Dallas to Houston High-Speed Rail
Draft Environmental Impact Statement

Appendix E

Federal Railroad Administration

Dallas to Houston High-Speed Rail
Draft Environmental Impact Statement

Appendix E:
Technical Memorandums
Set 1 of 2

Air Quality
Noise and Vibration
Hazmat Initial Site Assessment
Wildlife Crossings
Waters of the U.S.
Transportation
Land Use
Socioeconomic
Environmental Justice
Soils and Geology
USACE 408 Impacts

DEPARTMENT OF TRANSPORTATION
UNITED STATES OF AMERICA

Federal Railroad
Administration

TECHNICAL MEMORANDUM
AIR QUALITY

To: Jerry Smiley, AICP, AECOM

From: Carl Sepulveda, AECOM

Date: November 1, 2017

RE: DALLAS TO HOUSTON HSR – AIR QUALITY TECHNICAL MEMORANDUM AND CONSTRUCTION EMISSIONS AIR QUALITY ANAYSIS

Construction emissions account for emissions from construction equipment on site, employee trips to the construction site, delivery of construction materials (hauling by both trucks and rail) to the material storage yards and to the construction sites, and emissions from other on-road vehicles used during construction activities.

Included in this technical memorandum are:

- A summary of on-site construction elements and annual NO_x, VOC and GHG CO_2 emissions
- Construction material quantities used in the emissions calculations
- Locomotive line-haul emissions calculations
- Truck hauling emissions calculations
- On-road (non-hauling) vehicle emission calculations
- Equipment lists by construction activity
- Detailed construction phase equipment quantities
- Detailed construction emissions calculations for track, stations, TMFs, and MOWs
- Detailed construction GHG emissions calculations for track, stations, TMFs, and MOWs

Maximum Annual Construction-Related NO_x and VOC Emissions for Years 2018–2021[a] (tons/year)				
Construction Activity	DFW NAA[b]		HGB NAA[c]	
	NO_x (tons)	VOC (tons)	NO_x (tons)	VOC (tons)
Off-Road Construction Equipment	62.72	5.20	63.74	5.28
On-Road Construction Vehicles	33.14	11.44	27.13	9.73
Locomotive Hauling	3.27	0.17	4.89	0.26
Total	**99.13**	**16.81**	**95.76**	**15.27**

Source: AECOM, 2016

Notes:

[a] These construction emissions were estimated for Alternative C, which is used as a proxy to estimate construction emissions for all other alternatives. Total construction emissions of NO_x and VOC from all other alternatives would be lower and are estimated to differ from Alternative C by less than 2.2%.

[b] The applicable DFW NAA counties are Dallas and Ellis counties.

[c] The applicable HGB NAA counties are Harris and Waller counties.

Maximum Annual Construction-Related GHG Emissions for Years 2018–2021[a]	
Construction Activity	**CO_2e (metric tons)**
Off-Road Construction Equipment	35,132
On-Road Construction Vehicles	85,132
Locomotive Hauling	15,776
Total	**136,040**

Notes:

[a] The construction GHG emissions were estimated for the HSR Alternative C, which is used as a proxy to estimate construction emissions for all other alternatives. Total construction GHG emissions from all other alternatives would be lower and are estimated to differ from Alternative C by less than 2.2%.

HIGH SPEED RAIL PROJECT

DALLAS TO HOUSTON

CONSTRUCTION ANALYSIS

CONSTRUCTION MATERIAL QUANTITIES

Data Taken from Project Descriptions or Provided
Estimated Values
Data Used in Calculations

Item	Unit	Revised End to End Alignment A	Notes
Total Length	miles	241.09	
Drill Shafts	CY	3,562,743	
Column	CY	697,099	
Cap	CY	807,218	
Beams	CY	2,324,452	
Deck	CY	1,922,417	
Drainage	CY	250,000	
Systems	CY	133,000	
Electrical	CY	20,000	
Stations	CY	330,000	
Misc Other	CY	221,534	Assume concrete for cantenary poles included here
Total Concrete	CY	10,268,463	
Cement	Ton	1,568,508	Assume 50% delivered by rail and 50% by truck
Sand	Ton	3,722,318	Assume 50% delivered by rail and 50% by truck
Gravel	Ton	4,107,385	Assume 50% delivered by rail and 50% by truck
Reinforcement	lbs	2,567,115,750	
Structural Steel	lbs	13,205,875	stations, parking structures, trainset maintenance facilities and Cantenary poles
Sub-Ballast	CY	974,819	
Ballast	CY	2,293,441	
Concrete Ties	Each	1,371,124	
Rail	TF	2,742,247	
Excavation	CY	12,600,093	
Filling	CY	11,335,373	
Trainset Maintenance Facility	Each	2	
Maintenance-of-Way Facility	Each	5	

Notes:

Assume water available at batching/precasting sites

Assume 1 delivery of ballast every two weeks via locomotive

Assume 1 delivery of cement, sand and gravel every two weeks via locomotive

HIGH SPEED RAIL PROJECT
DALLAS TO HOUSTON
CONSTRUCTION ANALYSIS
MATERIAL HAULING LOCOMOTIVE EMISSIONS

HSR Material Hauling - Locomotive

Data Taken from Project Descriptions or Provided
Estimated Values
Data Used in Calculations

HSR Annual Material Hauling by Rail

Source Geography	Material Hauled	Total Quantity[1]	Units	Total Quantity	Units	Possible Material Location	Average Distance Traveled within NAA by rail (1-way mi)	Duration of Activity (Years)
HSR Alternative C Construction by Rail in DFW NAA per year								
Dallas Rail Connection	Sub-Ballast	23,550	cy	49,456	tons	C. Texas	30.9	4
Dallas Rail Connection	Ballast	55,406	cy	116,353	tons	C. Texas	30.9	4
	Sand			37,256	tons	C. Texas	30.9	4
	Gravel			41,110	tons	C. Texas	30.9	4
	Cement			15,699	tons	C. Texas	30.9	4
	Steel Reinforcing			33,916	tons	Out of State	30.9	3
	Steel Structural			211	tons	Out of State	30.9	3
	Rail			1,391	tons	Out of State	30.9	4
Ellis Rail Connection	Sub-Ballast	23,550	cy	49,456	tons	C. Texas	15.3	4
Ellis Rail Connection	Ballast	55,406	cy	116,353	tons	C. Texas	15.3	4
	Sand			37,256	tons	C. Texas	15.3	4
	Gravel			41,110	tons	C. Texas	15.3	4
	Cement			15,699	tons	C. Texas	15.3	4
	Steel Reinforcing			33,916	tons	Out of State	15.3	3
	Steel Structural			211	tons	Out of State	15.3	3
	Rail			1,391	tons	Out of State	15.3	4
HSR Alternative C Construction by Rail in HGB NAA per year						Possible	Average Distance Traveled	Duration
Source Geography	Material Hauled	Total Quantity[1]	Units	Total Quantity	Units	Material Location	within NAA by rail (1-way mi)	of Activity (Years)
HGB Rail Connection	Sub-Ballast	50,296	cy	105,621	tons	C. Texas	32.3	4
HGB Rail Connection	Ballast	118,329	cy	248,492	tons	C. Texas	32.3	4
	Sand			79,566	tons	C. Texas	32.3	4
	Gravel			87,797	tons	C. Texas	32.3	4
	Cement			33,527	tons	C. Texas	32.3	4
	Steel Reinforcing			72,432	tons	Out of State	32.3	3
	Steel Structural			450	tons	Out of State	32.3	3
	Rail			2,971	tons	Out of State	32.3	4

Total Alignment Length - (mi)	241.09	
DFW NAA Alignment Length (mi)	45.7	18.96%
HGB NAA Alignment Length (mi)	48.8	20.24%
Total Sub-Ballast (cy - total 4 yrs)	993,914	
Total Ballast (cy - total 4 yrs)	2,338,365	
Total Sand (tons - total 4 yrs)	1,572,340	
Total Gravel (tons - total 4 yrs)	1,734,996	
Total Cement (tons - total 4 yrs)	662,552	
Total Reinforing Steel (tons - total 4 yrs)	1,084,372	
Total Structural Steel (tons - total 4 yrs)	6,732	
Total Rail (tons - total 4 yrs)	58,715	

Notes:

(1) Total quantities was obtained from Construction Quantities and Construction Equipment list.

(2) Distance travelled by rail calculated for travel in NAA only.

(3) Density of ballast and sub-ballast was assumed to be 2.1 tons/cubic yard (based on California HSR calculations)

(4) Total rail = 2,795,962 TF. Weight of rail (UIC60 rail) is 42 lbs/ft (Source: http//www.railway-technical.com/track.shtml)

HSR Alternative C Construction Rail Hauling - Total Quantities (tons)			
Material	**DFW (2018-2021)**	**HGB (2018-2021)**	(50% to Dallas rail connection, 50% to Ellis Co. rail connection)
Sub-Ballast	98,911	105,621	
Ballast	232,707	248,492	
Sand	74,512	79,566	
Gravel	82,220	87,797	
Cement	31,398	33,527	
Steel Reinforcing	67,831	72,432	
Steel Structural	421	450	
Rail	2,782	2,971	

Emission Factors - Rail (g/gal)[1]							
	VOC	CO	NOx	SO2	PM10	PM2.5	CO2
2018	5.408	26.624	102.96	0.094	3.744	3.63168	10217

Emission Factors - Rail (g/ton-mile)[2]							
	VOC	CO	NOx	SO2	PM10	PM2.5	CO2
2018	0.011	0.056	0.218	0.0002	0.008	0.008	21.6

Notes

(1) Emission factors based on Tier 2 line-haul locomotive emission factors as listed in the EPA Report "Emission Factors for Locomotives - Large Line Haul", USEPA Office of Transportation and Air Quality, EPA-420-F-09-025, April 2009. Grams per gal calculations based on a 20.8 bhp-hr/gal conversion factor as listed in the same EPA report.

(2) The conversion factor of 473 ton-mile/gallon based on the report by the American Association of Railroads "The Environmental Benefits of Moving Freight by Rail, April 2016.

(3) 2018 was assumed to be the most conservative year, so rail emission factors in 2018 were used for all years.

(4) for DFW: Assume 50% to Dallas rail connection, 50% to Ellis Co. rail connection

HSR Alternative C Construction Rail Hauling Emissions per Year								
Dallas Railroad Connection (Sta 100310+00)			**VOC ER**	**VOC**	**VOC**	**NOx ER**	**NOx**	**NOx**
	tons	**miles**	**g/ton-mile**	**g/yr**	**tons/yr**	**g/ton-mile**	**g/yr**	**tons/yr**
Sub-Ballast	49,456	30.9	0.011	17,472	0.019	0.218	332,645	0.367
Ballast	116,353	30.9	0.011	41,107	0.045	0.218	782,608	0.863
Sand	37,256	30.9	0.011	13,162	0.015	0.218	250,587	0.276
Gravel	41,110	30.9	0.011	14,524	0.016	0.218	276,510	0.305
Cement	15,699	30.9	0.011	5,546	0.006	0.218	105,592	0.116
Steel Reinforcing	33,916	30.9	0.011	11,982	0.013	0.218	228,121	0.251
Steel Structural	211	30.9	0.011	74	0.00008	0.218	1,416	0.002
Rail	1,391	30.9	0.011	492	0.001	0.218	9,358	0.010
					0.115			2.190
Ellis Railroad Connection (Sta 80650+00)			**VOC ER**	**VOC**	**VOC**	**NOx ER**	**NOx**	**NOx**
	tons	**miles**	**g/ton-mile**	**g/yr**	**tons/yr**	**g/ton-mile**	**g/yr**	**tons/yr**
Sub-Ballast	49,456	15.3	0.011	8,651	0.010	0.218	164,708	0.182
Ballast	116,353	15.3	0.011	20,354	0.022	0.218	387,505	0.427
Sand	37,256	15.3	0.011	6,517	0.007	0.218	124,077	0.137
Gravel	41,110	15.3	0.011	7,191	0.008	0.218	136,913	0.151
Cement	15,699	15.3	0.011	2,746	0.003	0.218	52,284	0.058
Steel Reinforcing	33,916	15.3	0.011	5,933	0.007	0.218	112,953	0.125
Steel Structural	211	15.3	0.011	37	0.000	0.218	701	0.001
Rail	1,391	15.3	0.011	243	0.0003	0.218	4,633	0.005
					0.057			1.084
Houston Railroad Connection (Sta 11250+00)			**VOC ER**	**VOC**	**VOC**	**NOx ER**	**NOx**	**NOx**
	tons	**miles**	**g/ton-mile**	**g/yr**	**tons/yr**	**g/ton-mile**	**g/yr**	**tons/yr**
Sub-Ballast	105,621	32.3	0.011	39,006	0.043	0.218	742,606	0.819
Ballast	248,492	32.3	0.011	91,768	0.101	0.218	1,747,118	1.926
Sand	79,566	32.3	0.011	29,384	0.032	0.218	559,419	0.617
Gravel	87,797	32.3	0.011	32,423	0.036	0.218	617,290	0.680
Cement	33,527	32.3	0.011	12,382	0.014	0.218	235,728	0.260
Steel Reinforcing	72,432	32.3	0.011	26,749	0.029	0.218	509,264	0.561
Steel Structural	450	32.3	0.011	166	0.000	0.218	3,162	0.003
Rail	2,971	32.3	0.011	1,097	0.001	0.218	20,890	0.023
					0.257			4.889

Notes:

1) pounds per gram = 0.0022046

2) tons per pound = 0.0005

Totals (tons)	
DFW VOC	0.17
DFW NOx	3.27
HGB VOC	0.26
HGB NOx	4.89

HIGH SPEED RAIL PROJECT
DALLAS TO HOUSTON
CONSTRUCTION ANALYSIS
MATERIAL HAULING TRUCK EMISSIONS

HSR Material Hauling

Data Taken from Project Descriptions or Provided

Estimated Values

Data Used in Calculations

Truck Capacity

20 cy/truck

30 tons/truck

Material Hauled	Total Quantity[1]	Units	Possible Origin Location	Duration of Activity (years)
From RR Connection / Precast Yard				
Sub-Ballast	993,914	CY	from rail connection yard	4
Ballast	2,338,365	CY	from rail connection yard	4
Concrete Rail Ties	1,397,981	Each	batch plant to construction site	4
Total Concrete	8,674,980	CY	batch plant to construction site	4
Rail	2,795,962	TF	Out of state	4
Excavation	7,541,885	CY	within alignment	4
Fill	25,425,626	CY	within alignment	4
Structural Steel	6,732	Ton	from rail connection yard	3
Reinforcing Steel	1,084,372	Ton	from rail connection yard	3
Construction Waste - Concrete	59,457	CY	within alignment	4
Construction Waste - Rebar	16,266	Ton	within alignment	4
To Precast Yard[2]				
Sand	1,861,159	Ton	Texas	4
Cement	784,254	Ton	Texas	4
Gravel	2,053,693	Ton	Texas	4

Notes:

(1) Information about total quantities was obtained from HSR Construction Quantities and Equipment Estimates.

(2) Number shown assumes 50% of total Sand, Cement, and Gravel delivered to precast yards by truck.

(3) Truck hauling emissions were calculated using a standard truck capacity of 20 cubic yards or 30 tons per truck, and by multiplying the emission factor by the anticipated distance traveled and the amount of material hauled per trip for each hauling method.

HSR Material Hauling Truck Calculations

Material Hauled	Total Truck Hauling Trips Alternative C	No. Trucks Trips HGB	No. Trucks Trips DAL	No. Trucks Trips Ellis/Freestone Co.
From RR Connection / Precast Yard				
Sub-Ballast	49,696	9,939	9,939	9,939
Ballast	116,918	23,384	23,384	23,384
Concrete Rail Ties	23,300	4,660	4,660	4,660
Total Concrete	433,749	86,750	86,750	86,750
Rail	1,957	391	391	391
Excavation	377,094	75,419	75,419	75,419
Fill	1,271,281	254,256	254,256	254,256
Structural Steel	224	45	45	45
Reinforcing Steel	36,146	7,229	7,229	7,229
Construction Waste - Concrete	2,973	595	595	595
Construction Waste - Rebar	542	108	108	108
To Precast Yard				
Sand	62,039	12,408	12,408	12,408
Cement	26,142	5,228	5,228	5,228
Gravel	68,456	13,691	13,691	13,691

Assumptions:

Weight of average concrete railway tie is 1,000 pounds

No. of trucks allocated based on ratio of railroad connection / precasting yards to total (5 total, 1 in Dal, 1 in Ellis Co. and 1 in Hou (20% each))

Weight of rail (UIC60 rail) is 42 lbs/ft (Source: http//www.railway-technical.com/track.shtml)

HSR Material Hauling Mileage Calcuations

Material Hauled	No. Trucks HGB	HGB Annual Miles	No. Trucks DAL	DAL Annual Miles	No. Trucks ELLIS	ELLIS Annual Miles	FREESTONE Annual Miles
From RR Connection / Precast Yard							
Sub-Ballast	9,939	57,150	9,939	42,241	9,939	32,302	12,424
Ballast	23,384	134,456	23,384	99,381	23,384	75,997	29,230
Concrete Rail Ties	4,660	26,795	4,660	19,805	4,660	15,145	5,825
Total Concrete	86,750	498,811	86,750	368,687	86,750	281,937	108,437
Rail	391	2,251	391	1,664	391	1,272	489
Excavation	75,419	433,658	75,419	320,530	75,419	245,111	94,274
Fill	254,256	1,461,973	254,256	1,080,589	254,256	826,333	317,820
Structural Steel	45	258	45	191	45	146	56
Reinforcing Steel	7,229	41,568	7,229	30,724	7,229	23,495	9,036
Construction Waste - Concrete	595	3,419	595	2,527	595	1,932	743
Construction Waste - Rebar	108	624	108	461	108	352	136
To Precast Yard							
Sand	12,408	176,810	12,408	192,320	12,408	102,364	15,510
Cement	5,228	74,504	5,228	81,040	5,228	43,134	6,535
Gravel	13,691	195,101	13,691	212,215	13,691	112,953	17,114
Total	**494,103**	**3,107,378**	**494,103**	**2,452,373**	**494,103**	**1,762,473**	**617,629**

Assumptions:

Distance traveled is estimated based on the origin of the material being delivered.

Average R/T Distance from Rail Connection Yard: HGB = 23 miles, Average R/T Distance DAL = 17 miles, Average R/T Distance Ellis Co = 13 miles, Average R/T Distance Freestone Co = 5 miles

Average roadway R/T distance within NAA to Rail Precast Yard: HGB = 57 miles, DAL = 62 miles, Ellis Co = 33 miles, Freestone Co. = 5 miles

Material haul: quantities will be delivered over a three or four-year time frame (2018-2021) for use in the construction phase (as per schedule).

Assume concrete will be hauled in support of concrete batch plant operations.

Data from MOVES2014a			
	2017 Long Haul Truck		
	Emissions in Grams per Mile		
	NOx	**VOC**	**SO2**
Ellis	**3.225**	**0.426**	
Dallas	**3.225**	**0.424**	
Freestone Co			**0.0034**
Harris	3.166	0.424	
Waller	3.168	0.424	
Average HGB Emissions	**3.167**	**0.424**	

Note:
Emissions averaged for Harris and Waller Counties

HSR Material Hauling Emissions - HGB

	Long Haul Truck	
	Emissions (Tons/Year)	
Year		
	NOx	**VOC**
Annual Emissions 2018 - 2021	**10.85**	**1.45**

Notes:
1) pounds per gram = 0.0022046
2) tons per pound = 0.0005

HSR Material Hauling Emissions - DAL

	Long Haul Truck	
	Emissions (Tons/Year)	
Year		
	NOx	**VOC**
Annual Emissions 2018 - 2021	**8.72**	**1.15**

Notes:
1) pounds per gram = 0.0022
2) tons per pound = 0.0005

HSR Material Hauling Emissions - Ellis Co

	Long Haul Truck	
	Emissions (Tons/Year)	
Year		
	NOx	**VOC**
Annual Emissions 2018 - 2021	**6.27**	**0.83**

Notes:
1) pounds per gram = 0.0022
2) tons per pound = 0.0005

Total NAA Truck Haul Annual Emissions

	NOx	**VOC**
DFW NAA (Dallas and Ellis counties)	**14.985**	**1.974**
HGB NAA (Harris and Waller counties)	**10.849**	**1.452**

HSR Material Hauling Emissions - Freestone Co.

	Long Haul Truck	
	Emissions (Tons/Year)	
Year		
	SO2	
Annual Emissions 2018 - 2021	**0.0023**	

Notes:
1) pounds per gram = 0.0022
2) tons per pound = 0.0005

HIGH SPEED RAIL PROJECT
DALLAS TO HOUSTON
CONSTRUCTION ANALYSIS
MATERIAL HAULING TRUCK EMISSIONS - TRACK CONSTRUCTION

HSR Material Hauling

Data Taken from Project Descriptions or Provided
Estimated Values
Data Used in Calculations

Truck Emissions - Track	**On-Road (Non-Haul) Trucks**		No Trucks Dal Co	No Trucks Ellis Co	No Trucks Harris Co	No Trucks Waller Co	No Trucks Freestone Co
		County distance ratio to overall alignment	0.07003	0.11987	0.15787	0.03682	0.008
Non-Haul Truck Category	Trucks	Total Number of Non-Haul Trucks					
Light Commercial Truck	Flatbed F350	24					
	Flat Bed F700	18					
	Total	**42**	**2.94126**	**5.03454**	**6.63054**	**1.54644**	**0.336**
Passenger Truck	Mechanics Truck (small)	29					
	Pick-up 1/2 Ton	597					
	Pick-up 3/4 Ton	383					
	Worker Trips	5620					
	Total	**6629**	**464.22887**	**794.61823**	**1046.52023**	**244.07978**	**53.032**
Single-Unit Short Haul	Fuel Truck	44					
	Water Truck 4000 gal	25					
		69	**4.83207**	**8.27103**	**10.89303**	**2.54058**	**0.552**

Worker Trips: Assume 47 mob and demob sites (30 vehicles/site) and 20 sites each for demo,land clearing, earth moving, road crossings,track at-grade,track elevated, and structures (20 vehicles/site)

Avg R/T Distance 40 Miles/Day Average R/T Distance (miles)	Total Miles Per Year 2018-2021 Dallas Co	Total Miles Per Year 2018-2021 Ellis Co	Total Miles Per Year 2018-2021 Harris Co	Total Miles Per Year 2018-2021 Waller Co
40				
Light Commercial Truck	**36,707**	**62,831**	**82,749**	**19,300**
Passenger Truck	**5,793,576**	**9,916,836**	**13,060,572**	**3,046,116**
Single-Unit Short Haul	**60,304**	**103,222**	**135,945**	**31,706**

Emission Rates	**Ellis Co**		**Ellis Co**		**Ellis Co**		
Truck Category	**2017 JAN**		**2017 JUL**		**2017 Composite Efs (g/mi)**		
	NOX	**VOC**	**NOX**	**VOC**		**NOX**	**VOC**
Passenger Truck	0.694	0.311	0.634	0.417	Passenger Truck	0.664	0.364
Light Commercial Truck	0.830	0.343	0.791	0.452	Light Commercial Truck	0.811	0.398
Single Unit Short-Haul Truck	3.208	0.491	2.564	0.526	Single Unit Short-Haul Truck	2.886	0.508
Single Unit Long-Haul Truck	3.573	0.423	2.878	0.429	Single Unit Long-Haul Truck	3.225	0.426

Freestone Co	
2017 Composite Efs (g/mi)	
	SO2
All Trucks	0.0034

Emission Rates	**Dallas Co**		**Dallas Co**		**Dallas Co**		
Truck Category	**2017 JAN**		**2017 JUL**		**2017 Composite Efs (g/mi)**		
	NOX	**VOC**	**NOX**	**VOC**		**NOX**	**VOC**
Passenger Truck	0.678	0.298	0.614	0.389	Passenger Truck	0.646	0.343
Light Commercial Truck	0.815	0.330	0.771	0.424	Light Commercial Truck	0.793	0.377
Single Unit Short-Haul Truck	3.206	0.487	2.560	0.514	Single Unit Short-Haul Truck	2.883	0.501
Single Unit Long-Haul Truck	3.573	0.422	2.878	0.426	Single Unit Long-Haul Truck	3.225	0.424

Emission Rates	**Harris Co**		**Harris Co**		**Harris Co**		
Truck Category	**2017 JAN**		**2017 JUL**		**2017 Composite Efs (g/mi)**		
	NOX	**VOC**	**NOX**	**VOC**		**NOX**	**VOC**
Passenger Truck	0.539	0.244	0.495	0.305	Passenger Truck	0.517	0.274
Light Commercial Truck	0.666	0.274	0.636	0.338	Light Commercial Truck	0.651	0.306
Single Unit Short-Haul Truck	2.927	0.456	2.411	0.479	Single Unit Short-Haul Truck	2.669	0.467
Single Unit Long-Haul Truck	3.461	0.423	2.872	0.425	Single Unit Long-Haul Truck	3.166	0.424

Emission Rates	**Waller Co**		**Waller Co**		**Waller Co (g/mi)**		
Truck Category	**2017 JAN**		**2017 JUL**		**2017 Composite Efs**		
	NOX	**VOC**	**NOX**	**VOC**		**NOX**	**VOC**
Passenger Truck	0.864	0.383	0.782	0.461	Passenger Truck	0.823	0.422
Light Commercial Truck	0.977	0.408	0.916	0.488	Light Commercial Truck	0.946	0.448
Single Unit Short-Haul Truck	2.926	0.455	2.416	0.478	Single Unit Short-Haul Truck	2.671	0.467
Single Unit Long-Haul Truck	3.459	0.422	2.877	0.425	Single Unit Long-Haul Truck	3.168	0.424

		NOx	**NOx**	**VOC**	**VOC**
Dallas Co		**Total Emissions (g)**	**Total Emissions (tons)**	**Total Emissions (g)**	**Total Emissions (tons)**
	Light Commercial Truck	29,104	0.032	13,837	0.015
	Passenger Truck	3,742,846	4.117	1,989,835	2.189
	Single Unit Short-Haul Truck	173,850	0.191	30,204	0.033
		NOx	**Nox**	**VOC**	**VOC**
Ellis Co		**Total Emissions (g)**	**Total Emissions (tons)**	**Total Emissions (g)**	**Total Emissions (tons)**
	Light Commercial Truck	50,934	0.056	24,985	0.027
	Passenger Truck	6,587,529	7.246	3,607,733	3.969
	Single Unit Short-Haul Truck	297,868	0.328	52,456	0.058
		NOx	**Nox**	**VOC**	**VOC**
Harris Co		**Total Emissions (g)**	**Total Emissions (tons)**	**Total Emissions (g)**	**Total Emissions (tons)**
	Light Commercial Truck	53,858	0.059	25,341	0.028
	Passenger Truck	6,752,344	7.428	3,583,544	3.942
	Single Unit Short-Haul Truck	362,864	0.399	63,512	0.070
Waller Co		**NOx**	**Nox**	**VOC**	**VOC**
	Light Commercial Truck	**Total Emissions (g)**	**Total Emissions (tons)**	**Total Emissions (g)**	**Total Emissions (tons)**
	Passenger Truck	18,261	0.020	8,643	0.010
	Single Unit Short-Haul Truck	2,506,540	2.757	1,285,649	1.414
		84,675	0.093	14,805	0.016

Freestone Co		**VOC**	**VOC**
		Total Emissions (g)	**Total Emissions (tons)**
	All Trucks	2,275	0.0025

Truck Emissions - Track

		NOx	**VOC**
DFW NAA		**Total Emissions (tons/yr)**	**Total Emissions (tons/yr)**
	Truck (non-haul)	11.970	6.291
HGB NAA		**NOx**	**VOC**
		Total Emissions (tons/yr)	**Total Emissions (tons/yr)**
	Truck (non-haul)	10.756	5.480

HIGH SPEED RAIL PROJECT
DALLAS TO HOUSTON
CONSTRUCTION ANALYSIS
MATERIAL HAULING TRUCK EMISSIONS - STATION CONSTRUCTION

HSR Material Hauling

Data Taken from Project Descriptions or Provided
Estimated Values
Data Used in Calculations

Truck Emissions - Station	**On-Road (Non-Haul) Trucks**		No Trucks Dal Co	No Trucks Ellis Co	No Trucks Harris Co	No Trucks Waller Co	Average R/T Distance HGB	Total Miles Per Year 2018-2021	Total Miles Per Year 2018-2021	Total Miles Per Year 2018-2021	Total Miles Per Year 2018-2021
		No. of Stations in County	1	0	1	0	(miles)	Dallas Co	Ellis Co	Harris Co	Waller Co
Non-Haul Truck Category	Trucks	Total Number of Non-Haul Trucks									
Light Commercial Truck	Flatbed F350	3					**20**				
	Flat Bed F700	2									
	Total	**5**	**5**	**0**	**5**	**0**	Light Commercial Truck	**31,200**	**0**	**31,200**	**0**
Passenger Truck	Mechanics Truck (small)	1									
	Pick-up 1/2 Ton	8									
	Pick-up 3/4 Ton	8									
	Worker Trips	500									
	Total	**517**	**517**	**0**	**517**	**0**	Passenger Truck	**3,226,080**	**0**	**3,226,080**	**0**
Single-Unit Short Haul	Fuel Truck	1									
	Water Truck 4000 gal	1									
		2	**2**	**0**	**2**	**0**	Single-Unit Short Haul	**12,480**	**0**	**12,480**	**0**
Single-Unit Long Haul	Semi Tractor	2									
		2	**2**	**0**	**2**	**0**	Single-Unit Long Haul	**12,480**	**0**	**12,480**	**0**

Emission Rates	**Ellis Co**			**Ellis Co**			**Ellis Co**
Truck Category	**2017 JAN**			**2017 JUL**			**2017 Composite Efs (g/mi)**
	NOX	**VOC**	**NOX**	**VOC**		**NOX**	**VOC**
Passenger Truck	0.694	0.311	0.634	0.417	Passenger Truck	0.664	0.364
Light Commercial Truck	0.830	0.343	0.791	0.452	Light Commercial Truck	0.811	0.398
Single Unit Short-Haul Truck	3.208	0.491	2.564	0.526	Single Unit Short-Haul Truck	2.886	0.508
Single Unit Long-Haul Truck	3.573	0.423	2.878	0.429	Single Unit Long-Haul Truck	3.225	0.426

Emission Rates	**Dallas Co**		**Dallas Co**		**Dallas Co**		
Truck Category	**2017 JAN**		**2017 JUL**		**2017 Composite Efs (g/mi)**		
	NOX	**VOC**	**NOX**	**VOC**		**NOX**	**VOC**
Passenger Truck	0.678	0.298	0.614	0.389	Passenger Truck	0.646	0.343
Light Commercial Truck	0.815	0.330	0.771	0.424	Light Commercial Truck	0.793	0.377
Single Unit Short-Haul Truck	3.206	0.487	2.560	0.514	Single Unit Short-Haul Truck	2.883	0.501
Single Unit Long-Haul Truck	3.573	0.422	2.878	0.426	Single Unit Long-Haul Truck	3.225	0.424

