share on Rail	% rail mode share	CONNECT	P6, N1
8	Capital Cost per Passenger-Mile	USD 2010/pax-mi	CONNECT with local data	P8

3.2.1 Ridership

Ridership is an important metric for the operational, financial and environmental evaluation of project alternatives. Ridership estimates guide many design and operational decisions, such as service frequencies, train lengths, stopping patterns and station and platform capacities. If a rail service is affordable, it will attract high ridership and distribute its benefits to passengers of all economic levels. Ridership also provides the basis for evaluating many wider economic and environmental impacts, such as consumer surplus, emissions reductions and congestion relief.

3.2.2 Capital Cost

For this metric, capital cost is compared to the overall benefits of the project to assess its cost-efficiency. The trade-off between capital cost and service quality is a central theme throughout the alternatives analysis, and capital cost is discussed in Section 11.0 of this report, Initial Cost Estimates. Greenfield alignments, for example, can permit higher speeds with less or no interruption from freight, but are more costly than using existing railway alignments.

3.2.3 Revenue/Operating Cost Ratio

The revenue/operating cost ratio is a critical measure of financial performance. Any service with a ratio below one will require an operating subsidy, which may be difficult to secure. On the other hand, alternatives with a ratio above one would produce a profit that could help at least partially finance the capital costs.

3.2.4 Reduce Travel Times

Reduced travel times are used directly to determine economic benefits, but also serve as an indicator of the competitiveness of the proposed service.

3.2.5 Enhance Mode Share on Rail

Enhanced mode share on rail offers an indication of market penetration, and helps assess the environmental impact and fulfilment of purpose P3 of the alternatives considered.

3.2.6 Capital Cost per Passenger Mile

Capital cost per passenger mile normalizes the capital cost so that alternatives can be compared more directly. For example, a longer alignment such as S4 may be costlier than S6, but may generate greater benefits by serving more people.

3.3 The CONNECT Model

Many of the screening criteria variables were estimated using FRA's CONNECT model. CONNECT is a tool that enables regional high-speed intercity passenger rail (HSIPR) sketch-level planning in the context of a user-defined network. Consistent with the current stage and service level of analysis of this project, the tool is intended for use at the outset of the planning process, before detailed alignments and operational plans are developed. CONNECT can support the analysis of multiple network configurations in study areas with multiple MSAs and compare the relative operational and financial performance of different configuration and service plan scenarios. CONNECT is not a substitute for detailed corridor planning models; however in the early stages of the planning process, it can efficiently screen a larger number of high-level alternatives, helping to select a limited number of more compelling ones to carry into a more detailed analysis.

CONNECT's approach to forecasting the potential ridership of a proposed HSIPR service comprises three broad stages. In the first stage, the total intercity travel market is estimated for each existing mode. In the second stage, CONNECT estimates the number of trips that would be diverted to the proposed HSIPR service from each of the existing modes. Finally, induced ridership is also calculated explicitly in CONNECT. Most results are reported at the origin-destination (O-D) level, with some outputs aggregated further to the Metropolitan Statistical Area (MSA), corridor and network levels. All outputs are reported by CONNECT in ranges, to avoid implying more precision than is appropriate. For purposes of this analysis and to support the comparative evaluation amongst alternatives, the median ridership value is reported.

3.4 Ridership-related Criteria Evaluation Methodology

Each of the criteria used in the Route Alternatives Analysis that was dependent on ridership estimates is listed below. The methodology and assumptions used for evaluating each is also described. All estimates are based on a reference year of 2010.

3.4.1 Ridership

Ridership is the number of passengers that travel on any part of the section, assuming that the other two sections are also implemented. The default routes and service levels for the sections outside of the section being analysed were kept constant; for example, when evaluating ridership for a Northern section alternative, an assumed route and service level was used for each of the Central and Southern sections to represent the remainder of the rail system. The routes and service levels used for this purpose were based on the initial alternatives and were as follows:

- Northern: N4 route/Conventional service/4 daily roundtrips
- Central: C3A/C3B route/High speed rail/16 daily roundtrips
- Southern: S2 route/Conventional service/4 daily roundtrips + S5 route/Conventional service/4 daily roundtrips

There is an important distinction that should be acknowledged regarding the initial alternatives. Because the CONNECT ridership forecasts were prepared prior to the route alternatives evaluation (and prior to the recommendations in this report to eliminate some routes from further consideration), the evaluation process includes some routes and service levels that were not carried forward for further consideration. Consequently, these ridership forecasts should be used as relative indicators in support of alternatives comparison within a section and not as a refined estimate of ridership across the system. Refined ridership estimates for each retained alternative will be required and developed to support analysis for the subsequent EIS-phase of the Study using a detailed corridor-specific demand forecasting model.

3.4.2 Capital Cost

Ridership values were used to estimate the capital cost for each alignment and service level by applying the CONNECT tool to substantive alignment and certain cost inputs. CONNECT can estimate capital costs from basic operational inputs using unit costs derived from domestic and international averages, but can also accommodate more detailed input data for specific sections of the corridor. Other factors were also considered for the initial capital cost evaluation, and these are discussed in Section 11.0 of this report, Initial Cost Estimates. However, to estimate capital cost using the CONNECT model, a profile was developed for each section under consideration based on the following criteria:

- New track *vs.* existing track
- Public right-of-way *vs.* new acquisition (urban) *vs.* new acquisition (rural)
- Low *vs.* medium *vs.* high freight density
- Good *vs.* medium *vs.* poor track quality

While the inputs improved the accuracy of the capital cost estimates, the sketch-level nature of CONNECT means that the estimates are highly approximate. The capital cost of HSIPR systems is sensitive to topography, development patterns, and myriad additional local variables, and only a thorough engineering evaluation of specific proposed alignments could produce a reliable estimate.

3.4.3 Revenue/Operating Cost Ratio

This criterion assesses the ratio of ticket revenue to operating costs for the alternatives analysed using CONNECT. An alternative with a score of 0% would have none of its operating costs covered by ticket revenues, whereas an alternative with a score of 100% would have all of its operating costs covered by ticket revenues. Both ticket revenue and total operating cost are direct outputs of CONNECT.

3.4.4 Reduce Travel Times

This criterion compares rail to automobile travel time for the alternatives analysed using CONNECT. This helps to identify the alternatives that would provide travel time savings compared to automobile travel. Both rail and automobile travel times are direct outputs of CONNECT. Note that in CONNECT auto travel times do not change with the introduction of rail service.
Rail and air travel times were not directly compared because in CONNECT these times are measured as the run or flight times between rail stations or airports, and rail would generally not be expected to show a shorter time on this basis. If door-to-door travel time and service frequency were considered, rail travel times could be competitive with air travel; however this level of detail exceeds the initial evaluation scope of the study. Later phases of the work will compare air and rail using this more specific approach.

3.4.5 Enhance Mode Share on Rail

This criterion assesses the rail mode share for the alternatives analysed using CONNECT. Rail mode share is a direct output of CONNECT.

3.4.6 Capital Cost per Passenger Mile

This criterion assesses the ratio of capital cost to passenger miles for the alternatives analysed using CONNECT. Both capital cost and passenger miles are direct outputs of CONNECT.

3.5 Comparison of Route Alternatives using Ridership-related Criteria

For each of the ridership-related criteria, values were calculated for route alternatives using the methods described above. Table 3-3 shows the color-coding scheme used to compare alternatives at a high-level. Note that values for ridership and cost were not color-coded because these values were considered “alternative attributes,” and were not used directly to screen alternatives, but to help explain differences between route alternatives that are identified using other criteria.

Table 3-3: Color-coding Thresholds for Relevant Assessment Criteria

Criterion		Green	Yellow	Red
Revenue/Operating Cost Ratio [a]	CONV	Over 50%	25-50%	0–25%
	HrSR	Over 75%	50-75%	0–50%
	HSR	Over 100%	50–100%	0–50%
Reduce Travel Times		Savings in travel time of more than 50% compared to auto	Savings in travel time of 25% to 50% compared to auto	Savings in travel time of 25% or less compared to auto
Enhance Mode Share on Rail		Over 20% rail mode share	10%–20% rail mode share	0–10% rail mode share
Capital cost		Under $16 (capital cost per annual passenger mile)	$16 - $100 (capital cost per annual passenger mile)	Over $100 (capital cost per annual passenger mile)

[a] Revenue/Operating Cost Ratio criterion is analyzed by service-level option:

CONV= conventional rail

HrSR = higher speed rail

HSR = high-speed rail

Tables 3-4 through 3-7 below present values for the ridership-related criteria in the Northern, Central and Southern Sections. The route alternatives evaluated in the table are shown in Figure 2-1 in Section 2.0, Initial Range of Alternatives above.

Table 3-4: Northern Section – Ridership-related Criteria

Crit. No.	Route Alternatives Analysis Criteria	Service Level	N1/ N1A	N1/N 1B	N2	N4/N 4A*	N4/N 4B	N4/N 4C
2	Ridership (millions of passengers per year in 2010)	CONV	0.26	0.26		0.30	0.30	0.30
		HrSR	0.39	0.39	0.42	0.42	0.42	0.42
		HSR			0.46			
4	Capital Cost	CONV	$0.66 billion	$0.66 billion		$0.65 billion	$2.94 billion	$0.71 billion
		HrSR	$4.35 billion	$4.34 billion	$1.69 billion	$4.60 billion	$6.10 billion	$5.08 billion
		HSR			$5.24 billion			
5	Revenue/ Operating Cost Ratio	CONV	20%	19%		27%	31%	31%
		HrSR	23%	23%	25%	24%	26%	26%
		HSR			29%			
6	Reduce Travel Times	CONV	9%	9%		14%	14%	14%
		HrSR	30%	30%	33%	33%	33%	33%
		HSR			68%			
7	Enhance Mode Share on Rail	CONV	12%	12%		12%	12%	12%
		HrSR	17%	17%	17%	17%	17%	17%
		HSR			21%			
8	Capital Cost per Passenger Mile	CONV	$10.60	$10.60		$10.50	$47.50	$11.50
		HrSR	$46.20	$46.20	$19.10	$52.00	$69.00	$57.50
		HSR			$52.80			

[a] Cells shaded gray indicate that the service level does not apply to this route.

[b] Service-Level Option: CONV= conventional rail; HrSR = higher speed rail; HSR = high-speed rail

*The N4A Alternative has been carried forward past the alternatives screening process and will be evaluated in the next service level EIS, stage of the project

Table 3-5: Central Section – Ridership-related Criteria

Crit. No.	Route Alternatives Analysis Criteria	Service Level	C1	C2/C 2A	C2/C 2B	C4/C 4A*	C4/C4 B**
2	Ridership (millions of passengers per year in 2010)	CONV	1.2	1.7	1.7		
		HrSR	2.4	2.5	2.5	2.5	2.5
		HSR				2.7	2.7
4	Capital Cost	CONV	$1.38 billion	$1.51 billion	$1.54 billion		
		HrSR	$4.22 billion	$6.58 billion	$5.19 billion	$4.22 billion	$4.65 billion
		HSR				$5.65 billion	$5.36 billion
5	Revenue/ Operating Cost Ratio	CONV	60%	89%	87%		
		HrSR	82%	87%	89%	89%	89%
		HSR				114%	114%
6	Reduce Travel Times	CONV	16%	21%	21%		
		HrSR	35%	37%	37%	37%	37%
		HSR				67%	67%
7	Enhance Mode Share on Rail	CONV	11%	16%	16%		
		HrSR	23%	23%	23%	23%	23%
		HSR				27%	27%
8	Capital Cost per Passenger Mile	CONV	$7.90	$5.40	$5.50		
		HrSR	$6.80	$10.80	$8.50	$6.90	$7.60
		HSR				$8.00	$7.50

[a] Cells shaded gray indicate that the service level does not apply to this route.

[b] Service-Level Option: CONV= conventional rail; HrSR = higher speed rail; HSR = high-speed rail

*The C4A Alternative has been carried forward past the alternatives screening process and will be evaluated in the next service level EIS, stage of the project

**The C4B Alternative has been carried forward past the alternatives screening process and will be evaluated in the next service level EIS, stage of the project

Table 3-6: Southern Section without Monterrey Extension – Ridership-related Criteria

Crit. No.	Route Alternatives Analysis Criteria	Service Level	S2	S4*	S5	S6**
2	Ridership (millions of passengers per year in 2010)	CONV	0.058		0.35	
		HrSR	0.069	0.32	0.39	0.069
		HSR		0.33		0.083
4	Capital Cost	CONV	$0.17 billion		$0.31 billion	
		HrSR	$2.37 billion	$2.46 billion	$4.29 billion	$0.84 billion
		HSR		$3.59 billion		$1.23 billion
5	Revenue/ Operating Cost Ratio	CONV	7%		24%	
		HrSR	7%	20%	26%	7%
		HSR		12%		5%
6	Reduce Travel Times	CONV	22%		12%	
		HrSR	46%	25%	34%	46%
		HSR		56%		69%
7	Enhance Mode Share on Rail	CONV	6%		15%	
		HrSR	7%	11%	17%	7%
		HSR		13%		10%
8	Capital Cost per Passenger Mile	CONV	$19.30		$3.40	
		HrSR	$225.10	$42.20	$40.70	$79.90
		HSR		$51.60		$103.40

[a] Cells shaded gray indicate that the service level does not apply to this route.

[b] Service-Level Option: CONV= conventional rail; HrSR = higher speed rail; HSR = high-speed rail

*The S4 Alternative has been carried forward past the alternatives screening process and will be evaluated in the next service level EIS, stage of the project

**The S6 Alternative has been carried forward past the alternatives screening process and will be evaluated in the next service level EIS, stage of the project

Table 3-7: Southern Section with Monterrey Extension – Ridership-related Criteria

Crit. No.	Route Alternatives Analysis Criteria	Service Level	S2	S4	S5	S6
2 - M	Ridership (millions of passengers per year in 2010)	CONV				
		HrSR		0.68		0.59
		HSR		0.77		0.72
4-M	Capital Cost	CONV				
		HrSR		$2.98 billion		$1.43 billion
		HSR		$4.86 billion		$2.67 billion
5 - Ma	Revenue/ Operating Cost Ratio (Costs for Mexico portion excluded)	CONV				
		HrSR		61%		96%
		HSR		31%		73%
5 - Mb	Revenue/ Operating Cost Ratio (Costs for Mexico portion discounted by 35%)	CONV				
		HrSR		45%		58%
		HSR		30%		37%
6 - M	Reduce Travel Times	CONV				
		HrSR		40%		48%
		HSR		59%		67%
7 - M	Enhance Mode Share on Rail	CONV				
		HrSR		15%		9%
		HSR		18%		12%
8 - Ma	Capital Cost per Passenger Mile (Costs for Mexico portion excluded)	CONV				
		HrSR		$10.40		$5.30
		HSR		$13.60		$6.60
8 - Mb	Capital Cost per Passenger Mile	CONV				
		HrSR		$12.60		$9.10
		HSR		$18.40		$14.3 0

[a] Cells shaded gray indicate that the service level does not apply to this route.

[b] Service-Level Option: CONV= conventional rail; HrSR = higher speed rail; HSR = high-speed rail

*The S4 Alternative has been carried forward past the alternatives screening process and will be evaluated in the next service level EIS, stage of the project

**The S6 Alternative has been carried forward past the alternatives screening process and will be evaluated in the next service level EIS, stage of the project

3.6 Analysis of Results

The ridership-related criteria results are analysed below with respect to the Purpose and Need elements that each supports. How the sections and/or alternatives performed against these criteria is also included in the discussion.

- *P-1 Provide infrastructure for a* ***high-quality*** *intercity rail* ***service*** *that will reduce travel times, increase schedule reliability, and increase traveler comfort.*

  Understandably, the high-speed alternatives reduced travel-times the most. Alignments N2, C4 and S6 performed best according to this criterion. While we did not assess reliability and comfort directly, both are strongly correlated with service type. High-speed service is less likely to be interrupted by freight service or track failure, and is more likely to offer a smoother ride.

- *P-3 Provide an* ***equitable and affordable*** *intercity* ***travel alternative*** *to automobile, bus, and air service; P-6* ***Enhance interregional access*** *to employment, entertainment, recreation, health, and shopping opportunities for existing and future residents in the Program corridor.*

  Ridership is an indicator of affordability (P-3) and how well the alternative enhances access (P-6) to amenities and employment. N1, C1 and S4 attracted fewer riders, and thus present a less competitive alternative.

- *P-8 Be a* ***cost-efficient*** *investment where the projected train service revenue meets or exceeds operations and maintenance costs, based on service level.*

  In general, the Central section alignments perform much better than the Northern and Southern section alignments under the criteria studied here. The revenue/operating cost ratio, which is a strong indicator of long-term financial feasibility, surpasses 100% for the C4 alignment with high-speed service.

The Southern section only performs well with the inclusion of the Monterrey extension. Alignment S6 with higher-speed service covers 96% of its operating cost with ticket revenue.

4.0 Preliminary Station Location and Transit Connections Evaluation

The purpose of the preliminary transit connections and station location evaluation process was to assess the accessibility and mobility service and to verify the feasibility of the assumed station locations across the alternatives for TOPRS. Potential transit connections and stations locations included cities in all three sections, Northern, Central, and Southern. The evaluation of these cities is described in detail in the Local Transit System Profiles and Connectivity to Potential TOPRS Passenger Rail Stations for Texas-Oklahoma Passenger Rail Study: AA Screening Alternative Phase Technical Memorandum (TranSystems 2013).

This section includes a summary of the evaluation of the transit connections and station locations for each section, including a description of the existing transit facilities, intercity bus service, passenger rail service, future plans and the connectivity prospective with potential TOPRS stations.