Emission Rates	**Harris Co**		**Harris Co**		**Harris Co**		
Truck Category	**2017 JAN**		**2017 JUL**		**2017 Composite Efs (g/mi)**		
	NOX	**VOC**	**NOX**	**VOC**		**NOX**	**VOC**
Passenger Truck	0.539	0.244	0.495	0.305	Passenger Truck	0.517	0.274
Light Commercial Truck	0.666	0.274	0.636	0.338	Light Commercial Truck	0.651	0.306
Single Unit Short-Haul Truck	2.927	0.456	2.411	0.479	Single Unit Short-Haul Truck	2.669	0.467
Single Unit Long-Haul Truck	3.461	0.423	2.872	0.425	Single Unit Long-Haul Truck	3.166	0.424

Emission Rates	**Waller Co**		**Waller Co**		**Waller Co (g/mi)**		
Truck Category	**2017 JAN**		**2017 JUL**		**2017 Composite Efs**		
	NOX	**VOC**	**NOX**	**VOC**		**NOX**	**VOC**
Passenger Truck	0.864	0.383	0.782	0.461	Passenger Truck	0.823	0.422
Light Commercial Truck	0.977	0.408	0.916	0.488	Light Commercial Truck	0.946	0.448
Single Unit Short-Haul Truck	2.926	0.455	2.416	0.478	Single Unit Short-Haul Truck	2.671	0.467
Single Unit Long-Haul Truck	3.459	0.422	2.877	0.425	Single Unit Long-Haul Truck	3.168	0.424

		NOx	**NOx**	**VOC**	**VOC**
Dallas Co		**Total Emissions (g)**	**Total Emissions (tons)**	**Total Emissions (g)**	**Total Emissions (tons)**
	Light Commercial Truck	24,738	0.027	11,761	0.013
	Passenger Truck	2,084,157	2.293	1,108,015	1.219
	Single Unit Short-Haul Truck	35,978	0.040	6,251	0.007
	Single Unit Long-Haul Truck	40,249	0.044	5,291	0.006
		NOx	**Nox**	**VOC**	**VOC**
Ellis Co		**Total Emissions (g)**	**Total Emissions (tons)**	**Total Emissions (g)**	**Total Emissions (tons)**
	Light Commercial Truck	0	0.000	0	0.000
	Passenger Truck	0	0.000	0	0.000
	Single Unit Short-Haul Truck	0	0.000	0	0.000
	Single Unit Long-Haul Truck	0	0.000	0	0.000
		NOx	**Nox**	**VOC**	**VOC**
Harris Co		**Total Emissions (g)**	**Total Emissions (tons)**	**Total Emissions (g)**	**Total Emissions (tons)**
	Light Commercial Truck	20,307	0.022	9,555	0.011
	Passenger Truck	1,667,890	1.835	885,168	0.974
	Single Unit Short-Haul Truck	33,312	0.037	5,830	0.006
	Single Unit Long-Haul Truck	39,517	0.043	5,291	0.006
		NOx	**Nox**	**VOC**	**VOC**
Waller Co		**Total Emissions (g)**	**Total Emissions (tons)**	**Total Emissions (g)**	**Total Emissions (tons)**
	Light Commercial Truck	0	0.000	0	0.000
	Passenger Truck	0	0.000	0	0.000
	Single Unit Short-Haul Truck	0	0.000	0	0.000
	Single Unit Long-Haul Truck	0	0.000	0	0.000

Truck Emissions - Station

DFW NAA		**NOx**	**VOC**
		Total Emissions (tons/yr)	**Total Emissions (tons/yr)**
	Truck (non-haul)	2.404	1.244
HGB NAA		**NOx**	**VOC**
		Total Emissions (tons/yr)	**Total Emissions (tons/yr)**
	Truck (non-haul)	1.937	0.996

HIGH SPEED RAIL PROJECT
DALLAS TO HOUSTON
CONSTRUCTION ANALYSIS
MATERIAL HAULING TRUCK EMISSIONS - TMF CONSTRUCTION

HSR Material Hauling

Data Taken from Project Descriptions or Provided
Estimated Values
Data Used in Calculations

Truck Emissions - TMF	**On-Road (Non-Haul) Trucks**		No Trucks Dal Co	No Trucks Ellis Co	No Trucks Harris Co	No Trucks Waller Co	Average R/T Distance HGB	Total Miles Per Year 2018-2021	Total Miles Per Year 2018-2021	Total Miles Per Year 2018-2021	Total Miles Per Year 2018-2021
		No. TMF in County	1	0	1	0	(miles)	Dallas Co	Ellis Co	Harris Co	Waller Co
Non-Haul Truck Category	Trucks	Total Number of Non-Haul Trucks									
Light Commercial Truck	Flatbed F350	3					**20**				
	Flat Bed F700	2									
	Total	**5**	**5**	**0**	**5**	**0**	Light Commercial Truck	**31,200**	**0**	**31,200**	**0**
Passenger Truck	Mechanics Truck (small)	1									
	Pick-up 1/2 Ton	8									
	Pick-up 3/4 Ton	8									
	Worker Trips	250									
	Total	**267**	**267**	**0**	**267**	**0**	Passenger Truck	**1,666,080**	**0**	**1,666,080**	**0**
Single-Unit Short Haul	Fuel Truck	1									
	Water Truck 4000 gal	1									
		2	**2**	**0**	**2**	**0**	Single-Unit Short Haul	**12,480**	**0**	**12,480**	**0**
Single-Unit Long Haul	Semi Tractor	2									
		2	**2**	**0**	**2**	**0**	Single-Unit Long Haul	**12,480**	**0**	**12,480**	**0**

Emission Rates	**Ellis Co**		**Ellis Co**		**Ellis Co**		
Truck Category	**2017 JAN**		**2017 JUL**		**2017 Composite Efs (g/mi)**		
	NOX	**VOC**	**NOX**	**VOC**		**NOX**	**VOC**
Passenger Truck	0.694	0.311	0.634	0.417	Passenger Truck	0.664	0.364
Light Commercial Truck	0.830	0.343	0.791	0.452	Light Commercial Truck	0.811	0.398
Single Unit Short-Haul Truck	3.208	0.491	2.564	0.526	Single Unit Short-Haul Truck	2.886	0.508
Single Unit Long-Haul Truck	3.573	0.423	2.878	0.429	Single Unit Long-Haul Truck	3.225	0.426

Emission Rates	**Dallas Co**		**Dallas Co**		**Dallas Co**		
Truck Category	**2017 JAN**		**2017 JUL**		**2017 Composite Efs (g/mi)**		
	NOX	**VOC**	**NOX**	**VOC**		**NOX**	**VOC**
Passenger Truck	0.678	0.298	0.614	0.389	Passenger Truck	0.646	0.343
Light Commercial Truck	0.815	0.330	0.771	0.424	Light Commercial Truck	0.793	0.377
Single Unit Short-Haul Truck	3.206	0.487	2.560	0.514	Single Unit Short-Haul Truck	2.883	0.501
Single Unit Long-Haul Truck	3.573	0.422	2.878	0.426	Single Unit Long-Haul Truck	3.225	0.424

Emission Rates	**Harris Co**		**Harris Co**		**Harris Co**		
Truck Category	**2017 JAN**		**2017 JUL**		**2017 Composite Efs (g/mi)**		
	NOX	**VOC**	**NOX**	**VOC**		**NOX**	**VOC**
Passenger Truck	0.539	0.244	0.495	0.305	Passenger Truck	0.517	0.274
Light Commercial Truck	0.666	0.274	0.636	0.338	Light Commercial Truck	0.651	0.306
Single Unit Short-Haul Truck	2.927	0.456	2.411	0.479	Single Unit Short-Haul Truck	2.669	0.467
Single Unit Long-Haul Truck	3.461	0.423	2.872	0.425	Single Unit Long-Haul Truck	3.166	0.424

Emission Rates	**Waller Co**		**Waller Co**		**Waller Co (g/mi)**		
Truck Category	**2017 JAN**		**2017 JUL**		**2017 Composite Efs**		
	NOX	**VOC**	**NOX**	**VOC**		**NOX**	**VOC**
Passenger Truck	0.864	0.383	0.782	0.461	Passenger Truck	0.823	0.422
Light Commercial Truck	0.977	0.408	0.916	0.488	Light Commercial Truck	0.946	0.448
Single Unit Short-Haul Truck	2.926	0.455	2.416	0.478	Single Unit Short-Haul Truck	2.671	0.467
Single Unit Long-Haul Truck	3.459	0.422	2.877	0.425	Single Unit Long-Haul Truck	3.168	0.424

		NOx	**NOx**	**VOC**	**VOC**
Dallas Co		**Total Emissions (g)**	**Total Emissions (tons)**	**Total Emissions (g)**	**Total Emissions (tons)**
	Light Commercial Truck	24,738	0.027	11,761	0.013
	Passenger Truck	1,076,344	1.184	572,224	0.629
	Single Unit Short-Haul Truck	35,978	0.040	6,251	0.007
	Single Unit Long-Haul Truck	40,249	0.044	5,291	0.006
		NOx	**Nox**	**VOC**	**VOC**
Ellis Co		**Total Emissions (g)**	**Total Emissions (tons)**	**Total Emissions (g)**	**Total Emissions (tons)**
	Light Commercial Truck	0	0.000	0	0.000
	Passenger Truck	0	0.000	0	0.000
	Single Unit Short-Haul Truck	0	0.000	0	0.000
	Single Unit Long-Haul Truck	0	0.000	0	0.000
		NOx	**Nox**	**VOC**	**VOC**
Harris Co		**Total Emissions (g)**	**Total Emissions (tons)**	**Total Emissions (g)**	**Total Emissions (tons)**
	Light Commercial Truck	20,307	0.022	9,555	0.011
	Passenger Truck	861,367	0.948	457,137	0.503
	Single Unit Short-Haul Truck	33,312	0.037	5,830	0.006
	Single Unit Long-Haul Truck	39,517	0.043	5,291	0.006
		NOx	**Nox**	**VOC**	**VOC**
Waller Co		**Total Emissions (g)**	**Total Emissions (tons)**	**Total Emissions (g)**	**Total Emissions (tons)**
	Light Commercial Truck	0	0.000	0	0.000
	Passenger Truck	0	0.000	0	0.000
	Single Unit Short-Haul Truck	0	0.000	0	0.000
	Single Unit Long-Haul Truck	0	0.000	0	0.000

Truck Emissions - TMF

DFW NAA		**NOx**	**VOC**
		Total Emissions (tons/yr)	**Total Emissions (tons/yr)**
	Truck (non-haul)	1.295	0.655
HGB NAA		**NOx**	**VOC**
		Total Emissions (tons/yr)	**Total Emissions (tons/yr)**
	Truck (non-haul)	1.050	0.526

HIGH SPEED RAIL PROJECT
DALLAS TO HOUSTON
CONSTRUCTION ANALYSIS
MATERIAL HAULING TRUCK EMISSIONS - MOW CONSTRUCTION

HSR Material Hauling

Data Taken from Project Descriptions or Provided
Estimated Values
Data Used in Calculations

Truck Emissions - MOW	On-Road (Non-Haul) Trucks		No Trucks Dal Co	No Trucks Ellis Co	No Trucks Harris Co	No Trucks Waller Co	Average R/T Distance HGB (miles)	Total Miles Per Year 2020-2021 Dallas Co	Total Miles Per Year 2020-2021 Ellis Co	Total Miles Per Year 2020-2021 Harris Co	Total Miles Per Year 2020-2021 Waller Co
		No. MOW Facilities in County	1	1	1	1					
Non-Haul Truck Category	Trucks	Total Number of Non-Haul Trucks									
Light Commercial Truck	Flatbed F350	2					20				
	Flat Bed F700	1									
	Total	**3**	**3**	**3**	**3**	**3**	Light Commercial Truck	**18,720**	**18,720**	**18,720**	**18,720**
Passenger Truck	Mechanics Truck (small)	1									
	Pick-up 1/2 Ton	4									
	Pick-up 3/4 Ton	4									
	Worker Trips	250									
	Total	**259**	**259**	**259**	**259**	**259**	Passenger Truck	**1,616,160**	**1,616,160**	**1,616,160**	**1,616,160**
Single-Unit Short Haul	Fuel Truck	1									
	Water Truck 4000 gal	1									
		2	**2**	**2**	**2**	**2**	Single-Unit Short Haul	**12,480**	**12,480**	**12,480**	**12,480**
Single-Unit Long Haul	Semi Tractor	1									
		1	**1**	**1**	**1**	**1**	Single-Unit Long Haul	**6,240**	**6,240**	**6,240**	**6,240**

Assumptions:
Trucks operate six days per week, 52 weeks per year

Emission Rates / Truck Category	Ellis Co 2017 JAN NOX	VOC	Ellis Co 2017 JUL NOX	VOC		Ellis Co 2017 Composite Efs (g/mi) NOX	VOC
Passenger Truck	0.694	0.311	0.634	0.417	Passenger Truck	0.664	0.364
Light Commercial Truck	0.830	0.343	0.791	0.452	Light Commercial Truck	0.811	0.398
Single Unit Short-Haul Truck	3.208	0.491	2.564	0.526	Single Unit Short-Haul Truck	2.886	0.508
Single Unit Long-Haul Truck	3.573	0.423	2.878	0.429	Single Unit Long-Haul Truck	3.225	0.426

Emission Rates / Truck Category	Dallas Co 2017 JAN NOX	VOC	Dallas Co 2017 JUL NOX	VOC	Dallas Co 2017 Composite Efs (g/mi)	NOX	VOC
Passenger Truck	0.678	0.298	0.614	0.389	Passenger Truck	0.646	0.343
Light Commercial Truck	0.815	0.330	0.771	0.424	Light Commercial Truck	0.793	0.377
Single Unit Short-Haul Truck	3.206	0.487	2.560	0.514	Single Unit Short-Haul Truck	2.883	0.501
Single Unit Long-Haul Truck	3.573	0.422	2.878	0.426	Single Unit Long-Haul Truck	3.225	0.424

Emission Rates / Truck Category	Harris Co 2017 JAN NOX	VOC	Harris Co 2017 JUL NOX	VOC	Harris Co 2017 Composite Efs (g/mi)	NOX	VOC
Passenger Truck	0.539	0.244	0.495	0.305	Passenger Truck	0.517	0.274
Light Commercial Truck	0.666	0.274	0.636	0.338	Light Commercial Truck	0.651	0.306
Single Unit Short-Haul Truck	2.927	0.456	2.411	0.479	Single Unit Short-Haul Truck	2.669	0.467
Single Unit Long-Haul Truck	3.461	0.423	2.872	0.425	Single Unit Long-Haul Truck	3.166	0.424

Emission Rates / Truck Category	Waller Co 2017 JAN NOX	VOC	Waller Co 2017 JUL NOX	VOC	Waller Co (g/mi) 2017 Composite Efs	NOX	VOC
Passenger Truck	0.864	0.383	0.782	0.461	Passenger Truck	0.823	0.422
Light Commercial Truck	0.977	0.408	0.916	0.488	Light Commercial Truck	0.946	0.448
Single Unit Short-Haul Truck	2.926	0.455	2.416	0.478	Single Unit Short-Haul Truck	2.671	0.467
Single Unit Long-Haul Truck	3.459	0.422	2.877	0.425	Single Unit Long-Haul Truck	3.168	0.424

		NOx Total Emissions (g)	NOx Total Emissions (tons)	VOC Total Emissions (g)	VOC Total Emissions (tons)
Dallas Co					
	Light Commercial Truck	14,843	0.016	7,057	0.008
	Passenger Truck	1,044,094	1.149	555,079	0.611
	Single Unit Short-Haul Truck	35,978	0.040	6,251	0.007
	Single Unit Long-Haul Truck	20,125	0.022	2,646	0.003
		NOx Total Emissions (g)	**Nox Total Emissions (tons)**	**VOC Total Emissions (g)**	**VOC Total Emissions (tons)**
Ellis Co					
	Light Commercial Truck	15,175	0.017	7,444	0.008
	Passenger Truck	1,073,578	1.181	587,957	0.647
	Single Unit Short-Haul Truck	36,013	0.040	6,342	0.007
	Single Unit Long-Haul Truck	20,127	0.022	2,660	0.003
		NOx Total Emissions (g)	**Nox Total Emissions (tons)**	**VOC Total Emissions (g)**	**VOC Total Emissions (tons)**
Harris Co					
	Light Commercial Truck	12,184	0.013	5,733	0.006
	Passenger Truck	835,558	0.919	443,440	0.488
	Single Unit Short-Haul Truck	33,312	0.037	5,830	0.006
	Single Unit Long-Haul Truck	19,758	0.022	2,646	0.003
		NOx Total Emissions (g)	**Nox Total Emissions (tons)**	**VOC Total Emissions (g)**	**VOC Total Emissions (tons)**
Waller Co					
	Light Commercial Truck	17,713	0.019	8,383	0.009
	Passenger Truck	1,329,880	1.463	682,119	0.750
	Single Unit Short-Haul Truck	33,329	0.037	5,827	0.006
	Single Unit Long-Haul Truck	19,768	0.022	2,645	0.003

Truck Emissions - MOW

		NOx Total Emissions (tons/yr)	VOC Total Emissions (tons/yr)
DFW NAA			
	Truck (non-haul)	2.486	1.293
HGB NAA			
	Truck (non-haul)	2.532	1.272

Houston Rail Project

Construction Emissions - Non-Road Engines (Stations)

Description	Equipment category based on NONROAD classification	SCC [1]	Fuel Type	Engine Technology Type	Equipment HP	Number of Equipment	Total Days	Total Weeks	Total Months	Usage Rate	Hours per Week per Engine	Total Working hrs
Cat 416 Comb BH/LDR	Tractor/Loader/Backhoe	2270002066	Diesel	T3	70	0		52		0	58	0
Cat 436 Comb BH/LDR	Tractor/Loader/Backhoe	2270002066	Diesel	T3	90	4		52		0.4	58	4,826
Cat 446 Comb BH/LDR	Tractor/Loader/Backhoe	2270002066	Diesel	T3	105	2		52		0.4	58	2,413
Cat D3	Crawler Tractor	2270002069	Diesel	T3	70	4		52		0.4	58	4,826
Cat D6N	Crawler Tractor	2270002069	Diesel	T3	165	2		52		0.4	58	2,413
Cat 320BL Backhoe	Excavators	2270002036	Diesel	T3	135	4		52		0.5	58	6,032
Cat 325BL Backhoe	Excavators	2270002036	Diesel	T3	180	2		52		0.5	58	3,016
Cat 330BL Backhoe	Excavators	2270002036	Diesel	T3	240	4		52		0.5	58	6,032
Cat 345BL Backhoe	Excavators	2270002036	Diesel	T3	290	0		52		0	58	0
Cat 365BL Backhoe	Excavators	2270002036	Diesel	T3	410	0		52		0	58	0
Cat 140G Grader	Graders	2270002048	Diesel	T3	150	3		52		0.25	58	2,262
60Ton R/T Crane	Cranes	2270002045	Diesel	T3	250	1		52		0.1	58	302
80Ton RT Crane	Cranes	2270002045	Diesel	T3	300	1		52		0.1	58	302
110 Ton Crawler Crane	Cranes	2270002045	Diesel	T3	330	1		52		0.1	58	302
150 Ton Crawler Crane	Cranes	2270002045	Diesel	T3	350	1		52		0.1	58	302
200-Ton LS248 / 14000 Crawler	Cranes	2270002045	Diesel	T3	400	1		52		0.1	58	302
230 Ton Crawler Crane / 888	Cranes	2270002045	Diesel	T3	400	0		52		0	58	0
275 Ton Crawler Crane / 999	Cranes	2270002045	Diesel	T3	450	0		52		0	58	0
300 Ton Crawler Crane	Cranes	2270002045	Diesel	T3	450	1		52		0.1	58	302
VME L120B Wheel Loader	Rubber Tire Loaders	2270002060	Diesel	T3	210	1		52		0.5	58	1,508
VME L90C Wheel Loader	Rubber Tire Loaders	2270002060	Diesel	T3	160	4		52		0.4	58	4,826
Bobcat 743	Skid Steer Loaders	2270002072	Diesel	T3	40	1		52		0.5	58	1,508
120' Aerial Lift	Aerial Lifts	2270003010	Diesel	T3	75	1		52		0.2	58	603
30' Aerial Lift	Aerial Lifts	2270003010	Diesel	T3	50	1		52		0.2	58	603
60' Aerial Lift	Aerial Lifts	2270003010	Diesel	T3	65	4		52		0.2	58	2,413
80' Aerial Lift	Aerial Lifts	2270003010	Diesel	T3	65	1		52		0.2	58	603
350HP VIB HMR/EXT I416	Generator Sets (powering pile driver)	2270006005	Diesel	T3	350	2		52		0.1	58	603
Cat 433 CS Roller	Roller	2270002015	Diesel	T3	105	2		52		0.25	58	1,508
Cat 563 -CS (84" Smooth Drum)	Roller	2270002015	Diesel	T3	145	2		52		0.25	58	1,508
Cat 563 -CP (84" Padfoot)	Roller	2270002015	Diesel	T3	145	2		52		0.25	58	1,508
PS 130Pneumatic Compactor	Roller	2270002015	Diesel	T3	230	1		52		0.4	58	1,206
Cat RM 500 Reclaimer	Paving Equipment	2270002021	Diesel	T3	450	0		52		0	58	0
Air Compressors	Air Compressor	2270006015	Diesel	T3	75	6		52		0.6	58	10,858
Generators	Generator Sets	2270006005	Diesel	T3	5	4		52		0.6	58	7,238
Grout Pump	Pumps	2270006010	Diesel	T3	15	5		52		0.6	58	9,048
Walk behind roller	Rollers	2270002015	Diesel	T3	7	3		52		0.6	58	5,429
Small Vac Sweeper	Sweepers	2270003030	Diesel	T3	150	2		52		0.6	58	3,619
All Welders	Welders	2270006025	Diesel	T3	50	2		52		0.6	58	3,619
Bidwell Deck Finishers	Paving Equipment	2270002021	Diesel	T3	50	0		52		0	58	0

Houston Rail Project
Construction Emissions - Non-Road Engines (Track)

Description	Equipment category based on NONROAD classification	SCC [1]	Fuel Type	Engine Technology Type	Equipment HP	Number of Equipment	Total Days	Total Weeks	Total Months	Usage Rate	Hours per Week per Engine	Total Working hrs
Cat 416 Comb BH/LDR	Tractor/Loader/Backhoe	2270002066	Diesel	T3	70	2		52		0.4	58	2,413
Cat 436 Comb BH/LDR	Tractor/Loader/Backhoe	2270002066	Diesel	T3	90	18		52		0.4	58	21,715
Cat 446 Comb BH/LDR	Tractor/Loader/Backhoe	2270002066	Diesel	T3	105	4		52		0.4	58	4,826
Cat D3	Crawler Tractor	2270002069	Diesel	T3	70	16		52		0.4	58	19,302
Cat D6N	Crawler Tractor	2270002069	Diesel	T3	165	7		52		0.4	58	8,445
Cat 320BL Backhoe	Excavators	2270002036	Diesel	T3	135	25		52		0.5	58	37,700
Cat 325BL Backhoe	Excavators	2270002036	Diesel	T3	180	8		52		0.5	58	12,064
Cat 330BL Backhoe	Excavators	2270002036	Diesel	T3	240	27		52		0.5	58	40,716
Cat 345BL Backhoe	Excavators	2270002036	Diesel	T3	290	0		52		0	58	0
Cat 365BL Backhoe	Excavators	2270002036	Diesel	T3	410	0		52		0	58	0
Cat 140G Grader	Graders	2270002048	Diesel	T3	150	12		52		0.25	58	9,048
60Ton R/T Crane	Cranes	2270002045	Diesel	T3	250	4		52		0.1	58	1,206
80Ton RT Crane	Cranes	2270002045	Diesel	T3	300	1		52		0.1	58	302
110 Ton Crawler Crane	Cranes	2270002045	Diesel	T3	330	1		52		0.1	58	302
150 Ton Crawler Crane	Cranes	2270002045	Diesel	T3	350	3		52		0.1	58	905
200-Ton LS248 / 14000 Crawler	Cranes	2270002045	Diesel	T3	400	2		52		0.1	58	603
230 Ton Crawler Crane / 888	Cranes	2270002045	Diesel	T3	400	1		52		0.1	58	302
275 Ton Crawler Crane / 999	Cranes	2270002045	Diesel	T3	450	0		52		0	58	0
300 Ton Crawler Crane	Cranes	2270002045	Diesel	T3	450	1		52		0.1	58	302
VME L120B Wheel Loader	Rubber Tire Loaders	2270002060	Diesel	T3	210	3		52		0.5	58	4,524
VME L90C Wheel Loader	Rubber Tire Loaders	2270002060	Diesel	T3	160	42		52		0.4	58	50,669
Bobcat 743	Skid Steer Loaders	2270002072	Diesel	T3	40	2		52		0.5	58	3,016
120' Aerial Lift	Aerial Lifts	2270003010	Diesel	T3	75	5		52		0.2	58	3,016
30' Aerial Lift	Aerial Lifts	2270003010	Diesel	T3	50	6		52		0.2	58	3,619
60' Aerial Lift	Aerial Lifts	2270003010	Diesel	T3	65	22		52		0.2	58	13,270
80' Aerial Lift	Aerial Lifts	2270003010	Diesel	T3	65	6		52		0.2	58	3,619
350HP VIB HMR/EXT I416	Generator Sets (powering pile driver)	2270006005	Diesel	T3	350	1		52		0.1	58	302
Cat 433 CS Roller	Roller	2270002015	Diesel	T3	105	6		52		0.25	58	4,524
Cat 563 -CS (84" Smooth Drum)	Roller	2270002015	Diesel	T3	145	5		52		0.25	58	3,770
Cat 563 -CP (84" Padfoot)	Roller	2270002015	Diesel	T3	145	7		52		0.25	58	5,278
PS 130Pneumatic Compactor	Roller	2270002015	Diesel	T3	230	3		52		0.4	58	3,619
Cat RM 500 Reclaimer	Paving Equipment	2270002021	Diesel	T3	450	2		52		0.1	58	603
Air Compressors	Air Compressor	2270006015	Diesel	T3	75	21		52		0.6	58	38,002
Generators	Generator Sets	2270006005	Diesel	T3	5	24		52		0.6	58	43,430
Grout Pump	Pumps	2270006010	Diesel	T3	15	13		52		0.6	58	23,525
Walk behind roller	Rollers	2270002015	Diesel	T3	7	12		52		0.6	58	21,715
Small Vac Sweeper	Sweepers	2270003030	Diesel	T3	150	24		52		0.6	58	43,430
All Welders	Welders	2270006025	Diesel	T3	50	12		52		0.6	58	21,715
Bidwell Deck Finishers	Paving Equipment	2270002021	Diesel	T3	50	1		52		0.1	58	302

HSR Rail Project
TMF Construction Emissions - Non-Road Engines

Description	Equipment category based on NONROAD classification	SCC [1]	Fuel Type	Engine Technology Type	Equipment HP	Number of Equipment	Total Days	Total Weeks	Total Months	Usage Rate	Hours per Week per Engine	Total Working hrs
Cat 416 Comb BH/LDR	Tractor/Loader/Backhoe	2270002066	Diesel	T3	70	0		52		0	58	0
Cat 436 Comb BH/LDR	Tractor/Loader/Backhoe	2270002066	Diesel	T3	90	4		52		0.4	58	4,826
Cat 446 Comb BH/LDR	Tractor/Loader/Backhoe	2270002066	Diesel	T3	105	2		52		0.4	58	2,413
Cat D3	Crawler Tractor	2270002069	Diesel	T3	70	4		52		0.4	58	4,826
Cat D6N	Crawler Tractor	2270002069	Diesel	T3	165	2		52		0.4	58	2,413
Cat 320BL Backhoe	Excavators	2270002036	Diesel	T3	135	4		52		0.5	58	6,032
Cat 325BL Backhoe	Excavators	2270002036	Diesel	T3	180	2		52		0.5	58	3,016
Cat 330BL Backhoe	Excavators	2270002036	Diesel	T3	240	4		52		0.5	58	6,032
Cat 345BL Backhoe	Excavators	2270002036	Diesel	T3	290	0		52		0	58	0
Cat 365BL Backhoe	Excavators	2270002036	Diesel	T3	410	0		52		0	58	0
Cat 140G Grader	Graders	2270002048	Diesel	T3	150	3		52		0.25	58	2,262
60Ton R/T Crane	Cranes	2270002045	Diesel	T3	250	1		52		0.1	58	302
80Ton RT Crane	Cranes	2270002045	Diesel	T3	300	1		52		0.1	58	302
110 Ton Crawler Crane	Cranes	2270002045	Diesel	T3	330	1		52		0.1	58	302
150 Ton Crawler Crane	Cranes	2270002045	Diesel	T3	350	1		52		0.1	58	302
200-Ton LS248 / 14000 Crawler	Cranes	2270002045	Diesel	T3	400	1		52		0.1	58	302
230 Ton Crawler Crane / 888	Cranes	2270002045	Diesel	T3	400	0		52		0	58	0
275 Ton Crawler Crane / 999	Cranes	2270002045	Diesel	T3	450	0		52		0	58	0
300 Ton Crawler Crane	Cranes	2270002045	Diesel	T3	450	1		52		0.1	58	302
VME L120B Wheel Loader	Rubber Tire Loaders	2270002060	Diesel	T3	210	1		52		0.5	58	1,508
VME L90C Wheel Loader	Rubber Tire Loaders	2270002060	Diesel	T3	160	4		52		0.4	58	4,826
Bobcat 743	Skid Steer Loaders	2270002072	Diesel	T3	40	1		52		0.5	58	1,508
120' Aerial Lift	Aerial Lifts	2270003010	Diesel	T3	75	1		52		0.2	58	603
30' Aerial Lift	Aerial Lifts	2270003010	Diesel	T3	50	1		52		0.2	58	603
60' Aerial Lift	Aerial Lifts	2270003010	Diesel	T3	65	4		52		0.2	58	2,413
80' Aerial Lift	Aerial Lifts	2270003010	Diesel	T3	65	1		52		0.2	58	603
350HP VIB HMR/EXT I416	Generator Sets (powering pile driver)	2270006005	Diesel	T3	350	2		52		0.1	58	603
Cat 433 CS Roller	Roller	2270002015	Diesel	T3	105	2		52		0.25	58	1,508
Cat 563 -CS (84" Smooth Drum)	Roller	2270002015	Diesel	T3	145	2		52		0.25	58	1,508
Cat 563 -CP (84" Padfoot)	Roller	2270002015	Diesel	T3	145	2		52		0.25	58	1,508
PS 130Pneumatic Compactor	Roller	2270002015	Diesel	T3	230	1		52		0.4	58	1,206
Cat RM 500 Reclaimer	Paving Equipment	2270002021	Diesel	T3	450	0		52		0	58	0
Air Compressors	Air Compressor	2270006015	Diesel	T3	75	6		52		0.6	58	10,858
Generators	Generator Sets	2270006005	Diesel	T3	5	4		52		0.6	58	7,238
Grout Pump	Pumps	2270006010	Diesel	T3	15	5		52		0.6	58	9,048
Walk behind roller	Rollers	2270002015	Diesel	T3	7	3		52		0.6	58	5,429
Small Vac Sweeper	Sweepers	2270003030	Diesel	T3	150	2		52		0.6	58	3,619
All Welders	Welders	2270006025	Diesel	T3	50	2		52		0.6	58	3,619
Bidwell Deck Finishers	Paving Equipment	2270002021	Diesel	T3	50	0		52		0	58	0