4.1 Methodology

Based upon initial ridership estimates, knowledge of connectivity options and GIS-level information about the corridor, preliminary station locations were identified for TOPRS (See Section 6.0 – Preliminary Service Schedule and Initial Operations Plan Evaluation). These station locations were determined based upon a relatively coarse level of geographic specificity, sufficient to assess the accessibility and mobility service that they will provide and verify the feasibility of the locations based on general engineering and urban planning criteria. Within each city existing transit, facilities, intercity bus, and passenger rail services were identified. Future plans were also recognized where information was readily available.

4.2 Potential Transit Connections and Station Locations

The following discussion summarizes the potential transit connections and stations locations in all three sections. These cities were identified according to population size with a general division of these cities with populations greater than 500,000 people and less than 500,000 people. Summary tables were developed and are included below for each of the three sections. The associated cities within each section and the key elements evaluated regarding transit connections/station locations are reflected, if applicable. Select cities have identified future planned improvements and/or projects and that information is also provided in the section tables.

4.2.1 Northern Section: Oklahoma City to Dallas and Fort Worth

Oklahoma City, Oklahoma, was the only city identified with a population greater than 500,000. Seven cities in Oklahoma, Ardmore, Chickasha, Duncan, Edmond, Norman, and Pauls Valley and one city in Texas, Gainesville, were identified with a population less than 500,000. Table 4-1 includes a summary of these cities in the Northern Section and their existing transit and stations and followed by a brief location description of each city.

Table 4-1: Existing Transit and Stations – Northern Section

City	Bus/ BRT	Inter-city Bus	LRT	Comm-uter Rail	Passen-ger Rail	Other	Hub/Station Transfer/Tran-sit Center	Future Planned Improve-ments and Projects
Oklahoma City, OK	X	X			X	X	X	X*
Ardmore, OK		X			X			
Chickasha, OK								
Duncan, OK								
Edmond, OK	X						X	X**
Norman, OK	X	X			X		X	
Pauls Valley, OK		X			X			
Gainesville, TX		X			X			

Other – vanpool, ferry boat service

* Cities with population greater than 500,000 may include, but not limited to commuter rail, streetcar

** Cities with population less than 500,000 may include, but not limited to intermodal transportation center, additional passenger rail and local transit service

Oklahoma City, OK. Oklahoma City is the largest city in the state and 30th largest city by population in the United States. Oklahoma City is one of the top five largest cities in the country in terms of geographic area. Oklahoma City is home to several large corporations including Chesapeake Energy, Devon Energy, and Sonic Drive-In. The Oklahoma City Thunder NBA basketball team plays downtown at the Chesapeake Energy Arena.

Ardmore, OK. Ardmore is located along I-35 midway between Dallas and Oklahoma City, approximately 90 miles from each city.

Chickasha, OK. Chickasha is located approximately 40 miles southwest of Oklahoma City.

Duncan, OK. Duncan is located approximately 90 miles southwest of Oklahoma City.

Edmond, OK. Edmond is located adjacent to the northern border of Oklahoma City and is home to the University of Central Oklahoma, the third largest university in the state.

Norman, OK. Norman is located approximately 20 miles south of Oklahoma City. Norman is home to the University of Oklahoma (OU), the largest university in the state and also includes the National Weather Center.

Pauls Valley, OK. Pauls Valley is located along I-35 approximately 50 miles south of Oklahoma City.

Gainesville, TX. Gainesville is located in north Texas on I-35 approximately 70 miles north of Dallas.

4.2.2 Central Section: Dallas and Fort Worth to San Antonio

Three cities the Central Section within Texas - Austin, Dallas, and Fort Worth - were identified with a population greater than 500,000. Eight cities in the Central Section within Texas - San Marcos, Schertz, Seguin, Taylor, Temple, Killeen, Waco, and Waxahachie - were identified with a population less than 500,000. Table 4-2 includes a summary of these cities in the Central Section and their existing transit and stations and followed by a brief location description of each city.

Table 4-2: Existing Transit and Stations – Central Section

City	Bus/ BRT	Inter-city Bus	LRT	Comm-uter Rail	Passen-ger Rail	Other	Hub/Station Transfer/Tran-sit Center	Future Planned Improve-ments and Projects
Austin, TX	X	X[M]	X	X	X	X	X	X*
Dallas, TX	X	X[M]	X	X	X	X	X	X*
Fort Worth, TX	X	X		X	X	X	X	X*
San Marcos, TX	X	X			X		X	
Schertz, TX								
Seguin, TX		X						
Taylor, TX	X				X			
Temple, TX	X				X			
Killeen, TX	X							
Waco, TX	X	X[M]					X	
Waxahachie, TX		X						

Other –vanpool

*Cities with population greater than 500,000 may include, but not limited to commuter rail, streetcar, BRT, LRT, general regional connectivity

M = includes bus service between U.S. and Monterrey, Mexico

Austin, TX. Austin is the state capital and located in Central Texas. It is the 11th most populous city in the United States and the 4th most populous in Texas. Austin is home to one of the largest universities in the nation, University of Texas (UT), state government agencies, many large companies, technology businesses, and a vibrant media and music culture. One Fortune 500 company, Whole Foods, has its headquarters in Austin.

Dallas, TX. Dallas is the 9th largest city in the United States and the 3rd most populous in Texas. Dallas is home to twelve Fortune 500 companies, the third largest concentration in the country. AT&T, Southwest Airlines, HollyFrontier, Texas Instruments, Dean Foods, and Tenet Healthcare are some of the largest companies headquartered in Dallas. There is $15 billion of development underway in the downtown and throughout the city. Top tourist destinations include the West End, the historic heart of the city, and Uptown, a center for nightlife. Victory Park is a 75-acre development that is anchored by the American Airlines Center, home to NBA's Dallas Mavericks and NHL's Dallas Stars. Deep Ellum is a former industrial area that is a top location for culture

Fort Worth, TX. Fort Worth is the 16th largest city in the United States. The Dallas-Fort Worth metro area is the top tourist destination in Texas and features the 35-block downtown known as Sundance Square, world-renowned museums in the Cultural District, and the Stockyards National Historic District. The largest employers in the city are Lockheed Martin Aeronautics and Naval Air Station Joint Reserve Base.

San Marcos, TX. San Marcos is located in central Texas along I-35 approximately 30 miles south of Austin and approximately 50 miles north of San Antonio. Texas State University-San Marcos is the fifth largest university in Texas.

Schertz, TX. Schertz is a northeast suburb of San Antonio.

Seguin, TX. Seguin is located approximately 30 miles east of downtown San Antonio.

Taylor, TX. Taylor is located approximately 35 miles northeast of downtown Austin. The area continues to be a large producer of cotton as it has been throughout its history

Temple-Killeen, TX. Temple and Killeen are adjacent cities along I-35 approximately 65 miles north of Austin and approximately 35 miles south of Waco. Killeen is home to Fort Hood, the largest active duty armored post in the United States Armed Services.

Waco, TX. Waco is located approximately halfway between Dallas and Austin on the I-35 corridor.

Waxahachie, TX. Waxahachie is located along I-35E approximately 30 miles south of Dallas.

4.2.3 Southern Section: San Antonio to south Texas

Two cities, San Antonio, Texas and Monterrey, Mexico, were identified with a population greater than 500,000. Nine cities in Texas, Alice, Brownsville, Corpus Christi, Harlingen, Kingsville, Laredo, McAllen, Raymondville, and Weslaco were identified with a population less than 500,000. Table 4-3 includes a summary of these cities in the Southern Section and their existing transit and stations and followed by a brief location description of each city.

Table 4-3: Existing Transit and Stations – Southern Section

City	Bus/ BRT	Inter-city Bus	LRT	Comm-uter Rail	Passen-ger Rail	Other	Hub/Station Transfer/Tran-sit Center	Future Planned Improve-ments and Projects
San Antonio, TX	X	X^M			X			X*
Monterrey, Mexico	X	X^M	X				X	X*
Alice, TX		X						
Brownsville, TX	X	X^M					X	
Corpus Christi, TX	X	X				X	X	
Harlingen, TX	X	X						
Kingsville, TX		X						
Laredo, TX	X	X^M					X	
McAllen, TX	X	X					X	
Raymondville, TX	X	X						
Weslaco, TX	X	X						

Other – vanpool, ferry boat service

*Cities with population greater than 500,000 may include, but not limited to commuter rail, streetcar, BRT, LRT, general regional connectivity, HOV lanes, stations

M = includes bus service between U.S. and Monterrey, Mexico

San Antonio, TX. San Antonio is the seventh most populous city in the United States and the second most populous city in Texas. The greater San Antonio (the San Antonio–New Braunfels Metropolitan Statistical Area) is the 24th largest metropolitan area in the United States and third largest in Texas. San Antonio has a strong military presence and is the headquarters city for five Fortune 500 companies. South Texas Medical Center is located in San Antonio and it is the only medical research and care provider in the South Texas region. San Antonio is visited by approximately 26 million tourists per year.

Monterrey, Mexico. Monterrey is the capital of the state of Nuevo León, located in Mexico approximately 200 miles west of the Gulf of Mexico and 100 miles southwest of the U.S.-Mexico border. It is the ninth largest city in Mexico and the third most populous metropolitan area in the country. Monterrey is home to several large Mexican and international companies including Sony, Toshiba, Whirlpool, Samsung, Toyota, Ericsson, Nokia, Dell, Boeing, HTC, General Electric, Heineken, and LG. At approximately 100 acres, the Macroplaza is one of the biggest public plazas in the world with shopping and tourism located in the heart of Monterrey near three museums. The Paseo Santa Lucia is a 1.25-mile canal and river walk that connects the Macroplaza to Fundidora Park. Canyons, mountains, and waterfalls outside of the city are popular natural attractions. Historically known for its strong steel industry, Monterrey is currently the northern Mexico hub for industry, manufacturing, banking, health care, and education.

Alice, TX. Alice is located in south Texas, approximately 45 miles west of Corpus Christi.

Brownsville, TX. Brownsville is located in southern Texas at the U.S.-Mexico border and is home to the University of Texas at Brownsville campus.

Corpus Christi, TX. Corpus Christi is located in southeast Texas adjacent to Upper Padre Island along the Gulf of Mexico and it the 8th largest city in Texas. The economy is driven by tourism and the oil/petrochemical industry. Corpus Christi attracts tourists to its more than hundred miles of beaches and outdoor recreational activities. The city is home to the Port of Corpus Christi, the 5th largest port in the nation, which handles mostly oil and agricultural products.

Harlingen, TX. Harlingen is located in the Rio Grande Valley in south Texas, approximately 30 miles from the coast of the Gulf of Mexico and approximately 10 miles from the Rio Grande River.

Kingsville, TX. Kingsville is located in south Texas approximately 40miles southwest of Corpus Christi. The city includes Texas A& M University-Kingsville and Naval Air Station-Kingsville.

Laredo, TX. Laredo is located on the north bank of the Rio Grande River along the border with Mexico and it is the U.S. principal port of entry into Mexico, connecting I-35 with the Pan American Highway that stretches into Central and South America. Laredo is located across the river from the adjacent Mexican city of Nuevo Laredo.

McAllen, TX. McAllen is located in south Texas along the north bank of the Rio Grande River approximately 70 miles west of the Gulf of Mexico. McAllen was a rural and agricultural area until growth and development increased in recent decades. McAllen is located across the river from the Mexican city of Reynosa.

Raymondville, TX. Raymondville is located approximately 30 miles north of the U.S.-Mexico border and approximately 20 miles west of the Gulf of Mexico.

Weslaco, TX. Weslaco is located in the Rio Grande Valley approximately 10 miles north of the U.S.-Mexico border.

4.3 Summary of Evaluation Results

The following discussion summarizes the connectivity and TOPRS station potential of the evaluated cities for all three sections.

4.3.1 Northern Section: Oklahoma City to Dallas and Fort Worth

Oklahoma City, OK. The proposed Edmond-Oklahoma City-Norman commuter rail as well as the TOPRS Edmond-Oklahoma City-Dallas/Fort Worth service could very likely share the new Oklahoma City Intermodal Transportation Center passenger rail station located at the current Amtrak (ex-ATSF) passenger station. This station would be served by all routings of the northern section of the TOPRS corridor. Furthermore, most of the northern section alternatives under consideration (including all of the regional and emerging scenarios) would parallel the BNSF (ex-ATSF) route and the proposed new commuter rail all the way Edmond-Oklahoma City-Norman. Because of plans to build the Oklahoma City Streetcar and the Transportation Center at the existing passenger station, there would be excellent local transit collection/distribution service at the TOPRS station.

Ardmore, OK. The current Amtrak BNSF (ex-ATSF) Station site is a potential stop for emerging and regional TOPRS trains serving the Northern Section.

Chickasha, OK. There is currently no specific TOPRS station location under consideration.

Duncan, OK. There is currently no specific TOPRS station location under consideration.

Edmond, OK. The proposed Edmond-Oklahoma City-Norman Commuter rail as well as the TOPRS Edmond-Oklahoma City-Dallas/Fort Worth service could likely share a new Edmond station on the BNSF, located near the site of the former ATSF passenger station and adjacent to the Citylink Transit center, providing good local feeder/distribution bus service. As the (newly extended) northern terminus of the TOPRS corridor, Edmond would be served by all Northern Section corridor trains.

Norman, OK. The current Amtrak BNSF (ex-ATSF) Station site could be a logical potential stop location for TOPRS trains serving the Northern Section, and if proposed Norman-Oklahoma City-Edmond commuter rail is implemented, it would also serve as the commuter rail's southern terminus.   Three of CART's existing 8 routes operate within 2 blocks or less of this location, providing for good potential connectivity.

Pauls Valley, OK. The current Amtrak BNSF (ex-ATSF) Station site would be a logical potential stop for TOPRS emerging and regional trains serving the Northern Section.

Gainesville, TX. The current Amtrak Heartland Flyer station site is a potential stop for Emerging and Regional TOPRS trains on the Northern Section of the corridor.

4.3.2 Central Section: Dallas and Fort Worth to San Antonio

Austin, TX. Connectivity between Austin Cap Metro and potential TOPRS station sites is among the most complicated in the entire TOPRS route network. The Lone Star Rail District (LSRD) is already in advanced planning stages for a major new regional commuter rail service operating Georgetown-Austin-San Marcos-San Antonio, largely on the UP (ex-MP) line currently used by Amtrak. The physical constraints and resultant capacity limitations of the Amtrak/LSRD UP Corridor will likely require regional and core express TOPRS trains to utilize an entirely new, Greenfield alignment east of I-35, potentially as far north as Taylor and continue to just northeast of San Antonio. There are several alternative routings under/around Austin-Bergstrom Airport that could result in an attractive TOPRS station connected to the airport. Depending on the timeline of the new TOPRS service and Austin's own transit development plan, this station could serve as an intermodal connection to either high-frequency/service-quality bus service or a fixed guideway rail transit service direct to downtown.

In addition to connecting service to downtown, it may be very desirable to maintain highly competitive passenger rail service from the north to provide single-seat, direct TOPRS trains to downtown Austin. Subject to capacity and other operational considerations, the TOPRS Service Development Plan (SDP) will examine scenarios in which selected Emerging, Regional or even Core Express (at reduced speed) trains would share ROW with the LSRD and Amtrak, allowing service to the current (or near the current) Amtrak station site, just west of the downtown core. There is even one particularly creative alternative that would allow these trains to continue south a couple of miles (on the existing line) and then proceed east on a nearly abandoned line to meet up with the Greenfield corridor, and terminate at Austin Bergstrom Airport. Lastly, there is also a Service Plan alternative that would allow a small number of residual, conventional (emerging) corridor trains that to continue south overlapping the LSRD/ Amtrak UP route to San Antonio.

Dallas, TX. Virtually all possible TOPRS route alternatives for both the Northern and Central Sections include a Dallas Downtown stop at the current Dallas Union Station, the locally preferred location. Most of the alternative routings actually traverse the TRE Corridor between Dallas and Fort Worth, with an intermediate new station directly at DFW Airport (at the site of future Terminal F). Several Service Plan alternatives envision a triangular "loop" operation to/from the north and south, with Oklahoma trains, for example, operating Denton-Dallas-FORT Worth-Denton and San Antonio trains operating Hillsboro-Dallas-Fort Worth-Hillsboro or the opposite. In all of these scenarios there would be excellent local collection/distribution because of the cross-platform connects at Union Station to the TRE and multiple DART LRT Lines. Union Station is also served out front by multiple DART bus routes and in the future by the South Oak Cliff Streetcar. There are multiple possible north suburban and south suburban potential TOPRS stations in the greater Dallas-Fort Worth area, which may also be collocated with regional or commuter rail service. Their primary intended access/egress would be by automobile.

Fort Worth, TX. Virtually all possible route TOPRS alternatives for both the Northern and Central Sections include a Fort Worth stop at the current Fort Worth T Amtrak/TRE ITC Station. Most of the alternatives actually are planned to traverse the TRE Corridor with an intermediate new station directly at DFW Airport. In any of these scenarios there would be excellent collection/distribution to all of central Fort Worth because of the existing major Fort Worth T Transit Center adjacent to ITC. There will also be cross platform connections to existing TRE and planned TEX rail commuter rail service. There are multiple possible north suburban and south suburban potential TOPRS stations in the greater Dallas-Fort Worth area, which may also be collocated with regional or commuter rail service. Their primary intended access/egress would be by automobile.

San Marcos, TX. The LSRD is in advanced planning stages for a major new regional commuter rail service Georgetown-Austin-San Marcos-San Antonio. The physical constraints and capacity limitations of the current Amtrak/proposed LSRD UP Corridor will likely require higher speed/frequency TOPRS trains to utilize a new, Greenfield alignment east of I-35 and central San Marcos making a San Marcos stop infeasible. The only possible exception would be a small number of residual, conventional (emerging) corridor trains that would overlap the existing Amtrak UP route and stop at the Intermodal Station.

Schertz, TX. The physical constraints and capacity limitations of the current Amtrak/proposed LSRD UP Austin-San Antonio Corridor will likely require TOPRS trains to utilize a new, Greenfield alignment east of I-35 and central Schertz. There could be a new (eastern suburban) station, of unspecified location, to serve Schertz for emerging and regional TOPRS trains.

Seguin, TX. The capacity limitations of the current Amtrak/proposed LSRD UP Austin-San Antonio Corridor will likely require TOPRS trains to utilize a new, Greenfield alignment east of I-35 and central Seguin. There could be a new (eastern suburban) station, of unspecified location, to serve Seguin for emerging and regional TOPRS trains.

Taylor, TX. Taylor is a potential transition point between a TOPRS alignment paralleling the UP (from Temple and the north) to a stand-alone Greenfield alignment (to Austin and the south). The potential station site for TOPRS emerging and regional corridor services has not been identified.

Temple-Killeen, TX. There are multiple alternative potential alignments serving Temple-Killeen, noting that all alternatives pass through Temple, whether coming from the north via Waco (new route) or McGregor (existing Amtrak route). The specific TOPRS station site will depend on which route is ultimately recommended. It is anticipated that Hill County Transit District will provide bus service to the station because of the large potential ridership opportunity.

Waco, TX. All proposed TOPRS Central Section route alternatives that operate south directly from Dallas, and some routes from Fort Worth would bring new passenger rail service to Waco. Waco would likely be a stop for TOPRS core express services and definitely a stop for emerging and regional services operating on this segment. The city has identified a site adjacent to the Baylor University's Floyd Casey Stadium as a potential station site. WTS already serves this site. The Downtown Transit Terminal, served by all local transit routes, is adjacent to the tracks proposed for passenger rail service, making this an option for the TOPRS station location.

Waxahachie, TX. The proposed potential TOPRS Central Section alignment running from Dallas directly to the south would likely share this corridor and possible share track with the proposed commuter rail. No specific station stop location for the TOPRS service is being identified, but it would be presumed and logical to share a station with the new commuter rail service to allow convenient transfers and operational efficiencies.

4.3.3 Southern Section: San Antonio to south Texas

San Antonio, TX. The Westside Multimodal center and adjacent former IGN/MP Station is a very likely candidate for the southern terminus of the TOPRS Central Section as well as for the Lone Star Rail District (LSRD) planning new regional commuter rail service Georgetown-Austin-San Marcos-San Antonio. The physical constraints and resultant capacity limitations of the current Amtrak/ LSRD UP Corridor will likely require all regional and core express TOPRS trains to utilize an entirely new, Greenfield alignment east of I-35, beginning as far north as Taylor and continuing to northeast of San Antonio. A variety of potential alternative Greenfield/existing parallel railroad alignments would then either serve San Antonio's International Airport directly, or with a nearby station before continuing to terminate at the Multimodal Site.

Depending on ultimate station location, in addition to intermodal airport access, the potential TOPRS SAT Airport Station could also serve as a north suburban Park & Ride Location. The locally preferred IGN/MP Multimodal Station site would be immediately adjacent to a large VIA transit center served by multiple local bus routes, the high-frequency E-W BRT and likely a future fixed guideway circulator streetcar system. It would also benefit from cross-platform transfer connections to LSRD regional commuter trains.

Monterrey, Mexico. It would be important for new passenger rail service to have a direct connection to one of the metro rail routes. The disused passenger rail station is intact but is not ideally-located, approximately a half mile from the closest Metro station. While the freight rail lines through the city are not grade-separated, there are routes from both the east and northeast that come close to the center of the city. One of these routes passes very close to the city's airport, General Mariano Escobedo International, located in Apodaca, northeast of the city.

Alice, TX. As explained in the TOPRS South Section routing alternatives, there is a potential complex combination of true Greenfield, shared and restored abandoned corridor that could provide Alice with new rail service to multiple destinations: San Antonio, Corpus Christi, Laredo, McAllen, and Brownsville. If any of these service-level study alternatives is recommended, Alice could likely be a stop, or even a transfer point between routes. There is no specific TOPRS station location under consideration.

Brownsville, TX. While there is currently no definitive potential location identified for a TOPRS station, it has been assumed that TOPRS service to Brownsville would follow the alignment of the UPRR (ex-MP) tracks to a site located on the edge of downtown and close to a border crossing. It is presumed that Brownsville Metro bus service would be routed to effectively serve the TOPRS station.

Corpus Christi, TX. Three very different approaches to providing TOPRS service to Corpus Christi are under consideration:

- Under the alternative using the UPRR (ex-MP) route enroute to Brownsville, it would be most logical to locate a station in the Calellen neighborhood of Corpus Christi (approximately 14 miles west of downtown) with an express bus on I-37 connecting to the CCRTA Staples Street Station in the downtown area.

- If the route over the UPRR terminated in Corpus Christi, it could follow the branch line that terminates at the historic station which still exists (approximately 0.5 mile from Staples Street Station).
- Under the alternative using the Greenfield/Restored Abandoned ROW corridor via Alice, the link to Corpus Christi would probably operate along the KCS route, with a station possibly located at the airport.

Harlingen, TX. Although no specific station site is currently under consideration, Harlingen would be a potential stop for Southern Section Regional and Emerging TOPRS services on the San Antonio-Brownsville route. All four local bus routes converge at a point where the railroad tracks cross Harrison Street, making this a logical point for a TOPRS station.

Kingsville, TX. The former SP (now UP) station site could be a potential location for a TOPRS passenger train stop for Regional and Emerging Corridor services on the San Antonio-Brownsville branch of the Southern Section, if appropriate arrangements could be made with the Train Depot Museum. No specific definitive site has been selected. It is assumed the A&M Shuttle would be modified to serve the TOPRS station.

Laredo, TX. If the San Antonio-Laredo service is provided by the Greenfield/ Restored Abandoned ROW Corridor via Alice, this line would be located approximately 2.5 miles from the Laredo Airport. If a direct high speed rail route is constructed between San Antonio and Monterrey, Mexico the border crossing would likely at Columbia, approximately 23 miles from downtown Laredo. In either case, it is presumed that the El Metro bus services would be realigned to serve the TOPRS station.

McAllen, TX. There is a potential complex combination of true Greenfield and Restored Abandoned ROW corridor that could provide McAllen with new TOPRS rail service from San Antonio and possibly continuing to either (or both of) Harlingen/Brownsville, TX or Monterrey, MX. It is presumed the McAllen Metro bus transit would provide service to a TOPRS station. Since this line passes near the McAllen Airport, it could provide a TOPRS station location supporting intermodal air connections. Central Station is located adjacent to the rail line being considered for use as part of Rio Grande Valley commuter rail line, making it a potential TOPRS station location.

Raymondville, TX. Although no specific station site is identified selected, the site of the former SP (now UP) station in Raymondville would be a potential location for Southern Section regional and emerging services on the San Antonio-Brownsville shared corridor route.

Weslaco, TX. There is a proposed McAllen-Harlingen-Brownsville commuter rail service that would pass through and serve Weslaco directly. Weslaco could also be a stop for TOPRS regional or emerging service trains if the Greenfield/Restored Abandoned ROW corridor alignment is selected for San Antonio-McAllen before continuing on existing shared ROW to Harlingen and Brownsville. No specific Weslaco TOPRS station location is under consideration.

5.0 Route Alternatives Analysis

The purpose of the Route Alternatives Analysis was to compare study route alternatives and service-level options by geographic section (Northern, Central, and Southern), with the objective of screening out alternatives that are fatally flawed or that performed considerably less well than other alternatives within the same geographic section. This analysis resulted in the set of route alternatives to be carried forward into the Service-level Environmental Impact Statement (EIS). The route alternatives considered as part of the Route Alternatives Analysis were those that were not screened out during the feasibility analysis discussed in Section 2.0. As part of the Route Alternatives Analysis, route alternatives were evaluated based on the ability of each to fulfil the Purpose and Need, the estimated cost, potential environmental issues, and the level of community and agency support or opposition. The Route Alternatives Analysis process and results is described in detail in the Final Route Alternatives Analysis Technical Memorandum (CH2M HILL 2014).

This section includes a description of the alternatives carried forward into the Route Alternatives Analysis, the Route Alternatives Analysis criteria, and the key findings and results of the Route Alternatives Analysis.

5.1 Route Alternatives Carried Forward into Route Alternatives Analysis

The route alternatives carried forward into the Route Alternatives Analysis were the outcome of the Initial Range of Alternatives process described in Section 2.0, and are shown in Figure 5-1 and described below. Each route alternative includes two of the following service-level alternatives: conventional service, higher speed service, and high-speed service.

5.1.1 Northern Section Route Alternatives

N1 (conventional and higher speed) - This alternative would begin at Edmond, OK, and follow a local railroad to Chickasha, then follow the UPRR to Bowie, where the route can either (Option N1A) continue on UPRR track to Fort Worth or (Option N1B) transition back to the BNSF for entry into Fort Worth at the Intermodal Transportation Center (ITC). It would then continue to Dallas Union Station (DUS) via the Trinity Railway Express (TRE).

N2 (higher speed and high-speed) - This alternative would begin at Edmond, OK, and follow the BNSF south to Norman, where the route would transition into a new greenfield alignment. It would follow this alignment to a point near Krum, Texas, where it would transition onto the Kansas City Southern Railway (KCS) and the Dallas Garland and Northeastern Railroad (DGNO) to DUS, entering from the west, and then reverse direction to continue to the Fort Worth ITC on a new high-speed alignment built over IH-30.

N4 (conventional and higher speed) - This alternative would begin at Edmond, OK, and follow the BNSF south to Krum, Texas. Option N4A would continue to the Fort Worth ITC on the BNSF (as does the existing Amtrak Heartland Flyer) and then continue to DUS via the TRE. Option N4B would continue to DUS over the KCS/DGNO and then reverse direction to Fort Worth over the TRE. Option N4C would continue to DUS over the KCS and then continue to Fort Worth over the TRE.

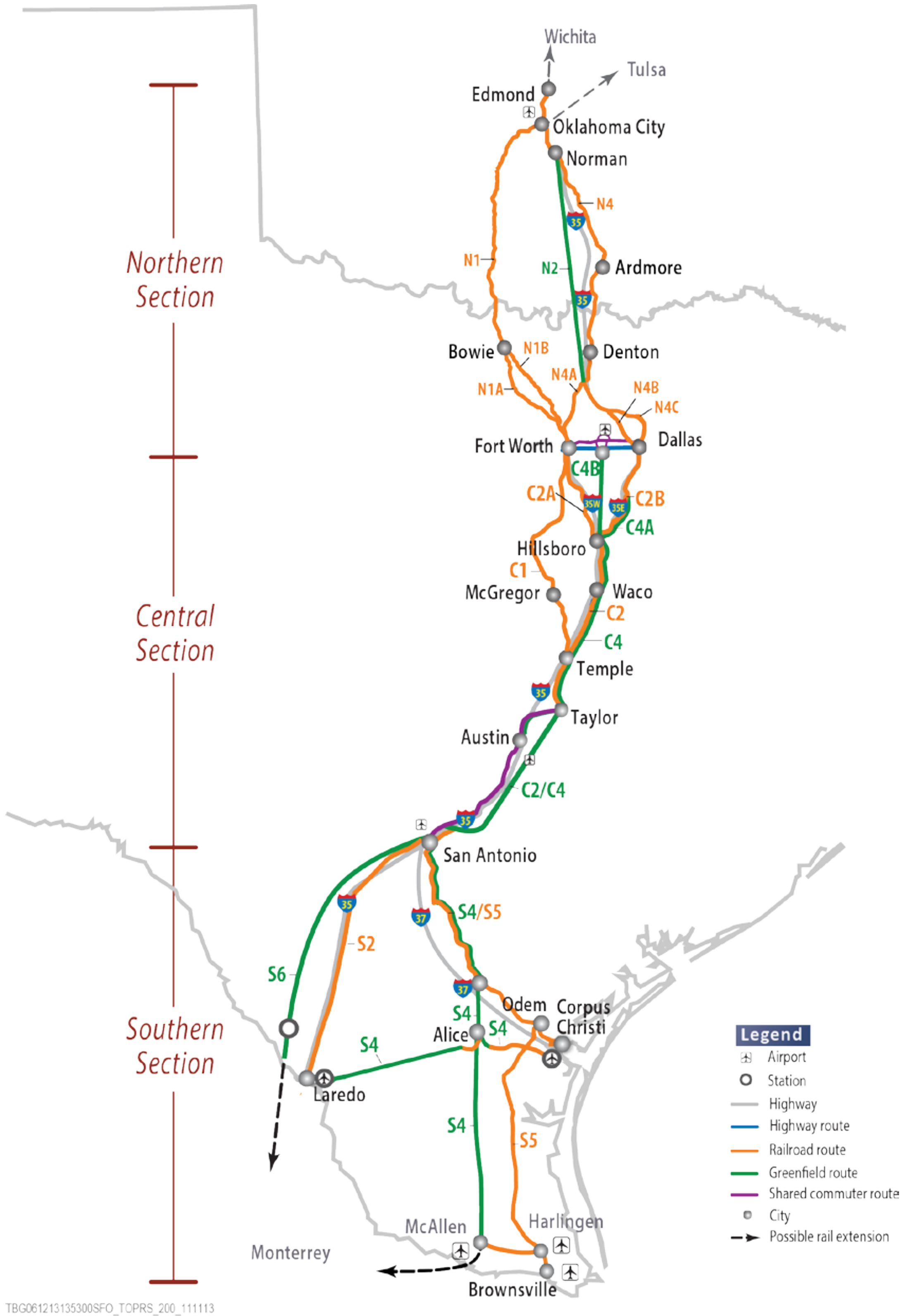

Figure 5-1: Route Alternatives Carried Forward into the Route Alternative Analysis

5.1.2 Central Section Route Alternatives

C1 (conventional and higher speed) - This alternative would begin at DUS and follow the TRE to the Fort Worth ITC. From there it would run on the existing BNSF line south to Temple where it would continue on to the UPRR track to Taylor, Austin and San Antonio, coordinating schedules with Lone Star Rail District trains which are planned to operate along this line.

C2 (conventional and higher speed) - Option C2A would begin at DUS and follow the TRE to the Fort Worth ITC and then run on the UPRR south to Hillsboro. Option C2B would begin at the Fort Worth ITC and follow the TRE to DUS. It would then run on the BNSF south to Waxahachie, where it would enter a rebuilt abandoned railroad corridor to Hillsboro. These options can be combined to provide a “loop” service where trains travel to and from Dallas and Fort Worth before returning south. All of these options would then continue south from Hillsboro through Waco to Taylor. At Taylor conventional service trains would follow the UPRR through Austin and San Antonio, coordinating schedules with the proposed Lone Star regional rail service. Higher speed service would enter a new greenfield right-of-way through the Austin-Bergstrom International Airport and south to San Antonio.

C4 (higher and high-speed) - Option C4A would begin at the Fort Worth ITC and follow the TRE to DUS, where it would then follow the BNSF south toward Waxahatchi and enter a high-speed greenfield corridor to travel south to Hillsboro and Taylor. Option C4B would begin at both the Fort Worth ITC and DUS, with trains following a high-speed alignment above IH 30 to Arlington, where the lines would merge and turn south to Hillsboro on a high-speed greenfield alignment to Taylor and south, following the same alignment as the C2 higher-speed alternative. Alternative C4 also has an option of direct service to downtown Austin via connections with trains operating over the UPRR from Taylor to Austin, which would coordinate schedules with the proposed Lone Star Rail District.

5.1.3 Southern Section Alternatives

S2 (conventional and higher speed) - This alternative would begin at the San Antonio VIA Transit Center station and continue southwest on the UPRR, ending at Laredo.

S4 (higher and high-speed) - This alternative would begin at the San Antonio VIA Transit Center station and continue southeast on the UPRR to George West, where the line would enter a greenfield right-of-way to Alice. At Alice, there would be a stop where this alternative would divide into three legs, each of which could have direct service to San Antonio or shuttle service to Alice. The first leg would travel west along the KCS Railway to San Diego, Texas, where it would enter a greenfield right-of-way to Pescadito and then re-join the KCS Railway to end at the Laredo International Airport. The second leg would travel south along rebuilt abandoned track to McAllen, where a connection could be made to Harlingen and Brownville over a proposed commuter rail service (which is not part of this study). This leg could also be extended into Mexico over a greenfield border crossing and then follow another route of the KCS de Mexico to Monterrey. The third leg would travel east along the KCS Railway to Corpus Christi to a new station facility at Corpus Christi International Airport.

S5 (conventional and higher speed) - This alternative would begin at the San Antonio VIA Transit Center station and continue southeast on the UPRR to Odem, where a shuttle train or bus would provide service from Odem to Corpus Christi. This route alternative would continue south from Odem on the UPRR to Brownsville, stopping at a new station near the Brownsville Transit Center. A proposed commuter rail service (which is not a part of this study) could connect to Harlingen and McAllen.

S6 (higher and high-speed) - This alternative was added as a result of stakeholder meetings in Laredo, at which attendees expressed a desire for direct service from San Antonio to Monterrey, Mexico, with a new stop northwest of Laredo near the Laredo-Columbia Solidarity Bridge (LCSB). This alternative would begin at the San Antonio VIA Transit Center station and continue on a direct line to the station at the LCSB. It would then cross on a new railway bridge to join a new line being constructed in Mexico, which would continue to Monterrey, Mexico. This study only examines the U.S. component of this new line, but it does consider the ridership impact of such a connection.

5.2 Route Alternatives Analysis Criteria and Methodology

Screening criteria for the Route Alternatives Analysis were developed to support a number of Study goals. These included whether routes were aligned with the project Purpose and Need, consistency with local and regional goals, stakeholder comments and input received during individual stakeholder meetings and during the scoping process, and potential effects of routes on environmental resources.