HSR Rail Project
MOW Construction Emissions - Non-Road Engines

Description	Equipment category based on NONROAD classification	SCC [1]	Fuel Type	Engine Technology Type	Equipment HP	Number of Equipment	Total Days	Total Weeks	Total Months	Usage Rate	Hours per Week per Engine	Total Working hrs
Cat 416 Comb BH/LDR	Tractor/Loader/Backhoe	2270002066	Diesel	T3	70	0		52		0	58	0
Cat 436 Comb BH/LDR	Tractor/Loader/Backhoe	2270002066	Diesel	T3	90	2		52		0.4	58	2,413
Cat 446 Comb BH/LDR	Tractor/Loader/Backhoe	2270002066	Diesel	T3	105	1		52		0.4	58	1,206
Cat D3	Crawler Tractor	2270002069	Diesel	T3	70	2		52		0.4	58	2,413
Cat D6N	Crawler Tractor	2270002069	Diesel	T3	165	1		52		0.4	58	1,206
Cat 320BL Backhoe	Excavators	2270002036	Diesel	T3	135	2		52		0.5	58	3,016
Cat 325BL Backhoe	Excavators	2270002036	Diesel	T3	180	1		52		0.5	58	1,508
Cat 330BL Backhoe	Excavators	2270002036	Diesel	T3	240	2		52		0.5	58	3,016
Cat 345BL Backhoe	Excavators	2270002036	Diesel	T3	290	0		52		0	58	0
Cat 365BL Backhoe	Excavators	2270002036	Diesel	T3	410	0		52		0	58	0
Cat 140G Grader	Graders	2270002048	Diesel	T3	150	2		52		0.25	58	1,508
60Ton R/T Crane	Cranes	2270002045	Diesel	T3	250	1		52		0.1	58	302
80Ton RT Crane	Cranes	2270002045	Diesel	T3	300	1		52		0.1	58	302
110 Ton Crawler Crane	Cranes	2270002045	Diesel	T3	330	1		52		0.1	58	302
150 Ton Crawler Crane	Cranes	2270002045	Diesel	T3	350	1		52		0.1	58	302
200-Ton LS248 / 14000 Crawler	Cranes	2270002045	Diesel	T3	400	1		52		0.1	58	302
230 Ton Crawler Crane / 888	Cranes	2270002045	Diesel	T3	400	0		52		0	58	0
275 Ton Crawler Crane / 999	Cranes	2270002045	Diesel	T3	450	0		52		0	58	0
300 Ton Crawler Crane	Cranes	2270002045	Diesel	T3	450	1		52		0.1	58	302
VME L120B Wheel Loader	Rubber Tire Loaders	2270002060	Diesel	T3	210	1		52		0.5	58	1,508
VME L90C Wheel Loader	Rubber Tire Loaders	2270002060	Diesel	T3	160	2		52		0.4	58	2,413
Bobcat 743	Skid Steer Loaders	2270002072	Diesel	T3	40	1		52		0.5	58	1,508
120' Aerial Lift	Aerial Lifts	2270003010	Diesel	T3	75	1		52		0.2	58	603
30' Aerial Lift	Aerial Lifts	2270003010	Diesel	T3	50	1		52		0.2	58	603
60' Aerial Lift	Aerial Lifts	2270003010	Diesel	T3	65	2		52		0.2	58	1,206
80' Aerial Lift	Aerial Lifts	2270003010	Diesel	T3	65	1		52		0.2	58	603
350HP VIB HMR/EXT I416	Generator Sets (powering pile driver)	2270006005	Diesel	T3	350	1		52		0.1	58	302
Cat 433 CS Roller	Roller	2270002015	Diesel	T3	105	1		52		0.25	58	754
Cat 563 -CS (84" Smooth Drum)	Roller	2270002015	Diesel	T3	145	1		52		0.25	58	754
Cat 563 -CP (84" Padfoot)	Roller	2270002015	Diesel	T3	145	1		52		0.25	58	754
PS 130Pneumatic Compactor	Roller	2270002015	Diesel	T3	230	1		52		0.4	58	1,206
Cat RM 500 Reclaimer	Paving Equipment	2270002021	Diesel	T3	450	0		52		0	58	0
Air Compressors	Air Compressor	2270006015	Diesel	T3	75	3		52		0.6	58	5,429
Generators	Generator Sets	2270006005	Diesel	T3	5	2		52		0.6	58	3,619
Grout Pump	Pumps	2270006010	Diesel	T3	15	3		52		0.6	58	5,429
Walk behind roller	Rollers	2270002015	Diesel	T3	7	2		52		0.6	58	3,619
Small Vac Sweeper	Sweepers	2270003030	Diesel	T3	150	1		52		0.6	58	1,810
All Welders	Welders	2270006025	Diesel	T3	50	1		52		0.6	58	1,810
Bidwell Deck Finishers	Paving Equipment	2270002021	Diesel	T3	50	0		52		0	58	0

HSR Rail Project
Construction Emissions Summary - Track

Total Construction Emissions (Entire Project)

	VOC (tons)	CO (tons)	PM10 (tons)	PM2.5 (tons)	SO2 (tons)	NOx (tons)	GHG - CO2e (tons)	GHG - CO2e (metric tons)
Non-Road Year 1	6.52	49.68	11.80	11.45	0.142	79.55	15,686.38	14,230.44
Non-Road Year 2	6.52	49.68	11.80	11.45	0.142	79.55	15,686.38	14,230.44
Non-Road Year 3	6.52	49.68	11.80	11.45	0.142	79.55	15,686.38	14,230.44
Non-Road Year 4	6.52	49.68	11.80	11.45	0.142	79.55	15,686.38	14,230.44
Total Project	**26.09**	**198.71**	**47.22**	**45.80**	**0.57**	**318.22**	**62,745.52**	**56,921.78**

Dallas-Fort Worth Ozone Nonattainment Area (Dallas and Ellis Counties) Construction Emissions

	VOC (tons)	CO (tons)	PM10 (tons)	PM2.5 (tons)	SO2 (tons)	NOx (tons)	GHG - CO2e (tons)
Non-Road Year 1	1.24	9.42	2.24	2.17	0.027	15.08	2,973.44
Non-Road Year 2	1.24	9.42	2.24	2.17	0.027	15.08	2,973.44
Non-Road Year 3	1.24	9.42	2.24	2.17	0.027	15.08	2,973.44
Non-Road Year 4	1.24	9.42	2.24	2.17	0.027	15.08	2,973.44
Total Project (DFW)	**4.95**	**37.67**	**8.95**	**8.68**	**0.11**	**60.32**	**11,893.77**

Houston-Galveston-Brazoria Ozone Nonattainment Area (Harris and Waller Counties) Construction Emissions

	VOC (tons)	CO (tons)	PM10 (tons)	PM2.5 (tons)	SO2 (tons)	NOx (tons)	GHG - CO2e (tons)
Non-Road Year 1	1.32	10.06	2.39	2.32	0.029	16.10	3,175.14
Non-Road Year 2	1.32	10.06	2.39	2.32	0.029	16.10	3,175.14
Non-Road Year 3	1.32	10.06	2.39	2.32	0.029	16.10	3,175.14
Non-Road Year 4	1.32	10.06	2.39	2.32	0.029	16.10	3,175.14
Total Project (HGB)	**5.28**	**40.22**	**9.56**	**9.27**	**0.12**	**64.41**	**12,700.57**

Note: 48-month construction schedule.

HSR Rail Project
Construction Emissions Summary - Station

Total Construction Emissions (per Station)

	VOC (tons)	CO (tons)	PM10 (tons)	PM2.5 (tons)	SO2 (tons)	NOx (tons)	GHG - CO2e (tons)	GHG - CO2e (metric tons)
Non-Road Year 1	0.00	0.00	0.00	0.00	0.000	0.00	0.00	0.00
Non-Road Year 2	0.63	4.83	1.09	1.05	0.013	7.57	1,460.66	1,325.09
Non-Road Year 3	1.26	9.66	2.17	2.11	0.026	15.14	2,921.33	2,650.18
Non-Road Year 4	1.26	9.66	2.17	2.11	0.026	15.14	2,921.33	2,650.18
Total Project	**3.14**	**24.16**	**5.43**	**5.27**	**0.07**	**37.84**	**7,303.32**	**6,625.46**

Note: 30-month construction schedule.

HSR Rail Project
Construction Emissions Summary - TMF

Total Construction Emissions (Per TMF Facility)

	VOC (tons)	CO (tons)	PM10 (tons)	PM2.5 (tons)	SO2 (tons)	NOx (tons)	GHG - CO2e (tons)	GHG - CO2e (metric tons)
Non-Road Year 1	0.00	0.00	0.00	0.00	0.000	0.00	0.00	0.00
Non-Road Year 2	0.00	0.00	0.00	0.00	0.000	0.00	0.00	0.00
Non-Road Year 3	1.26	9.66	2.17	2.11	0.026	15.14	2,921.33	2,650.18
Non-Road Year 4	1.26	9.66	2.17	2.11	0.026	15.14	2,921.33	2,650.18
Total Project	**2.51**	**19.32**	**4.35**	**4.22**	**0.05**	**30.27**	**5,842.65**	**5,300.37**

Note: 24-month construction schedule.

HSR Rail Project

Construction Emissions Summary - MOW

Total Construction Emissions (per MOW Facility)

	VOC (tons)	CO (tons)	PM10 (tons)	PM2.5 (tons)	SO2 (tons)	NOx (tons)	GHG - CO2e (tons)	GHG - CO2e (metric tons)
Non-Road Year 1	0.00	0.00	0.00	0.00	0.000	0.00	0.00	0.00
Non-Road Year 2	0.00	0.00	0.00	0.00	0.000	0.00	0.00	0.00
Non-Road Year 3	0.36	2.72	0.61	0.59	0.008	4.34	843.38	765.10
Non-Road Year 4	0.72	5.44	1.22	1.19	0.015	8.68	1,686.75	1,530.20
Total Project	**1.08**	**8.16**	**1.83**	**1.78**	**0.02**	**13.03**	**2,530.13**	2,295.29

Notes: One MOW each located in Dallas, Ellis, Waller, and Harris Counties.
18-Month construction schedule.

HIGH SPEED RAIL PROJECT
DALLAS TO HOUSTON
CONSTRUCTION ANALYSIS
MATERIAL HAULING LOCOMOTIVE GHG EMISSIONS

HSR Material Hauling - Locomotive

Data Taken from Project Descriptions or Provided

Estimated Values

Data Used in Calculations

HSR Annual Material Hauling by Rail								
HSR Alternative C Construction by Rail per year								
Source Geography	**Material Hauled**	**Total Quantity[1]**	**Units**	**Total Quantity**	**Units**	**Possible Material Location**	**Average Distance Traveled**	**Duration (Years)**
HGB Rail Connection	Sub-Ballast	248,479	cy	521,805	tons	C. Texas	241.09	4
HGB Rail Connection	Ballast	584,591	cy	1,227,642	tons	C. Texas	241.09	4
	Sand			393,085	tons	C. Texas	241.09	4
	Gravel			433,749	tons	C. Texas	241.09	4
	Cement			165,638	tons	C. Texas	241.09	4
	Steel Reinforcing			271,093	tons	Out of State	241.09	3
	Steel Structural			1,683	tons	Out of State	241.09	3
	Rail			14,679	tons	Out of State	241.09	4
Total Alignment Length - (mi)		241.09						
DFW NAA Alignment Length (mi)		45.7	18.96%					
HGB NAA Alignment Length (mi)		48.8	20.24%					
Freestone County SO2 NAA Alignment Length (mi)		0	0.00%					
Total Sub-Ballast (cy - total 4 yrs)		993,914						
Total Ballast (cy - total 4 yrs)		2,338,365						
Total Sand (tons - total 4 yrs)		1,572,340						
Total Gravel (tons - total 4 yrs)		1,734,996						
Total Cement (tons - total 4 yrs)		662,552						
Total Reinforing Steel (tons - total 3 yrs)		1,084,372						
Total Structural Steel (tons - total 3 yrs)		6,732						
Total Rail (tons - total 4 yrs)		58,715						

Notes:

(1) Total quantities was obtained from Construction Quantities and Construction Equipment list.

(2) Distance travelled by rail calculated for length of Alt. C alignment.

(3) Density of ballast and sub-ballast was assumed to be 2.1 tons/cubic yard (based on California HSR calculations)

(4) Total rail = 2,795,962 TF. Weight of rail (UIC60 rail) is 42 lbs/ft (Source: http//www.railway-technical.com/track.shtml)

HSR Alternative C Construction Rail Hauling - Total Quantities (tons)							
Material		**(2018-2021)**					
Sub-Ballast		521,805					
Ballast		1,227,642					
Sand		393,085					
Gravel		433,749					
Cement		165,638					
Steel Reinforcing		271,093					
Steel Structural		1,683					
Rail		14,679					
Emission Factors - Rail (g/gal)[1]							
	VOC	CO	NOx	SO2	PM10	PM2.5	CO2
2018	5.408	26.624	102.96	0.094	3.744	3.63168	10217
Emission Factors - Rail (g/ton-mile)[2]							
	VOC	CO	NOx	SO2	PM10	PM2.5	CO2
2018	0.011	0.056	0.218	0.0002	0.008	0.008	21.6
Notes							

(1) Emission factors based on Tier 2 line-haul locomotive emission factors as listed in the EPA Report "Emission Factors for Locomotives - Large Line Haul", USEPA Office of Transportation and Air Quality, EPA-420-F-09-025, April 2009. Grams per gal calculations based on a 20.8 bhp-hr/gal conversion factor as listed in the same EPA report.

(2) The conversion factor of 473 ton-mile/gallon based on the report by the American Association of Railroads "The Environmental Benefits of Moving Freight by Rail, April 2016.

(3) 2018 was assumed to be the most conservative year, so rail emission factors in 2018 were used for all years.

(4) for DFW: Assume 50% to Dallas rail connection, 50% to Ellis Co. rail connection

HSR Alternative C Construction Rail Hauling Emissions per Year											
			VOC ER	**VOC**	**VOC**	**NOx ER**	**NOx**	**NOx**	**CO2 ER**	**CO2**	**CO2**
	tons	**miles**	**g/ton-mile**	**g/yr**	**tons/yr**	**g/ton-mile**	**g/yr**	**tons/yr**	**g/ton-mile**	**g/yr**	**tons/yr**
Sub-Ballast	521,805	241.09	0.011	1,438,344	1.585	0.218	27,383,862	30.185	21.6	2,717,374,909	2,995.4
Ballast	1,227,642	241.09	0.011	3,383,969	3.730	0.218	64,425,559	71.016	21.6	6,393,122,925	7,047.1
Sand	393,085	241.09	0.011	1,083,531	1.194	0.218	20,628,757	22.739	21.6	2,047,047,505	2,256.5
Gravel	433,749	241.09	0.011	1,195,620	1.318	0.218	22,762,768	25.091	21.6	2,258,811,219	2,489.9
Cement	165,638	241.09	0.011	456,578	0.503	0.218	8,692,537	9.582	21.6	862,584,058	950.8
Steel Reinforcing	271,093	241.09	0.011	747,262	0.824	0.218	14,226,724	15.682	21.6	1,411,756,361	1,556.2
Steel Structural	1,683	241.09	0.011	4,639	0.005	0.218	88,322	0.097	21.6	8,764,468	9.7
Rail	14,679	241.09	0.011	40,462	0.045	0.218	770,331	0.849	21.6	76,441,996	84.3
					9.205			175.242			17,389.778
	Totals (tons)										
VOC	9.20										
NOx	175.24		**Totals (metric tons)**								
CO2	17,390	CO2	15,776								

Notes:

1) pounds per gram = 0.0022046

2) tons per pound = 0.0005

HIGH SPEED RAIL PROJECT
DALLAS TO HOUSTON
CONSTRUCTION ANALYSIS
MATERIAL HAULING TRUCK GHG EMISSIONS

HSR Material Hauling

Data Taken from Project Descriptions or Provided

Estimated Values

Data Used in Calculations

Truck Capacity

20 cy/truck

30 tons/truck

Material Hauled	Total Quantity[1]	Units	Possible Origin Location	Duration of Activity (years)
From RR Connection / Precast Yard				
Sub-Ballast	993,914	CY	from rail connection yard	4
Ballast	2,338,365	CY	from rail connection yard	4
Concrete Rail Ties	1,397,981	Each	batch plant to construction site	4
Total Concrete	8,674,980	CY	batch plant to construction site	4
Rail	2,795,962	TF	Out of state	4
Excavation	7,541,885	CY	within alignment	4
Fill	25,425,626	CY	within alignment	4
Structural Steel	6,732	Ton	from rail connection yard	3
Reinforcing Steel	1,084,372	Ton	from rail connection yard	3
Construction Waste - Concrete	59,457	CY	within alignment	4
Construction Waste - Rebar	16,266	Ton	within alignment	4
To Precast Yard[2]				
Sand	1,572,340	Ton	Texas	4
Cement	662,552	Ton	Texas	4
Gravel	1,734,996	Ton	Texas	4

Notes:

(1) Information about total quantities was obtained from HSR Construction Material Quantities and Equipment Estimates.

(2) Number shown assumes 50% of total Sand, Cement, and Gravel delivered to precast yards by truck.

(3) Truck hauling emissions were calculated using a standard truck capacity of 20 cubic yards or 30 tons per truck, and by multiplying the emission factor by the anticipated distance traveled and the amount of material hauled per trip for each hauling method.

HSR Material Hauling Mileage Calcuations

Material Hauled	No. Trucks Total	Total Annual Miles
From RR Connection / Precast Yard		
Sub-Ballast	49,696	248,479
Ballast	116,918	584,591
Concrete Rail Ties	23,300	116,498
Total Concrete	433,749	2,168,745
Rail	1,957	9,786
Excavation	377,094	1,885,471
Fill	1,271,281	6,356,407
Structural Steel	224	1,496
Reinforcing Steel	36,146	240,972
Construction Waste - Concrete	2,973	14,864
Construction Waste - Rebar	542	2,711
To Precast Yard		
Sand	52,411	786,170
Cement	22,085	331,276
Gravel	57,833	867,498
Total	**2,446,210**	**13,614,964**

Assumptions:
Weight of average concrete railway tie is 1,000 pounds
Weight of rail (UIC60 rail) is 42 lbs/ft (Source: http//www.railway-technical.com/track.shtml)
Distance traveled is estimated based on the origin of the material being delivered.
Average R/T Distance from Rail Connection Yard: 20 miles.
Average R/T Distance to Rail Connection Yard: 60 miles.
Material haul: quantities will be delivered over a three or four-year time frame (2018-2021) for use in the construction phase (as per schedule).
Assume concrete will be hauled in support of concrete batch plant operations.

Data from MOVES2014a			
	2017 Long Haul Truck		
	Emissions in Grams per Mile		
	NOx	**VOC**	**CO2E**
Ellis	3.225	0.426	1,447
Dallas	3.225	0.424	1,447
Harris	3.166	0.424	1,432
Waller	3.168	0.424	1,430
Average HGB Emissions	**3.167**	**0.424**	**1,431**
Composite EF	**3.196**	**0.425**	**1439**

	HSR Material Hauling Emissions - Total		
	Long Haul Truck		
	Emissions (Tons/Year)		
Year			
	CO2E	**CO2E (metric tons)**	
Annual Emissions 2018 - 2021	**21,591**	**19,587**	

Notes:
1) pounds per gram = 0.0022
2) tons per pound = 0.0005

HIGH SPEED RAIL PROJECT
DALLAS TO HOUSTON
CONSTRUCTION ANALYSIS
MATERIAL HAULING TRUCK GHG EMISSIONS - TRACK CONSTRUCTION

HSR Material Hauling

Data Taken from Project Descriptions or Provided
Estimated Values
Data Used in Calculations

Truck Emissions - Track	**On-Road (Non-Haul) Trucks**				
		County distance ratio to overall alignment	1	Average R/T Distance	Total Miles Per Year 2018-2021
Non-Haul Truck Category	Trucks	Total Number of Non-Haul Trucks	No Trucks Total Alignment	(miles)	
Light Commercial Truck	Flatbed F350	24		**40**	
	Flat Bed F700	18			
	Total	**42**	**42**	Light Commercial Truck	**524,160**
Passenger Truck	Mechanics Truck (small)	29			
	Pick-up 1/2 Ton	597			
	Pick-up 3/4 Ton	383			
	Worker Trips	5620			
	Total	**6629**	**6629**	Passenger Truck	**82,729,920**
Single-Unit Short Haul	Fuel Truck	44			
	Water Truck 4000 gal	25			
		69	**69**	Single-Unit Short Haul	**861,120**

Notes:
(1) Assume 312 working days per year.
(2) Number of trucks shown for entire Alternative C alignment.

Worker Trips: Assume 47 mob and demob sites (30 vehicles/site) and 20 sites each for demo,land clearing, earth moving, road crossings,track at-grade,track elevated, and structures (20 vehicles/site)

Emission Rates	**Ellis Co**	**Ellis Co**		**Ellis Co**
Truck Category	**2017 JAN**	**2017 JUL**		**2017 Composite Efs (g/mi)**
	CO2E	**CO2E**		**CO2E**
Passenger Truck	582	652	Passenger Truck	617
Light Commercial Truck	589	660	Light Commercial Truck	625
Single Unit Short-Haul Truck	1406	1602	Single Unit Short-Haul Truck	1,504
Single Unit Long-Haul Truck	1348	1545	Single Unit Long-Haul Truck	1,447

Emission Rates	**Dallas Co**	**Dallas Co**		**Dallas Co**
Truck Category	**2017 JAN**	**2017 JUL**		**2017 Composite Efs (g/mi)**
	CO2E	**CO2E**		**CO2E**
Passenger Truck	583	653	Passenger Truck	618
Light Commercial Truck	590	661	Light Commercial Truck	625
Single Unit Short-Haul Truck	1406	1602	Single Unit Short-Haul Truck	1,504
Single Unit Long-Haul Truck	1348	1545	Single Unit Long-Haul Truck	1,447

Emission Rates	**Harris Co**	**Harris Co**		**Harris Co**
Truck Category	**2017 JAN**	**2017 JUL**		**2017 Composite Efs (g/mi)**
	CO2E	**CO2E**		**CO2E**
Passenger Truck	575	635	Passenger Truck	605
Light Commercial Truck	583	643	Light Commercial Truck	613
Single Unit Short-Haul Truck	1405	1572	Single Unit Short-Haul Truck	1,488
Single Unit Long-Haul Truck	1348	1515	Single Unit Long-Haul Truck	1,432

Emission Rates	**Waller Co**	**Waller Co**		**Waller Co (g/mi)**
Truck Category	**2017 JAN**	**2017 JUL**		**2017 Composite Efs**
	CO2E	**CO2E**		**CO2E**
Passenger Truck	582	639	Passenger Truck	611
Light Commercial Truck	589	647	Light Commercial Truck	618
Single Unit Short-Haul Truck	1405	1567	Single Unit Short-Haul Truck	1,486
Single Unit Long-Haul Truck	1348	1511	Single Unit Long-Haul Truck	1,430

Emission Rates	**Other Co**	**Other Co**		**Other Co (g/mi)**
Truck Category	**2017 JAN**	**2017 JUL**		**2017 Composite Efs**
	CO2E	**CO2E**		**CO2E**
Passenger Truck	580.489	644.801	Passenger Truck	613
Light Commercial Truck	587.598	652.864	Light Commercial Truck	620
Single Unit Short-Haul Truck	1405.075	1585.893	Single Unit Short-Haul Truck	1,495
Single Unit Long-Haul Truck	1348.090	1529.215	Single Unit Long-Haul Truck	1,439

		CO2E	**CO2E**
Total Alignment		**Total Emissions (g)**	**Total Emissions (tons)**
	Light Commercial Truck	325,100,084	358
	Passenger Truck	50,684,071,838	55,752
	Single Unit Short-Haul Truck	1,287,790,967	1,417
	Single Unit Long-Haul Truck	0	0

Truck Emissions - Track Construction

Total Project		**CO2E**	**CO2E**
		Total Emissions (tons/yr)	**Total Emissions (metric tons/yr)**
	Truck (non-haul)	57,527	52,187

HIGH SPEED RAIL PROJECT
DALLAS TO HOUSTON
CONSTRUCTION ANALYSIS
MATERIAL HAULING TRUCK GHG EMISSIONS - STATION CONSTRUCTION

HSR Material Hauling

Data Taken from Project Descriptions or Provided
Estimated Values
Data Used in Calculations

Truck Emissions - Station	**On-Road (Non-Haul) Trucks**				
		No. of Stations in County	1	1	1
Non-Haul Truck Category	Trucks	Total Number of Non-Haul Trucks	No Trucks Dal Co	No Trucks Harris Co	No Trucks Central Co
Light Commercial Truck	Flatbed F350	3			
	Flat Bed F700	2			
	Total	**5**	**5**	**5**	**5**
Passenger Truck	Mechanics Truck (small)	1			
	Pick-up 1/2 Ton	8			
	Pick-up 3/4 Ton	8			
	Worker Trips	500			
	Total	**517**	**517**	**517**	**517**
Single-Unit Short Haul	Fuel Truck	1			
	Water Truck 4000 gal	1			
		2	**2**	**2**	**2**
Single-Unit Long Haul	Semi Tractor	2			
		2	**2**	**2**	**2**

Average R/T Distance (miles)	Total Miles Per Year 2018-2021 per County
20	
Light Commercial Truck	**31,200**
Passenger Truck	**3,226,080**
Single-Unit Short Haul	**12,480**
Single-Unit Long Haul	**12,480**

Notes:
(1) Assume 312 working days per year.
(2) Stations would be located in Dallas, Harris, and a centrally located county only.

Emission Rates	**Ellis Co**	**Ellis Co**		
Truck Category	**2017 JAN**	**2017 JUL**		
	CO2E	**CO2E**		**CO2E**
Passenger Truck	582	652	Passenger Truck	617
Light Commercial Truck	589	660	Light Commercial Truck	625
Single Unit Short-Haul Truck	1406	1602	Single Unit Short-Haul Truck	1,504
Single Unit Long-Haul Truck	1348	1545	Single Unit Long-Haul Truck	1,447

Emission Rates	**Dallas Co**	**Dallas Co**		
Truck Category	**2017 JAN**	**2017 JUL**		
	CO2E	**CO2E**		**CO2E**
Passenger Truck	583	653	Passenger Truck	618
Light Commercial Truck	590	661	Light Commercial Truck	625
Single Unit Short-Haul Truck	1406	1602	Single Unit Short-Haul Truck	1,504
Single Unit Long-Haul Truck	1348	1545	Single Unit Long-Haul Truck	1,447

Emission Rates	**Harris Co**	**Harris Co**		
Truck Category	**2017 JAN**	**2017 JUL**		
	CO2E	**CO2E**		**CO2E**
Passenger Truck	575	635	Passenger Truck	605
Light Commercial Truck	583	643	Light Commercial Truck	613
Single Unit Short-Haul Truck	1405	1572	Single Unit Short-Haul Truck	1,488
Single Unit Long-Haul Truck	1348	1515	Single Unit Long-Haul Truck	1,432

Emission Rates	**Waller Co**	**Waller Co**		
Truck Category	**2017 JAN**	**2017 JUL**		
	CO2E	**CO2E**		**CO2E**
Passenger Truck	582	639	Passenger Truck	611
Light Commercial Truck	589	647	Light Commercial Truck	618
Single Unit Short-Haul Truck	1405	1567	Single Unit Short-Haul Truck	1,486
Single Unit Long-Haul Truck	1348	1511	Single Unit Long-Haul Truck	1,430

Emission Rates	**Composite**	**Composite**		
Truck Category	**2017 JAN**	**2017 JUL**		
	CO2E	**CO2E**		**CO2E**
Passenger Truck	580.489	644.801	Passenger Truck	613
Light Commercial Truck	587.598	652.864	Light Commercial Truck	620
Single Unit Short-Haul Truck	1405.075	1585.893	Single Unit Short-Haul Truck	1,495
Single Unit Long-Haul Truck	1348.090	1529.215	Single Unit Long-Haul Truck	1,439

		CO2E	**CO2E**
Dallas Co		**Total Emissions (g)**	**Total Emissions (tons)**
	Light Commercial Truck	19,513,338	21
	Passenger Truck	1,993,475,484	2,193
	Single Unit Short-Haul Truck	18,769,421	21
	Single Unit Long-Haul Truck	18,053,818	20
		CO2E	**CO2E**
Harris Co		**Total Emissions (g)**	**Total Emissions (tons)**
	Light Commercial Truck	19,125,912	21
	Passenger Truck	1,951,867,117	2,147
	Single Unit Short-Haul Truck	18,571,051	20
	Single Unit Long-Haul Truck	17,868,240	20
		CO2E	**CO2E**
Centrally Located County		**Total Emissions (g)**	**Total Emissions (tons)**
	Light Commercial Truck	19,351,196	21
	Passenger Truck	1,976,441,782	2,174
	Single Unit Short-Haul Truck	18,663,637	21
	Single Unit Long-Haul Truck	17,954,383	20

Truck Emissions - Station

		CO2E	**CO2E**
DFW NAA		**Total Emissions (tons/yr)**	**Total Emissions (metric tons/yr)**
	Truck (non-haul)	2,255	2,046
HGB NAA		**CO2E**	**CO2E**
		Total Emissions (tons/yr)	**Total Emissions (metric tons/yr)**
	Truck (non-haul)	2,208	2,003
Centrally Located County		**CO2E**	**CO2E**
		Total Emissions (tons/yr)	**Total Emissions (metric tons/yr)**
	Truck (non-haul)	2,236	2,028
Total Project		**CO2E**	**CO2E**
		Total Emissions (tons/yr)	**Total Emissions (metric tons/yr)**
	Truck (non-haul)	6,699	6,077

HIGH SPEED RAIL PROJECT
DALLAS TO HOUSTON
CONSTRUCTION ANALYSIS
MATERIAL HAULING TRUCK GHG EMISSIONS - TMF CONSTRUCTION

HSR Material Hauling

Data Taken from Project Descriptions or Provided
Estimated Values
Data Used in Calculations

Truck Emissions - TMF	**On-Road (Non-Haul) Trucks**			
		No. of TMFs in County	1	1
Non-Haul Truck Category	Trucks	Total Number of Non-Haul Trucks	No Trucks Dal Co	No Trucks Harris Co
Light Commercial Truck	Flatbed F350	3		
	Flat Bed F700	2		
	Total	**5**	**5**	**5**
Passenger Truck	Mechanics Truck (small)	1		
	Pick-up 1/2 Ton	8		
	Pick-up 3/4 Ton	8		
	Worker Trips	250		
	Total	**267**	**267**	**267**
Single-Unit Short Haul	Fuel Truck	1		
	Water Truck 4000 gal	1		
		2	**2**	**2**
Single-Unit Long Haul	Semi Tractor	2		
		2	**2**	**2**

Average R/T Distance (miles)	Total Miles Per Year 2018-2021 per County
20	
Light Commercial Truck	**31,200**
Passenger Truck	**1,666,080**
Single-Unit Short Haul	**12,480**
Single-Unit Long Haul	**12,480**

Notes:
(1) Assume 312 working days per year.
(1) Assume two TMFs, one each in Dallas and Harris counties.

Emission Rates	**Ellis Co**	**Ellis Co**		
Truck Category	**2017 JAN**	**2017 JUL**		
	CO2E	**CO2E**		**CO2E**
Passenger Truck	582	652	Passenger Truck	617
Light Commercial Truck	589	660	Light Commercial Truck	625
Single Unit Short-Haul Truck	1406	1602	Single Unit Short-Haul Truck	1,504
Single Unit Long-Haul Truck	1348	1545	Single Unit Long-Haul Truck	1,447

Emission Rates	**Dallas Co**	**Dallas Co**		
Truck Category	**2017 JAN**	**2017 JUL**		
	CO2E	**CO2E**		**CO2E**
Passenger Truck	583	653	Passenger Truck	618
Light Commercial Truck	590	661	Light Commercial Truck	625
Single Unit Short-Haul Truck	1406	1602	Single Unit Short-Haul Truck	1,504
Single Unit Long-Haul Truck	1348	1545	Single Unit Long-Haul Truck	1,447

Emission Rates	**Harris Co**	**Harris Co**		
Truck Category	**2017 JAN**	**2017 JUL**		
	CO2E	**CO2E**		**CO2E**
Passenger Truck	575	635	Passenger Truck	605
Light Commercial Truck	583	643	Light Commercial Truck	613
Single Unit Short-Haul Truck	1405	1572	Single Unit Short-Haul Truck	1,488
Single Unit Long-Haul Truck	1348	1515	Single Unit Long-Haul Truck	1,432

Emission Rates	**Waller Co**	**Waller Co**		
Truck Category	**2017 JAN**	**2017 JUL**		
	CO2E	**CO2E**		**CO2E**
Passenger Truck	582	639	Passenger Truck	611
Light Commercial Truck	589	647	Light Commercial Truck	618
Single Unit Short-Haul Truck	1405	1567	Single Unit Short-Haul Truck	1,486
Single Unit Long-Haul Truck	1348	1511	Single Unit Long-Haul Truck	1,430

Emission Rates	**Composite**	**Composite**		
Truck Category	**2017 JAN**	**2017 JUL**		
	CO2E	**CO2E**		**CO2E**
Passenger Truck	580.489	644.801	Passenger Truck	613
Light Commercial Truck	587.598	652.864	Light Commercial Truck	620
Single Unit Short-Haul Truck	1405.075	1585.893	Single Unit Short-Haul Truck	1,495
Single Unit Long-Haul Truck	1348.090	1529.215	Single Unit Long-Haul Truck	1,439

		CO2E	**CO2E**
Dallas Co		**Total Emissions (g)**	**Total Emissions (tons)**
	Light Commercial Truck	19,513,338	21
	Passenger Truck	1,029,512,484	1,132
	Single Unit Short-Haul Truck	18,769,421	21
	Single Unit Long-Haul Truck	18,053,818	20
		CO2E	**CO2E**
Harris Co		**Total Emissions (g)**	**Total Emissions (tons)**
	Light Commercial Truck	19,125,912	21
	Passenger Truck	1,008,024,217	1,109
	Single Unit Short-Haul Truck	18,571,051	20
	Single Unit Long-Haul Truck	17,868,240	20

Truck Emissions - TMF			
DFW NAA		**CO2E**	**CO2E**
		Total Emissions (tons/yr)	**Total Emissions (metric tons/yr)**
	Truck (non-haul)	1,194	1,084
HGB NAA		**CO2E**	**CO2E**
		Total Emissions (tons/yr)	**Total Emissions (metric tons/yr)**
	Truck (non-haul)	1,170	1,061
Total Project		**CO2E**	**CO2E**
		Total Emissions (tons/yr)	**Total Emissions (metric tons/yr)**
	Truck (non-haul)	2,364	2,145

HIGH SPEED RAIL PROJECT
DALLAS TO HOUSTON
CONSTRUCTION ANALYSIS
MATERIAL HAULING TRUCK GHG EMISSIONS - MOW CONSTRUCTION

HSR Material Hauling

Data Taken from Project Descriptions or Provided
Estimated Values
Data Used in Calculations

Truck Emissions - MOW	**On-Road (Non-Haul) Trucks**						
		No. MOW Facilities in County	1	1	1	1	1
Non-Haul Truck Category	Trucks	Total Number of Non-Haul Trucks	No Trucks Dal Co	No Trucks Ellis Co	No Trucks Harris Co	No Trucks Waller Co	No Trucks Other Co
Light Commercial Truck	Flatbed F350	2					
	Flat Bed F700	1					
	Total	**3**	**3**	**3**	**3**	**3**	**3**
Passenger Truck	Mechanics Truck (small)	1					
	Pick-up 1/2 Ton	4					
	Pick-up 3/4 Ton	4					
	Worker Trips	250					
	Total	**259**	**259**	**259**	**259**	**259**	**259**
Single-Unit Short Haul	Fuel Truck	1					
	Water Truck 4000 gal	1					
		2	**2**	**2**	**2**	**2**	**2**
Single-Unit Long Haul	Semi Tractor	1					
		1	**1**	**1**	**1**	**1**	**1**

Notes:
(1) Assume five stand-alone MOW facilities.
(2) Assume 312 working days per year.

Average R/T Distance HGB (miles)	Total Miles Per Year 2018-2021 Per County
20	
Light Commercial Truck	**18,720**
Passenger Truck	**1,616,160**
Single-Unit Short Haul	**12,480**
Single-Unit Long Haul	**6,240**

Emission Rates	**Ellis Co**	**Ellis Co**		**Ellis Co**
Truck Category	**2017 JAN**	**2017 JUL**		**2017 Composite Efs (g/mi)**
	CO2E	**CO2E**		**CO2E**
Passenger Truck	582	652	Passenger Truck	617
Light Commercial Truck	589	660	Light Commercial Truck	625
Single Unit Short-Haul Truck	1406	1602	Single Unit Short-Haul Truck	1,504
Single Unit Long-Haul Truck	1348	1545	Single Unit Long-Haul Truck	1,447

Emission Rates	**Dallas Co**	**Dallas Co**		**Dallas Co**
Truck Category	**2017 JAN**	**2017 JUL**		**2017 Composite Efs (g/mi)**
	CO2E	**CO2E**		**CO2E**
Passenger Truck	583	653	Passenger Truck	618
Light Commercial Truck	590	661	Light Commercial Truck	625
Single Unit Short-Haul Truck	1406	1602	Single Unit Short-Haul Truck	1,504
Single Unit Long-Haul Truck	1348	1545	Single Unit Long-Haul Truck	1,447

Emission Rates	**Harris Co**	**Harris Co**		**Harris Co**
Truck Category	**2017 JAN**	**2017 JUL**		**2017 Composite Efs (g/mi)**
	CO2E	**CO2E**		**CO2E**
Passenger Truck	575	635	Passenger Truck	605
Light Commercial Truck	583	643	Light Commercial Truck	613
Single Unit Short-Haul Truck	1405	1572	Single Unit Short-Haul Truck	1,488
Single Unit Long-Haul Truck	1348	1515	Single Unit Long-Haul Truck	1,432

Emission Rates	**Waller Co**	**Waller Co**		**Waller Co (g/mi)**
Truck Category	**2017 JAN**	**2017 JUL**		**2017 Composite Efs**
	CO2E	**CO2E**		**CO2E**
Passenger Truck	582	639	Passenger Truck	611
Light Commercial Truck	589	647	Light Commercial Truck	618
Single Unit Short-Haul Truck	1405	1567	Single Unit Short-Haul Truck	1,486
Single Unit Long-Haul Truck	1348	1511	Single Unit Long-Haul Truck	1,430

Emission Rates	**Other Co**	**Other Co**		**Composite (g/mi)**
Truck Category	**2017 JAN**	**2017 JUL**		**2017 Composite Efs**
	CO2E	**CO2E**		**CO2E**
Passenger Truck	580	645	Passenger Truck	613
Light Commercial Truck	588	653	Light Commercial Truck	620
Single Unit Short-Haul Truck	1405	1586	Single Unit Short-Haul Truck	1,495
Single Unit Long-Haul Truck	1348	1529	Single Unit Long-Haul Truck	1,439

		CO2E	**CO2E**
Dallas Co		**Total Emissions (g)**	**Total Emissions (tons)**
	Light Commercial Truck	11,708,003	13
	Passenger Truck	998,665,668	1,099
	Single Unit Short-Haul Truck	18,769,421	21
	Single Unit Long-Haul Truck	9,026,909	10
		CO2E	**CO2E**
Ellis Co		**Total Emissions (g)**	**Total Emissions (tons)**
	Light Commercial Truck	11,692,278	13
	Passenger Truck	997,340,417	1,097
	Single Unit Short-Haul Truck	18,769,546	21
	Single Unit Long-Haul Truck	9,026,909	10
		CO2E	**CO2E**
Harris Co		**Total Emissions (g)**	**Total Emissions (tons)**
	Light Commercial Truck	11,475,547	13
	Passenger Truck	977,821,244	1,076
	Single Unit Short-Haul Truck	18,571,051	20
	Single Unit Long-Haul Truck	8,934,120	10
		CO2E	**CO2E**
Waller Co		**Total Emissions (g)**	**Total Emissions (tons)**
	Light Commercial Truck	11,567,041	13
	Passenger Truck	986,702,044	1,085
	Single Unit Short-Haul Truck	18,544,531	20
	Single Unit Long-Haul Truck	8,920,829	10
		CO2E	**CO2E**
Other Co		**Total Emissions (g)**	**Total Emissions (tons)**
	Light Commercial Truck	11,610,717	13
	Passenger Truck	990,132,343	1,089
	Single Unit Short-Haul Truck	18,663,637	21
	Single Unit Long-Haul Truck	8,977,192	10

Truck Emissions - MOW

DFW NAA		**CO2E**	**CO2E**
		Total Emissions (tons/yr)	**Total Emissions (metric tons/yr)**
	Truck (non-haul)	2,282	2,071
HGB NAA		**CO2E**	**CO2E**
		Total Emissions (tons/yr)	**Total Emissions (metric tons/yr)**
	Truck (non-haul)	2,247	2,038
Other Co.		**CO2E**	**CO2E**
		Total Emissions (tons/yr)	**Total Emissions (metric tons/yr)**
	Truck (non-haul)	1,132	1,027
		CO2E	**CO2E**
		Total Emissions (tons/yr)	**Total Emissions (metric tons/yr)**
Total Project	Truck (non-haul)	5,662	5,136

AIR QUALITY AND GREENHOUSE GAS OPERATIONAL EMISSIONS CALCULATIONS

Operational emissions of the proposed action would occur from power plants supplying electricity to operate the HSR ("train operation emissions"), which would represent an increase in emissions, and from reduction in vehicle travel ("vehicle emissions reduction"), due to HSR use, which would represent a decrease in emissions. The calculation of air quality and greenhouse (GHG) gas emissions were done using the same models, methodology and assumptions described below, because emissions factors for GHGs are available from the same sources and models as those for air quality criteria pollutants. Therefore, the details of calculations are presented together. The following subsections describe the modeling and estimate of these emissions.

TRAIN OPERATION EMISSIONS

Power Consumption

Emissions due to the power consumption, trains and stations were calculated using power consumption information supplied by the engineering firm retained by Texas Central Railway Partners to design the HSR. The following steps summarize the procedure:

- Calculate daily power consumption from train traction, station, maintenance facilities and signaling using consumption rates from project engineers
- Calculate annual power consumption based on operational assumptions for train, station, and maintenance facilities from project engineers
- Calculate power transmission and transformation losses using statewide average loss derived from Energy Information Agency (EIA) data for Texas
- Calculate annual total power consumption (including losses)
- Extract power generation emissions factors (EF) from EPA Emissions & Generation Resource Integrated Database (eGRID) database and National Renewable Energy Laboratory (NREL) data for the Electric Reliability Council (ERCOT) of Texas power sub-region.
- Calculate emissions using power consumption and EFs

Daily power consumption information was provided for initial service at an interim level of ridership, and full service at the full assumed level of ridership. Initially, the full service level was used, since it represented the maximum level of train activity and associated emissions. However, the initial service level was used due to concern that although the train activity would be lower, the emissions factors would be higher than in 2040 because the projected change would be less, due to a shorter time elapsed during the project downward trend. Therefore, initial service scenario was also calculated in case it resulted in higher net emissions. Train power consumption included the power used for traction (i.e. locomotion), onboard services (e.g. lights, controls, public address, etc.). Electricity generated due to regenerative braking was indicated by project engineers to be returned to the train's power demand and accounted for in the power consumption provided. **Table E3.2-1** below provides the details of the consumption, operational assumptions provided by the engineers, and the calculated total daily demand. Because the service will be assumed to be provided 365 days a year, yearly power consumption was calculated assuming this. The power consumption of Alternative A is shown, because it is the longest track-length alternative with the highest power consumption, although the difference with the alternative consuming the least power (Alternative E) is negligible at 1 percent.

The EIA is an agency under the U.S. Department of Energy that collects statistics on energy including power generation (in megawatt-hours [MWh] or gigawatt-hours [GWh]) nationwide and by state. Data is obtained through surveys submitted by power management regions like ERCOT, and analysis of submitted data. The data includes an estimate of power lost through transmission and transformers. Power is lost in transmission as heat generated by the resistance of power line conductors, and in transformers mainly as heat also due to conductor resistance and due to other electrical effect losses. It is not practical to estimate losses at the project transmission line level due to the variability in what plant specifically would supply power, and necessary design detail has not yet been developed. Annual loss data for Texas from 1996 to 2013 (latest data available) was used to calculate a rate of loss as a percentage of power generated[1]. The percentage was observed to decline through this period with the rate steadying in the last few years. Advances in technology and power management have resulted in significantly increasing system efficiency, which explains this decline. The average in the last few years has been approximately 5 percent, which is consistent with nationwide data[2]. The loss percentage of 5 percent was assumed.

Table E3.2-1: Train Traction Power Consumption

Train Consumption		
Train Assumed	Shinkansen	
Operational Scenario	Initial Service Level	Full Service Level
Traction energy (MWh) consumed per round trip (each trainset)	7.5	8.5
Power consumption conditions		
Regenerative braking efficiency:	included	
On-board services consumption:	included	
Number of train trips per day	68	80
Total daily train power demand (MWh)	448.9	680.0

Source: Power consumption provided by TCRR engineers.

[1] Energy Information Agency. 2015. Table 10. Supply and disposition of electricity, 1990 through 2014. *Texas Electricity Profile*. Online date available at https://www.eia.gov/electricity/state/Texas/ (accessed January 25, 2016).
[2] Jackson, Roderick, Omer C. Onar, Harold Kirkham, Emily Fisher, Klaehn Burkes, Michael Starke, Olama Mohammed and George Weeks. 2015. Opportunities for Energy Efficiency Improvements in the U.S. Electricity Transmission and Distribution System. Oak Ridge National Laboratory (ORNL) Report ORNL/TM-2015/5. National Technical Information Service, Springfield, VA.

Table E3.2-2: Station and Facilities Power Consumption			
Station Consumption	**No. of Facilities**	**Total daily power consumption (MWh)**	**% Total Daily Demand**
Major Stations (Houston, Dallas)	2	209.4	17%
Brazos Valley Station	1	29.5	2%
Maintenance Facility Consumption			
Train Maintenance Facilities and additional MOW	2	129.3	11%
Maintenance of way (MOW) facility	5	34.4	3%
Switching and Substations			
Switching, subswitching and substations	36	109.8	9%
Signaling Consumption			
Communication House	47	4.4	0.4%
Sub-Signal House	3	2.7	0.2%
Signaling House (MSCH)	7	10.4	1%
Signaling House (ISCH)	6	9.0	1%
Total Daily Station & Facility Consumption (MWh)		538.9	44%

Source: Power consumption provided by TCRR engineers.

Table E3.2-3: Total Train Operations Power Consumption		
Operational Scenario	**ISL**	**FSL**
Total daily train power demand (MWh)	448.9	680.0
Total Daily Station & Facility Consumption (MWh)	538.9	538.9
Total Daily Operating Power Consumption (MWh)	987.8	1,218.9
Transmission & Transformer Losses		
Percentage lost	5%	5%
Power lost (MWh)	49	61
Total Daily Power + Losses (MWh)	1,037	1,280
Operating days/year	365	365
Total Electric Power Consumed per Year (MWH)	**378,562**	**467,143**

Source: Power consumption provided by TCRR engineers.

Emissions Factors

The power grid in Texas is interconnected throughout the state to meet demand. The ERCOT power subregion is the entity that manages and regulates the power grid for most of Texas, including the project corridor. Because there is no certain set of power plants designated or dedicated to providing electricity the HSR, power generation and distribution are interconnected statewide and primarily controlled by ERCOT, emissions from power supplied to the HSR were determined using ERCOT data.

The EPA's eGRID is a comprehensive source of data on the environmental characteristics of almost all electric power generated in the United States[3]. It is based on a yearly compilation of power plant-reported information on power generation, and emissions estimation. eGRID provides aggregation of this data by plant, power sub-region, and state. Emissions factors for the ERCOT subregion were used. Power in any subregion such as ERCOT is supplied by various sources such as natural gas, coal, nuclear, and to a smaller degree, renewable sources (e.g. wind, solar). The emissions factors for ERCOT reflect the blend of power generation of this subregion. Factors were available for NO_x, SO_2 and GHGs. Source emissions rates used in the calculation and reporting by sub-regions typically rely on those published in the EPA's AP-42, *Compilation of Air Pollutant Emission Factors*.

The eGRID data did not include VOC, CO, or PM_{10} emissions factor. These emissions factors were derived from a study of source energy and emission factors for energy use in buildings conducted by the NREL that included emissions from power[4]. Similar to eGRID, data was reported by power sub-region, including ERCOT. The emissions factors in this study were derived from the NREL's Life Cycle Inventory database for combustion of each fuel type in utility boilers and electricity and on the fuel totals used for electricity generation reported to EIA. The LCI also uses emission rates from AP-42. For VOC, the NREL study provided an emission factor for total non-methane organic compounds (TNMOC). In air monitoring, TNMOC is a group of organic compounds sampled and analyzed by a similar but more inclusive method than that used for VOC measured by standard gas chromatography, which is normally used for CAA standards comparison. Studies comparing measurement by both methods indicate that TNMOC can be 1 to almost 2 times the VOC result, and therefore are conservatively assumed to represent VOCs in air emissions inventories[5,6]. Therefore, the TNMOC emission factor was assumed to represent VOC. The ERCOT emissions factors for VOC, CO, and PM_{10} were used and reflect the Year 2004 data. No later comparable data was available. However, the use of earlier year factors is conservative, because emissions factors have been decreasing as time progresses, as discussed in the **Future Year Train Emissions Adjustment** section below.

The emission factor for combustion effects was used. Regional emissions factors expressed as mass of pollutant per unit power reflect the pollutant contribution and generated power amounts from combustion (e.g. gas, coal) and non-combustion (e.g. wind, nuclear) generation. Because non-combustion power generation does not contribute pollutants, it has the effect of diluting the overall regional emission factor. Because the NREL emissions factors only reflected combustion

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[3] U.S. Environmental Protection Agency (EPA). 2016. eGRID. Online database available at https://www.epa.gov/energy/egrid (Accessed February 2016)
[4] Deru, M. and P. Torcellini. Source Energy and Emission Factors for Energy Use in Buildings Technical Report NREL/TP-550-38617 Revised June 2007
[5] Maris, Christophe, Myeong Chung, Udo Krischke, Richard Meller and Suzanne Paulson. An Investigation of the Relationship Between Total Non-Methane Organic Carbon and the Sum of Speciated Hydrocarbons and Carbonyls Measured by Standard GC/FID: Measurements in the South Coast Air Basin. Presentation given at the Air Resources Board (ARB) Research Seminar, June 17, 2002, California EPA Headquarters, 1001 "I" Street, Sacramento, CA. Department of Atmospheric Sciences, University of California at Los Angeles. Available at http://www.arb.ca.gov/research/seminars/paulson/paulson.htm (Accessed 5/10/2016)
[6] U.S. Department of the Interior (USDOI) Bureau of Ocean Energy Management (BOEM). 2015. Gulf of Mexico Air Emissions Calculations Instructions and PRA Statement. Office of Management and Budget (OMB) Form OMB Control No. 1010-0151, BOEM Instructions for Form 0138.

generation, it was necessary to adjust them to reflect the contribution of non-combustion power to give overall emissions rates that reflect the total regional power mix. This was calculated using the percent of non-combustion power, using eGRID data for 2004 to be consistent with the NREL emissions factors, which were for 2004. eGRID did not begin explicitly listing combustion vs non-combustion generation distribution until 2005, but the 2004 distribution data for hydroelectric, nuclear, solar, and wind generation, which comprise the non-combustion portion, was used. More detail on combustion and non-combustion power and emissions factors, and their calculation is provided in the **Future Year Train Emissions Adjustment** section below.

Future Year Train Emissions Adjustment

Because the available power generation and emissions factor data used to calculate train operation emissions only reflect current and historical data and practices, they do not incorporate the improvements to emissions controls that vehicle emissions models account for in future years, and they do not reflect the increasing percentage of power from renewable or non-fossil fuel energy.

Electric power generation in Texas comes from 1) combustion sources such as natural gas and coal, and minor sources such as oil and biomass, and 2) non-combustion sources such as wind, nuclear, solar, and hydroelectric generation. Only the combustion sources produce criteria pollutants. EIA state-level data for power generation by source was used to calculate the non-combustion portions[7]. This data indicates a strong trend between 1990 and 2013 of an increasing percentage of power by noncombustion sources, changing from 6 percent to 17 percent. **Figure E3.2-1** below shows this trend in black markers and plot line. This trend means that an increasing portion of power generated would not produce emissions, and the overall emission rate per power generated should have dropped. The eGRID data by state corroborates this, indicating a Year 2000 NOx emission rate of 2.308 lbs/MWh and a Year 2012 rate of 0.699 lbs/MWh, a decrease of 70 percent.

The increasing percentage of non-combustion power reflects the significant increase in renewable energy, most notably, wind power in Texas. The decrease in the NO_x emission rate reflects the increasing non-combustion power, but also the improvements in plant emissions controls and shifts to lower NO_x fossil fuel generation such as natural gas. Two methods were used to project this trend to the future years of 2024 and 2040: using the 1990-2013 simple average annual rate of change of 0.48 percent (orange markers and line), and inserting a linear-fit trend line and extending it to 2040 (thin black line). This resulted in projections of non-combustion power in 2024 constituting between 21 percent and 23 percent of total power generated, and in 2040 constituting between 27 percent and 30 percent of total power generated. The more conservative trend line values of 21 percent and 27 percent for 2024 and 204 were selected. These rates would be used to estimate an effect on the future year overall NO_x rate. The change in non-combustion power percentage was predicted using state-level data which will differ slightly from ERCOT, as the state statistics include the small portions of Texas outside of ERCOT. However, checks of the eGrid ERCOT data between 2005 and 2012 indicate that the ERCOT non-combustion percent

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[7] Energy Information Agency. "Table 5. Electric power industry generation by primary energy source, 1990 through 2013" Texas Electricity Profile. 2015. https://www.eia.gov/electricity/state/Texas/. (accessed January 25, 2016)

power is 1 to 3 percent higher for the same years. Therefore, using state-level data is a conservative projection of the change in non-combustion percent power.

Overall emissions factors or rates per unit of power generated for subregions such as ERCOT are derived from the emissions produced by the combustion sources divided by the sum of all (combustion plus non-combustion) power generated, as shown in the following example for NO_x:

$$\frac{\text{lbs}_{\text{NOx}}}{(\text{megawatt-hours}_{\text{Combust}} + \text{megawatt-hours}_{\text{Noncombust}})} = \text{EF}_{\text{NOx-TOTAL}} \qquad \{1\}$$

eGRID calculates and lists related emission rates and quantities for combustion sources only, which is shown in the following example for NOx:

$$\frac{\text{lbs}_{\text{NOx}}}{(\text{megawatt-hours}_{\text{Combust}})} = \text{EF}_{\text{NOx-Combust}} \qquad \{2\}$$

The equations above follow general calculations of combustion and non-combustion power emissions rates that can be found in eGRID and NREL technical documentation[8,9]. Equation 1 can be rewritten using Equation 2 as follows:

$$\frac{\text{EF}_{\text{NOx-Combust}} \times \text{megawatt-hours}_{\text{Combust}}}{(\text{megawatt-hours}_{\text{Combust}} + \text{megawatt-hours}_{\text{Noncombust}})} = \text{EF}_{\text{NOx-TOTAL}} \qquad \{3\}$$

The megawatt-hour terms collectively are equivalent to the percent of total power generation that combustion power generation comprises. Therefore, Equation 4 becomes:

$$\text{EF}_{\text{NOx-Combust}} \times \%\ \text{power generation}_{\text{Combust}} = \text{EF}_{\text{NOx-TOTAL}} \qquad \{4\}$$

Expressing the percent power generation from combustion using the non-combustion percentage, Equation 4 becomes:

$$\text{EF}_{\text{NOx-Combust}} \times (1 - \%\ \text{power generation}_{\text{Noncombust}}) = \text{EF}_{\text{NOx-TOTAL}} \qquad \{5\}$$

As long as the combustion EF remains constant, the overall NOx emission factor can be calculated using the change in percent of non-combustion power. However, as shown before, the NO_x emission rate has decreased substantially with some of that decrease attributable to reduction of

[8] Deru, M. and P. Torcellini. Source Energy and Emission Factors for Energy Use in Buildings Technical Report NREL/TP-550-38617 Revised June 2007

[9] Abt Associates. 2015. The Emissions and Generation Resource Integrated Database Technical Support Document for eGRID with Year 2012 Data. Technical report prepared for Clean Air Markets Division, Office of Atmospheric Programs, U.S. Environmental Protection Agency Washington, DC. Abt Associates, Bethesda, MD.

combustion emission rates. eGRID only began tracking subregion combustion emission rates since 2005. This data indicates an average decrease of the combustion NO_x EF of 7 percent per year[10]. Available eGRID information was used to project the change in combustion emission rates of NO_x, SO_2, and the GHGs (CO_2, CH_4, N_2O) to estimate emissions based on the emission rates change indicated by the data[11]. The eGRID data was used to project future $EF_{combust}$ using the average rate of change or percent change calculated with the 2004-2012 data, and applied to extrapolate future values in 2024 and 2040. The annual change is compounding, and therefore follows the general Equation 6 below for value growth of a compounded rate of change, similar to calculating future value in financial calculations. The projections for NO_x, SO_2, and the GHGs are shown in **Figures E3.2- 2** through **6**. The projected $EF_{combust}$ was then used in Equation 5 to calculate the overall EF_{total} for power generation in ERCOT in the Year 2040 for NO_x, SO_2, and the GHGs. The resultant EF_{total} are shown in **Table E3.2-4** below.

$$FV = PV(1 + r)^n \qquad \{6\}$$

Where:
FV = future value
PV = present value
r = annual rate of change
n = time period

Table E3.2-4: eGRID ERCOT Current and Projected Emissions Rates

Combustion Emissions Rates ($EF_{combust}$)										
	NO_x		SO_2		CO_2		CH_4		N_2O	
Year	(lb/MWH)	Avg. Annual Change	(lb/MWH)	Avg. Annual Change	(lb/MWH)	Avg. Annual Change	(lb/GWH)	Avg. Annual Change	(lb/GWH)	Avg. Annual Change
2012	0.7522	-7%	2.38	-8%	1,413	-3%	20.6	-1%	15.2	-3%
2024	0.3153	-	0.82	-	954	-	18.2	-	10.5	-
2040	0.0989	-	0.20	-	565	-	15.4	-	6.4	-
Calculated Overall Emissions Rates (EF_{total})										
2024	0.230	-	0.600	-	696	-	0.013	-	0.008	-
2040	0.072	-	0.146	-	413	-	0.011	-	0.005	-

Source: Data sourced from USEPA eGRID database available at https://www.epa.gov/energy/egrid

The eGRID data did not track VOC, PM_{10} or CO historically; therefore it could not be used to estimate the change in the combustion emissions rates for those pollutants. The EPA maintains and aggregates data from the National Emissions Inventory (NEI) which is a comprehensive and detailed estimate of air emissions of criteria pollutants, criteria precursors, and hazardous air pollutants from major air emissions sources. The state average annual emissions trends data contains aggregation of the NEI emissions by Tier 1 categories[12]. National inventories typically follow IPCC tiered categorization of emissions and factors by sources, and Tier 1 is the most basic level. Tier 1 categories include fuel combustion by electric utilities and track VOC, PM_{10} and CO by

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[10] U.S. Environmental Protection Agency (EPA). 2016. eGRID. Online database available at https://www.epa.gov/energy/egrid
[11] ibid
[12] EPA. 2016. Air Pollutant Emissions Trends Data. Online data available at https://www.epa.gov/air-emissions-inventories/air-pollutant-emissions-trends-data (Accessed May 30, 2016)

year. The Texas annual emissions (in thousands of tons) for this category were used. To maintain consistency with projections for the other pollutants from eGRID, the available data from 2004 and forward was used. By pairing this emissions data with power generation (i.e. MWh) for equivalent categories from the EIA data discussed in the Power Consumption section above, a relative change in the emissions rates per unit of power generated could be estimated to assess whether combustion power plants were improving emissions for these pollutants too. State EIA data for combustion-generated power for electric utilities and independent producers of electricity (i.e. privatized power providers) was used, as this most closely matches the Tier 1 category for electric utilities[13]. The annual emissions for each pollutant were divided by the total category power generated to provide annual emissions rate for state electric utilities.

These state-level emissions rates were not used directly for EF calculations and projections, but rather to estimate the rate of improvement of power plant emissions of these pollutants in Texas and ERCOT. The most current year ERCOT EFs for VOC, PM_{10} and CO sourced from NREL were more consistent with eGRID estimations used for the other pollutants. Even though the estimate of improvements are state-level, Texas is dominated by ERCOT power, and improvements in emissions would be largely reflective of improvements within ERCOT. **Figures E3.2-7** through **9** show the NEI-based emissions rates for VOC, PM_{10} and CO which show gradual downward trends. The average percent change from this data was then used to project changes in the NREL-based $EF_{combust}$ factors for VOC, PM_{10} and CO for the Year 2012 (conservatively assumed the same as 2004) to forecast these factors for the Years 2024 and 2040. The projection was conducted in the same manner as NO_x, SO_2, and the GHGs. **Table E3.2-5** summarizes the percent change calculated and the projected 2024 and 2040 $EF_{combust}$ factors. The projected $EF_{combust}$ was then used in Equation 5 to calculate the overall EF_{total} for power generation in ERCOT in the Years 2024 and 2040 for VOC, PM_{10} and CO. The resultant EF_{total} are shown in **Table E3.2-5**.

Table E3.2-5: NREL ERCOT Current and Projected Emissions Rates

Combustion Emissions Rates ($EF_{combust}$)						
	VOC		PM_{10}		CO	
Year	(lb/MWH)	Avg. Annual Change	(lb/MWH)	Avg. Annual Change	(lb/MWH)	Avg. Annual Change
2012	0.0522	-2.5%	0.0855	-5.4%	0.401	-2.9%
2024	0.039	-	0.0437	-	0.282	-
2040	0.0259	-	0.0178	-	0.176	-
Overall Emissions Rates (EF_{total})						
2024	0.028	-	0.032	-	0.206	-
2040	0.019	-	0.013	-	0.128	-

Source: Baseline 2012 data from Deru, M. and P. Torcellini, Source Energy and Emission Factors for Energy Use in Buildings Technical Report NREL/TP-550-38617 Revised June 2007. Projected Data estimated using average change derived from EPA NEI data in *Air Pollutant Emissions Trends Data*, available online at https://www.epa.gov/air-emissions-inventories/air-pollutant-emissions-trends-data

The 2024 and 2040 EF_{total} for all pollutants were then multiplied by the train operations annual power consumption to calculate the train operations emissions in tons per year. These results are shown in **Table E3.2-6** below.