Table 5-1 lists the final criteria that were used to screen alternatives for the Route Alternatives Analysis. The criteria are grouped into four categories:

- Alternative attributes – these were not used independently to screen alternatives, but instead to help explain differences between route alternatives
- Operational criteria – these describe features such as operating cost and travel time
- Infrastructure criteria – these describe features including capital cost and right-of-way
- Environmental criteria – these describe potential effects on environmental resources such as agriculture, cultural and biological resources

The measure used to evaluate each criterion is shown in Table 5-1, along with threshold values, when applicable. In addition, the source of data used to evaluate each criterion is listed.

Table 5-1: Route Alternatives Analysis Criteria

Criterion No.	Criterion	Measure	Threshold	Data Source
Alternative Attributes				
1a	Access to Stations	Total population of cities served by stations	N/A	U.S. Census (2010)

Criterion No.	Criterion	Measure	Threshold	Data Source
1b	Access to Stations with endpoint cities removed	Total population of cities served by stations with endpoint cities removed	N/A	U.S. Census (2010)
2	Ridership for each Alternative	Ridership (annual trips)	N/A	CONNECT model
3	Length of Route	Length of route in miles	N/A	Route design files
4	Cost to Construct Alternative	Total Capital Cost for Alternative ($)	N/A	CONNECT model with local data
Operational Criteria				
5	Revenue/ Operating Cost Ratio	Revenue/ Operating Cost (%)	Conventional: 50% cost recovery; higher-speed: 75% cost recovery; high-speed: 100% cost recovery	CONNECT model
6	Reduce Travel Times	Time reduction vs. Automobile	N/A	CONNECT model
7	Enhance Mode Share on Rail	Rail mode share (%)	N/A	CONNECT model
Infrastructure Criteria				
8	Capital Cost per Passenger Mile	Capital Cost per Passenger Mile ($)	N/A	CONNECT model and local cost enhance-ments
9	Minimize Right-of-Way/ Real Estate Impacts	Acres of non-transportation right-of-way within study area	N/A	Study route right-of-way
10	Provides Additional Improvements to National Railroad Network	Professional judgment (value of improvements and risk reduction evaluation)	N/A	Analysis of railroad infrastructure and operations

Criterion No.	Criterion	Measure	Threshold	Data Source
Environmental Criteria [b]				
Minimize Impacts on Natural Resources				
11a	Wetlands	Acres within study area	N/A	National Land Cover Data Base
11b	Critical Habitat	Acres within study area	N/A	U.S. Fish and Wildlife Service Data
Minimize Impacts on Cultural/Recreational Resources				
12a	National and State Historic Places	Number of Historic Sites	N/A	National Register of Historic Places, State Historic Data
12b	River and Stream Crossings	Number of river and stream crossings	N/A	Number of river and stream crossings
12c	Parks and Open Space	Acres within study area	N/A	ESRI parks data and Texas Parks & Wildlife data
Minimize Impacts on Social Resources				
13a	Prime Farmland	Acres within study area	N/A	Natural Resources Conservation Service, U.S. Dept. of Agriculture
13b	Sensitive Receptors	Number of schools, places of worship, and hospitals within study area	N/A	USGS, ESRI, and Texas Education Agency data
13c	Environmental Justice	Number of census blocks with % minority greater than state	N/A	US Census (2010)

Notes:

N/A = not applicable

USGS = U.S. Geological Survey

[a] FRA's CONNECT rail planning model is described in Section 3.3 of this memorandum.

[b] The study area for environmental impacts equals 250 feet on either side of centerline, unless alternative uses existing infrastructure.

5.3 Route Alternatives Analysis Results

The Route Alternatives Analysis compared study route alternatives and service-level options by geographic section (Northern, Central, and Southern), with the objective of screening out alternatives that are fatally flawed or that performed considerably less well than other alternatives within the same geographic section. The route alternatives recommended to be carried forward into the EIS are shown in Figure 5-2, and are listed below, along with the rationale for retaining each.

5.3.1 Northern Section

N4A (conventional speed level) – This route alternative covers most of the same line that has been upgraded by the TxDOT and ODOT as part of an on-going rail passenger improvement program and therefore represents a good use of resources that can be further built-upon. While Route alternative N4A does not meet the revenue to operating cost threshold it has the lowest capital cost per passenger mile for the Northern Section alternatives and will therefore be carried forward to represent the Northern Section in the EIS.

5.3.2 Central Section

C2B (conventional service level). C2B has the lowest capital cost of the central section route alternatives and among the highest revenue/operating cost ratios. Unlike C2A, it avoids crossing the highly congested Tower 55 in Ft. Worth. Therefore, it is recommended to be carried forward into the EIS.

C4 (A, B, and C) (higher-speed and high speed service levels). All of the C4 alternatives have the highest revenue/operating cost ratio, the biggest travel time savings compared to auto travel, and are comparable with other route options in the central section in terms of potential environmental effects. Therefore, they are recommended to be carried forward into the EIS.

5.3.3 Southern Section

S4 (higher-speed service level). While S4 has the greatest potential effect parks and open space, it is the longest alternative by a factor of 2 or 3, to serve the population centers, which contribute to operational performance. So while the environmental criterion is highest for this alternative, this is a condition that could be avoided with project level refinement of the route and would not be expected to be a fatal flaw.

S5 (conventional speed service level). This alternative avoids the potential effects on wetlands seen for the S5 higher speed alternative.

S6 (higher-speed service level)

Route alternatives S4 and S6 both allow extension to Monterrey, Mexico. Without that extension these alternatives would not be recommended to be carried forward because they do not meet the revenue to operating cost ratio threshold. Route alternative S5 also does not meet the revenue to operating cost threshold but it has the highest ratio and the lowest capital cost per passenger mile for the Southern Section alternatives and will therefore be carried forward to represent the Southern Section in the EIS.

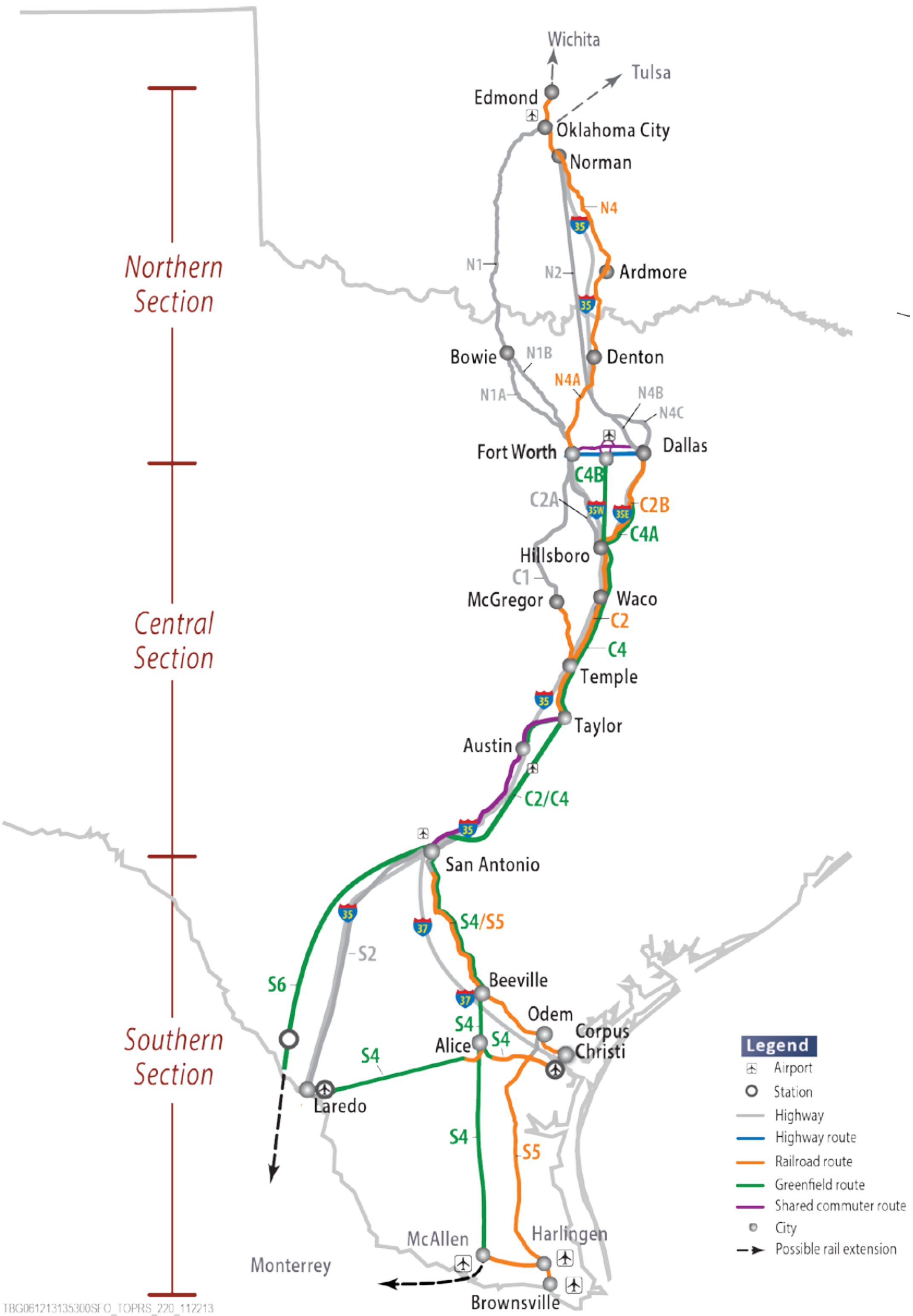

Figure 5-2: Route Alternatives and Options Recommended for Evaluation in the EIS

6.0 Preliminary Service Schedule and Initial Operations Plan Evaluation*

This section evaluates the key service schedule and operations plan elements for each of the Texas-Oklahoma Passenger Rail Study (Study) alternatives. As referenced at the beginning of this report these alternatives are being examined in greater detail in direct support of the service-level environmental impact study (EIS) phase. Consistent with the reports corridor structure, covering the Northern, Central and Southern sections, this alternative comparison also includes an Inter-section service operations evaluation between the Northern-Central and Central-Southern section's (TOPRS EIS Phase Operating Assumptions with Service Characteristics by Section; 2013). Detailed descriptions of the service schedule and operations plan components, the key objectives, the evaluation criterion, and alternatives performance against those criterion is provided below.

6.1 Key Components and Objectives

The primary service schedule and operations plan components include the proposed route, assumed service speed (conventional, higher speed, and or true high-speed), range of frequencies, stopping patterns, station stops, type of equipment (train consist), and potential schedules in tabular form. Drawing from initial ridership estimates (Section 3.0), the preliminary station location evaluations (Section 4.0) and the preliminary understanding of the other identified components the key objective of this evaluation are to compare the alternative performance within these defined parameters, including distance, average speed, timeline, and again preliminary station stopping assumptions.

6.2 Northern Section

The alternative alignment for N4A generally follows the route of Amtrak's Heartland Flyer, but with extensions north of Oklahoma City to Edmond, and east of Fort Worth to Dallas. Unlike the Central Section alternatives operating between Fort Worth Intermodal Transportation Center (ITC) and Dallas Union Station (DUS) on the Trinity Railway Express (TRE), it is assumed that Northern Section trains will not divert on a new loop route directly serving Dallas/Fort Worth International Airport (DFW Airport). Instead, the Oklahoma trains will travel straight across TRE, with a proposed intermediate stop at TRE's Centreport Station, where connecting shuttle bus service is available to DFW.

6.2.1 Service Plan

The N4A alternative assumes a conventional service speed with three to six daily round trips (RTs). The potential for accelerated travel-time options (express) assumes that 2 or 3 of the RTs would operate on an accelerated schedule, making roughly 7 stops, with remaining "local" trains making

* Based on stakeholder input, Alternative C4C has recently been added to the project. A preliminary evaluation of Alternative C4C has been included in Section 6.0 only.

between 10 and 12 stops (Section 4.0 Preliminary Station Location and Transit Connections Evaluation).

6.2.2 Preliminary Station Stopping Patterns

Based on the conventional service speed and alternative route the potential station stops for N4A are listed below. As noted above express trains would not make stops at all stations. More detailed station stopping patterns may be developed after completion of the pending TOPRS Corridor-Specific Demand Model, which will provide estimated forecast station-specific passenger volumes.

- Edmond
- Oklahoma City
- Norman
- Purcell
- Paul's Valley
- Ardmore
- Thackerville (potential new station)
- Gainesville
- Krum/Denton (potential new station)
- Fort Worth (ITC)
- Centreport (TRE)
- Dallas (DUS)

6.2.3 Train Frequency and Consist

The range of train frequencies would be between three to six daily RTs with between 7 and 12 stops, including the end points. These baseline contributions to Alternative N4A would be utilized during the service-level EIS analysis and documentation efforts. The analysis efforts will benefit from and include a combination of estimated operating costs and the ridership/revenue forecasts from the pending Corridor-Specific Demand Model. Combined, thereby providing a more precise determination of frequency and station stopping pattern recommendations.

The assumed train consist, based on preliminary capital/operating cost estimation, would consist of a new, high-performance diesel locomotive; one "split" (one-half business-class and one-half coach-class car); one "split" café (roughly one-half revenue seats and one-half table/lounge seating); and two to four conventional coaches. Revenue seating average capacity will range from 179 to 391 seats per train set.

6.3 Central Section (C4A, C4B and C4C)

There are five alternatives within the Central Section based on routing and service speed, including C4A and C4B (higher speed) and C4A, C4B and C4C (true high-speed). The routing for C4A and C4B with the higher speed service will predominantly follow a greenfield alignment. Alternative C4B would feature a direct link between Forth Worth, Arlington, and Dallas, predominantly following Interstate Highway 30 and southward service continuing between Arlington, Waco, Austin, and San Antonio. The C4A and C4B (true high-speed) alternatives would follow the same route alignments and include the same additional features (C4B only). The fifth alternative, C4C, is only studied at true high-speed service and is an expanded variation of C4A with an additional leg going directly south from the Fort Worth ITC Station through the Tower 55 area (fully grade-separated from freight rail) and roughly paralleling I-35W to Hillsboro where it rejoins C4A alignment running south from Dallas.

There are additional routing differences between the C4A and C4B warrant further discussion. The C4A alternatives (higher speed and true high-speed) would operate across the Trinity Railroad Express between the Fort Worth Transit Center and Dallas Union Station with a midway shift onto a new, greenfield track loop through Dallas-Fort Worth airport. This C4A shift to the airport would include a station stop directly under the planned and future Terminal F.

The C4B alternatives (higher speed and true high-speed) would also operate between the Fort Worth Transit Center and Dallas Union Station but this route would follow the IH-30 highway corridor to Arlington. The southward routing from Arlington would then follow the State Highway 360 (SH-360) corridor to Hillsboro. This C4B route would include an Arlington station with potential transfer options to the other metropolitan destinations. The C4B route would not serve the DFW airport.

C4A and C4B may also include limited and overlapping service along the Lone Star Railroad District (LSRD) corridor route from Taylor to downtown Austin. This LSRD route would either terminate, continue to the Austin airport, or continue on to San Antonio.

6.3.1 Service Plan – C4A Higher Speed

The C4A alternative assumes higher speed service with 6 to 12 daily RTs. The potential for accelerated travel-time options (express) assumes approximately 4 of the RT's would operate on an accelerated schedule. Express trains would likely make seven stops. Local trains would make approximately 12 (Section 4.0 Preliminary Station Location and Transit Connections Evaluation). If demand warrants, up to three daily RTs may be through-routed into the Southern Section and on to Monterrey or McAllen/Corpus Christi.

6.3.1.1 Preliminary Station Stopping Pattern

Based on the higher service speed and alternative routing described above the potential station stops for C4A are listed below. As noted above express trains would not make stops at all stations. More detailed station stopping patterns may be developed after completion of the pending TOPRS Corridor-Specific Demand Model, which will provide estimated forecast station-specific passenger volumes.

- Fort Worth (ITC)
- DFW Airport (Terminal F)
- Dallas Union Station
- Waxahachie
- Waco
- Temple/Killeen/Fort Hood
- Austin Airport
- Austin Downtown
- San Antonio Airport
- San Antonio

6.3.1.2 Train Frequency and Consist

The range of train frequencies would be between 6 to 12 daily RTs with between 9 and 15 stops, including the end points. These baseline contributions to Alternative C4A would be utilized during the service-level EIS analysis and documentation efforts. The analysis efforts will benefit from and include a combination of estimated operating costs and the ridership/revenue forecasts from the pending Corridor-Specific Demand Model. Combined, thereby providing a more precise determination of frequency and station stopping pattern recommendations.

The assumed train consist, based on preliminary capital/operating cost estimation, would consist of a new, high-performance diesel locomotive, one full-length business-class car, one “split” café (roughly one-half revenue seats and one-half table/lounge seating); and four to six conventional coaches. Revenue seating average capacity will range from 391 to 543 seats per train set.

6.3.2 Service Plan – C4B Higher Speed

The C4B alternative assumes higher speed service with 6 to 12 daily RTs. The potential for accelerated travel-time options (express) assumes approximately 4 of the RT’s would operate on an accelerated schedule. Express trains would likely make seven stops. Local trains would make approximately nine stops (Section 4.0 Preliminary Station Location and Transit Connections Evaluation). If demand warrants, up to three daily RTs may be through-routed into the Southern Section and on to Monterrey or McAllen/Corpus Christi.

6.3.2.1 Preliminary Station Stopping Pattern

Based on the higher service speed and alternative routing described above the potential station stops for C4B are listed below. As noted above express trains would not make stops at all stations. More detailed station stopping patterns may be developed after completion of the pending TOPRS Corridor-Specific Demand Model, which will provide estimated forecast station-specific passenger volumes.