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[13] EIA. 1990-2014 Net Generation by State by Type of Producer by Energy Source (EIA-906, EIA-920, and EIA-923) (Revised: November 2015). Online data available at https://www.eia.gov/electricity/data/state/

Table E3.2-6: Train Operations Emissions in the Year 2040								
Emissions (tons per year)								
NO_x	VOC	PM_{10}	SO_2	CO	CO_2	CH_4	N_2O	$CO_{2equivalent}$
43.6	5.3	6.0	113.6	38.9	131,819	2.5	1.5	132,316
16.9	4.4	3.0	34.0	30.0	96,354	2.6	1.1	96,747

Source: AECOM, 2016

VEHICLE EMISSIONS REDUCTION

The shift in travel mode due to the HSR from passenger vehicles to high speed rail use would result in passenger vehicles no longer making the round trip from Dallas to Houston and vice versa. This would eliminate the emissions from those vehicles. This section presents the estimate of emissions from these vehicles.

Reduction in Vehicle Miles Traveled

Ridership information from the January 14, 2016 Memorandum, *Station Area Guidance for EIS Documentation* and the May 15, 2017 report *Texas Central Dallas to Houston High-Speed Rail Final Draft Conceptual Engineering Report* – FDCEv5, provided by ARUP, Texas Central Partners, and Freese and Nichols, Inc. (hereafter referred to as the "1/14/2016 Station Area Guidance Memo" and the "May 15, 2017 Final Draft Conceptual Engineering Report") were used to derive the expected numbers of cars no longer making the trip between Dallas and Houston. These documents contained projections and assumptions of ridership and travel mode being used to plan station capacities, including vehicles expected, and parking requirements.

The May 15, 2017 Final Draft Conceptual Engineering Report assumed an annual ridership of 7,200,000 passengers for the 2040 FSL, and the 1/14/2016 Station Area Guidance Memo contained an estimate of existing and projected travel mode share of people traveling between Dallas and Houston from a planning forecast report provided for the project. These assumptions are displayed in the calculations shown below. The estimated 2013 mode share represents the existing percentage of passengers expected to use either cars, airplanes, or bus to make the Dallas-Houston trip, in the absence of the HSR project. This mode share and the annual ridership were used to calculate the number of passengers that would be using cars to travel between Houston and Dallas on IH-45.

The May 15, 2017 Final Draft Conceptual Engineering Report also contained an assumption of average passenger occupancy of cars, which was 1.2 passengers per car that was used to derive the numbers of cars that would now be expected to show up at HSR stations. This was used to derive the number of cars expected from the passengers estimated using this mode. This information was used to calculate the number of passengers traveling by car as follows:

Table E3.2-7: Existing and Projected Mode Share of People Traveling Between Dallas and Houston		
Trip Type	2013 Market	2043 Market
Car	89%	73%
HSR	-	21%
Air	9%	3%
Bus	2%	2%

Source: TCRR. Memorandum, Station Area Guidance for EIS Documentation, January 14, 2016

2024 Calculation:

4,400,000 passengers/year X 89% car share = 3,916,000 passengers using car

3,916,000 passengers/1.2 passengers/car = 3,263,334 cars/year

2040 Calculation:

7,200,000 passengers/year X 89% car share = 6,408,000 passengers using car

6,408,000 passengers/1.2 passengers/car = 5,340,000 cars/year

The 1/14/2016 Station Area Guidance Memo contained projections of rates of ground transportation activity into the stations generated from park and ride, passenger drop off, rental car etc. in terms of vehicles per hour for the Dallas and Houston stations. The distribution of trips originating in Dallas versus Houston were assumed to reflect the proportion between these ground activity rates; that is the more active station would have a larger share of the 3.3 million or 5.34 million passenger car trips calculated. **Table E3.2-8** shows the distribution of trips and **Table E3.2-9** provides the resulting annual numbers of cars inferred for each city from this distribution.

Table E3.2-8: Distribution of Trips Between Dallas and Houston

Metro Area	No. Ground Transport Vehicles Arriving and Departing Station (vehicles/hr)		Inferred Trip Balance	
	Low	High	Low	High
Dallas	1320	1610	47%	47%
Houston	1500	1830	53%	53%

Source: Vehicles/hour from TCRR. Memorandum, Station Area Guidance for EIS Documentation, January 14, 2016

Table E3.2-9: Number of Cars Originating from Each City Assuming Inferred Trip Balance

Operating Scenario	ISL	FSL	Percentage (%)
Total cars/year	3,263,334	5,340,000	
Dallas	1,527,316	2,499,244	47%
Houston	1,736,018	2,840,756	53%

Source: AECOM, 2016

City center origin travel was assumed for simplicity, and because the origin of car trips going to Dallas from Houston, and vice versa, would be anticipated to come from all around the respective urban cores to connect to IH-45. This would include major metropolitan areas north and south of city centers that would tend to average out shorter and longer distances past the city centers. Also, since the proposed Dallas and Houston stations are relatively close to city centers and IH-45 is relatively centered east-west in both of these cities, car trips from outlying east or west areas would still travel inward to connect to or use IH-45 in the absence of the HSR, and with the HSR, would still travel close to the city center to the proposed stations. Therefore trip distance along IH-45 was assumed to average out to trip lengths from the city centers. Assumption of city center

Highway centerline geospatial data from TxDOT was used to calculate a city center-to-city center distance of 239 miles between Houston and Dallas.

Consistent with the average length of stay assumption of 2 days in the 1/14/2016 Station Area Guidance Memo, it would be expected that travel between Houston and Dallas using HSR would primarily be temporary travel for business, tourism, or visitation, and not supplant travel for one-way moves etc. Since Dallas and Houston are already major airline hubs, use of HSR to connect from one city to the other to catch connecting flights to other destinations would be anticipated to be negligible. Considering this, round trips from either Houston or Dallas back to the origin was assumed.

Table E3.2-10: Assumed Trip Distances

Trip	Distance (miles)
City center-City-Center	239
Assume round trip	478

Source: AECOM, 2016

The round trip distance and calculated cars/year were used to calculate the vehicle miles traveled (VMT) that would have been traveled in the absence of the HSR as follows:

Round trip distance X cars/year = VMT

Table E3.2-11: Calculated VMT

Metro Share of VMT	VMT	
	ISL	FSL
Dallas VMT	730,057,145	1,194,638,721
Houston VMT	829,816,507	1,357,881,279
Total VMT avoided	1,559,873,652	2,552,520,000

Source: AECOM, 2016

Emissions Factors

The MOVES2014a, was used to derive emissions factors[14]. Because the HSR stations that would generate the majority of the HSR travel are located in Houston and Dallas, vehicles that would have otherwise used IH-45 to travel between Houston and Dallas would overwhelmingly be expected to originate in the counties of these two metropolitan areas. For consistency with the construction emissions estimated, the NAA counties in the project corridor were used MOVES 2014a to define vehicle characteristics.

MOVES input data from the two relevant MPOs was used to provide regional and county model inputs for meteorological, inspection and monitoring program, age and vehicle class distributions. MPOs are the regional organizations designated under the Clean Air Act to provide coordinated transportation planning for their designated metropolitan areas to comply with SIPs under the

[14] U.S. Environmental Protection Agency. 2016. MOVES (Motor Vehicle Emission Simulator). Air quality emissions modeling system available at https://www3.epa.gov/otaq/models/moves/ (Accessed February 2016)

Transportation Conformity Rules. The Harris-Galveston Area Council (H-GAC) MPO website for the 2040 Regional Transportation Plan (RTP) conformity demonstration and the North Central Texas Council of Governments (NCTCOG) website for conformity demonstration of the Metropolitan Transportation Plan (MTP) [named Mobility 2040], and the 2015-2018 Transportation Improvement Plan (TIP) were used[15,16]. The demonstrations from both of these MPOs contain the results and input data used to model base and future year vehicle emissions (including 2040) from the roadway and other approved transportation improvements to demonstrate consistency with State Implementation Plan (SIP) for compliance with the CAA Transportation Conformity rules under 40 CFR 51 and 93. These demonstrations used MOVES, and reflect the local characteristics of climate, fuel, vehicle age and VMT mix, and other inputs required for MOVES. Key assumptions and model inputs used to generate emissions factors are listed in **Table E3.2-12**.

Information for the years 2024 and 2040 were sought for the reasons previously exaplined to match the ISL and FSL years. For 2024, Year 2025 and 2027 projected input data was available from the Houston and Dallas MPOs, respectively. The information from these years would be conservative for estimating net air emissions impacts, because future years tend to represent better parameters for fuel type, inspection programs etc. that reduce car air emissions, and therefore would reduce the amount emissions avoided through train usage. This would result in higher net emissions than using Year 2024 data. In practicality, the difference in these factors between 2025 or 2027 and 2024 would not be significant. For 2040, input data for that year was available from the MPO sources. Other internal MOVES data projected for the Years 2024 and 2040 were used. The time of year chosen to generate emissions factors was January and July, to represent the range of conditions that affect fuel and meteorological parameters.

The modeling assumed a rural restricted road type which is defined for rural highways that can only be accessed by an on-ramp. Though IH-45 is an urban highway within the Dallas and Houston metropolitan areas (including the 30-mile length north of BW-8 in Houston to Conroe) most of the length through the project corridor is highway in a rural area with access primarily through on ramps from service or frontage roads. From an emissions reduction standpoint, this is a conservatively low assumption, given that the metropolitan segments are not modeled as urban highways, which would result in greater vehicle emissions calculated that would otherwise be avoided through HSR use.

The vehicle speed assumed was an average speed of 40 miles per hour (MPH) which was the average speed (39 MPH rounded up) projected by TxDOT in 2035 for IH-45 travel between DFW and Houston, contained in the Project Planning Documentation for the State's funding application for the High-Speed Intercity Passenger Rail (HSIPR) Program[17]. This speed reflects a decrease from the 2002 average of 59 MPH, commensurate with the increasing traffic volume trend observed in traffic data, and the exceedance of the highway's design capacity in future years.

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[15] Houston-Galveston Area Council (H-GAC). 2016. 2040 RTP Conformity. Available at http://www.h-gac.com/taq/airquality_model/conformity/2040-RTP-Conformity.aspx (Accessed May 2016)
[16] North Central Texas Council of Governments (NCTCOG). 2016. 2016 Transportation Conformity. Available at http://nctcog.org/trans/air/conformity/2016TransportationConformity.asp (Accessed May 2016)
[17] Texas Department of Transportation. 2011. Section 5: Planning Documentation, TxDOT Narrative Application Form for the High-Speed Intercity Passenger Rail (HSIPR) Program March 2011 Notice of Funding Availability (NOFA)

Because the large majority of passengers that would use HSR for Dallas-Houston travel would be those using passenger vehicles (and not commercial light or heavy duty trucks), emissions factors for passenger cars and trucks were calculated. Emissions avoided for travel by bus and aircraft were not calculated as they represent a relatively minor portion of the projected travel mode shift. On a relative basis, shifting to HSR from bus travel would result in some reduction of criteria pollutants. One study showed that per passenger mile traveled; operational NOx emissions from some transit rail systems including Massachusetts Green Line light rail and CAHSR would be approximately an order of magnitude (12X to 35X) lower than those from bus and for PM, approximately 7 times lower[18]. Given the small percentage (2%) of bus travel mode shift, the reductions would be minor.

Table E3.2-12: MOVES Assumptions Used for Vehicle Emissions Modeling

Assumption/Input	Value/description	Source	Comments
Years	2024 and 2040	EIS assumption	Year of HSR full service
Counties	Dallas, Ellis, Harris, and Waller	EIS assumption	NAA counties in project area
Time of Year modeled	January & July	EIS assumption	
Meteorological	Avg. January & Avg. July temp and RH	DFW, Houston airport station data	
Road grade	Avg. = 0.03%	Difference in city center USGS topographic elevations ÷ IH-45 trip distance	Effect on model results same as grade = 0%
Road type	Rural restricted	Bulk of IH-45 between Houston and Dallas is rural highway accessed by on-ramp	
Speed	Avg. = 40 MPH	TxDOT HSIPR Application Planning Documentation	
Vehicle types	Passenger cars and trucks	EIS assumption	Majority of passengers using HSR would otherwise use passenger vehicles
Vehicle age distribution	2040 for NAA counties	H-GAC, NCTOG input files	
VMT mix	2040 Houston District	H-GAC input files NCTOG input files	
Inspection and maintenance (I&M)	2040 Houston District	H-GAC input files NCTOG input files	
Fuel type and formulations	MOVES defaults	MOVES model	

Source: AECOM, 2016

Emissions

The resultant emissions factors generated for the DFW and HGB NAA counties in the project area, for January and July, were averaged to provide emission factors for each of the NAA areas for the criteria pollutants, expressed as grams per mile (g/mile) and converted to pounds per mile (lbs/mile) shown in **Tables E3.2-13a** and **b,** and **Tables E3.2-14a** and **b**. The total annual VMT

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[18] Chester, Mikhail, and Arpad Horvath. "Life-Cycle Environmental Assessment of California High Speed Rail." Access, 2010: 5.

avoided and emission factors were used to calculate the emissions that would have occurred in the absence of the HSR as shown in **Tables E3.2-15a** and **b**.

Table E3.2-13a: HGB Passenger Vehicle Emissions Factors – 2024

County/Month	HGB Emissions Factors(g/mile)						
Harris	**CO**	**NO_x**	**VOC**	**PM_{10}**	**$PM_{2.5}$**	**SO_2**	**CO_2 Eq.**
January	1.3653	0.0915	0.0759	0.0344	0.0074	0.0018	274.7
July	2.0132	0.0898	0.1024	0.0343	0.0073	0.0020	299.0
Average	1.6893	0.0907	0.0892	0.0344	0.0074	0.0019	286.8
Waller							
January	1.8162	0.1449	0.1096	0.0356	0.0085	0.0020	301.3
July	3.0433	0.1560	0.1476	0.0352	0.0081	0.0022	326.6
Average	2.4297	0.1504	0.1286	0.0354	0.0083	0.0021	313.9
HGB Project Avg.	**2.0595**	**0.1206**	**0.1089**	**0.0349**	**0.0078**	**0.0020**	**300.4**
	Converted to lb/mile						
HGB Project Avg.	0.0045	2.66E-04	0.0002	7.69E-05	1.73E-05	4.4E-06	0.662

Source: Factors derived from EPA MOVES2014a modeling.

Table E3.2-13b: HGB Passenger Vehicle Emissions Factors – 2040

County/Month	HGB Emissions Factors(g/mile)						
Harris	**CO**	**NO_x**	**VOC**	**PM_{10}**	**$PM_{2.5}$**	**SO_2**	**CO_2 Eq.**
January	0.4313	0.0161	0.0438	0.0330	0.0058	0.0013	184.7
July	0.6788	0.0151	0.0513	0.0331	0.0058	0.0014	201.6
Average	*0.5551*	*0.0156*	*0.0475*	*0.0330*	*0.0058*	*0.0013*	*193.1*
Waller							
January	0.4868	0.0186	0.0570	0.0329	0.0059	0.0013	188.6
July	0.9080	0.0204	0.0661	0.0330	0.0060	0.0014	205.2
Average	*0.6974*	*0.0195*	*0.0616*	*0.0329*	*0.0060*	*0.0013*	*196.9*
HGB Project Avg.	***0.6262***	***0.0176***	***0.0546***	***0.0330***	***0.0059***	***0.0013***	***195.0***
	Converted to lb/mile						
HGB Project Avg.	***0.0014***	***3.87E-05***	***0.0001***	***7.27E-05***	***1.30E-05***	***2.9E-06***	***0.430***

Source: Factors derived from EPA MOVES2014a modeling.

Table E3.2-14a: DFW Passenger Vehicle Emissions Factors – 2025							
County/Month	**DFW Emissions Factors(g/mile)**						
Dallas	**CO**	**NO_x**	**VOC**	**PM_{10}**	**$PM_{2.5}$**	**SO_2**	**CO_2 Eq.**
January	1.4011	0.1081	0.0787	0.0346	0.0077	0.0018	270.3
July	2.1350	0.0936	0.1102	0.0342	0.0073	0.0020	298.7
Average	1.7680	0.1009	0.0945	0.0344	0.0075	0.0019	284.5
Ellis							
January	1.7904	0.1414	0.0962	0.0353	0.0084	0.0019	281.1
July	2.7202	0.1221	0.1328	0.0352	0.0083	0.0021	309.8
Average	2.2553	0.1318	0.1145	0.0353	0.0083	0.0020	295.5
DFW Project Avg.	***2.0117***	***0.1163***	***0.1045***	***0.0348***	***0.0079***	***0.0019***	***290.0***
	Converted to lb/mile						
DFW Project Avg.	0.0044	2.56E-04	0.0002	7.68E-05	1.74E-05	4.28E-06	0.639

Source: Factors derived from EPA MOVES2014a modeling.

Table E3.2-14b: DFW Passenger Vehicle Emissions Factors – 2040							
County/Month	**DFW Emissions Factors(g/mile)**						
Dallas	**CO**	**NO_x**	**VOC**	**PM_{10}**	**$PM_{2.5}$**	**SO_2**	**CO_2 Eq.**
January	0.5871	0.0291	0.0527	0.0326	0.0059	0.0013	186.3
July	0.8826	0.0247	0.0633	0.0327	0.0060	0.0014	205.7
Average	*0.7348*	*0.0269*	*0.0580*	*0.0327*	*0.0060*	*0.0013*	*196.0*
Ellis							
January	0.8258	0.0443	0.0636	0.0331	0.0064	0.0013	195.6
July	1.2070	0.0367	0.0760	0.0335	0.0067	0.0015	215.2
Average	*1.0164*	*0.0405*	*0.0698*	*0.0333*	*0.0066*	*0.0014*	*205.4*
DFW Project Avg.	***0.8756***	***0.0337***	***0.0639***	***0.0330***	***0.0063***	***0.0014***	***200.7***
	Converted to lb/mile						
DFW Project Avg.	***0.0019***	***7.43E-05***	***0.0001***	***7.27E-05***	***1.38E-05***	***3E-06***	***0.442***

Source: Factors derived from EPA MOVES2014a modeling.

Table E3.2-15a: 2025 Passenger Vehicle Emissions Reduction							
Emissions (TPY)							
VMT	**CO**	**NO_x**	**VOC**	**PM_{10}**	**$PM_{2.5}$**	**SO_2**	**CO_2 Eq.**
Houston Trip Emissions							
829,816,507	1,883.8	110.3	99.6	31.9	7.2	1.8	274,762
Dallas Trip Emissions							
730,057,145	1,618.9	93.6	84.1	28.0	6.4	1.6	233,362
TOTAL	**3,502.7**	**203.9**	**183.7**	**59.9**	**13.5**	**3.4**	**508,124**

Source: AECOM, 2016.

Table E3.2-15b: 2040 Passenger Vehicle Emissions Reduction							
Emissions (TPY)							
VMT	**CO**	**NO_x**	**VOC**	**PM_{10}**	**$PM_{2.5}$**	**SO_2**	**CO_2 Eq.**
Houston Trip Emissions							
1,357,881,279	937.3	26.3	81.7	49.4	8.8	2.0	291,898
Dallas Trip Emissions							
1,194,638,721	1,153.1	44.4	84.2	43.4	8.3	1.8	264,249
TOTAL	**2,090.4**	**70.7**	**165.8**	**92.8**	**17.1**	**3.8**	**556,147**

Source: AECOM, 2016.

NET OPERATIONAL EMISSIONS

The train operation emissions represent increases in emissions due to the proposed action. The vehicle emissions reduction represents emissions reduced by the proposed action. The vehicle VMT reduction emissions were subtracted from the train operation emissions to calculate the net emissions due to the proposed action. **Table E3.2-16** below shows the results using the 2024 and 2040 train operations emissions factors and the 2024 and 2040 passenger vehicles emissions reductions calculated above.

Table E3.2-16: Net Operational Emissions					
NO_x	**VOC**	**PM10**	**SO_2**	**CO**	**$CO_{2eq.}$**
Year 2024 (Initial Service Level)					
(160.3)	(178.3)	(53.9)	110.2	(3,464)	(375,808)
Year 2040 (Future Service Level)					
(53.8)	(161.4)	(89.7)	30.3	(2,060)	(459,401)

Source: AECOM, 2016.

As shown, there are net reductions of all the estimated criteria pollutants except SO_2. This is commonly the case in other high speed rail projects, comparing train power consumption emissions vs vehicle emissions[19,20,21]. This net increase in SO_2 occurs because electric power generation from coal produces significantly more SO_2 than other forms of power generation and passengers vehicles produce very little SO_2 due to the nature of the fuel, its refinement, and car emission controls. Even in places where coal constitutes a small percentage of power generation, such as California, power consumption for traction and station power still produces more SO_2 than vehicles eliminated by travel mode shift[22]. The emissions are relatively small, no counties in the project area are in nonattainment of the SO_2 standard, and the proposed action results in net reduction of all the other pollutants. The net result of the proposed action is that emissions for

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[19] California High-Speed Rail Authority and USDOT Federal Railroad Administration. 2012. FINAL California High-Speed Train Project Environmental Impact Report/Environmental Impact Statement, Merced to Fresno Section Project EIR/EIS

[20] Florida High-Speed Rail Authority and USDOT Federal Railroad Administration. 2005. Final Environmental Impact Statement. Florida High Speed Rail Tampa to Orlando.

[21] USDOT Federal Railroad Administration. 2011. Final Environmental Impact Statement and Final Section 4(f) Evaluation for the Proposed DesertXpress High-Speed Passenger Train Victorville, California to Las Vegas, Nevada

[22] ibid California High-Speed Rail Authority and USDOT Federal Railroad Administration 2012

most pollutants would be reduced over the long term. Therefore no adverse significant impact is expected from the proposed action.

GENERAL CONFORMITY OPERATIONAL EMISSIONS

The conformity analysis focuses on the criteria pollutants for which nonattainment is designated, and for the NAAs at both ends of the project alignment (HGB and DFW) and the one in the middle (Freestone-Anderson). Not all of the proposed project length is located in a NAA. Therefore, the emissions attributable to the NAAs in the project had to be estimated. The following describes the estimate of the portion of operational emissions that would occur in the HGB, DFW and Freestone-Anderson NAAs. It should be noted that the project only traverses through the Freestone County portion of the Freestone-Anderson NAA.

Train General Conformity Emissions

The general conformity (GC) regulations in 40 CFR 93, states at Rule 93.153(d)(1) that the portion of an action that includes major or minor new or modified stationary sources that require a permit under the new source review (NSR) program or the prevention of significant deterioration program of the CAA, is exempt from the GC rules. Power plants are permitted as stationary sources under these programs and emissions from them would therefore be exempt. Therefore, power plant emissions from electricity demand by the HSR train would be exempt. However, the operational analysis included the power plant emissions for demonstration, even though they do not technically apply to determining GC applicability. The emissions due to train and station power consumption of electricity from the power grid are relatively indirect effects spatially since they occur at distant power plants located away from the proposed project. These emissions would occur at the power plants meeting the operational demand at any particular time that the trains and stations are operating, which can be any number of regional power plants connected to the ERCOT grid. The interconnectivity and power demand management across the ERCOT sub-region make it impractical to identify or directly attribute the HSR power demand throughout the year to any particular set of power plants within ERCOT. The proposed substations would also be distributed along the HSR alignment across the 10 project counties, further complicating attribution to specific power plants.

However, assumptions can be made and analyzed about the fraction of power used by HSR operations being supplied by power plants in the NAA counties. The EPA eGRID database contains plant-level statistics by subregion that was used to calculate the fractions under two basic assumptions. The most current data (2012) was used.[23] The following summarizes those assumptions and the resulting effect on NAA NO_x, VOC, and SO_2 emissions.

Assumption 1: Uniform Demand on ERCOT Plants – This assumes the entire HSR operation draws power from the ERCOT grid uniformly, and the proportion of HSR power drawn from plants in the NAA reflects the percentage of annual power generated that the NAA plants generate compared to total ERCOT annual power generation. For this assumption, generation from the plants in all 8 HGB counties was used for the HGB percent, generation in the Freestone county power plant, and generation from all 10 DFW counties was used for the DFW percent. Drawing from NAA-wide

[23] U.S. Environmental Protection Agency (EPA). 2016. eGRID. Online database available at https://www.epa.gov/energy/egrid (Accessed February 2016)

plants was assumed because plants and power distribution to demand areas within the NAAs tend to be more regionally spread rather than concentrated in individual counties, larger plants that meet higher demands tend to be located in less populated counties, and such indirect emissions in non-project counties would still occur within the NAA. The emissions were calculated using the current and projected 2040 EFs, for comparison. The results are provided in **Tables E3-17a** and **b** below:

Table E3-17a: Assumption 1 Train Operation General Conformity Emissions - 2024									
Region	Annual Generated (MWh)	% of ERCOT MWh	Portion of Annual HSR Power Consumption	Annual Emissions (tons)					
				Current EFs			2040 EFs		
ERCOT	360,221,517			NOx	VOC	SO_2	NOx	VOC	SO_2
DFW NAA	28,859,992	8%	30,329	9	1	-	3	0.4	-
HGB NAA	76,009,178	21%	79,879	24	2	-	9	1.1	-
Freestone NAA (SO_2 only)	12,593,140	3%	13,234	-	-	13		-	4.0

Source: AECOM, 2016.

Table E3-17b: Assumption 1 Train Operation General Conformity Emissions - 2040									
Region	Annual Generated (MWh)	% of ERCOT MWh	Portion of Annual HSR Power Consumption	Annual Emissions (tons)					
				Current EFs			2040 EFs		
ERCOT	360,221,517			NOx	VOC	SO_2	NOx	VOC	SO_2
DFW NAA	28,859,992	8%	37,426	**11**	**1**	**-**	**1**	**0.4**	**-**
HGB NAA	76,009,178	21%	98,570	**30**	**3**	**-**	**4**	**0.9**	**-**
Freestone NAA (SO_2 only)	12,593,140	3%	16,331	**-**	**-**	**16**	**-**	**-**	**1.2**

Source: AECOM, 2016.

Assumption 2: Station and TMF on Location, Traction Along Alignment – This assumes that the traction power of the HSR operation draws power uniformly from plants along the alignment evenly. However, the station, TMFs, and a maintenance-of-way (MOW) facility associated with each TMF, which comprise 28 percent of the daily demand, are assumed to draw from plants in their respective locations. The major stations in Houston and Dallas, which are in NAAs comprise 17 percent of the FSL daily demand, while the mid-point station in Grimes, representing 2 percent of the daily demand is not in an NAA. There are no stations in the Freestone NAA. The TMFs which together comprise 11 percent of the FSL daily demand are at the Dallas and Houston ends of the project. The other train components, such MOW facilities along the alignment, and signaling houses comprise 14 percent of FSL daily demand, are evenly distributed along the alignment, and are included with traction power in the calculation and apportionment. The percentages of daily demand for the ISL scenario are very similar to those for the FSL. The results are provided in **Table E3-18** below.

Table E3-18: Assumption 2 Train Operation General Conformity Emissions

Table E3-18a: Trackside Power Consumption				
Component	ISL		FSL	
	% Daily Demand	Portion of Annual HSR Power Consumption	% Daily Demand	Portion of Annual HSR Power Consumption
Traction	45%	172,029	56%	260,610

MOW	3%	13,184	3%	13,184
Switching & subs	11%	42,081	9%	42,081
Signaling	3%	10,156	2%	10,156
Totals	63%	237,449	70%	326,031

Source: AECOM, 2016.

Table E3-18b: Distribution on Plants Along Alignment

County	NAA	%	Portion of Trackside Consumption ISL	FSL
Dallas	DFW	17%	39,575	54,338
Ellis	DFW	17%	39,575	54,338
Freestone	FRE	17%	39,575	54,338
Limestone	-	17%	39,575	54,338
Grimes	-	17%	39,575	54,338
Harris	HGB	17%	39,575	54,338
	Totals	100%	237,449	326,031
		DFW Total	79,150	108,677
		HGB Total	39,575	54,338
		FRE Total	39,575	54,338

Source: AECOM, 2016.

Table E3-18c: Station and Maintenance Facilities

Facility	NAA	% Daily Demand	Portion of Annual HSR Power Consumption
ISL (Year 2024)			
Dallas Station	DFW	10.6%	40,126
Houston Station	HGB	10.6%	40,126
Grimes Station	-	3%	11,306
Dallas TMF + 1 MOW	DFW	6.5%	24,777
Houston TMF + 1 MOW	HGB	6.5%	24,777
	Totals	37%	141,113
		DFW Total	64,903
		HGB Total	64,903
FSL (Year 2040)			
Dallas Station	DFW	8.6%	40,126
Houston Station	HGB	8.6%	40,126
Grimes Station	-	2%	11,306
Dallas TMF + 1 MOW	DFW	5.3%	24,777
Houston TMF + 1 MOW	HGB	5.3%	24,777
	Totals	30%	141,113
		DFW Total	64,903
		HGB Total	64,903

Source: AECOM, 2016.

Table E3-18d: DFW and HGB NAA Total Trackside, Station, & TMF Power and Emissions					
		Portion of Annual HSR Power Consumption	Annual Emissions (tons)		
			NOx	VOC	SO_2
ISL (Year 2024)					
Current Emissions Factors	DFW	144,053	43.8	3.8	
	HGB	104,478	31.8	2.7	
	FRE	39,575			38.1
2024 EFs	DFW	16.6	2.0		16.6
	HGB	12.0	1.5		12.0
	FRE			11.9	
FSL (Year 2040)					
Current Emissions Factors	DFW	173,580	52.8	4.5	
	HGB	119,242	36.3	3.1	
	FRE	54,338			64.6
2040 EFs	DFW	173,580	6.3	1.6	
	HGB	119,242	4.3	1.1	
	FRE	54,338			4.0

Source: AECOM, 2016.

As shown, in none of the assumptions of distribution or assumptions of emissions factors do the annual emissions apportioned to the DFW or HGB NAAs exceed the *de minimis* thresholds of 100 tons for a moderate NAA, nor do those apportioned to the Freestone NAA exceed the *de minimis* thresholds of 100 tons for its nonattainment designation. Texas power plants in the future would continue to improve emissions and derive a greater percentage of power from non-combustion sources; therefore, they would more closely reflect the projected 2024 and 2040 emissions than emissions with current EFs. Even absent of the improvements, train operation emissions would not be expected to exceed *de minimis* thresholds for NO_x, VOC, or SO_2.

Vehicle Emissions Reduction General Conformity Emissions

Since vehicle emissions are directly tied to the vehicle travel producing the emissions, those emissions occurring in NAAs can be more readily estimated geographically than power plant emissions. The segments of IH-45 within the DFW, HGB and FRE NAAs used to conduct the city center-to-city center trips discussed in Table 3-37 above would be the location where such emissions would take place. These are emissions within the NAAs that would have occurred in the absence of the HSR. The geospatial data used in the vehicle emissions reduction analysis was used to calculate the segment lengths in the HGB NAA, in the DFW NAA, and in the FRE NAA. IH-45 passes through the counties listed in **Tables E3-19a** through **f** below. Conceptually, the vehicle activity in each NAA would be comprised of local cars leaving, then returning to the NAA, and visiting cars arriving then departing the NAA through the associated lengths of IH-45 for the HGB and DFW NAAs. For the FRE NAA, conceptually, the vehicle activity would be comprised of cars passing through Freestone County from Dallas going to Houston and vice versa. The segment lengths, arriving/leaving assumptions and numbers of annual vehicles from **Table E3.2-9**, were used to calculate the VMT. The same EFs and methodology described in Vehicle Emissions

Reduction section were then used to calculate the emissions. **Tables E3-19a** through **f** below provides the results of the estimated emissions.

Table E3-19: Vehicle Emissions Reduction General Conformity Emissions

Table E3-19a: DFW NAA IH-45 Miles and VMT		
Dallas County miles	17.9	
Ellis County miles	23.5	
Total length in NAA	41.4	
Dallas vehicle travel miles leaving for Houston	41.4	
Dallas vehicle travel miles returning from Houston	41.4	
Total Dallas vehicle trip miles	82.8	
	ISL	**FSL**
Dallas no. of vehicles	1,527,316	2,499,244
Dallas vehicle VMT	126,400,689	206,837,449
Houston vehicle miles arriving	41.4	
Houston vehicle miles departing	41.4	
Total Houston vehicle trip miles	82.8	
	ISL	**FSL**
Houston no. of vehicles	1,736,018	2,840,756
Houston vehicle VMT	143,672,833	235,100,951
DFW NAA VMT	**270,073,522**	**441,938,400**

Source: AECOM, 2016.

Table E3-19b: DFW NAA Vehicle Emissions Reduction	
Emissions (TPY)	
NOx	**VOC**
ISL (2024)	
34.63	31.10
FSL (2040)	
12.23	28.71

Source: AECOM, 2016.

Table E3-19c: HGB NAA IH-45 Miles and VMT		
Montgomery County miles	27.9	
Harris County miles	56.8	
Total length in NAA	84.6	
Houston vehicle miles leaving for Dallas	84.6	
Houston vehicle miles returning from Dallas	84.6	
Total Houston vehicle trip miles	169.2	
	ISL	**FSL**
Houston no. of vehicles	1,736,018	2,840,756
Houston vehicle VMT	293,803,652	480,769,514
Dallas vehicle miles arriving	84.6	
Dallas vehicle miles departing	84.6	
Total Dallas vehicle trip miles	169.2	
	ISL	**FSL**
Dallas no. of vehicles	1,527,316	2,499,244

Dallas vehicle VMT	258,482,994	422,972,086
HGB NAA VMT	**552,286,646**	**903,741,600**

Source: AECOM, 2016.

Table E3-19d: HGB NAA Vehicle Emissions Reduction	
HGB Emissions (TPY)	
NOx	**VOC**
ISL (2024)	
73.39	66.28
FSL (2040)	
25.02	58.71

Source: AECOM, 2016.

Table E3-19e: FRE NAA IH-45 Miles and VMT		
Freestone County miles	31.9	
Dallas veh. miles heading for Houston	31.9	
Dallas veh. miles returning from Houston	31.9	
Total Dallas veh. trip pass through miles	63.8	
	ISL	**FSL**
Dallas no. vehicles	1,527,316	2,499,244
Dallas vehicle VMT	97,442,774	159,451,779
Houston veh. miles heading for Dallas	31.9	
Houston veh. miles returning from Dallas	31.9	
Total Houston veh. trip pass through miles	63.8	
	ISL	**FSL**
Houston # veh.	1,736,018	2,840,756
Houston veh. VMT	110,757,935	181,240,221
FRE NAA VMT	**208,200,709**	**340,692,000**

Source: AECOM, 2016.

Table E3-19f: FRE NAA Vehicle Emissions Reduction
FRE Emissions SO_2 (TPY)
ISL (2024)
0.45
FSL (2040)
0.50

Source: AECOM, 2016.

Net General Conformity Emissions

Using the 2024 and 2040 train operation emissions and vehicle emissions reduction for each NAA, the net operational emissions within each NAA was calculated with the two assumptions of train power draw on the power grid discussed above. The results are provided in **Table E3-20** and **Table E3-21** below. Under the assumption that the train draws uniformly from the ERCOT power grid, there would be net reductions in all pollutants. Under the assumption that the train draws power from stations along the track evenly and stations and TMFs draw from plants in the counties of their location, net reductions in all pollutants except NO_x were estimated. The increase in NO_x is comparatively negligible and well below the current moderate nonattainment threshold of 100 TPY. Considering these results, operational emissions of the regulated pollutants in NAAs due to the proposed action are below *de minimis* thresholds and a general conformity determination is not necessary.

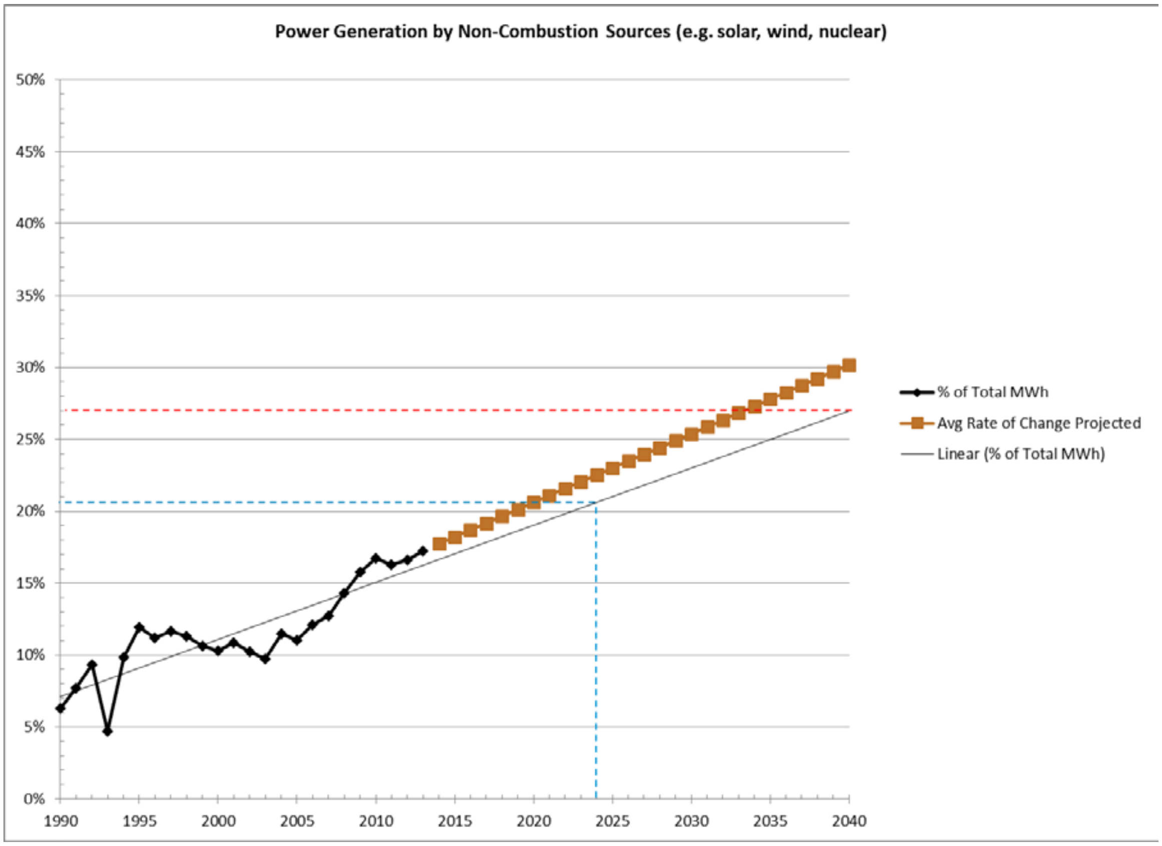
Table E3-20: Net General Conformity Emissions – 2024 (ISL)									
	Train Operation Emissions (tons)			Vehicle Emissions Reduction (TPY)			Net Emissions (TPY)		
NAA	NOx	VOC	SO_2	NOx	VOC	SO_2	NOx	VOC	SO_2
Assumption 1 – Uniform ERCOT Power									
DFW	3.5	0.4		34.6	31.1		-31.1	-30.7	
HGB	9.2	1.1		73.4	66.3		-64.2	-65.2	
FRE			4.0			0.45			3.52
Assumption 2 – Station and TMF on Location, Traction Along Alignment									
DFW	16.6	2.0		34.6	31.1		-18.1	-29.1	
HGB	12.0	1.5		73.4	66.3		-61.4	-64.8	
FRE			11.9			0.45			11.4

Source: AECOM, 2016.

Table E3-21: Net General Conformity Emissions – 2040 (FSL)									
	Train Operation Emissions (tons)			Vehicle Emissions Reduction (TPY)			Net Emissions (TPY)		
NAA	NOx	VOC	SO_2	NOx	VOC	SO_2	NOx	VOC	SO_2
Assumption 1 – Uniform ERCOT Power									
DFW	1.4	0.4		12.2	28.7		-10.9	-28.4	
HGB	3.6	0.9		25.0	58.7		-21.5	-57.8	
FRE			1.2			0.50			0.69
Assumption 2 – Station and TMF on Location, Traction Along Alignment									
DFW	6.3	1.6		12.2	28.7		-6.0	-27.1	
HGB	4.3	1.1		25.0	58.7		-20.7	-57.6	
FRE			4.0			0.50			3.5

Source: AECOM, 2016.

Figure E3.2-1: Texas Power Generation by Non-Combustion Sources



Source: EIA, Table 5 Electric power industry generation by primary energy source, 1990 through 2013 for State of Texas

Figure E3.2-2

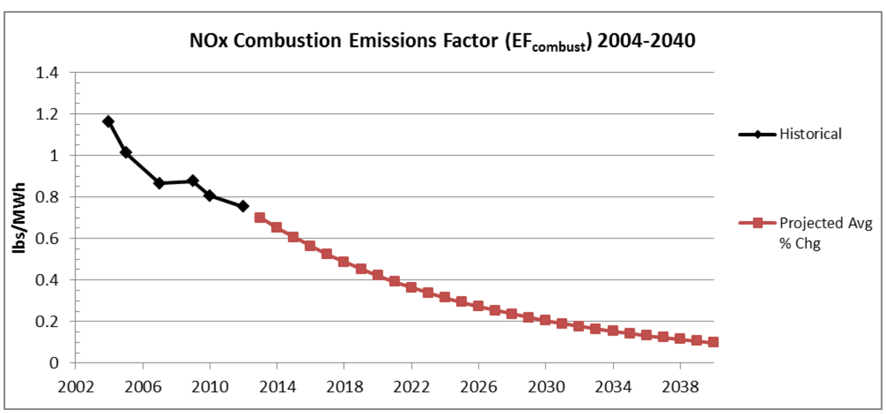


Figure E3.2-3

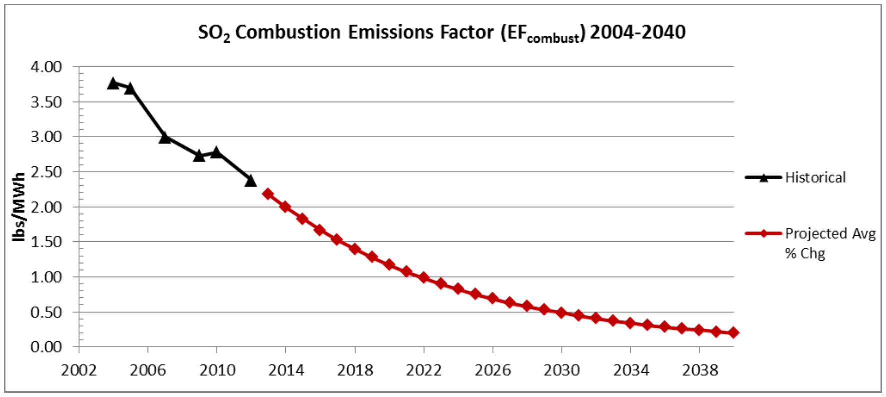


Figure E3.2-4

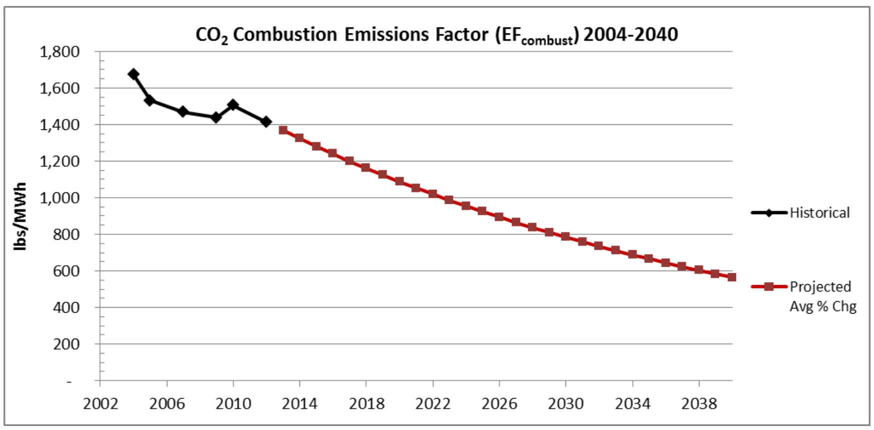


Figure E3.2-5

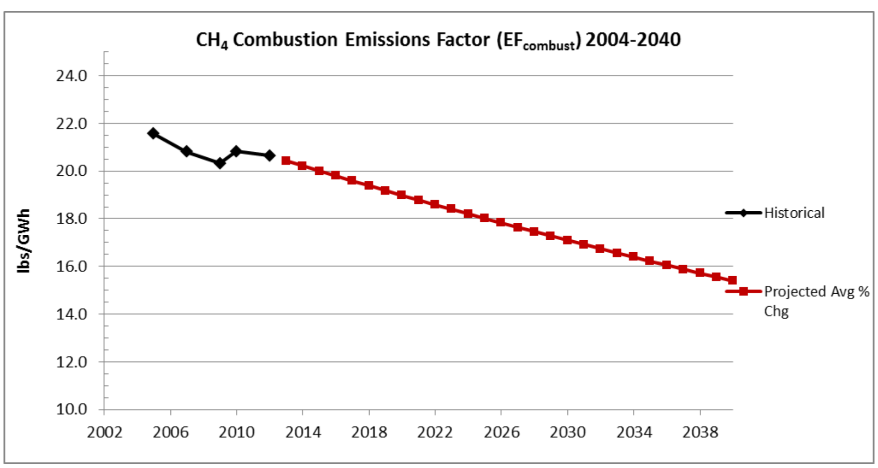


Figure E3.2-6

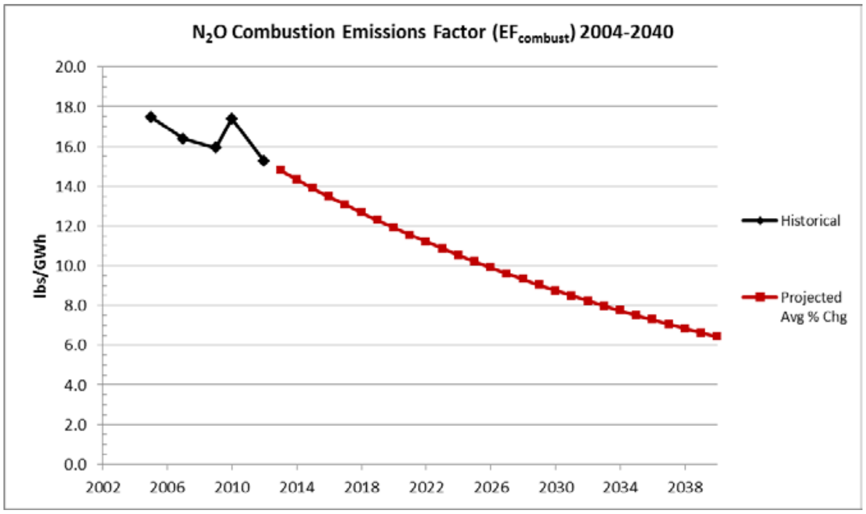


Figure E3.2-7

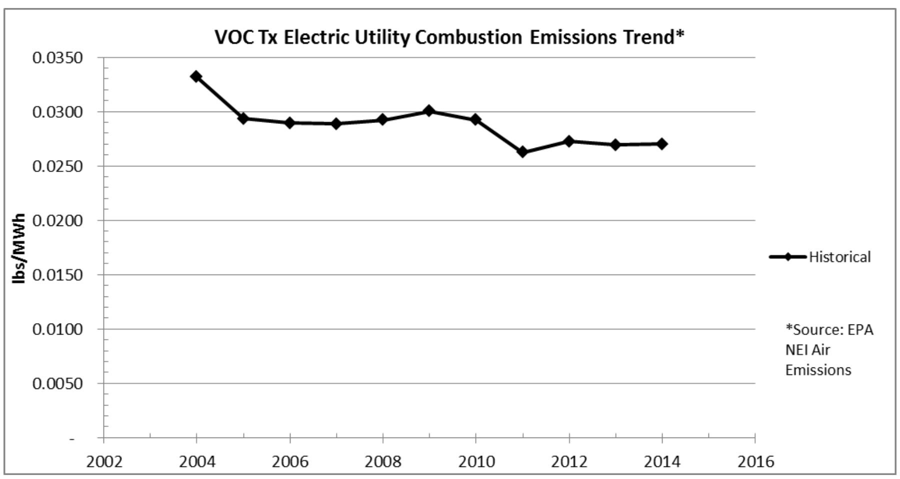


Figure E3.2-8

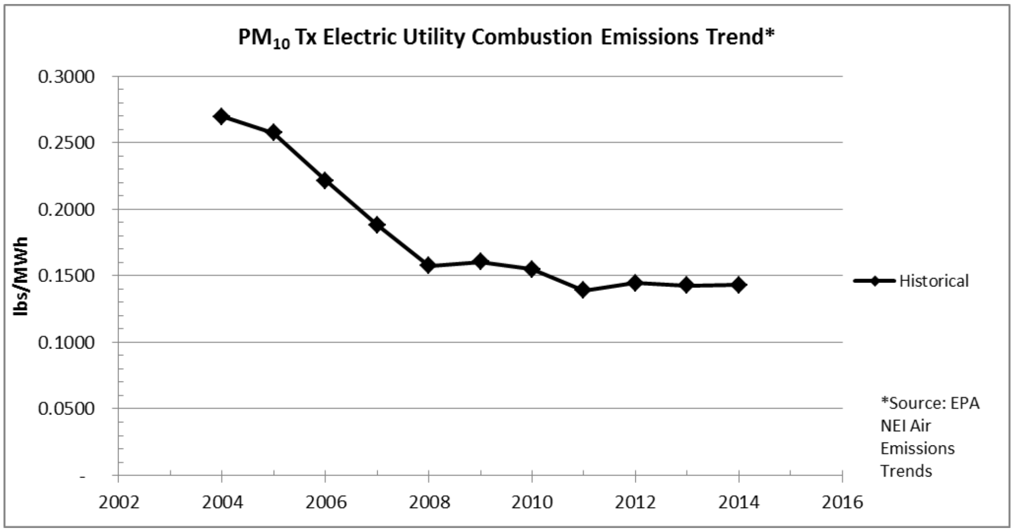
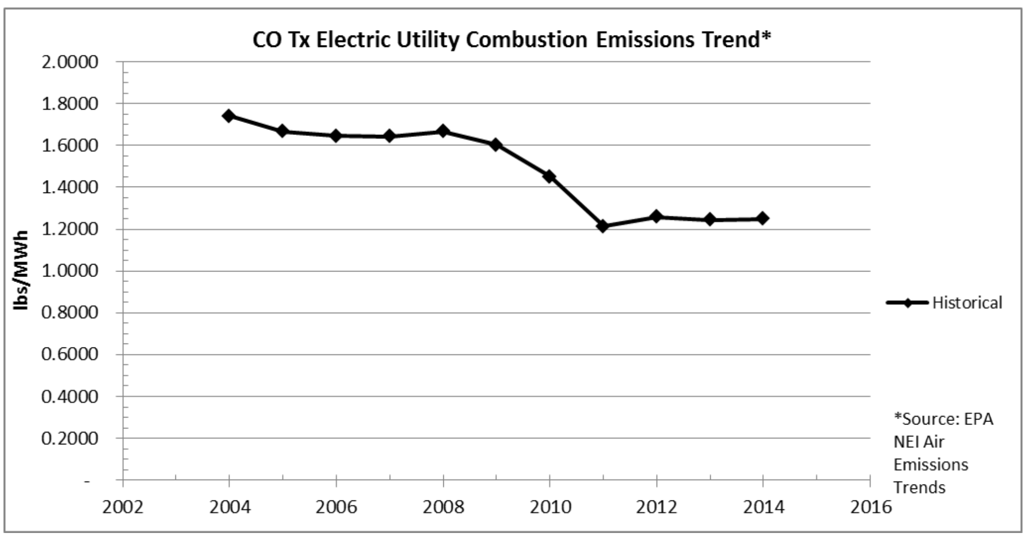


Figure E3.2-9



AECOM

TECHNICAL MEMORANDUM
NOISE AND VIBRATION

To: Jerry Smiley, AICP, AECOM

From: Lance Meister and David Towers, Cross Spectrum Acoustics

Date: November 1, 2017

RE: Dallas to Houston HSR –Noise and Vibration

Introduction

This technical report describes the existing noise and vibration conditions and impact analysis for operation and construction of the Dallas to Houston High-Speed Rail (HSR) Project along six alternative routes (A-F) through ten counties between Dallas and Houston, TX. Sensitive receptors or receivers along these routes include residential and institutional sites.

Regulatory Context

Several federal laws and guidelines are relevant to the assessment of ground transportation noise impacts:

- FRA Railroad Noise Emission Compliance Regulations (49 C.F.R.§ 210) prescribes minimum compliance regulations for enforcement of the Railroad Noise Emission Standards established by the Environmental Protection Agency in 40 C.F.R. Part 201
- The Noise Control Act of 1972 (42 U.S.C.§ 4910) was the first comprehensive statement of national noise policy. It declared "it is the policy of the U.S. to promote an environment for all Americans free from noise that jeopardizes their health or welfare."
- HUD Environmental Standards (24 C.F.R. Part 51) establishes standards for noise exposure used to assess the suitability of sites for new residential development
- OSHA Occupational Noise Exposure; Hearing Conversation Amendment (FR 48 (46), 9738—9785) establishes noise exposure limits in the work place
- EPA Railroad Noise Emission Standards (40 C.F.R. Part 201) establishes standards for noise emissions from railroads

For vibration, federal standards for safe vibration levels for residential buildings are limited to the safe blasting levels established by the U.S. Bureau of Mines (USBM RI 8507).

There are no state-wide noise or vibration regulations that apply to transportation systems. The TxDOT *Guidelines for Analysis and Abatement of Roadway Traffic Noise* applies to vehicular traffic. Texas does not have separate guidance for rail noise and vibration.

Local noise and vibration regulations are contained in city ordinances and general plans. Although noise and vibration from transportation systems are typically exempt from local regulations, noise and vibration from project construction activities and stationary sources (e.g., traction power substations) shall comply with the following local regulations:

City of Lancaster

Ordinance #2006-04-13 of the Lancaster Development Code includes environmental performance standards for both noise and vibration. Section 14.704 of the ordinance specifies noise limits of 56 dBA during daytime hours (7 AM – 7 PM) and 49 dBA during nighttime hours (7 PM – 7 AM) near property lines, which could be applied to stationary sources. Although there are no specific noise limits for construction activities, such noise is restricted to the hours between 6 AM and 9 PM. In addition, Section 14.708 of the ordinance includes property-line vibration standards based on frequency and ground displacement that could be applied to construction activities.

City of Wilmer

Section 8.06 of the Wilmer Code of Ordinances includes property-line limits on environmental sound levels from stationary sources in terms of A-weighted, statistical percentile noise metrics measured over a 10-minute to 30-minute period. These metrics include the L_1 (level exceeded 1 percent of the period), the L_{10} (level exceeded 10 percent of the period) and the L_{90} (level exceeded 90 percent of the period). The L_1 (near maximum) noise level from stationary sources is limited to 15 dBA above the ambient L_{90} (background) noise level. There are also L_{10} and L_{90} limits based on land use and time of day. For residential land use, the L_{10} and L_{90} limits are 65 dBA and 55 dBA, respectively, during daytime hours (7AM – 10 PM) and 60 dBA and 50 dBA, respectively, during nighttime hours (10 PM – 7 AM). For construction work, the L_{10} and L_{90} limits are 85 dBA and 75 dBA, respectively, at any time.

City of Houston

Chapter 30 of the City of Houston Code of Ordinances specifies noise limits of 65 dBA and 58 dBA at residential property lines for daytime and nighttime periods, respectively. However, noise from railroad equipment on railroad ROWs is exempted. Noise from construction between the hours of 7 AM and 8 PM is also exempted, provided the noise levels do not exceed 75 dBA at residential property lines.

Overview

For the No Build Alternative, existing sources throughout the study area (e.g. highways and freight trains) would continue to generate noise and vibration in the future. In addition, noise and vibration levels may increase, depending on changes in highway and rail traffic as well as the construction of any new transportation facilities unrelated to the Project. While there is insufficient information currently available to determine if there would be any noise or vibration impacts in the future from these and other sources, any significant projects that might be included in the No Build Alternative would have a separate environmental assessment to determine noise or vibration impacts and potential mitigation measures, if required.

As a summary of the assessment for the Build Alternatives with no mitigation, **Table 1-1** provides a comparison of the projected noise and vibration impacts from HSR operations by Build Alternative and land use. As shown in the table, HSR operations are projected to result in severe noise impacts at 15-19 residences and moderate noise impacts at 231-261 residences, depending on the route. In addition, moderate noise impact is predicted at one institutional site for all alternatives. No vibration impact is predicted from HSR operations for any of the Build Alternatives, and no noise or vibration impacts are anticipated due to activities at any of the proposed train station locations.

Table 1-1: Comparison of Noise and Vibration Impacts by Build Alternative							
Type of Impact		**Alt A**	**Alt B**	**Alt C**	**Alt D**	**Alt E**	**Alt F**
Severe Noise Impact	Residential	17	19	15	17	19	15
	Institutional	0	0	0	0	0	0
Moderate Noise Impact	Residential	247	261	242	236	250	231
	Institutional	1	1	1	1	1	1
Vibration Impact	Residential	0	0	0	0	0	0
	Institutional	0	0	0	0	0	0

Source: Cross-Spectrum Acoustics, 2016

With regard to the effects of noise from passing trains on animals, noise impact would be expected to occur only within about 15 feet from the tracks for HSR trains operating on viaduct at the maximum speed of 205 mph. Because no animals would be this close to the tracks, noise impact on wildlife is not anticipated. Similarly, increased annoyance due to the startle effect of noise from rapidly passing trains at the maximum train speed of 205 mph would only occur within about 45 feet from the tracks, which is within the ROW. Therefore, increased noise annoyance due to startle should not be an issue.

In terms of HSR noise mitigation, the results of the assessment indicate that that the impact locations tend to be scattered geographically such that the use of sound barriers as a practical mitigation measure may be limited. However, the application of sound barriers at specific locations will be investigated as the engineering design advances and the alternatives are refined. Where sound barriers are not practical, building sound insulation would be the most likely noise mitigation alternative.

The results of the vibration impact assessment indicate that no impacts are projected from HSR operations. Therefore, no operational vibration mitigation is required.

During Project construction, the potential for noise impact at residential sites would extend to distances of 40-200 feet from daytime construction and to distances of 125-630 feet from nighttime construction, depending on the activity. Although some activities may cause noticeable ground-borne vibration, it is unlikely that such activities would occur close enough to sensitive structures to have any significant damage effects. However, there is some potential for vibration annoyance or interference with the use of sensitive equipment at locations up to 500 from certain construction activities. To mitigate potential construction noise and vibration impacts, construction activities will be carried out in compliance with all applicable local regulations and appropriate mitigation measures will be applied.

NOISE AND VIBRATION CONCEPTS

This section describes the characteristics of transportation-related noise and vibration and the associated noise and vibration metrics.

Noise

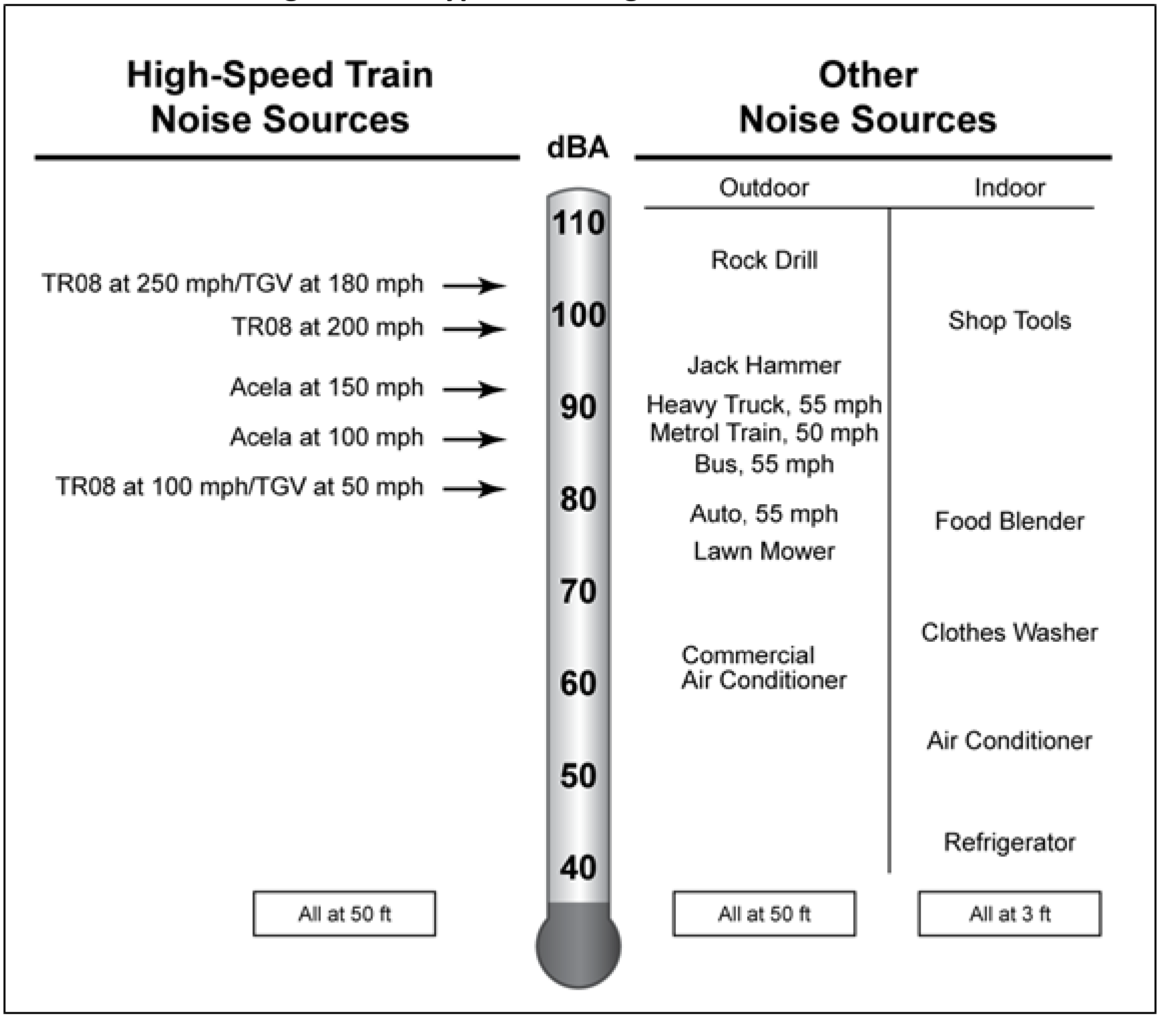
Noise Fundamentals and Descriptors

Sound is mechanical energy transmitted by pressure waves in a compressible medium such as air. Noise is generally defined as unwanted or excessive sound. Environmental noise sources may include traffic, aircraft, industrial activities, other human activity, or sounds in nature. Distant sources of noise combine to create background noise. Background noise may be fairly constant from moment to moment, and varies gradually from hour to hour as the activity levels of the distant noise sources change. Superimposed on the background noise is a succession of identifiable noisy events of relatively brief duration that are either near to a receiver or are of sufficiently high amplitude to dominate the noise environment at a location. Examples include the passing of a train, the over-flight of an airplane, the sound of a horn or siren, the barking of a dog, landscape maintenance activities, or the screeching of brakes. The descriptors used in the measurement of noise environments are summarized below.