- Fort Worth (ITC)
- Arlington
- Dallas Union Station
- Waco
- Temple/Killeen/Fort Hood
- Austin Airport
- Austin Downtown
- San Antonio Airport
- San Antonio

6.3.2.2 Train Frequency and Consist

The range of train frequencies would again be between 6 to 12 daily RTs with between seven and nine stops, including the end points. These baseline contributions to Alternative C4B would be utilized during the service-level EIS analysis and documentation efforts. The analysis efforts will benefit from and include a combination of estimated operating costs and the ridership/revenue forecasts from the pending Corridor-Specific Demand Model. Combined, thereby providing a more precise determination of frequency and station stopping pattern recommendations.

The assumed train consist, based on preliminary capital/operating cost estimation, would consist of a new, high-performance diesel locomotive, one full-length business-class car, one “split” café (roughly one-half revenue seats and one-half table/lounge seating); and four to six conventional coaches. Revenue seating average capacity will range from 391 to 543 seats per train set.

6.3.3 Service Plan – C4A True High-Speed

This C4A alternative assumes true high-speed electrified service with 12 to 20 daily RTs. Express trains would likely make six stops, and local trains would make approximately nine stops (Section 4.0 Preliminary Station Location and Transit Connections Evaluation). Again, if demand warrants, up to three daily RTs may be through-routed into the Southern Section and on to Monterrey or McAllen/Corpus Christi.

6.3.3.1 Preliminary Station Stopping Pattern

Based on the true high-speed service and alternative routing described above the potential station stops for C4A are listed below. As noted above express trains would not make stops at all stations. More detailed station stopping patterns may be developed after completion of the pending TOPRS Corridor-Specific Demand Model, which will provide estimated forecast station-specific passenger volumes.

- Fort Worth (ITC)
- DFW Airport (Terminal F)
- Dallas Union Station
- Waxahachie
- Waco
- Temple/Killeen/Fort Hood
- Austin Airport
- Austin Downtown
- San Antonio Airport
- San Antonio

6.3.3.2 Train Frequency and Consist

The range of train frequencies would again be between 12 to 20 daily RTs with between six and nine stops, including the end points. These baseline contributions to Alternative C4B would be utilized during the service-level EIS analysis and documentation efforts. The analysis efforts will benefit from and include a combination of estimated operating costs and the ridership/revenue forecasts from the pending Corridor-Specific Demand Model. Combined, thereby providing a more precise determination of frequency and station stopping pattern recommendations.

The assumed train consist, based on preliminary capital/operating cost estimation would consist of a contemporary (UIC-standard) distributed-power, 25 kilovolt (KV) catenary-supplied integrated train-set. This would likely include a “control-cab-equipped” business-class car, a full-length café-lounge car, five coach cars, and a “control-cab-equipped” coach car. Estimated average capacity is 465 seats.

6.3.4 Service Plan – C4B True High-Speed

This C4B alternative assumes true high-speed electrified service with 12 to 20 daily RTs. One key assumption for the C4B alternative is that alternate trains would originate/terminate in the Fort Worth and Dallas locations, respectively. Express trains would likely make six stops, and local trains would make approximately eight stops (Section 4.0 Preliminary Station Location and Transit Connections Evaluation). Again, if demand warrants, up to three daily RTs may be through-routed into the Southern Section and on to Monterrey or McAllen/Corpus Christi.

6.3.4.1 Preliminary Station Stopping Pattern

Based on the higher service speed and alternative routing described above the potential station stops for C4B are listed below. As noted above express trains would not make stops at all stations. More detailed station stopping patterns may be developed after completion of the pending TOPRS Corridor-Specific Demand Model, which will provide estimated forecast station-specific passenger volumes.

- Fort Worth (ITC)
- Arlington
- Dallas Union Station
- Waco
- Temple/Killeen/Fort Hood
- Austin Airport
- Austin Downtown
- San Antonio Airport
- San Antonio

6.3.4.2 Train Frequency and Consist

The range of train frequencies would again be between 12 to 20 daily RTs with between six and nine stops, including the end points. These baseline contributions to Alternative C4B would be utilized during the service-level EIS analysis and documentation efforts. The analysis efforts will benefit from and include a combination of estimated operating costs and the ridership/revenue forecasts from the pending Corridor-Specific Demand Model. Combined, thereby providing a more precise determination of frequency and station stopping pattern recommendations.

The assumed train consist, based on preliminary capital/operating cost estimation would consist of a contemporary (UIC-standard) distributed-power, 25 kilovolt (KV) catenary-supplied integrated train-set. This would likely include a “control-cab-equipped” business-class car, a full-length café-lounge car, five coach cars, and a “control-cab-equipped” coach car. Estimated average capacity is 465 seats.

6.3.5 Service Plan – C4C True High-Speed

This C4C alternative assumes true high-speed electrified service with 12 to 20 daily RTs. Express trains would likely make six stops, and local trains would make approximately nine stops (Section 4.0 Preliminary Station Location and Transit Connections Evaluation). Again, if demand warrants, up to three daily RTs may be through-routed into the Southern Section and on to Monterrey or McAllen/Corpus Christi.

6.3.5.1 Preliminary Station Stopping Pattern

Based on the true high-speed service and alternative routing described above the potential station stops for C4C are listed below. As noted above express trains would not make stops at all stations. More detailed station stopping patterns may be developed after completion of the pending TOPRS Corridor-Specific Demand Model, which will provide estimated forecast station-specific passenger volumes.

- Fort Worth (ITC)
- DFW Airport
- Dallas Union Station
- Waco
- Temple/Killeen/Fort Hood
- Austin Airport
- Austin Downtown
- San Antonio Airport
- San Antonio (Via/ex-IGN Station)

6.3.5.2 Train Frequency and Consist

The range of train frequencies would again be between 12 to 20 daily RTs with between six and eight stops, including the end points. These baseline contributions to Alternative C4C would be utilized during the service-level EIS analysis and documentation efforts. The analysis efforts will benefit from and include a combination of estimated operating costs and the ridership/revenue forecasts from the pending Corridor-Specific Demand Model, thereby providing a more precise determination of frequency and station stopping pattern recommendations.

The assumed train consist, based on preliminary capital/operating cost estimation would consist of a contemporary (UIC-standard) distributed-power, 25 kilovolt (KV) catenary-supplied integrated train-set. This would likely include a “control-cab-equipped” business-class car, a full-length café-lounge car, five coach cars, and a “control-cab-equipped” coach car. Estimated average capacity is 465 seats.

6.3.6 Service Plan – C4C Higher Speed

This alternative assumes higher speed service running 6 to 12 daily roundtrips with up to 8 stops. There might also be future limited optional alternative service overlapping the proposed LSRD route, either terminating at Austin (downtown); continuing on to the Austin Airport Rail Station, or continuing to Downtown San Antonio overlapping the LSRD. Because of the uncertainty of the development and implementation of the LSRD, the current TOPRS Service Level EIS SDP only assumes a potential "cross-platform" connection to LSRD (likely at Taylor, TX).

If demand warrants, up to 3 daily RTs could be through-routed to Monterrey or McAllen/Corpus Christi in the Southern Section of the Study. The unique, distinctive characteristic of C4C Higher-Speed is the inclusion of an additional direct north-south link between the Fort Worth (ITC) and Hillsboro, with routing across the Tower 55 (UP-BNSF Crossing). Each "round trip" would run in a clockwise loop pattern only passing through Tower 55 once per trip, so the total number of crossings would match the RT patterns depending on the service frequency.

6.3.6.1 *Preliminary Station Stopping Pattern*

Following is a list of likely potential station stops for C4C Higher-Speed service; it must be noted that not all trains will necessarily make stops at all stations. More detailed station stopping patterns may be developed after completion of the TOPRS Corridor-Specific Demand Model, which will provide estimated forecast station-specific passenger volumes.

- Fort Worth (ITC)
- DFW Airport
- Dallas (DUS)
- Waco
- Temple/Killeen/Fort Hood
- Taylor (only a potential stop if LSRD provides cross-platform connection to AUS downtown)
- Austin Airport
- San Antonio Airport
- San Antonio (VIA/ex-IGN Station)

6.3.6.2 *Train Frequency and Consist*

Based on passenger demand volumes identified in the screening phase of the Study, a range of train frequencies would again be from 6 to 12 daily RTs will be examined in this alternative. Similarly, for estimation purposes, it will be assumed that trains make 8 stops, including the end-points in the count. The combination of estimated operating costs and the ridership/revenue forecasts of the Corridor-Specific Demand Model will allow a more precise determination of frequency and station stopping pattern recommendation.

For preliminary planning purposes it is assumed that a typical train will consist of a new, high-performance diesel locomotive; one full-length business-class car; one “split” café (roughly one-half revenue seats and one-half table/lounge seating); and four to six conventional coaches. Revenue seating average capacity will range from 391 to 543 seats per train set.

6.4 *Southern Section (S6 and S4)*

There are three alternatives within the Southern Section based on routing and service speed, including S6 (higher speed) S6 (true high-speed) and S4 (higher speed). The routing for both S6 alternatives would run parallel to an existing Union Pacific line for approximately 10 miles before shifting to a predominantly greenfield alignment between San Antonio, Laredo and potentially across the border with Mexico and into Monterey. The S4 alternative would include a more complex network of two intersecting routes on a predominantly greenfield alignment. The S4 network would include a primarily North-South alignment connecting San Antonio, Alice, McAllen, Harlingen and Brownsville and an intersecting East-West alignment connecting Laredo, Alice, and Corpus Christi.

6.4.1 Service Plan – S6 Higher Speed

This S6 alternative assumes higher speed service with four to six daily RTs, making only the three identified stops including the end points.

6.4.1.1 Preliminary Station Stopping Pattern

Based on the higher service speed and alternative routing described above the potential station stops for S6 are listed below. More detailed station stopping patterns may be developed after completion of the pending TOPRS Corridor-Specific Demand Model, which will provide estimated forecast station-specific passenger volumes.

- San Antonio (VIA/ ex-IGN Station)
- Laredo (Columbia Crossing)
- Monterrey (NL)

6.4.1.2 Train Frequency and Consist

The range of train frequencies would again be between four to six daily RTs with three stops, including the end points. These baseline contributions to Alternative S6 would be utilized during the service-level EIS analysis and documentation efforts. The analysis efforts will benefit from and include a combination of estimated operating costs and the ridership/revenue forecasts from the pending Corridor-Specific Demand Model thereby providing a more precise determination of frequency recommendations.

The assumed train consist, based on preliminary capital/operating cost estimation would consist of a new, high-performance diesel locomotive; one “split” (one-half business-class and one-half coach-class car); one “split” café (roughly one-half revenue seats and one-half table/lounge seating); and two to four conventional coaches. Revenue seating average capacity will range from 179 to 391 seats per train set.

6.4.2 Service Plan – S6 True High-Speed

This S6 alternative assumes true high-speed service with 8 to s12 daily RTs, making only the three identified stops including the end points.

6.4.2.1 Preliminary Station Stopping Pattern

Based on the true high-speed service and alternative routing described above the potential station stops for S6 are listed below.

- San Antonio (VIA/ ex-IGN Station)
- Laredo (Columbia Crossing)
- Monterrey (NL)

6.4.2.2 Train Frequency and Consist

The range of train frequencies would again be between 8 to 12 daily RTs with three stops, including the end points. These baseline contributions to Alternative S6 would be utilized during the service-level EIS analysis and documentation efforts. The analysis efforts will benefit from and include a combination of estimated operating costs and the ridership/revenue forecasts from the pending

Corridor-Specific Demand Model. Combined, thereby providing a more precise determination of frequency.

The assumed train consist, based on preliminary capital/operating cost estimation would consist of a contemporary (UIC-standard) distributed-power, 25KV catenary-supplied integrated trainset. This would likely include a “control-cab-equipped” business-class car, a full-length café-lounge car; five coach cars, and a “control-cab-equipped” coach car. Estimated average capacity is 465 seats.

6.4.3 Service Plan – S4 Higher-Speed

This S4 alternative assumes higher speed service with four to six daily RTs, making all stops along their perspective routes, North-South (three stops) and East-West (three stops). If demand warrants, up to 3 daily RTs may be through-routed to DAL/FTW.

6.4.3.1 Preliminary Station Stopping Pattern

Based on the higher speed service and alternative routing described above the potential station stops for S4 are listed below. More detailed operational patterns may be developed after completion of the pending TOPRS Corridor-Specific Demand Model, which will provide estimated forecast station-specific passenger volumes.

- San Antonio (VIA/ ex-IGN Station)
- Alice (transfer/connection point)
- Corpus Christi
- Laredo (Airport)
- McAllen
- Harlingen
- Brownsville

6.4.3.2 Train Frequency and Consist

The range of train frequencies would again be between four to six daily RTs with three stops along each of the alignments and including the end points. These baseline contributions to Alternative S4 would be utilized during the service-level EIS analysis and documentation efforts. The analysis efforts will benefit from and include a combination of estimated operating costs and the ridership/revenue forecasts from the pending Corridor-Specific Demand Model. Combined, thereby providing a more precise determination of frequency and connecting train transfer patterns.

The assumed train consist, based on preliminary capital/operating cost estimation would consist of a new, high-performance diesel locomotive; one “split” (one-half business-class and one-half coach-class car); one “split” café (roughly one-half revenue seats and one-half table/lounge seating); and two to four conventional coaches. Revenue seating average capacity will range from 179 to 391 seats per train set.

One additional comparative element for this alternatives is the potential consideration of using contemporary European-design (Federal Railroad Administration-equivalent-compliant) DMUs, which would make the operation of a “splitting/merging” branch system at Alice relatively seamless and potentially provide single-seat, through-service between San Antonio and all three ultimate destination end-points.

6.5 Potential Inter-Section Train Service Schedule/Operations

Based on likely service frequency, demand-levels, and fundamental train technology differences in the three sections (Northern, Central, and Southern), limited opportunities to provide Inter-section (through) train operations. A high level description outlining the best opportunities for potential through service is provided within this section.

6.5.1 Northern-Central Inter-Section Service Opportunities

Assuming demand forecasts provide justification, one to two daily RTs of the Edmond, Oklahoma City, Fort Worth, Dallas service could be "through routed" to Austin and/or San Antonio via the C4A (higher speed) route or via a modified C4A using the "shared" conventional LSRD route south of Taylor via Austin (downtown) and San Marcos. Key assumptions for this possible through service include that the Edmond/Oklahoma City equipment would not be compatible with the C4A (true high-speed) operation or any service on the C4B alignment.

The train consist for this Northern-Central through service would include a conventional diesel-powered service with a one diesel locomotive, one business/café car, and four coaches with a typical capacity of 331 seats. There may be opportunity on the greenfield sections south of Dallas to operate up to 110 mph, or possibly 125 mph, using "high-performance" technology.

6.5.2 Central-Southern Inter-Section Service Opportunities

Assuming demand forecasts provide justification, two to three daily RTs of the Fort Worth, Dallas, Austin, San Antonio service could be "through routed" to either Monterrey (S6) or McAllen (S4). Key assumptions for these possible connections are that any likely Central-Southern through services would be operated on compatible (i.e., interoperable) "primary" services in both sections. The three most likely combinations are the following:

- C4A/B (higher speed) + S6 (higher speed) Fort Worth, Dallas, San Antonio, Monterrey; C4A/B (true high-speed) + S6 (true high-speed) Fort Worth, Dallas, San Antonio, Monterrey; C4A/B (higher speed) +S4 (higher speed) Fort Worth, Dallas, San Antonio, McAllen/Corpus Christi
- True high-speed (on both sections) would only be possible on the C4A/B + S6 combination with through true high-speed train sets operating between Fort Worth, Dallas, Austin, San Antonio, Monterrey.
- Higher speed (on both sections) with high-performance 125-mph trains could be possible between Fort Worth, Dallas, Austin, San Antonio, Monterrey and/or Corpus Christi, McAllen and Brownsville.

Higher-speed equipment would consist of one high-performance diesel locomotive, one business/café car, and five coaches with total capacity of 407 seats.

True high-speed equipment would consist of a contemporary (UIC-standard) distributed-power, 25kV catenary-supplied integrated trainset with one cab-control-business; one café; five coaches; and one cab-control-coach with typical total capacity of 465 seats.

7.0 Railroad Support Facilities

In order to support and maintain passenger railroad operations, it is estimated that two Vehicle Maintenance Bases (VMF), one Operations Centre, and multiple Maintenance of Way bases would be needed. In order to develop conceptual level capital cost estimates we have assumed locations for the above facilities and fitted them out accordingly.

The TOPRS passenger rail corridor is divided into three logical segment and the two intermediate termini points between these segments represent logical nexus for vehicle maintenance activities. Examination of the proposed schedules support this concept as well. In the Ft. Worth to Dallas corridor on the TRE there is an existing passenger railroad maintenance facility adjacent to the West Irving station that has both compatible uses and room for significant expansion. After discussions with TRE, who agreed with the assessment, we used that location for the planned northern maintenance facility. The location is not only in the center of the DFW system, but also within an industrial area that has numerous opportunities for expanded operations. It would also allow for shared costs for expensive items like wheel truing machines, drop tables, and painting facilities.

The southern terminal at San Antonio has similar attributes as the northern location. There are a number of potential locations west and south of downtown that could be utilized. Each yard would contain layover tracks with 480v power stand-by to maintain lights and HVAC during inspection and cleaning, security alarm connections to detect unauthorised train entry, potable water fill stations, compressed air charging (unless trains use EP brakes), tool outlets, and vehicle access for sanitary tank emptying and for commissary supplies. Separate facilities for car repair, locomotive servicing, locomotive repair, train inspection and servicing, train washing, and other support functions would be included once train operating patterns are determined and with the concurrence of planned maintenance facility contractors.

A system operations center would handle executive functions, dispatching, contract monitoring, and various oversight functions. It could be located at one of the above facilities or at another location. It would provide security monitoring through CCTV cameras at stations and handle train operations announcements as well as status board updates.

Maintenance of Way bases that handle the inspection and repair of the tracks, signals, structures, fencing, potential electrification equipment, and any grade crossing equipment would be located along the line in different configurations based on the infrastructure contractors' needs.