Sound can vary in intensity by over one million times within the range of human hearing. Because the range of actual sound pressures is so large (e.g. the sound pressure of a painful sound can be over one million times the sound pressure of the quietest sound that a human can hear), sound intensity is normally presented in a more manageable range by using the ratio between the sound pressure of the source of interest (e.g., passenger and freight trains) or background noise and a reference pressure (which approximates the quietest sound that a human can hear), and expressing this ratio in logarithmic form. The basic unit for measuring environmental sound levels is the decibel (dB).

Sound is characterized by both its amplitude and frequency (or pitch). The human ear does not hear all frequencies equally. In particular, the ear deemphasizes low and very high frequencies. In the 1930s, acoustical scientists studied the way that humans hear various sounds and developed response characteristics to represent the sensitivity of a typical ear. The “A” curve or “A-weighting scheme” represents the sensitivity of the human ear to various frequencies of environmental noise. A-weighting tends to deemphasize sounds of very low or very high frequencies and emphasize sound at middle frequencies. Sound levels that have been weighted according to the A-curve are expressed as A-weighted decibels (dBA). On this scale, the human range of hearing extends from approximately 3 dBA to around 140 dBA. **Figure 2–1** presents examples of A-weighted sound levels from high-speed train sources and common indoor and outdoor sounds.

Figure 2–1: Typical A-Weighted Sound Levels



Source: FRA, "High-Speed Ground Transportation Noise and Vibration Impact Assessment," Final Report DOT/FRA/ORD-12/15, September 2012.

As noted above, sounds in the environment constantly change. Various noise descriptors have been developed to allow the comparison of different types of environmental noise and to define noise emissions. The descriptors used in this report are described below:

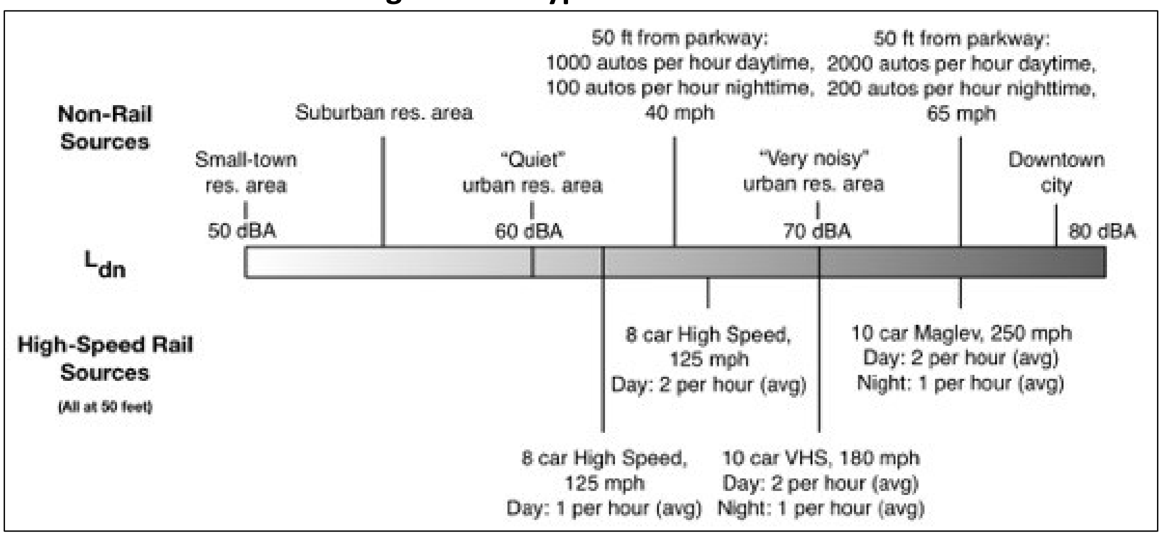
Maximum Sound Level (Lmax): The Lmax is the highest noise level achieved during a noise event or measurement period. Standard sound level meters have two settings, FAST and SLOW, which represent different time constants. For trains, Lmax measured using the FAST setting will typically be 1 to 3 dB greater than Lmax using the SLOW setting. Lmax values expressed in this report refer to the SLOW setting, which uses a time constant of 1 second.

Sound Exposure Level (SEL): The SEL describes a receiver's cumulative noise exposure from a single noise event. It is represented by the total A-weighted sound energy during the event, normalized to a one-second interval. It is the primary descriptor for low- and high-speed rail vehicle noise emissions, and is also a useful intermediate quantity for estimating the Leq and Ldn due to train pass-bys.

Equivalent Sound Level (Leq): Leq describes a receptor's cumulative noise exposure from noise events that occur during a specified period of time. It is sometimes referred to as the energy-average sound level. The Leq represents a constant sound that, over a specified period, has the same sound energy as the time-varying sound. The Hourly Equivalent Sound Level, Leq(h), is a measure of the accumulated sound exposure over a full hour. The Federal Highway Administration (FHWA) uses the peak traffic Leq(h) as the metric for establishing highway noise impact. The Federal Railroad Administration (FRA) uses Leq(h) to evaluate potential noise impacts to institutional land uses and to land uses where serenity and quiet are essential.

Day-Night Sound Level (Ldn): Ldn describes the cumulative noise exposure from those noise events that occur within a 24-hour period, with noise levels between 10 p.m. and 7 a.m. increased by 10 dB to account for greater nighttime sensitivity to noise. The effect of the penalty is that, when calculating Ldn, any event that occurs during the nighttime is equivalent to 10 of the same event during the daytime. Ldn is the most common measure of total community noise over a 24-hour period and is used by the Federal Railroad Administration (FRA) to evaluate potential noise impacts from proposed high-speed train projects at residential locations. Typical Ldn values for high-speed rail and non-rail sources are shown in **Figure 2-2**.

Figure 2–2: Typical Ldn Values

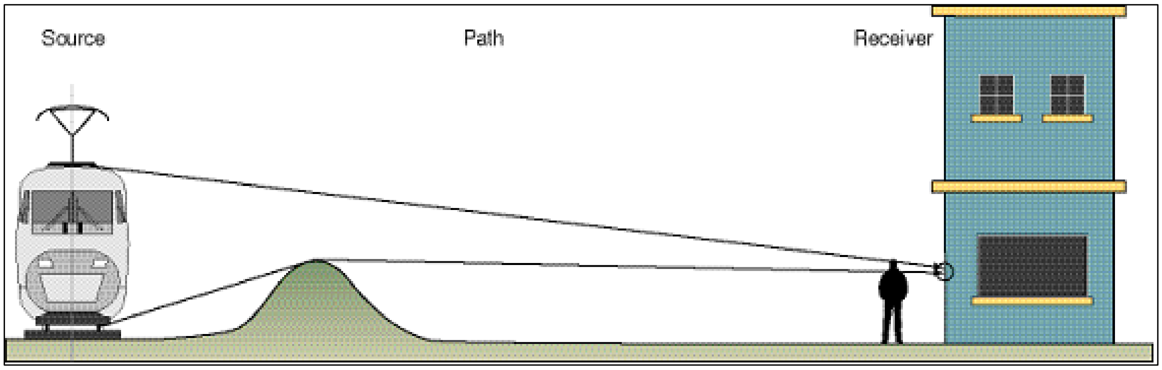


Source: FRA, "High-Speed Ground Transportation Noise and Vibration Impact Assessment," Final Report DOT/FRA/ORD-12/15, September 2012.

<u>Transportation Noise</u>

Highways and rail lines tend to be the most dominant noise sources when located in a typical community environment. Each source has distinctive noise characteristics with regard to both pitch and amplitude. Within the project area, areas along both sides of the proposed alignment would be exposed to existing highway and rail noise. Noise from a source can be evaluated in terms of a Source-Path-Receiver framework, as illustrated in **Figure 2–3**, in which the source of noise is a train moving on its tracks. The path describes the intervening course between the source and the receiver, wherein the noise levels are reduced by distance, topographical and man-made obstacles, reflections from surfaces, atmospheric effects, and other factors. At each receiver, the noise from all sources and source paths combines and comprises the noise environment at that location.

Figure 2–3: Source-Path-Receiver



Source: FRA, "High-Speed Ground Transportation Noise and Vibration Impact Assessment," Final Report DOT/FRA/ORD-12/15, September 2012.

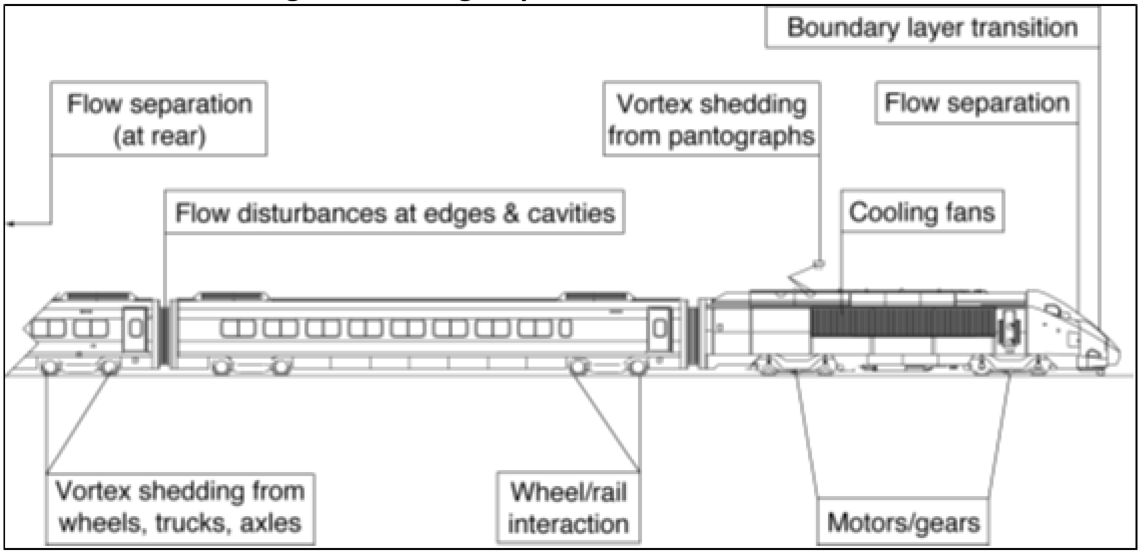
The noise from a train moving on its tracks is produced by several individual noise-generating mechanisms, each with its own characteristics (in terms of location, intensity, frequency content, directivity, and speed dependence) that depend on the train type. The most common train types include freight, commuter rail, light rail and high-speed rail. Conventional train noise sources would include locomotives, wheel/rail interaction, and audible warning devices at grade crossings, including train horns and warning bells.

For high speed rail, train noise characteristics are speed-dependent. For speeds below about 40 miles per hour (mph), referred to as Regime I by FRA guidance, noise emissions are dominated by the propulsion units, cooling fans, and under-car and top-of-car auxiliary equipment, such as compressors and air conditioning units.

In the speed range from 60 mph to about 150 mph, referred to as Regime II, mechanical noise, resulting from wheel/rail interaction and structural vibrations, dominates the noise emission from trains. In the project area, existing trains seldom exceed 79 mph; therefore, this speed range is the top end of noise characteristics for trains with which most people are familiar.

The aerodynamic noise component begins to be an important factor when the train speed exceeds about 160 mph (referred to as Regime III). Aerodynamic noise is generated from high-velocity airflow over the train. For a conventional steel-wheeled train, the components of aerodynamic noise are generated by unsteady flow separations at the front and rear of the train and on structural elements of the train (mainly in the regions encompassing the trucks, the pantograph, inter-coach gaps, and discontinuities along the surface), and a turbulent boundary layer generated over the entire surface of the train. The distribution of noise sources on a typical high-speed train is shown in **Figure 2–4**.

Figure 2–4: High-Speed Train Noise Sources



Source: FRA, "High-Speed Ground Transportation Noise and Vibration Impact Assessment," Final Report DOT/FRA/ORD-12/15, September 2012.

Noise from trains also depends on the type and configuration of the track structure. Typical noise levels refer to conventional rail operations at grade on ballast and tie track. For trains on elevated structures, train noise is increased, partially due to the loss of sound absorption by the ground and partially due to extra sound radiation from the bridge structure. Moreover, the sound from trains on elevated structures spreads about twice as far as it does from at-grade operations of the same train, because the sound source is higher above the ground and, therefore, is less affected by ground attenuation and shielding.

Horns are an example of a train noise source that is dominant at any train speed. Audible warning devices at grade crossings, including train horns and warning bells, are a common feature of conventional trains and a vital safety component of railroad operations. Persons living near railroad tracks often find horns to be annoying.

Another source of potential annoyance is wheel squeal that is produced by wheel-rail interaction, particularly on a curve where the radius of curvature is smaller than 100 times the truck length. According to the predecessor to FTA, a typical truck length for freight trains of about 5-1/2 feet (1.7 meters) and radius of curvature greater than 560 feet (170 meters) would not be expected to produce wheel squeal. Wheel squeal is normally an issue with transit systems where small-radius curves often occur. Freight trains and modern high-speed train tracks are typically designed to minimize this occurrence by limiting track curvature and incorporating design features such as canting at the curve to reduce wheel flange contact with the rail.

Noise from road traffic is generated by a wide variety of vehicle types, makes, and models. In general, the noise associated with highway vehicles can be divided into three vehicle classes: automobiles, medium trucks, and heavy trucks. Each class has its own noise characteristics depending on vehicle type, speed, and the condition of the roadway surface. These noise characteristics have been documented by FHWA. The noise from nearby and distant arterial streets and highways is a major source of background sound in an urban/suburban environment.

Ground-borne Vibration

Vibration Fundamentals and Descriptors

Ground-borne vibration from trains refers to the fluctuating or oscillatory motion experienced by persons on the ground and in buildings near railroad tracks. Vibration can be described in terms of displacement, velocity, or acceleration. Displacement is the easiest descriptor to understand. For a vibrating floor, the displacement is simply the distance that a point on the floor moves away from its static position. Velocity represents the instantaneous speed of the floor movement, and acceleration is the rate of change of the speed. Although displacement is easier to understand, the response of humans, buildings, and equipment to vibration is more accurately described using velocity or acceleration.

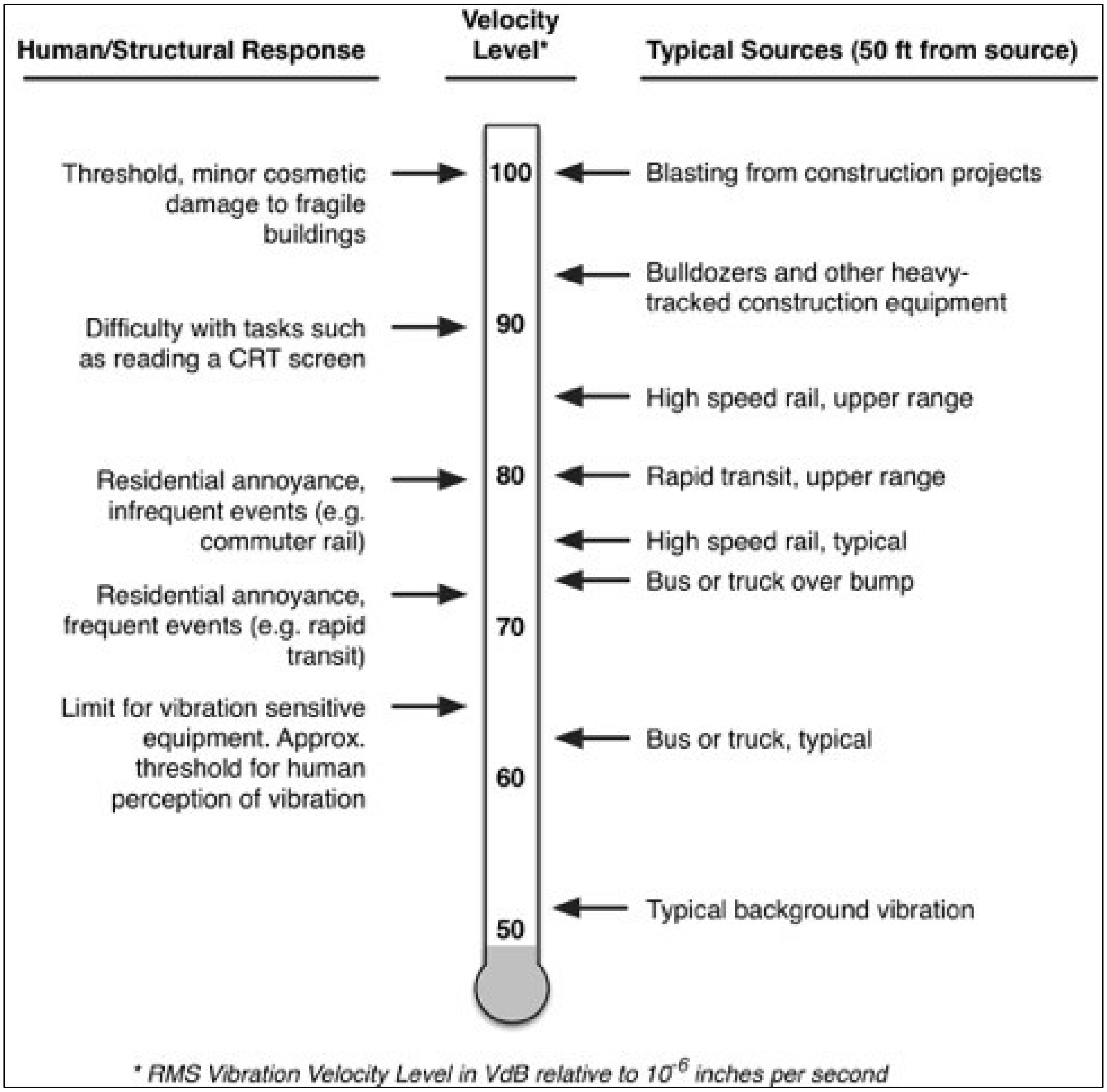
Two methods are used for quantifying vibration. The peak particle velocity (PPV) is defined as the maximum instantaneous positive or negative peak of the vibration signal. PPV often is used in monitoring of blasting vibration, since it is related to the stresses experienced by buildings. Although PPV is appropriate for evaluating the potential of building damage, it is not suitable for evaluating human response. It takes some time for the human body to respond to vibration impulses. In a sense, the human body responds to an average of the vibration amplitude. Because the net average of a vibration signal is zero, the root mean square (RMS) amplitude is used to describe the "smoothed" vibration amplitude.

PPV and RMS velocities are normally described in inches per second in the U.S. and in meters per second in the rest of the world. Although it is not universally accepted, decibel notation is in common use for vibration. Decibel notation compresses the range of numbers required to describe vibration. Vibration levels in this report are referenced to 1 x 10-6 inches per second (in/sec). Although not a universally accepted notation, the abbreviation "VdB" is used in this document for vibration decibels to reduce the potential for confusion with sound decibels.

Common vibration sources and human and structural response to ground-borne vibration are illustrated in **Figure 2-5**. Typical vibration levels can range from below 50 VdB to 100 VdB (0.000316 in/sec to 0.1 in/sec). The human threshold of perception is approximately 65 VdB.

Ground-borne noise is a low-volume, low-frequency rumble inside buildings, resulting when ground vibration causes the flexible walls of the building to resonate and generate noise. Ground-borne noise is normally not a consideration when trains are elevated or at grade. In these situations, the airborne noise usually overwhelms ground-borne noise, so the airborne noise level is the major consideration. However, ground-borne noise becomes an important consideration where there are sections of the corridor that are in a tunnel or where sensitive interior spaces are well-isolated from the airborne noise. In these situations, airborne noise is not a major path and ground-borne noise becomes the most important path into the building. Ground-borne noise may also need to be considered in cases where the airborne noise from a project is mitigated by a sound wall.

Figure 2-5: Typical Levels of Ground-borne Vibration



Source: FRA, "High-Speed Ground Transportation Noise and Vibration Impact Assessment," Final Report DOT/FRA/ORD-12/15, September 2012.

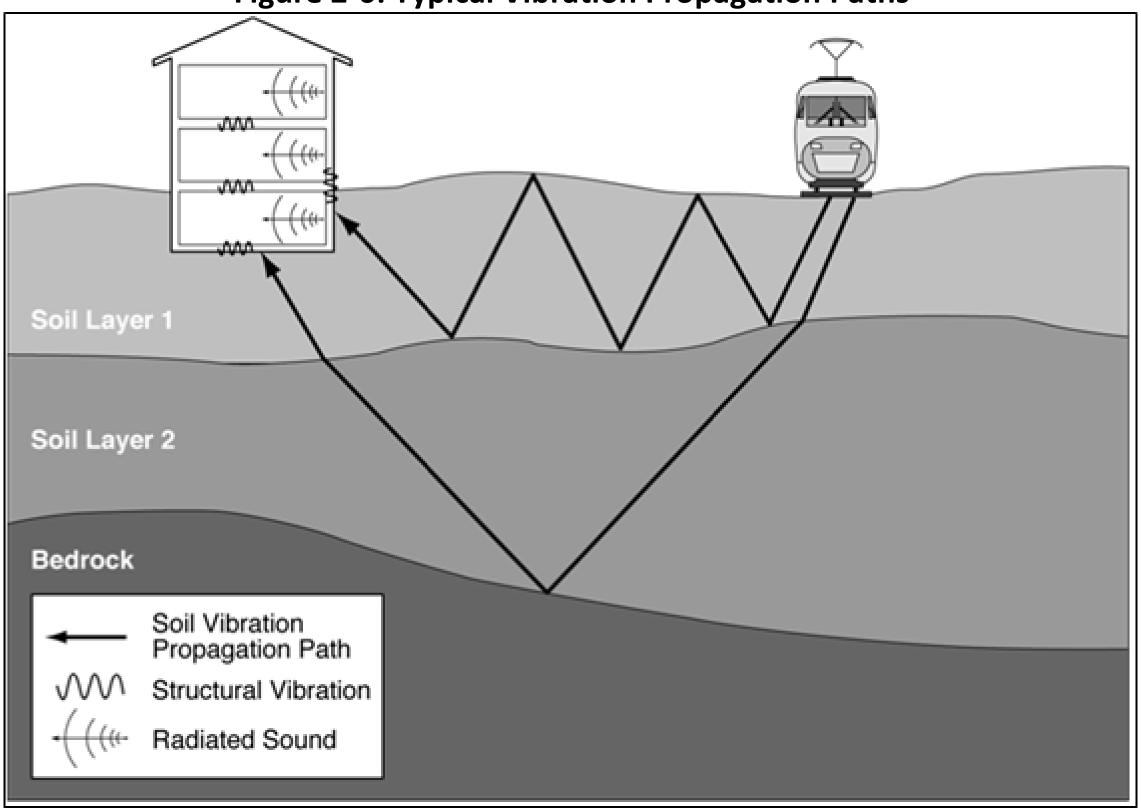
<u>Transportation Vibration</u>

The interaction of steel wheels rolling on steel rails causes vibration that is transmitted through the ground and into nearby buildings. Of concern to many building occupants is that the resulting building vibration could damage the building structure. In fact, the vibration from steel wheel/steel rail systems is almost always well below the vibration thresholds used to protect even fragile historic buildings from minor cosmetic damage. However, there are several different ways in which the building vibration may be intrusive and annoying to building occupants. First, the vibratory motion of room surfaces may felt. Second, the vibration may cause rattling of dishes and bric-a-brac on shelves, items hanging on walls, or windows. Third, the surfaces put into motion by ground-borne vibration will radiate sound that may be audible as a low-frequency rumbling noise that sometimes is akin to distant thunder.

The amount of energy generated by the wheels rolling on the track and then transmitted into the ground depends on factors such as the smoothness of the wheels and rails, the vehicle suspension system, and the track support system. The same speed-dependent vibration generation mechanisms are common to conventional and high-speed trains. Vibration levels increase with speed although the rate of the increase varies. A common assumption for high-speed trains is that the vibration levels are proportional to 20 times the logarithm of speed. For example, when train speed increases from 75 mph to 125 mph, the expected increase in ground-borne vibration is 4.4 VdB if all other conditions are the same.

As with noise, a source-path-receiver relationship exists for vibration. Vibration experienced at the receiver is a function of the magnitude of the source and the path that the vibration takes to get to the receiver, as shown in **Figure 2-6**. High-frequency vibration decays more rapidly than low-frequency vibration as the vibrational energy passes through the ground. Soil conditions have a strong influence on the attenuation of ground-borne vibration. For the purposes of high-speed rail assessments, vibration is reported in terms of vibration velocity level or VdB, which is the maximum RMS vibration velocity level using a decibel reference of 1µin/sec (1×10^{-6} in/sec).

Figure 2-6: Typical Vibration Propagation Paths



Source: FRA, "High-Speed Ground Transportation Noise and Vibration Impact Assessment," Final Report DOT/FRA/ORD-12/15, September 2012.

NOISE AND VIBRATION CRITERIA

Noise and vibration impact guidelines have been adopted by the FRA that prescribe methods for analyzing and assessing noise and vibration impacts. The impact criteria are based on maintaining a noise environment considered acceptable for land uses where noise may have an effect. The FRA guidance manual provides noise and vibration criteria for both construction and operation as described below.

Construction Noise Impact Criteria

Table 3-1 presents the FRA general assessment criteria for construction noise. The criteria are given in terms of 1-hour Leq for residential, commercial and industrial land use. The 1-hour Leq is estimated by combining the noise levels from the two noisiest pieces of equipment, assuming they both operate at the same time during a one-hour period. The construction noise limits are normally assessed at the noise-sensitive receiver property line.

Table 3-1: FRA General Assessment Criteria for Construction Noise

Land Use	1-Hour Leq (dBA)	
	Day	Night
Residential	90	80
Commercial	100	100
Industrial	100	100

Source: FRA, "High-Speed Ground Transportation Noise and Vibration Impact Assessment," Final Report DOT/FRA/ORD-12/15, September 2012.

Construction Vibration Impact Criteria

Guidelines in the FRA guidance manual provide the basis for the construction vibration assessment. FRA provides construction vibration criteria designed primarily to prevent building damage, and to assess whether vibration might interfere with vibration-sensitive building activities or temporarily annoy building occupants during the construction period. The FRA criteria include two ways to express vibration levels: (1) root-mean-square (RMS) VdB for annoyance and activity interference, and (2) peak particle velocity (PPV), which is the maximum instantaneous peak of a vibration signal used for assessments of damage potential.

To avoid temporary annoyance to building occupants during construction or construction interference with vibration-sensitive equipment inside special-use buildings, such as a magnetic resonance imaging (MRI) machine, FRA recommends using the long-term vibration criteria provided below in the section on operational vibration impact assessment criteria.

Table 3-2 shows the FRA building damage criteria for construction activity; the table lists PPV limits for four building categories. These limits are used to estimate potential problems that should be addressed during final design.

Table 3-2: Construction Vibration Damage Criteria		
Building Category	**PPV (inch/sec)**	**Approximate L_v***
I. Reinforced concrete, steel, or timber (no plaster)	0.5	102
II. Engineered concrete and masonry (no plaster)	0.3	98
III. Non-engineered timber and masonry buildings	0.2	94
IV. Buildings extremely susceptible to vibration damage	0.12	90
* RMS vibration velocity level in VdB relative to 1 micro-inch/second.		

Source: FRA, "High-Speed Ground Transportation Noise and Vibration Impact Assessment," Final Report DOT/FRA/ORD-12/15, September 2012.

Operational Noise Impact Criteria

The U.S. Department of Transportation has published guidelines that establish procedures for analyzing and assessing noise and vibration impacts from rail projects. Noise impact criteria have been adopted by the Federal Transit Administration (FTA) to assess the contribution of noise from conventional rail systems to the existing environment and by the Federal Railroad Administration (FRA) to assess the contribution of noise from high-speed rail systems to the existing environment. These guidelines include impact criteria that are based on maintaining a noise environment considered acceptable for land uses where noise may have an effect. The noise exposure is measured in terms of the Day-Night Sound Level (Ldn) for residential land uses or in terms of the hourly equivalent sound level (Leq(h)) for other land uses.

Ldn depends on the number of events during the day and night separately – and also on each event's duration, which is affected by vehicle speed. The FRA and FTA have adopted Ldn as the measure of cumulative noise impact for residential land uses (those involving sleep), because:

- L_{dn} correlates well with the results of attitudinal surveys of residential noise impact,
- L_{dn} increases with the duration of transit events, which is important to people's reaction,
- L_{dn} takes into account the number of transit events over the full 24 hours, which is also important to people's reaction,
- L_{dn} takes into account the increased sensitivity to noise at night when most people are asleep,
- L_{dn} allows composite measurements to capture all sources of community noise combined,
- L_{dn} allows quantitative comparison of transit noise with other types of community noises,
- L_{dn} is the designated metric of choice of other Federal agencies such as the Department of Housing and Urban Development (HUD), the Federal Aviation Administration (FAA), and the Environmental Protection Agency (EPA), and
- L_{dn} has wide international acceptance.

Hourly Leq is adopted by FRA and FTA as the measure of cumulative noise impact for non-residential land uses (those not involving sleep) because:

- L_{eq} correlates well with speech interference in conversation and on the telephone – as well as interruption of TV, radio, and music enjoyment,

- L_{eq} increases with the duration of events, which is important to people's reaction,
- L_{eq} takes into account the number of events over the hour, which is also important to people's reaction, and
- L_{eq} is used by the Federal Highway Administration in assessing highway-traffic noise impact.

Thus, the hourly Leq noise descriptor can be used to compare and contrast modal alternatives such as highway versus rail. Leq is computed for the loudest facility hour during noise-sensitive activity at each particular non-residential land use.