8.0 Railroad Simulation and Capacity Mitigation

One of the several factors for consideration in evaluating and screening out certain initial alternative scenarios was capacity of select freight railroad lines and their potential ability to add reliable scheduled intercity passenger rail in shared track operation without negatively impacting current and future freight. Because of the large number of alternative routes under consideration and the need for expediency and cost-efficiency in the alternative screening phase, it was determined that a very high-level analysis approach should be utilized.

Rather than the more narrowly targeted and detailed capacity simulation and mitigation analysis as was applied to the critical TRE corridor (described subsequently), for the majority of the other routes, the project team's railroad operations experts reviewed each of the subject shared-use sections to qualitatively evaluate current and planned future freight traffic with respect to physical capacity, by individual segment. The efforts then focused on how well or poorly a passenger service overlay might perform within these respective segments. In all cases the analysis considered the potential for reasonable investments in capacity improvement for the future scenarios.

Based on this section-by-section qualitative analysis, the TOPRS Team was able to assign a "degree of impact" ordinal ranking to each segment for each proposed service level. The impacts ranged from "highly negative to freight" at the bottom end of the scale, through "no significant (positive or negative) net impact" up to "net favorable impact" to freight fluidity. These evaluations were then used in the highly detailed, multi-faceted alternatives matrix that was applied to the quantitative Screening Process to select the best scenarios for continuation into the EIS-Phase of TOPRS. The complete description of all factors and their application is described in the TOPRS Draft Route Alternatives Analysis Technical Memorandum (Nov 2013)

Because of multiple highly unique circumstances surrounding the TRE, operated largely over the existing, publically owned (and proposed to be expanded and potentially electrified) TRE between Forth Worth ITC and Dallas Union Station, it was decided to perform a full blown railroad simulation and capacity analysis to provide a much more detailed understanding of the TOPRS impacts as well as the capital cost of full mitigation. It should be noted that use of the TRE is critical as a link for Dallas/Fort Worth Metroplex access/distribution in all North Section alternatives and a majority of the Central Section alternatives.

A select group from the TOPRS team, which specializes in railroad simulation, was deployed to model the TRE, the existing commuter rail system which connects the cities of Fort Worth and Dallas. TranSystems' "Operations Analysis" practice area used TMS, a custom rail modeling tool, to evaluate potential TRE improvements related to implementing TOPRS service. The corridor is already highly utilized by TRE during the day, with close to 50 daily commuter trains serving ten stations, as well as limited local and some thru freight in operation through-out the day. During this study, the TranSystems Operations Analysis team examined several alternative proposed infrastructure designs to provide the ability to compare various service levels and also the necessary capital cost requirements.

The primary objective of this study was to analyse potential infrastructure improvements designed to support the new TOPRS high-speed passenger rail service without impacting the significant existing commuter rail operations by TRE or the tenant freight services. The study indicated that the TRE, TOPRS and known freight services could coexist if the corridor is essentially double tracked and passing sidings are provided on the airport connector and around each TRE station.

The summary snapshot excerpt of the live schematic animation model outputs illustrates several of the identified necessary capacity upgrades.

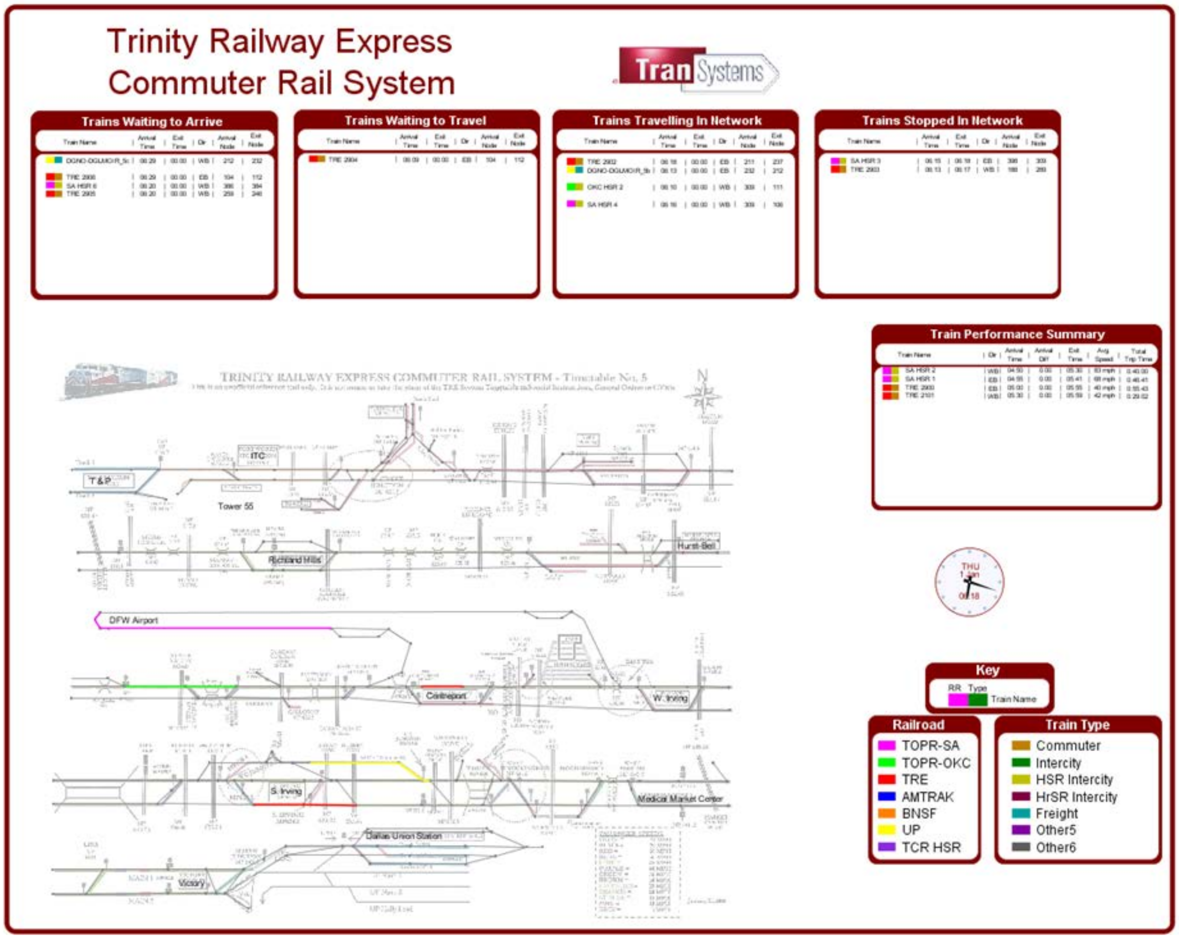

Figure 8-1: Model Output Schematic Example

For example:

- An eastbound TRE train at S. Irving station (track occupancy shown in red) is using a new double-track section as it heads towards Medical Market Center.
- An eastbound TOPR train (purple) is about to stop at the Dallas Fort Worth Airport station and has just cleared a passing siding on the west end of the spur.
- A westbound TOPR train (green) is approaching a bypass around Hurst-Bell station which it could use when a TRE train is at or approaching the station.
- A UP freight (yellow) is headed towards Madill.

With the upgrades, the reliability performance of TRE and existing freight traffic was essentially unaffected by the addition of TOPR trains.

9.0 Highway Crossings and Grade Separations

The purpose of the highway crossings and potential grade separations evaluation was to identify a range of general actions for existing and proposed at-grade crossings along the alternatives. This evaluation included the development of a methodology based upon the general practices presented in the U.S. Department of Transportation's (USDOT) Railroad-Highway Grade Crossing Handbook" and the American Association of State Highway and Transportation Officials (AASHTO) "Green Book". The review of these materials helped with the creation of a rating system for grade crossing conditions for each alternative and the results of the evaluation based upon these criteria and proposed service classifications. The assessment of highway crossings and grade separations and the general actions proposed for the alternatives are described in detail in the Evaluation of Highway Crossings and Potential Grade Separations (CH2M HILL 2014).

This section includes a description of the evaluation methodology, rating metrics applied to the alternatives, and the results of the assessment.

9.1 Methodology

Highway grade crossings and separations are an essential part of the evaluation process. Allowable crossings are determined by the corridor and speed classification of the proposed rail system. The USDOT's Railroad-Highway Grade Crossing Handbook was issued in August 2007 and provides a detailed reference of adopted standards and best practices related to highway-rail grade crossings. The Federal Highway Administration (FHWA) requires all states to develop and implement a highway safety improvement program (HSIP) and this applies to highway-rail grade crossings. The AASHTO Green Book, properly known as "A Policy on Geometric Design of Highways and Streets," details six warrants that are used to identify locations of interchanges and grade separations. Table 9-1 summarizes key criteria from the Railroad-Highway Grade Crossing Handbook and Green Book.

At this stage of the study, neither methodology was considered appropriate for the level of engineering analysis utilized in a National Environmental Policy Act (NEPA) study, however, the TOPRS evaluation methodology has used the Railroad Highway Grade Crossing Handbook and the AASHTO Green Book, which provide direction on permissibility and the requirements for locating interchanges and grade separations. The following evaluation criteria were utilized to determine general actions to be taken regarding the existing and proposed at-grade crossings along the proposed alternatives at a higher level of detail than what is typically applicable due to the service-level corridor analysis.

Table 9-1: Highway Grade Crossings Requirements and Criteria

U.S Department of Transportation Railroad-Highway Grade Crossing Handbook	AASHTO Green Book Grade Separation Warrants
▪ Review of grade crossings (as contained in the USDOT Grade Crossing Inventory) ▪ Determine safety of traffic for grade crossings, identify crossings that have the most need for improvement or reconstruction ▪ Identify deficiencies for grade crossings and associated recommendations for improvement ▪ Identify improvement alternatives (FRA regulations require grade crossings to either be eliminated or closed where trains operate at 125mph or higher) ▪ Safety considerations for train-involved and non-train-involved crashes ▪ Construction and maintenance costs	▪ Design Designation ▪ Reduction of Bottlenecks or Spot Congestion ▪ Safety Improvement ▪ Site Topography ▪ Road User Benefits ▪ Traffic Volumes

9.1.1 Existing Grade Crossings

- For existing grade crossings, match the existing crossings found to be crossed by a proposed route to their records in the FRA railroad crossing database.
- Record the AADT of automobile traffic at each crossing; if greater than 2,000 AADT then propose upgrade to gates and flashing lights if existing protection is weaker than that. If greater than 10,000 AADT, then propose grade separation.
- Note the distance to the nearest railroad crossing in the FRA crossings database; for areas in the Dallas-Fort Worth Metroplex area and in the San Antonio metropolitan area crossings closer than ¼ mile are considered redundant and have potential to be closed. In all other areas (considered "rural" here) the distance for crossing redundancy was considered to be 1/2 mile.
- Private crossings less than 5 miles away from an adjacent public crossing intended to be kept open were also considered eligible for closure.
- In cases where two adjacent crossings were considered to be suitable for closure, the crossing with the lesser AADT was considered to be more suitable for closure unless it currently had a stronger form of crossing protection.

9.1.2 Proposed Greenfield Alignments

- For true high-speed rail (HSR), all public crossings are recommended for grade separation, unless they appeared to be sufficiently redundant due to distance to the nearest crossing and can be considered for closure, as outlined previously. In select urban areas where true high speed is not attainable, the alignment may be considered a higher speed rail (HrSR) for grade crossing purposes.
- For Higher Speed Rail (HrSR), the only options available for the necessary "closed corridor" status were crossing closure, upgrade to four-quadrant gates, or grade separation.

9.1.2.1 Rating Metrics

Each grade crossing condition was rated 1 to 6 based on its assigned action to vehicular traffic, environmental, locations and rail speed limits. The crossing with the lowest rating (1) will have the most impacts and the crossing with the highest rating (6) will have the least impacts. This evaluation is based upon the methodology described above in Section 9.1 and adjusted for the conceptual alignments for each alternatives. All grade crossing rating recommendations would be subject to field diagnostic review during design development. These ratings categories are described below.

1. **Close**: the grade crossing meets the metrics to eliminate the crossing all together
2. **Do Nothing**: the grade crossing protection meets the needed standards. No upgrades to the protection will be required. However, gates and warning devices may need to be relocated to accommodate proposed tracks at required clearances.
3. **Construct new at-grade crossing**: no highway-railroad crossing exists today. Any new crossing will be designed to meet needed standards including four quadrant gates and/or traffic channelization.
4. **Upgrade to 4-quad gates**: existing crossing protection does not meet requirements and will need to be upgraded using four quadrant gates and/or traffic channelization.
5. **Construct grade separation**: due to rail classification and/or AADT traffic counts, a grade separation is warranted at this location. It can be at the site of an existing grade crossing or a new grade crossing. Grade separation options include:
    a. Roadway Underpass-roadway lowered /railroad tracks remain at grade
    b. Roadway Overhead-roadway elevated / railroad tracks remain at grade
    c. Track depressed – railroad tracks depressed / roadway remain at grade
    d. Tracks Elevated – railroad tracks raised / roadway remain at grade
    e. Combinations of the above

6. **Already grade separated**: the existing highway-railroad crossing is grade separation and will need no changes to the configuration. However, changes to the structures may be required to either lengthen the highway over rail span to accommodate additional track(s) or add additional railway over highway structure(s).

9.2 Summary of Results

The evaluation of highway crossings and grade separations utilized the rating metrics described in Section 9.1.2.1 for each alternative with consideration of the existing corridor location and service classification (conventional rail, higher speed service, and high speed rail). The following is a discussion of the evaluation results for each alternative and Table 9-2 is a summary of these results.

Table 9-2: Highway Crossings and Grade Separations Summary

Applied Ratings	Descriptions/ Recommendation	Edmond to DAL/FTW		DAL/FTW to AUS-SAT			SAT-LAR to Corpus Christi-Brownsville		
		N4 A (CONV)	C4 A (HrSR)	C4 A (HSR)	C4 B (HrSR)	C4 B (HSR)	S4 (HrSR, M*)	S6 (HrSR, M*)	S6 (HSR, M*)
1	Close	65	76	76	60	60	155	0	0
2	Do Nothing	0	0	0	0	0	0	0	0
3	Construct New At-Grade	1	6	6	5	5	34	0	0
4	Upgrade to 4-Quad Gates	145	96	95	58	57	102	0	0
5	Construct Grade Separation	26	274	275	350	351	118	63	63
6	Already Grade Separated	87	85	85	47	47	12	0	0
	Total Crossings	324	537	537	520	520	421	63	63

*M = Potential connection to Monterrey, Mexico

9.2.1 Northern Section: Oklahoma City to Dallas and Fort Worth

9.2.1.1 Alternative N4A

The only remaining northern segment alternative is N4A. This alternative begins north of Oklahoma City, OK and extend south to the Dallas – Fort Worth Metroplex area. The segment is approximately 250 miles long and follows an existing freight corridor. The N4A alignment follows the BNSF Red Rocks Sub out of Oklahoma City, OK to the south where it becomes the BNSF Fort Worth Sub in Gainesville, TX to get into Fort Worth. As this segment utilizes existing freight corridors, the Freight (Section 2.0 – Development of Initial Range of Alternatives) criteria will need to be considered for any shared corridor sections. The N4A Alternative is designed to conventional rail speeds. The alignment may share the existing freight corridor or parallel it as needed due to site constraints.

As alternative N4A is designed for conventional rail on a shared or parallel corridor, at grade crossings are permitted. There are 324 crossings that exist along this corridor, 45 percent (approximately 145) of them will need to be upgraded to four quadrant gates for train and vehicle protection, 27 percent (approximately 87) of the crossings are already grade separated, 20 percent (approximately 65) of the crossings can be assumed to be permanently closed, 8 percent (approximately 26) will require new grade separation and one new crossing (less than 1 percent) will need to be provided.

9.2.2 Central Section: Dallas and Fort Worth to San Antonio

There are two remaining central alternatives, C4A and C4B, with service classifications for both higher speed service (HrSR) and high speed rail (HSR).

9.2.2.1 Alternative C4A (HrSR and HSR)

The first is alternative is C4A. This alternative begins in Fort Worth continues east to Dallas, turns south in Dallas to Hillsboro, and then connects the cities of Waco, Austin and San Antonio. The segment is approximately 335 miles long. The specific routing of the C4A alternative includes connections through the Fort Worth to Dallas Metroplex area by following the existing TRE corridor, then turning south in Dallas and using the IH-35 E corridor to Hillsboro where it joins the UPRR Fort Worth Sub followed by the UPRR Waco Sub as far as Route 79. The route then enters a Greenfield corridor into Austin with continuing routing south, still on a Greenfield alignment, into San Antonio. As this segment includes the partial utilization of existing freight corridors, the Freight criteria (Section 2.0 – Development of Initial Range of Alternatives) will need to be considered for any shared corridor sections.

The HrSR option of alternative C4A is designed for higher speeds on either a parallel to freight or Greenfield corridor. At grade crossings are permitted for this speed classification. The HSR option of alternative C4A is designed mostly for high speeds on a parallel to freight or Greenfield corridor, and at grade crossings are not permitted at high speed. There are 537 crossings that exist along this corridor and for both the HrSR and HSR options 51 percent (approximately 274) of them will need to be grade separated, 18 percent (approximately 96) will need to be upgraded to four quadrant gates for train and vehicle protection, 16 percent (approximately 85) of the crossings are already grade separated, 1 percent (approximately 6) will need new at-grade crossing and 14 percent (approximately 76) of the crossings can be permanently closed.

9.2.2.2 Alternative C4B (HrSR and HSR)

The second remaining central alternative is C4B. This alternative begins in Fort Worth continues east to Dallas and turns south at Arlington to Hillsboro. The alignment connects the cities of Waco, Austin and San Antonio. The segment is approximately 310 miles long. The specific routing of the C4A alternative includes connections through Fort Worth and the Dallas Metroplex area by following the I-30 corridor. Midway through the Metroplex area, a connection to the south along the SR 360 corridor to Route 287 where it becomes a Greenfield alignment to Hillsboro. In Hillsboro, the route joins the UPRR Fort Worth Sub followed by the UPRR Waco Sub as far as Route 79 extends into Austin and continues south on a greenfield alignment to San Antonio. As this segment includes the partial utilization of existing freight corridors, the Freight criteria (Section 2.0 – Development of Initial Range of Alternatives) will need to be considered for any shared corridor sections.

The HrSR option of alternative C4B is designed for higher speeds on either a parallel to freight or Greenfield corridor. At grade crossings are permitted for this speed classification. The HSR option of alternative C4B is designed mostly for high speeds on a parallel to freight or Greenfield corridor, and at grade crossings are not permitted at high speeds. There are 520 crossings that exist along this corridor and for both the HrSR and HSR options 67 percent (approximately 351) of them will need to be grade separated, 11 percent (approximately 57) will be upgraded to four quadrant gates for train and vehicle protection, 9 percent (approximately 47) of the crossings are already grade separated, 1 percent (approximately 5) will need new at-grade crossing and 12 percent (approximately 60) of the crossings can be permanently closed.

9.3 Southern Section: San Antonio to South Texas

There are two remaining southern alternatives, S4 and S6. Service classification includes HrSR for S4 and both higher speed service (HrSR) and high speed rail (HSR) for S6. The option to extend to Monterrey, Mexico is included for S4 and S6 under all service classifications identified.

9.3.1 Alternative S4 (HrSR)

The S4 alternative begins in San Antonio and continues south towards Corpus Christi and in Alice this alternative splits into three legs. The East leg traverses into Corpus Christi, the West leg extends into Laredo and the South leg travels to Brownsville. The S4 alternative is approximately 415 miles long with connections to San Antonio and Alice on the UPRR Corpus Christi Sub. S4 then follows the I-37 highway corridor and then branches off to follow Route 281 into Alice. The East leg connects to Corpus Christi via the KCS Laredo Sub the West leg follows the KCS Laredo Sub part of the route to Laredo and provides some Greenfield alignment. The South leg continues to follow Route 281 to McAllen and connects east along Route 83 to the UPRR Brownsville Sub and extends south before terminating in Brownsville. As this segment includes the partial utilization of existing freight corridors, the Freight criteria will need to be considered for any shared corridor sections. The S4 Alternative is a higher speed rail alternative.

9.3.2 Alternative S6 (HrSR and HSR)

The second remaining southern alternative is S6. This alternative connects San Antonio and Laredo. This alternative is approximately 145 miles long. The specific routing of the S4 alternative includes connections between San Antonio to Laredo along the UPRR Laredo Sub and a Greenfield alignment. As this segment includes the partial utilization of existing freight corridors, the Freight criteria will need to be considered for any shared corridor sections. The S6 Alternative has both higher speed rail and high speed rail options.

The HrSR option of alternative S6 is designed for higher speeds on a shared corridor, parallel to freight or Greenfield corridor, at grade crossings are permitted. The HSR option of alternative S6 is designed mostly for high speeds on a parallel to freight or Greenfield corridor, at grade crossings are not permitted for high speed. There are 63 crossings that will be needed along this corridor and for both the HrSR and HSR options 100 percent will need to be grade separated.

10.0 Summary of Public Outreach and Feedback

One of the evaluation criteria considered in the TOPRS Route Alternatives Analysis is the level of community or agency support, interest, or opposition for the route alternatives under consideration. The public meetings, stakeholder meetings, and other efforts that were carried out to solicit the public feedback needed for the Alternatives Analysis were included in the Study's Public Involvement Plan, which was developed by the Texas Department of Transportation (TxDOT), in coordination with the Oklahoma Department of Transportation and the Federal Railroad Administration (FRA). As part of the public involvement effort, public meetings were held as well as individual meetings with key stakeholder groups identified by the team including local jurisdictions, local transportation planning groups, and railroads. The key components of this public involvement effort are described below.

10.1 Pubic Open House Meetings

To solicit public feedback on the route alternatives under consideration, eight public meetings were held throughout Oklahoma and Texas in January and February 2014. In addition, an "Online Public Meeting," described in greater detail below, was available that allowed individuals to provide comments via computer.

10.1.1 Notice

TxDOT distributed press releases, placed paid newspaper ads, used Facebook and Twitter, and sent emails to the 500 person study mailing list to promote the meetings. The team also distributed posters and newsletters to Metropolitan Planning Organizations (MPOs) and other local organizations for them to send to their respective constituencies. The Study received thorough media coverage in local newspapers and TV, including: Valley Morning Star, MySA, The Monitor, Dallas Morning News, Tulsa World, News9 (in Oklahoma), NBC (in Dallas-Fort Worth), Killeen Daily Herald, Progressive Railroading, San Marcos Mercury, Waco Tribune, KXXV News Channel 25 (in Waco), Waco Tribune, and the Hillsboro Reporter.

10.1.1.1 In-person Public Meetings

TxDOT hosted eight in-person public meetings along the IH-35 corridor between January 27 and February 6, 2014. A total of 259 people signed-in at the meetings and 43 submitted comment forms. All meetings included time for participants to review displays and talk with staff, as well as listen to a formal presentation that included a question and answer session. All meetings included the same materials and information.

The meetings included display boards providing information about the purpose and need of the Study, graphics illustrating the route alternatives, and information about the decision-making process. Meeting attendees received study newsletters, which also outlined this information, and comment forms that could be returned at the meeting or mailed in before February 28, 2014.

A PowerPoint presentation showing all of the display boards was translated into Spanish, including a Spanish narration of the slides, was available to meeting attendees.

Public Meeting Date/Time	City	Attendance
Monday, January 27, 2014, 6-8 p.m.	Waco	36
Tuesday, January 28, 2014, 6-8 p.m.	Austin	19
Wednesday, January 29, 2014, 5:30-7:30 p.m.	McAllen	53
Thursday, January 30, 2014, 6-8 p.m.	Laredo	24
Monday, February 3, 2014, 6-8 p.m.	Oklahoma City	11
Tuesday, February 4, 2014, 6-8 p.m.	Ardmore	13
Wednesday, February 5, 2014, 11 a.m.-1 p.m.	Dallas and Fort Worth	61
Thursday, February 6, 2014, 6-8 p.m.	San Antonio	42

10.1.2 Online Public Meeting

The team also created an “online public meeting” that was designed to replicate the in-person meeting format allowing community members to virtually review materials and provide comments until the closing date of February 28, 2014. Approximately 4,500 unique visitors (90% of which were new visitors) viewed the online public meeting between January 13 and February 28, 2014. Visitors were mostly driven to the site by earned media (newspaper or TV coverage). A high percentage of visitors came to the site from a Houston Chronicle article (about 35% of all visitors). TxDOT Facebook and Twitter accounts were also a large origin point for visitors (23% of all visitors).

10.1.3 Comments Collected

In total, more than 600 comments were received. The team summarized the comments collected at the public meetings, online (online public meeting, Twitter, and Facebook), as well as through emails and letters. The sections below describe the most common comments collected.

Comments generally supported the study recommendations. In some cases, comments reflect specific concerns about property impacts, or tax payer investment in either studying or constructing rail projects. Generally, comments point to desired station locations, route choices, and priorities for projects or modifications.

10.2 Stations, Alignments, and Extensions

The information presented at the public meetings and online divided the Study area into three sections (northern, central, and southern/Mexico).

Northern - In the northern section, most comments showed support for the suggested alternatives and placed an emphasis on the importance of connecting Dallas and Fort Worth to San Antonio. A number of comments supported the need for stations in both Dallas and Fort Worth.

Central - In the central section, many commenters expressed concern over alternatives without service to downtown Austin. Comments also suggested the need to connect to San Antonio, New Braunfels, and San Marcos. Some comments suggested that the team should consider routes both east and west of IH-35 (specifically to Houston and Amarillo).

Southern/Mexico - In the southern section, commenters questioned the viability of service in south Texas noting that population density may be too low to cover operating costs and highlighting that Amtrak dropped service to Laredo due to low ridership. Comments outlined a need for connections to McAllen, Corpus Christi, and Harlingen. Many comments supported a connection to Monterrey, Mexico via Laredo; many highlighted a need to serve Laredo on this line.

Outside the IH-35 Corridor - Some commenters suggested that the corridor should be extended from Dallas to Houston or from Fort Worth West toward Amarillo. Several comments reflect the need to coordinate with other ongoing studies like the Lone Start Rail District project and Dallas to Houston rail study.

10.3 Service and Multi-Modal Connections

Commenters noted that TxDOT should only study a high speed connection south of Dallas and Fort Worth, but not north into Oklahoma. Comments suggested using abandoned rail rights-of-way, using routes that are separate from freight routes, or adding capacity to existing rail lines. Comments noted that frequency, speed, and connections to local transit systems would be important to creating a successful system.

10.4 Environmental Issues

Commenters suggested that rail lines should be located away from pipelines and that geology should be considered in the central section. Many expressed concerns about impacts to property owners.

10.5 Stakeholder Meetings

In addition to the public meetings, a three focused stakeholder meetings were held to solicit comments from resource agencies, elected officials, tribal representatives, transit agencies, and environmental interest groups. At these meetings, the public meeting materials were presented and attendees were encouraged to submit comments. Organization representatives were encouraged to attend the public meetings, as well as to invite (via email and distribution of a flyer) their constituents and members to attend.

10.6 *Incorporation of Public Input into the Alternatives Analysis*

Comments provided by the public and by stakeholder groups were compiled and summarized in the TOPRS Alternative Analysis Report. This summary of public feedback provided information that enabled the Study team to incorporate public support for and opposition to route alternatives into preliminary studies, development of the Alternatives Analysis criteria, and during the analysis itself.

11.0 Initial Cost Estimates

The conceptual costs per mile were estimated using basic infrastructure costing categories while applying the team's knowledge of recent rail project costs. These costs have also taken into consideration relevant transportation industry standard unit costs applied to the quantities proposed. The quantities illustrated in the estimates were analysed and extracted from the conceptual route alignments provided and categorized by their independent operating characteristics and service type.

The infrastructure costs depend greatly on the characteristics of the service type, the location of the improvements and basic peripheral necessities. Track configurations were analysed and costs prepared based on the service types along each rail segment. These costs took into account general right of way assessment, track construction, rail and roadway structure requirements, necessary communication systems and professional services. Appropriate contingencies were applied to reflect the stage of analysis. The initial cost estimates along with specific assumptions of the individual service types are provided below in Table 11-1a, 11-1b and 11-1c. For ease of review purposes Table 11-1a and 11-1b include repeat rows for each of the originally considered alternatives with different column metrics/values. Table 11-1c includes descriptions and values used for cost estimation along with notes and assumptions.

Table 11-1a: Initial Cost Estimates

Route Name	"T" Segments	Route Length (miles)	Conventional Cost (110 mph)	Higher Type A - "Shared-ROW" Cost (125 mph)	Higher Type B - "HSR-Lite" Cost (125 mph)	HSR Cost (220 mph)	Total	Total with TRE Segments Costs Allocated 25% North and 75% Central
N1A (Conv)	1, 2, 6, 12, 18, 20, 19, 15	273	$1,803,770,000				$1,803,770,000	$664,662,500
N1A (Higher Type A)	1, 2, 6 ,12, 18, 20, 19, 15	273		$5,492,830,000			$5,492,830,000	$4,353,722,500
N1B (Conv)	1, 2, 8, 12, 18, 20, 19, 15	272	$1,802,650,000				$1,802,650,000	$663,542,500
N1B (Higher Type A)	1, 2, 8, 12, 18, 20, 19, 15	272		$5,477,340,000			$5,477,340,000	$4,338,232,500
N2 (Higher Type B)	1, 3, 4, 7, 9, 18, 20, 19, 15	248			$2,830,050,000		$2,830,050,000	$1,690,942,500
N2 (HSR)	1, 3, 4, 7, 9, 22, 17, 15	240				$5,235,080,000	$5,235,080,000	N/A
N4A (Conv)	1, 3, 5, 10, 12, 18, 20, 19, 15	260	$1,790,330,000				$1,790,330,000	$651,222,500
N4A (Higher Type A)	1, 3, 5, 10, 12, 18, 20, 19, 15	260		$5,738,040,000			$5,738,040,000	$4,598,932,500
N4B (Conv)	1, 3, 5, 7, 9, 18, 20, 19, 15	260	$4,088,990,000				$4,088,990,000	$2,937,012,500
N4B (Higher Type A)	1, 3, 5, 7, 9, 18, 20, 19, 15	260		$7,251,200,000			$7,251,200,000	$6,099,222,500
N4C (Conv)	1, 3, 5, 7, 11, 13, 18, 20, 19, 15	259	$1,853,450,000				$1,853,450,000	$714,342,500
N4C (Higher Type A)	1, 3, 5, 7, 11, 13, 18, 20, 19, 15	259		$6,224,880,000			$6,224,880,000	$5,085,772,500

Table 11-1a: Initial Cost Estimates

Route Name	"T" Segments	Route Length (miles)	Conventional Cost (110 mph)	Higher Type A - "Shared-ROW" Cost (125 mph)	Higher Type B - "HSR-Lite" Cost (125 mph)	HSR Cost (220 mph)	Total	Total with TRE Segments Costs Allocated 25% North and 75% Central
C1 (Conv)	26, 33, 32, 34, 18, 20, 19, 15	226	$1,759,850,000				$1,759,850,000	$1,380,147,500
C1 (Higher)	26, 33, 35, 34, 18, 20, 19, 15	227		$4,594,980,000			$4,594,980,000	$4,215,277,500
C2A (Conv)	24, 28, 30, 31, 33, 32, 34, 18, 20, 19, 15	321	$1,893,530,000				$1,893,530,000	$1,513,827,500
C2A (Higher)	24, 28, 30, 31, 33, 35, 34, 18, 20, 19, 15	322		$6,954,575,800			$6,954,575,800	$6,574,873,300
C2B (Conv)	13, 27, 29, 31, 33, 32, 34, 18, 20, 19, 15	316	$1,914,810,000				$1,914,810,000	$1,535,107,500
C2B (Higher)	13, 27, 29, 31, 33, 35, 34, 18, 20, 19, 15	317		$5,573,480,000			$5,573,480,000	$5,193,777,500
C4A (Higher)	13, 27, 29, 31, 33, 35, 34, 18, 20, 19, 15	333			$4,602,970,000		$4,602,970,000	$4,223,267,500
C4A (HSR)	13, 27, 29, 31, 33, 35, 34, 22, 17	323				$5,651,800,000	$5,651,800,000	N/A
C4B (Higher)	25, 31, 33, 35, 34, 22, 17	312			$4,653,560,000		$4,653,560,000	N/A
C4B (HSR)	25, 31, 33, 35, 34, 22, 17	312				$5,358,260,000	$5,358,260,000	N/A
S2 (Conv)	38, 48	153	$171,360,000				$171,360,000	N/A

Table 11-1a: Initial Cost Estimates

Route Name	"T" Segments	Route Length (miles)	Conventional Cost (110 mph)	Higher Type A - "Shared-ROW" Cost (125 mph)	Higher Type B - "HSR-Lite" Cost (125 mph)	HSR Cost (220 mph)	Total	Total with TRE Segments Costs Allocated 25% North and 75% Central
S2 (Higher Type A)	38, 48	153		$2,369,970,000			$2,369,970,000	N/A
S4 (Higher Type B)	37, 40, 43, 45, 42, 47, 46	418			$2,457,840,000		$2,457,840,000	N/A
S4 (HSR)	37, 40, 43, 45, 42, 47, 46	418				$3,586,440,000	$3,586,440,000	N/A
S4*BC (Higher Type B)	37, 40, 43, 42, 47, 46	326			$1,916,880,000		$1,916,880,000	N/A
S5 (Conv)	37, 39, 41, 44, 46	277	$310,240,000				$310,240,000	N/A
S5 (Higher Type A)	37, 39, 41, 44, 46	277		$4,290,730,000			$4,290,730,000	N/A
S6 (Higher Type B)	36	143			$840,840,000		$840,840,000	N/A
S6 (HSR)	36	143				$1,226,940,000	$1,226,940,000	N/A

1. All costs are $2013 dollars
2. This report only describes construction costs; no planning or design costs are included.
3. Cost include real estate acquisition, but excludes any additional railroad agreement costs.
4. Mexican costruction costs per mile for greenfield railroad track construction are considered to be 65% of comparable US contruction costs

Table 11-1b: Initial Cost Estimates

Route Name	"T" Segments	Route Length (miles)	Total if Paying to Go to Monterrey	Cost/Mile	Cost Less Dallas-Fort Worth	Length Less Dallas-Fort Worth	Cost/Mile Less Dallas-Fort Worth Figure Eight	Cost / Passenger - Mile	Cost / Passenger Mile with 25%Mprth and 75% Central TRE Cost Split	Cost / Passenger - Mile - to Monterrey (Mexican Costs included at 65%)	Cost / Passenger - Mile - to Monterrey (Mexican Costs NOT included)
N1A (Conv)	1, 2, 6, 12, 18, 20, 19, 15	273	N/A	$6,607,216	$255,360,000	228	$1,120,000	$28.74	$10.59		
N1A (Higher Type A)	1, 2, 6 ,12, 18, 20, 19, 15	273	N/A	$20,120,256	$3,531,720,000	228	$15,490,000	$58.27	$46.19		
N1B (Conv)	1, 2, 8, 12, 18, 20, 19, 15	272	N/A	$6,627,390	$254,240,000	227	$1,120,000	$28.71	$10.57		
N1B (Higher Type A)	1, 2, 8, 12, 18, 20, 19, 15	272	N/A	$20,137,279	$3,516,230,000	227	$15,490,000	$58.26	$46.15		
N2 (Higher Type B)	1, 3, 4, 7, 9, 18, 20, 19, 15	248	N/A	$11,411,492	$970,200,000	137	$7,081,752	$31.99	$19.12		
N2 (HSR)	1, 3, 4, 7, 9, 22, 17, 15	240	N/A	$21,812,833	$1,561,560,000	182	$8,580,000	$52.76	N/A		
N4A (Conv)	1, 3, 5, 10, 12, 18, 20, 19, 15	260	N/A	$6,885,885	$198,240,000	177	$1,120,000	$28.93	$10.52		
N4A (Higher Type A)	1, 3, 5, 10, 12, 18, 20, 19, 15	260	N/A	$22,069,385	$2,741,730,000	177	$15,490,000	$64.87	$51.99		
N4B (Conv)	1, 3, 5, 7, 9, 18, 20, 19, 15	260	N/A	$15,726,885	$198,240,000	177	$1,120,000	$66.08	$47.46		
N4B (Higher Type A)	1, 3, 5, 7, 9, 18, 20, 19, 15	260	N/A	$27,889,231	$2,741,730,000	177	$15,490,000	$81.98	$68.95		
N4C (Conv)	1, 3, 5, 7, 11, 13, 18, 20, 19, 15	259	N/A	$7,156,178	$204,160,000	179	$1,140,559	$29.95	$11.54		
N4C (Higher Type A)	1, 3, 5, 7, 11, 13, 18, 20, 19, 15	259	N/A	$24,034,286	$2,794,870,000	179	$15,613,799	$70.37	$57.50		
C1 (Conv)	26, 33, 32, 34, 18, 20, 19, 15	226	N/A	$7,786,947	$241,040,000	184	$1,310,000	$10.02	$7.86		
C1 (Higher)	26, 33, 35, 34, 18, 20, 19, 15	227	N/A	$20,242,203	$3,076,170,000	185	$16,627,946	$7.43	$6.82		
C2A (Conv)	24, 28, 30, 31, 33, 32, 34, 18, 20, 19, 15	321	N/A	$5,898,847	$285,840,000	224	$1,276,071	$6.78	$5.42		
C2A (Higher)	24, 28, 30, 31, 33, 35, 34, 18, 20, 19, 15	322	N/A	$21,598,061	$3,695,770,000	225	$16,425,644	$11.38	$10.75		
C2B (Conv)	13, 27, 29, 31, 33, 32, 34, 18, 20, 19, 15	316	N/A	$6,059,525	$291,760,000	226	$1,290,973	$6.86	$5.50		
C2B (Higher)	13, 27, 29, 31, 33, 35, 34, 18, 20, 19, 15	317	N/A	$17,581,956	$3,748,910,000	227	$16,515,022	$9.12	$8.50		
C4A (Higher)	13, 27, 29, 31, 33, 35, 34, 18, 20, 19, 15	333	N/A	$13,822,733	$1,391,460,000	227	$6,129,780	$7.53	$6.91		
C4A (HSR)	13, 27, 29, 31, 33, 35, 34, 22, 17	323	N/A	$17,497,833	$2,093,520,000	244	$8,580,000	$7.95	N/A		
C4B (Higher)	25, 31, 33, 35, 34, 22, 17	312	N/A	$14,915,256	$1,843,560,000	297	$6,207,273	$7.61	N/A		
C4B (HSR)	25, 31, 33, 35, 34, 22, 17	312	N/A	$17,173,910	$2,548,260,000	297	$8,580,000	$7.54	N/A		

Table 11-1b: Initial Cost Estimates

Route Name	"T" Segments	Route Length (miles)	Total if Paying to Go to Monterrey	Cost/Mile	Cost Less Dallas-Fort Worth	Length Less Dallas-Fort Worth	Cost/Mile Less Dallas-Fort Worth Figure Eight	Cost / Passenger - Mile	Cost / Passenger Mile with 25%Mprth and 75% Central TRE Cost Split	Cost / Passenger - Mile - to Monterrey (Mexican Costs included at 65%)	Cost / Passenger - Mile - to Monterrey (Mexican Costs NOT included)
S2 (Conv)	38, 48	153	N/A	$1,120,000	N/A	N/A	N/A	$19.35	N/A		
S2 (Higher Type A)	38, 48	153	N/A	$15,490,000	N/A	N/A	N/A	$225.13	N/A		
S4 (Higher Type B)	37, 40, 43, 45, 42, 47, 46	418	$2,977,632,000	$5,880,000	N/A	N/A	N/A	$42.22	N/A	$12.64	$10.44
S4 (HSR)	37, 40, 43, 45, 42, 47, 46	418	$4,858,516,000	$8,580,000	N/A	N/A	N/A	$51.56	N/A	$18.44	$13.61
S4*BC (Higher Type B)	37, 40, 43, 42, 47, 46	326	$2,436,672,000	$5,880,000	N/A	N/A	N/A	$34.55	N/A	$11.98	$9.42
S5 (Conv)	37, 39, 41, 44, 46	277	N/A	$1,120,000	N/A	N/A	N/A	$3.45	N/A		
S5 (Higher Type A)	37, 39, 41, 44, 46	277	N/A	$15,490,000	N/A	N/A	N/A	$40.69	N/A		
S6 (Higher Type B)	36	143	$1,429,428,000	$5,880,000	N/A	N/A	N/A	$79.87	N/A	$9.08	$5.34
S6 (HSR)	36	143	$2,667,379,000	$8,580,000	N/A	N/A	N/A	$103.36	N/A	$14.35	$6.60

1. All costs are $2013 dollars
2. This report only describes construction costs; no planning or design costs are included.
3. Cost include real estate acquisition, but excludes any additional railroad agreement costs.
4. Mexican costruction costs per mile for greenfield railroad track construction are considered to be 65% of comparable US contruction costs

Table 11-1c: Initial Cost Estimates, TOPRS Track Estimates

Description	Units	Unit Cost	Subtotal	Per Mile	Per-Mile
Upgrade Existing Single Freight Rail Track	TF	$93.00		5280	$491,040.00
New Single Track Construction	TF	$186.00		5,280	$982,080.00
New Double Track Construction	TF	$372.00		5,280	$1,964,160.00
Embankment Single Track construction (Assume 5-ft Fill)	CY	$8.90		28,355.56	$252,364.48
Embankment Double Track construction (Assume 5-ft Fill)	CY	$8.90		43,022.22	$382,897.76
ROW Acquired - 100-ft (Rural)	Lin. MILE	$1,000,000.00		1.00	$1,000,000.00
ROW Acquired - 100-ft (Urban)	LIN. MILE	$1,500,000.00		1.00	$1,500,000.00
Install 48-inch RCP Drainage Culvert (CL V) every 500 feet	LF	$330.00		0.10	$33.00
ighway Bridge - 2 Lane	EACH	$2,000,000.00	Assume one per five miles	0.20	$400,000.00
Highway Bridge - 4 Lane	EACH	$4,000,000.00	Assume one per two miles	0.50	$2,000,000.00
Railroad Bridge - 1 track, More than 25 feet tall	TF	$13,000.00		100	$1,300,000.00
Railroad Bridge - 2 tracks, Less than 25 ft. tall	TF	$18,300.00		100	$1,830,000.00
Railroad Bridge - 2 tracks, More than 25 feet tall	TF	$22,500.00		200	$4,500,000.00
Electric Power System (Electrification)	LS per mile	$2,500,000.00			$2,500,000.00
Railroad Crossover	EACH	$10,000,000.00		0.07	$666,666.67
Crash wall Barrier between tracks	LF	$1,000.00		5280	$5,280,000.00
Fencing	LF	$20.00		5280	$105,600.00
Purchase of Control of Access for Rural Greenfield Sites	LF	$5.00		5280	$26,400.00
Rail Signal System (CTC)	LS per mile	$1,000,000.00		1	$1,000,000.00
Rail Signal System with PTC	LS per mile	$2,000,000.00			$2,000,000.00
Railroad Franchise ROW (Rural)	LS per mile	$1,000,000.00			$1,000,000.00
Railroad Franchise ROW (Urban)	LS per mile	$2,000,000.00			$2,000,000.00

General Cost Per Mile for each Service Type	Existing Rail Corridor		Greenfield	
	Rural	Urban	Rural	Urban
Conventional (79 -90 mph) Cost-per-Mile	$1,120,000.00	$2,960,000.00	N/A	N/A
Higher Speed (Type A) (110-125 mph) -Crash wall barrier without Electrification- Cost-per-Mile	$15,490,000.00	$26,570,000.00	N/A	N/A
Higher Speed (Type B) (110-125 mph) -No Crash Wall or Electrification- Cost-per-Mile	N/A	N/A	$5,880,000.00	$8,580,000.00
High Speed (180-220 mph) - No Crash wall with Electrification - Cost-per-Mile	N/A	N/A	$14,390,000.00	N/A

Notes and Assumptions	
General Assumptions	
1.	Estimate unit cost per 2013 TXDOT Stwd Bid, BNSF, and/or previous projects
2.	A 40% Contingency added to the costs to address upgrades to non PTC signals and grade crossings and other items
3.	No Environmental Mitigation Costs are included within the infrastructure costs
4.	DOES NOT INCLUDE STATION COSTS WITHIN THE COST PER MILE LISTED ABOVE
Conventional Cost Per Mile Basis of Estimate	
5.	Upgrade existing track to higher speed assuming new ties and resurfacing and replacing a single track rail bridge every 5 miles, no new road overpasses
6.	Assume that existing sidings need to be increased for freight traffic, 10% additional track added.
7.	For Urban Segments, assume a existing double track with upgraded tracks assuming new ties, resurfacing, and replacing a double track rail bridge every 5 miles and new rail cross over every 15 miles
8.	NO ROW ACQUISTION COSTS OR TRACKAGE RIGHTS INCLUDED IN COST PER MILE
Higher Speed (Type A) - Passenger Service added to Existing Freight Rail R/W	
9.	For Rural area, construct two (2) new tracks (Freight and Passenger tracks with sidings. Assumed 75% Single Track and 25% Double Track for sidings for both Freight and Passenger. Assumes no new roadway bridges. Assumes new railroad bridge every five miles
10.	For Urban area, construct four (4) new tracks (2-Freight and 2-Passenger tracks). A new freight rail cross over is installed every 15 miles and no new roadway bridges. Assumes new railroad bridge every five miles. Assume that sidings need to be increased, 10% additional track added.
11.	Assumes relocation of existing freight rail CTC and new CTC signals for the Passenger rail
12.	For Urban segments, assume one (1) new four lane highway bridge every mile.
13.	Assume Railroad Francise ROW for rural and urban.
14.	NO ROW ACQUISTION COSTS OR TRACKAGE RIGHTS INCLUDED IN COST PER MILE

Notes and Assumptions	
Higher Speed (Type B) - Greenfield Passenger Service	
15.	Construct a new single passenger rail line within new 100 foot right of wayassuming 25% of length for sidings with new single track rail bridge every 5 miles
16.	For rural segments, assume one (1) new two lane highway bridge every five miles.
17.	Includes Fencing Costs and control of access costs
18.	For Urban segments, assume one (1) new four lane highway bridge every two miles.
High Speed - Greenfield Passenger Service	
19.	Construct two (2) new passenger rail line within new 100 foot right of way with new single track rail bridge every 5 miles
20.	For rural segments, assume one (1) new two lane highway bridge every five miles.
21.	Includes Fencing Costs and control of access costs

12.0 Conclusions

The TOPRS Alternatives Analysis comprises a number of analyses and rounds of screening designed to identify the range of alternatives to be included in the TOPRS service-level Environmental Impact Statement (EIS) (see Figure 12-1). As part of the Alternatives analysis, a range of studies were completed to allow evaluation and comparison of alternatives.

The first screening was completed through the Initial Range of Route Alternatives process, which looked at a wide range of possible alternatives that could provide additional or new passenger rail service between Oklahoma City and south Texas including routes that followed the existing railroad network, the existing interstate highway network, and several potential greenfield corridors. The goal of this analysis was to screen routes for overall feasibility and fatal flaws, with a focus on findings from the Oklahoma City to South Texas Infrastructure Analysis (TxDOT 2013a), and consent of railroads to continue studying routes that required use of existing railroad rights-of-way. The routes that passed this initial level of screening were carried forward into the TOPRS Route Alternatives Analysis.

The TOPRS Route Alternatives Analysis was conducted to compare study route alternatives and service-level options by geographic section (Northern, Central, and Southern), with the objective of screening out alternatives that are fatally flawed or that performed considerably less well than other alternatives within the same geographic section. The data used to perform this comparison were generated through a number of the evaluations and models discussed in this report. This included analysing parameters such as ridership, evaluation of station locations, and estimation of capital costs.

As part of the Route Alternatives Analysis, evaluations based on the ability of each alternative to fulfil the Purpose and Need, the estimated cost, potential environmental issues, and the level of community or agency support or opposition were conducted. The following route alternatives, classified by the respective Northern (N), Central (C), and Southern (S) segment and service-level (conventional, higher speed, and high speed), were recommended to be carried forward into the EIS based on the results from the Route Alternative Analysis:

- N4A – conventional speed
- C2B – conventional speed
- C4A – higher-speed and high speed
- C4B – higher-speed and high speed
- S4 – higher-speed
- S5 – conventional speed
- S6 – higher-speed

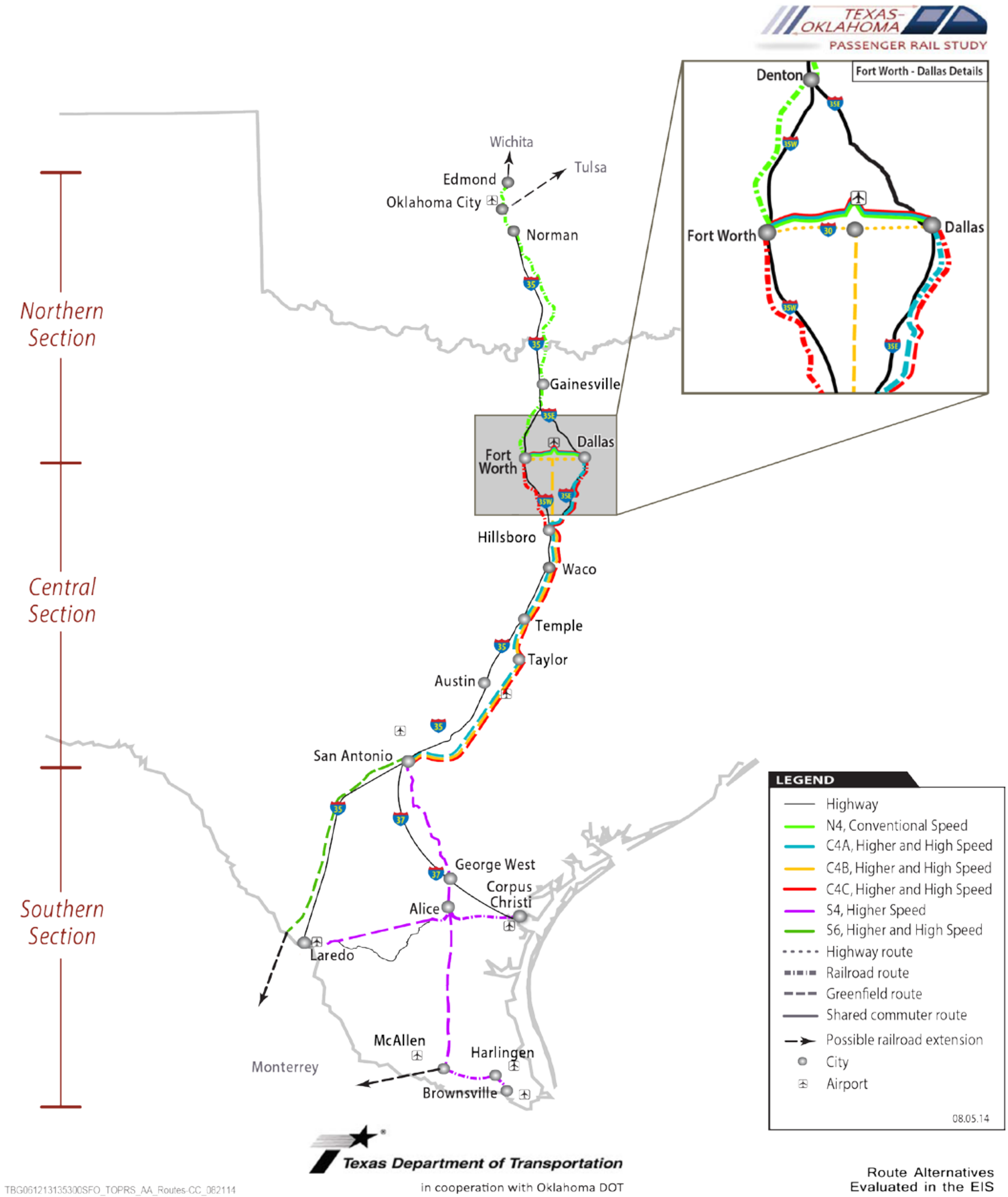

Figure 12-1: Route Alternatives and Options Recommended for Evaluation in the EIS

Subsequent to the Route Alternatives Analysis, input from stakeholders resulted in screening out of two route alternatives along with the addition of one new route alternative. Alternatives C2B and S5 were screened out because of potential conflicts with existing freight rail service. Alternative C4C, identical to C4A, but with a leg connecting Hillsboro to Fort Worth, was added. With these changes, the final range of alternatives being carried forward into the TOPRS service-level EIS is:

Northern Section: Alternative N4A with conventional service

Central Section: Alternatives C4A, C4B, and C4C with higher speed and high-speed service

Southern Section: Alternative S4 with higher speed service, and Alternative S6 with higher and high speed service.

This report was written on behalf of the Texas Department of Transportation by CH2M HILL

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