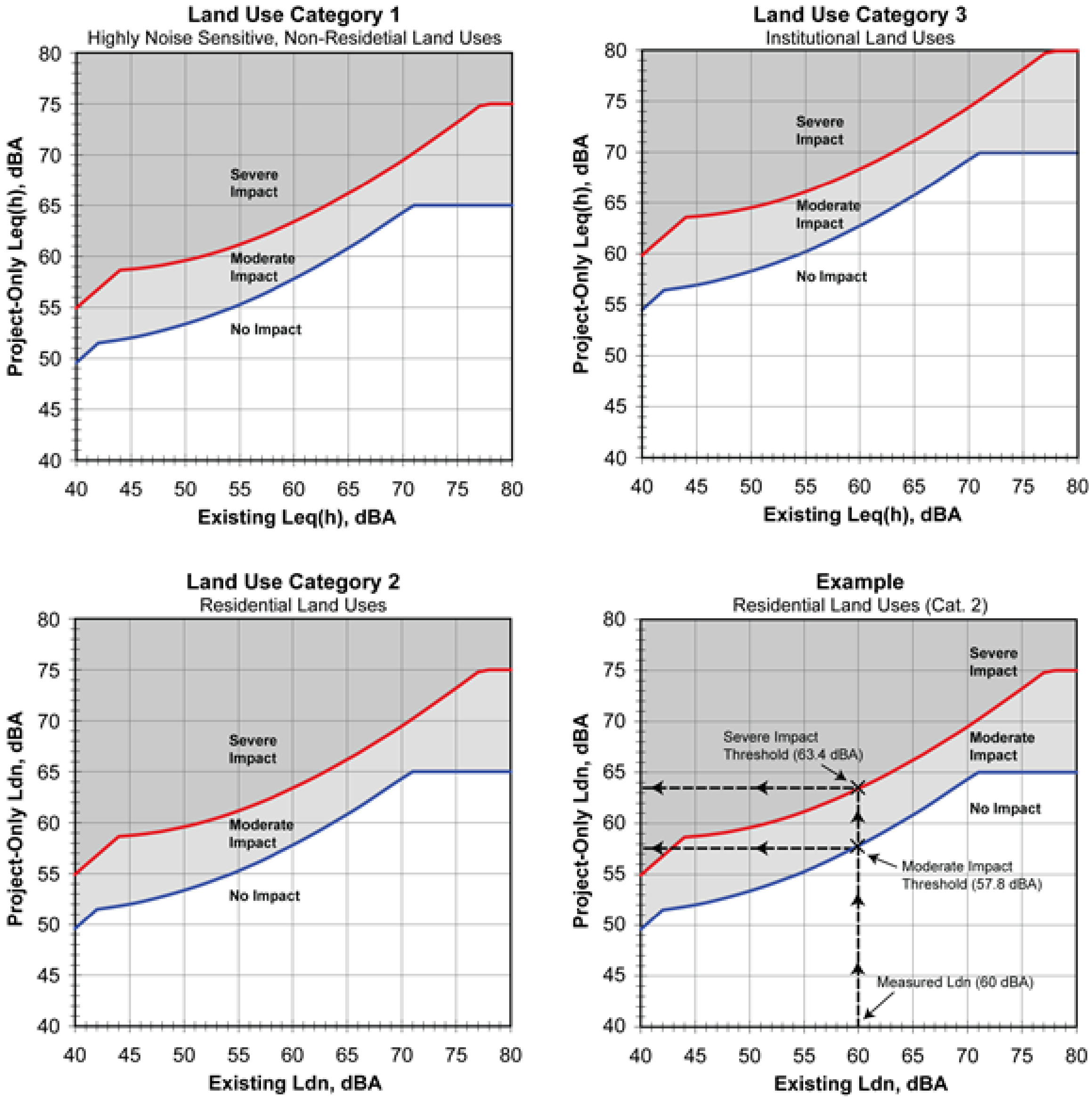
The noise impact criteria are defined by the two curves shown in **Figure 3-**1. These criteria are based on change in noise exposure using a sliding scale. Although higher project noise levels are allowed in areas with high levels of existing noise, smaller increases in total noise exposure are allowed with increasing levels of existing noise. Furthermore, the criteria curves incorporate a maximum limit for project noise. The FRA noise impact criteria include the following three levels of impact, as shown in **Figure 3-1**:

- **No Impact:** In this range, the proposed project is considered to have negligible impact since, on average, the introduction of the project will result in an insignificant increase in the number of people highly annoyed by the new project noise.

- **Moderate Impact:** At the moderate impact range, changes in the cumulative noise level are noticeable to most people, but may not be sufficient to cause strong, adverse reactions from the community. In this transitional area, other project-specific factors must be considered to determine the magnitude of the impact and the need for mitigation, such as the existing level, predicted increase over existing noise levels and the types and numbers of noise-sensitive land uses affected.

- **Severe Impact:** At the severe impact range, a significant percentage of people would be highly annoyed by the new project noise. Severe noise impacts are considered to be “significant” under NEPA, and should be avoided if possible. Noise mitigation should be applied for severe impacts where feasible.

Figure 3–1: Noise Impact Criteria for Transit and High-Speed Rail Projects



Source: FRA, "High-Speed Ground Transportation Noise and Vibration Impact Assessment," Final Report DOT/FRA/ORD-12/15, September 2012.

The magnitude of impact is assessed by comparing the project noise exposure to the existing noise exposure for three land use categories. Descriptions of these categories are given in **Table 3–3**. The noise exposure is measured in terms of Ldn for residential land uses and in terms of Leq(h) for other land uses. The exterior noise criteria are to be applied outside the building locations for residential land use and at either the property line or the nearest point of use for parks and other significant outdoor use. It is important to note that the criteria specify a comparison of future project noise with existing noise and not with projections of future "no-build" noise exposure.

Table 3–3: Federal Railroad Administration Land Use Categories and Metrics for High-Speed Train Noise Impact Assessments		
Land Use Category	**Noise Metric (dBA)**	**Land Use Category**
1	Outdoor $L_{eq}(h)^*$	Tracts of land where quiet is an essential element in their intended purpose. This category includes lands set aside for serenity and quiet, and such land uses as outdoor amphitheaters and concert pavilions, as well as National Historic Landmarks with significant outdoor use.
2	Outdoor L_{dn}	Residences and buildings where people normally sleep. This category includes homes, hospitals where nighttime sensitivity to noise is assumed to be of utmost importance.
3	Outdoor $L_{eq}(h)^*$	Institutional land uses with primarily daytime and evening use. This category includes schools, libraries, and churches, where it is important to avoid interference with such activities as speech, meditation, and concentration. Buildings with interior spaces where quiet is important, such as medical offices, conference rooms, recording studios, and concert halls fall into this category, as well as places for meditation or study associated with cemeteries, monuments, and museums. Certain historical sites, parks, and recreational facilities are also included.
* L_{eq} for the noisiest hour of transit-related activity during hours of noise sensitivity.		

Source: FRA, "High-Speed Ground Transportation Noise and Vibration Impact Assessment," Final Report DOT/FRA/ORD-12/15, September 2012.

The process of determining impact severity is to first determine land use from **Table 3–3**. The land use category determines the noise metric that should be used to determine level of impact (Ldn for Category 2, and Leq(h) for Category 1 and Category 3 land uses). The next step is to draw a vertical line at the value of the existing exterior noise exposure (including existing train traffic and all other community noise sources) for the property from the bottom axis of **Figure 3–1**. The impact thresholds are where the vertical line intersects the moderate and severe impact threshold curves.

The concept of a sliding scale for noise impact is difficult to grasp and may be clarified by the example illustrated in the bottom right graph in **Table 3–1**. Assume that the existing noise has been measured to be 60 dBA Ldn. This is the total noise from all existing noise sources over a 24-hour period: traffic, aircraft, lawn mowers, children playing, birds chirping, etc. Starting at 60 dBA on the horizontal axis, follow the vertical line up to where it intersects the moderate and severe impact curves. Then refer to the left axis to read off the impact thresholds. As shown in the example, an existing noise level of 60 dBA Ldn gives thresholds of 57.8 dBA Ldn for moderate impact and 63.4 dBA Ldn for severe impact. Note that the values are given in tenths of a decibel to avoid confusion from rounding off; in reality it is not possible to perceive a tenth of a decibel change in sound level.

The thresholds of 57.8 dBA and 63.4 dBA are for the project noise. If the predicted project noise is greater than 57.8 dBA Ldn, then there is moderate impact and noise mitigation must be considered. If the predicted project noise exceeds 63.4 dBA Ldn, then there is severe impact and, as discussed above, noise mitigation must be included in the project unless there are compelling reasons why mitigation is unfeasible.

To supplement the noise impact criteria in **Figure 3-1**, FRA provides guidelines for identifying noise-sensitive locations where increased annoyance can occur due to the sudden increase in noise (the startle effect) from the rapid approach of high-speed trains. This effect depends on the train speed and is confined to an area very close to the tracks. For example, 200 mph train operations would have the potential for increased annoyance within about 40 feet of the track centerline. Thus, the area where rapid onset rates of train noise may cause startle is typically within the right-of-way limits of the rail corridor.

FRA also addresses impacts on wildlife (mammals and birds) and domestic animals (livestock and poultry). Noise exposure limits for each are an SEL of 100 dBA from passing trains, as shown in **Table 3-4**.

Table 3-4: FRA Interim Criteria for Train Noise Effects on Animals

Animal Category	Class	Noise Metric	Noise Level (dBA)
Domestic	Mammals (Livestock)	SEL	100
	Birds (Poultry)	SEL	100
Wild	Mammals	SEL	100
	Birds	SEL	100

Source: FRA, "High-Speed Ground Transportation Noise and Vibration Impact Assessment," Final Report DOT/FRA/ORD-12/15, September 2012.

<u>Operational Vibration Impact Criteria</u>

FRA vibration impact levels, expressed in terms of the maximum root-mean-square (RMS) vibration level, are affected by the receptor land-use category and the number of vibration events per day. The impact level also depends on the type of analysis being conducted (i.e., ground-borne vibration or ground-borne noise).

The FRA manual states that the vibration impact thresholds are based on the maximum vibration level (Lmax) as a train passes. Lmax is defined to be the maximum average vibration level over a 1-second interval using RMS averaging. Most studies of train vibration report the RMS average vibration level over the period when trains are passing the measurement position. A more rigorous definition is the RMS average vibration level between the points where the vibration level is greater than Lmax-3, which are also defined as the "3 dB down points." The RMS average vibration level is defined as Lplateau.

FRA provides guidelines to assess the human response to different levels of ground-borne noise and vibration. These are shown in **Table 3–5**. In addition, the guidelines provide criteria for special buildings that are sensitive to ground-borne noise and vibration. The impact criteria for these special buildings are shown in **Table 3–6**. The criteria depend on land use category as well as the frequency of the vibration events (e.g. train pass-bys). "Frequent Events" is defined as more than 70 vibration events per day, "Occasional Events" is defined as 30-70 vibration events per day while "Infrequent Events" is defined as less than 30 vibration events per day.

Table 3-5: Ground-borne Vibration and Noise Impact Criteria						
Land Use Category	**Ground-Borne Vibration Impact Levels (VdB re 1 micro-inch /sec)**			**Ground-Borne Noise Impact Levels (dBA re 20 micro Pascals)**		
	Frequent Events	**Occasional Events**	**Infrequent Events**	**Frequent Events**	**Occasional Events**	**Infrequent Events**
Category 1: Buildings where vibration would interfere with interior operations.	65 VdB*	65 VdB*	65 VdB*	N/A**	N/A**	N/A**
Category 2: Residences and buildings where people normally sleep.	72 VdB	75 VdB	80 VdB	35 dBA	38 dBA	43 dBA
Category 3: Institutional land uses with primarily daytime use.	75 VdB	78 VdB	83 VdB	40 dBA	43 dBA	48 dBA

* This criterion limit is based on levels that are acceptable for most moderately sensitive equipment such as optical microscopes. For equipment that is more sensitive, a Detailed Vibration Analysis must be performed.
** Vibration-sensitive equipment is generally not sensitive to ground-borne noise.

Source: FRA, "High-Speed Ground Transportation Noise and Vibration Impact Assessment," Final Report DOT/FRA/ORD-12/15, September 2012.

Table 3-5 and **Table 3-6** include separate FRA criteria for ground-borne noise (the "rumble" that radiates from the motion of room surfaces in buildings from ground-borne vibration). Although the criteria are expressed in dBA, which emphasizes the more audible middle and high frequencies, the criteria are significantly lower than airborne noise criteria to account for the annoying low-frequency character of ground-borne noise. Because airborne noise often masks ground-borne noise for above-ground (i.e., at-grade or elevated) alignments, ground-borne noise criteria apply primarily to operations in a tunnel, where airborne noise is not a factor, and to buildings with sensitive interior spaces that are well insulated from exterior noise.

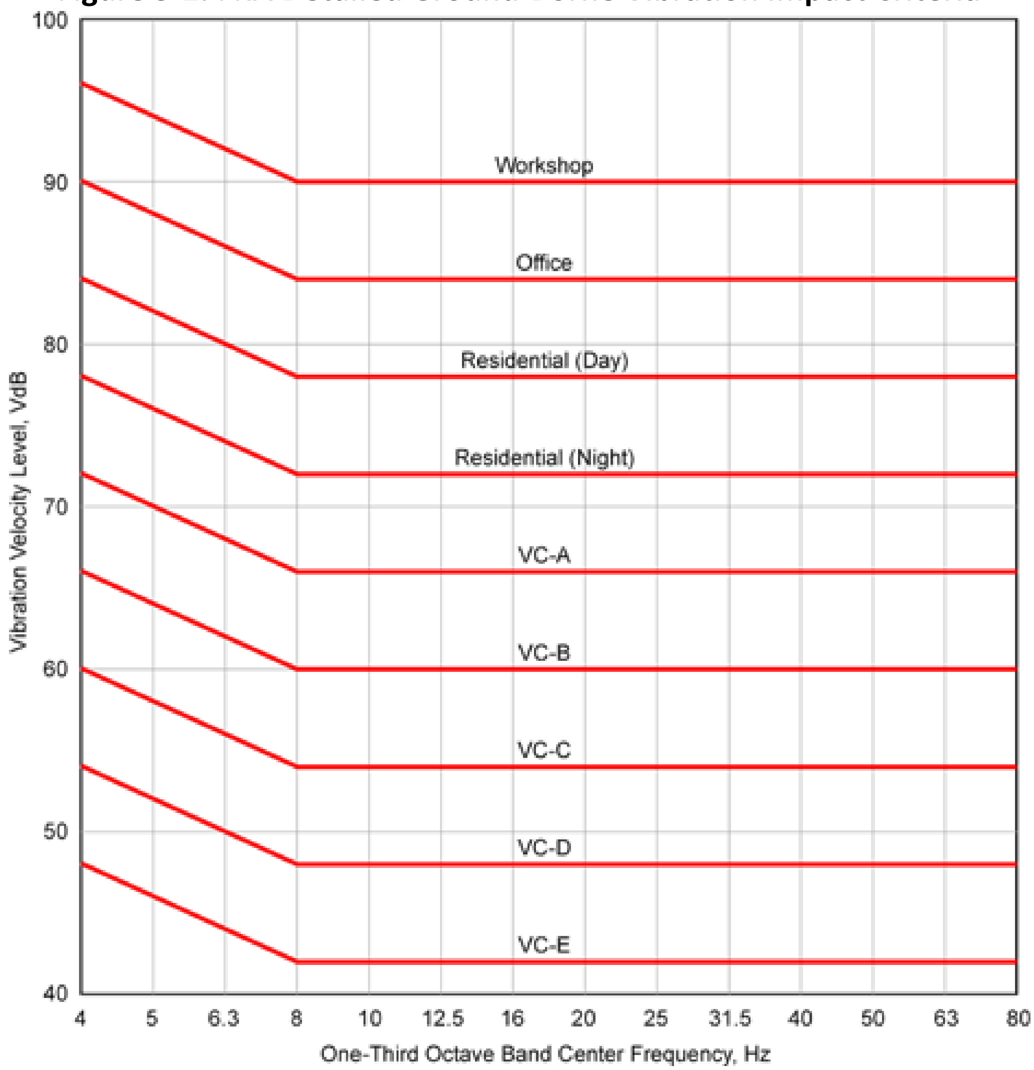
Table 3-6: Ground-borne Vibration and Noise Impact Criteria for Special Buildings				
Type of Building or Room	**Ground-Borne Vibration Impact Levels (VdB re 1 micro-inch/sec)**		**Ground-Borne Noise Impact Levels (dBA re 20 micro-Pascals)**	
	Frequent Events	**Occasional or Infrequent Events**	**Frequent Events**	**Occasional or Infrequent Events**
Concert Halls	65 VdB	65 VdB	25 dBA	25 dBA
TV Studios	65 VdB	65 VdB	25 dBA	25 dBA
Recording Studios	65 VdB	65 VdB	25 dBA	25 dBA
Auditoriums	72 VdB	80 VdB	30 dBA	38 dBA
Theaters	72 VdB	80 VdB	35 dBA	43 dBA

Source: FRA, "High-Speed Ground Transportation Noise and Vibration Impact Assessment," Final Report DOT/FRA/ORD-12/15, September 2012.

Specification of mitigation measures requires more detailed information and more refined impact criteria using the frequency distribution, or spectrum of the vibration energy. A detailed vibration analysis uses impact criteria in terms of the 1/3-octave band frequency spectrum. A detailed vibration analysis has been conducted for the Dallas to Houston High-Speed Rail assessment. **Figure 3-2** shows the FRA detailed ground-borne vibration impact criteria used in assessing this project's impacts.

The criteria in **Figure 3-2** are based on exceedances of the 1/3-octave band vibration levels over the frequency range of 8 to 80 Hz. For example, if the vibration levels in any frequency band from a high-speed train exceed the Residential (Night) line in **Figure 3-2** at a residential location, a vibration impact would be assessed. In addition, the detailed criteria are used to assess vibration impact at highly sensitive locations using the VC-A through VC-E thresholds shown in the figure. Descriptions of the curves are shown in **Table 3-7**.

Figure 3-2: FRA Detailed Ground-Borne Vibration Impact Criteria



Source: FRA, "High-Speed Ground Transportation Noise and Vibration Impact Assessment," Final Report DOT/FRA/ORD-12/15, September 2012.

Table 3-7: Interpretation of Vibration Criteria for Detailed Analysis		
Criterion Curve (See Figure 3-4)	**Max Lv (VdB)[1]**	**Description of Use**
Workshop	90	Distinctly feelable vibration. Appropriate to workshops and non-sensitive areas.
Office	84	Feelable vibration. Appropriate to offices and non-sensitive areas.
Residential Day	78	Barely feelable vibration. Adequate for computer equipment and low-power optical microscopes (up to 20X).
Residential Night, Operating Rooms	72	Vibration not feelable, but ground-borne noise may be audible inside quiet rooms. Suitable for medium-power optical microscopes (100X) and other equipment of low sensitivity.
VC-A	66	Adequate for medium- to high-power optical microscopes (400X), microbalances, optical balances, and similar specialized equipment.
VC-B	60	Adequate for high-power optical microscopes (1000X), inspection and lithography equipment to 3-micron line widths.
VC-C	54	Appropriate for most lithography and inspection equipment to 1-micron detail size.
VC-D	48	Suitable in most instances for the most demanding equipment, including electron microscopes operating to the limits of their capability.
VC-E	42	The most demanding criterion for extremely vibration-sensitive equipment.
[1] As measured in 1/3-octave bands of frequency over the frequency range 8 to 80 Hz.		

Source: FRA, "High-Speed Ground Transportation Noise and Vibration Impact Assessment," Final Report DOT/FRA/ORD-12/15, September 2012.

EXISTING NOISE AND VIBRATION

This section includes a description of the noise and vibration sensitive land use within the Study Area, as well as the noise and vibration measurements conducted to characterize the existing conditions for the Project.

Existing Noise Conditions

Noise-sensitive land use within the Study Area was identified based on Geographic Information System (GIS) data, aerial photography, drawings, plans and a field survey. Based on the information from these sources, a noise measurement program was developed and carried out as described below.

Noise Measurement Procedures and Equipment

To document the existing noise conditions for the Project, a series of noise measurements were conducted in January 2016 along the routes for the Build Alternatives. Because the thresholds for impact in the FRA noise criteria are based on the existing noise levels, measuring the existing noise and characterizing noise levels at sensitive locations is an important step in the impact assessment. The noise measurements included both long-term (24-hour) and short-term (one hour) monitoring of the A-weighted sound level at noise-sensitive locations within the Study Area.

The noise measurements were performed with NTi Audio model XL2 noise monitors and Larson Davis model 820 noise monitors that conform to American National Standard Institute (ANSI) standards for Type 1 (precision) sound measurement equipment. Calibrations, traceable to the

National Institute of Standards and Technology (NIST) were conducted before and after each measurement. The noise monitors were set to continuously monitor and record multiple noise level metrics, as well as obtain audio recordings, where appropriate, during the measurement periods.

At each site, the measurement was conducted at the approximate set back of the building or buildings relative to the Project alignment. The measurement microphones were protected with windscreens and positioned approximately 5 feet above the ground and at least 10 feet away from any major reflecting surface.

Noise Measurement Locations and Results

Table 4-1 summarizes the results of the existing noise measurement program and **Figures 4-1 through 4-4** show the locations of the 26 long-term noise monitoring sites (LT) and 19 short-term noise monitoring sites (ST) for the Project. The results of the existing noise measurements were used to characterize the existing noise levels at all noise-sensitive locations within the Study Area. **Appendix A** includes photographs of the noise measurement sites and **Appendix B** provides detailed noise measurement data.

Descriptions of the noise-sensitive land uses, as well as the associated noise measurement sites and sources, are provided below by county and segment.

Table 4-1: Summary of Existing Noise Measurements

Site No.	Measurement Location	County	Seg	Measurement Start		Meas. Dur. (hr)	Noise Level (dBA)	
				Date	Time		Leq	Ldn
LT-1	4019-4099 Bulova St, Dallas (Residences)	Dallas	1	1/21/2016	14:00	24	75	72
LT-1A	5125 Cleveland Rd, Dallas (Residences)	Dallas	1	5/11/2017	11:20	3**	50	53
LT-1B	1345 E Belt Line Rd, Lancaster (Residences)	Dallas	1	5/12/2017	2:49	3**	68	70
LT-1C	1786 Nail Dr, Lancaster (Residences)	Dallas	1	5/11/2017	14:00	3**	44	45
LT-2	911 FM 813, Palmer (Residence)	Ellis	2A	1/21/2016	9:09	24	62	55
LT-3	508 Old Waxahachie Rd, Waxahachie (Residence)	Ellis	2A	1/20/2016	16:00	24	58	53
LT-4	NW Co Rd 1320, Ennis (Residence)	Navarro	3A	1/20/2016	11:00	24	48	36
LT-5	SW 2120, Richland (Residence)	Navarro	3C	1/19/2016	15:17	24	50	46
LT-6	FM 1366, Wortham (Residential Parcel)	Freestone	4	1/19/2016	14:07	24	44	43
LT-7	132-264 CR 890, Teague (Ranch House)	Freestone	4	1/19/2016	14:00	24	49	42
LT-8	N Fwy Service Rd, Teague (Ranch)	Freestone	3C	1/18/2016	12:23	24	58	50
LT-9	633 LCR 882, Jewett (Ranch House)	Limestone	4	1/18/2016	12:00	24	52	48

Table 4-1: Summary of Existing Noise Measurements								
Site No.	Measurement Location	County	Seg	Measurement Start		Meas. Dur. (hr)	Noise Level (dBA)	
				Date	Time		Leq	Ldn
LT-10	Beddingfield Rd, Marquez (Residence)	Leon	4	1/18/2016	11:00	24	53	42
LT-11	N Fwy Service Rd, Buffalo (Ranch)	Leon	3C	1/18/2016	10:00	24	63	55
LT-12	534 FM 39 (Residence)	Leon	4	1/18/2016	14:00	24	60	62
LT-13	2076-2765 W Feeder Rd (Residence)	Leon	3C	1/18/2016	16:00	24	53	55
LT-14	7652 Greenbriar Rd (Residence)	Madison	3C	1/18/2016	13:00	24	63	65
LT-15	1977 Poteet Rd (Residence)	Madison	4	1/18/2016	17:00	24	48	50
LT-16	6113 FM 1696 (Residence)	Grimes	5	1/19/2016	14:00	24	45	47
LT-17	10735 TX-90 (Ranch)	Grimes	5	1/20/2016	16:00	24	47	49
LT-18	5126 FM 1774 (Residence)	Grimes	5	1/19/2016	20:00	24	60	62
LT-19	119 Plantation Drive, Todd Mission (Residence)	Waller	5	1/22/2016	12:39	24	47	49*
LT-20	21512 Binford Rd (Residence)	Harris	5	1/22/2016	10:56	24	49	51*
LT-21	1218 Canyon Arbor Way (Residence)	Harris	5	1/20/2016	19:00	24	67	69*
LT-22	14812 Hempstead Rd (Residence)	Harris	5	1/19/2016	21:00	24	44	46*
LT-23	11217 Todd St., Houston (Residence)	Harris	5	1/21/2016	14:00	24	47	49
ST-1	1213 Coleman Ave, Dallas (Residence)	Dallas	1	1/22/2016	11:40	1	63	61
ST-2	4412 Kolloch Dr, Dallas (Residence)	Dallas	1	1/21/2016	15:00	1	62	60
ST-3	6350 J. J. Lemmon Rd, Dallas (College Park Baptist Church)	Dallas	1	1/21/2016	17:10	1	54	52
ST-4	2607 Ferris Rd, Lancaster (Residence)	Ellis	2A	1/22/2016	10:00	1	52	50
ST-5	369 Farmer Rd, Ennis (Residential Area)	Ellis	2B	1/20/2016	16:31	1	62	60
ST-6	SW 1000, Corsicana (Residence)	Navarro	3B	1/20/2016	11:00	1	41	39
ST-7	117-123 CR 1041, Wortham (Residential Area)	Freestone	3C	1/19/2016	17:30	1	31	29
ST-8	N Fwy Service Rd & CR 1090, Streetman (Residential Area)	Freestone	3C	1/19/2016	16:00	1	54	52
ST-9	Old Mexia-Fairfield Rd, Fairfield (Parcel Adjacent to Several Hotels)	Freestone	3C	1/18/2016	13:50	1	70	68
ST-10	164 & FM 39, Groesbeck (Residential Area)	Limestone	4	1/18/2016	15:30	1	63	61
ST-11	N Fwy Service Rd & CR 306, Buffalo (Parcel Adjacent to Several Hotels)	Leon	3C	1/18/2016	17:00	1	68	66
ST-12	20559 I-45 Frontage Rd	Leon	3C	1/19/2016	9:06	1	61	59

Table 4-1: Summary of Existing Noise Measurements								
Site No.	Measurement Location	County	Seg	Measurement Start		Meas. Dur. (hr)	Noise Level (dBA)	
				Date	Time		Leq	Ldn
	(Residence)							
ST-13	5192 Dawkins Rd (Residence)	Madison	4	1/19/2016	11:12	1	54	52
ST-14	3159 Clark Rd (Residence)	Madison	4	1/20/2016	12:00	1	56	54
ST-15	15619 TX-90 (Residence)	Grimes	5	1/20/2016	14:47	1	53	51
ST-16	CR 341, Plantersville (Residence)	Grimes	5	1/21/2016	9:20	1	50	48
ST-17	31205 Hegar Rd (Residence)	Waller	5	1/21/2016	9:11	1	47	45
ST-18	6734 Limestone St (Residence)	Harris	5	1/21/2016	15:17	1	57	55
ST-19	20710 May Showers Circle (Residence)	Harris	5	1/21/2016	17:23	1	61	59

*Measurements were interrupted before 24 hours due to a noise monitor battery connection problem. Ldn was estimated using methods contained in the FRA guidance manual.

**Due to limited access, three one hour measurements were made at these sites. The Ldn was estimated using methods contained in the FRA guidance manual.

Source: Cross-Spectrum Acoustics, 2016.

Figure 4-1: Existing Noise Measurement Locations (Sheet 1 of 4)

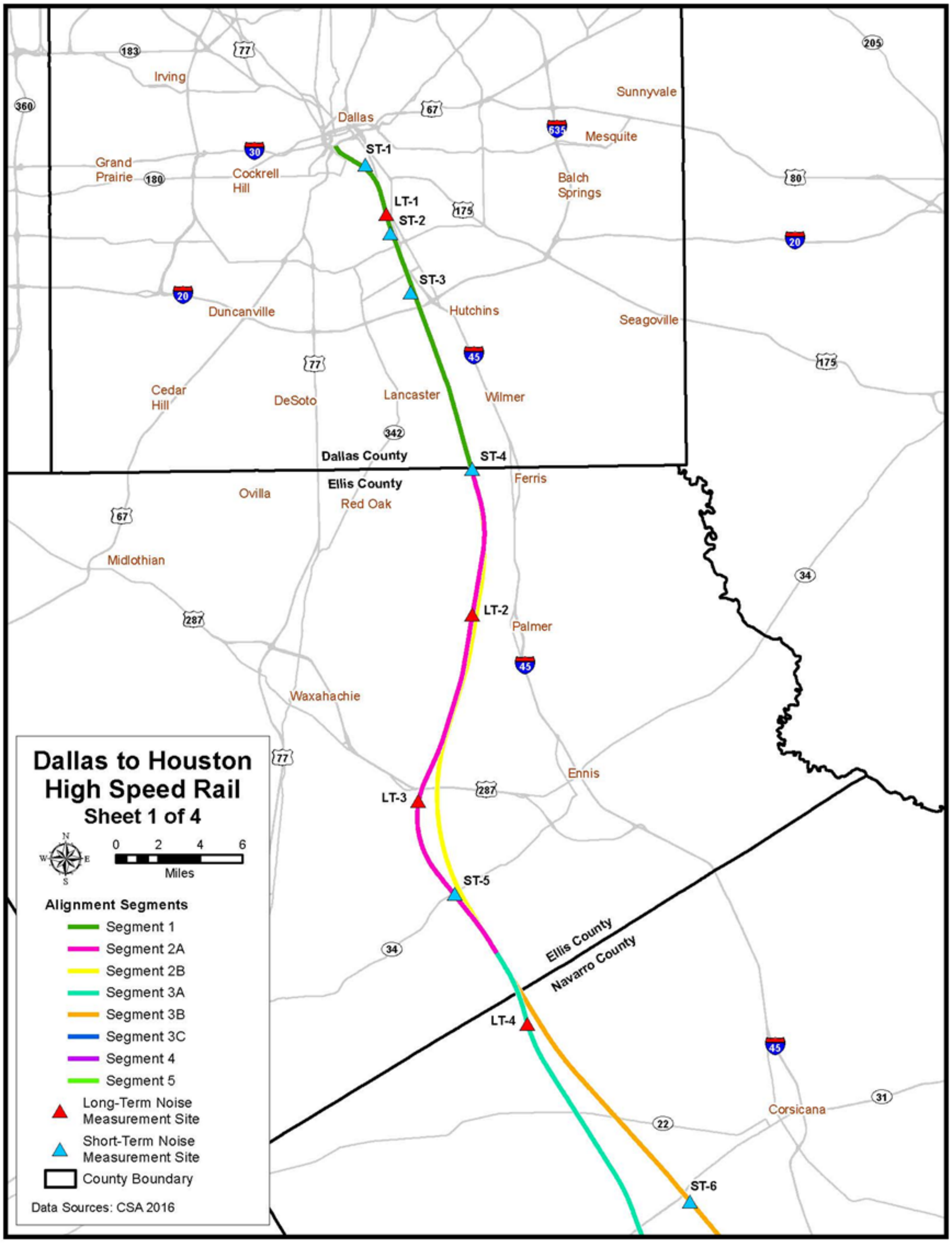


Figure 4-2: Existing Noise Measurement Locations (Sheet 2 of 4)

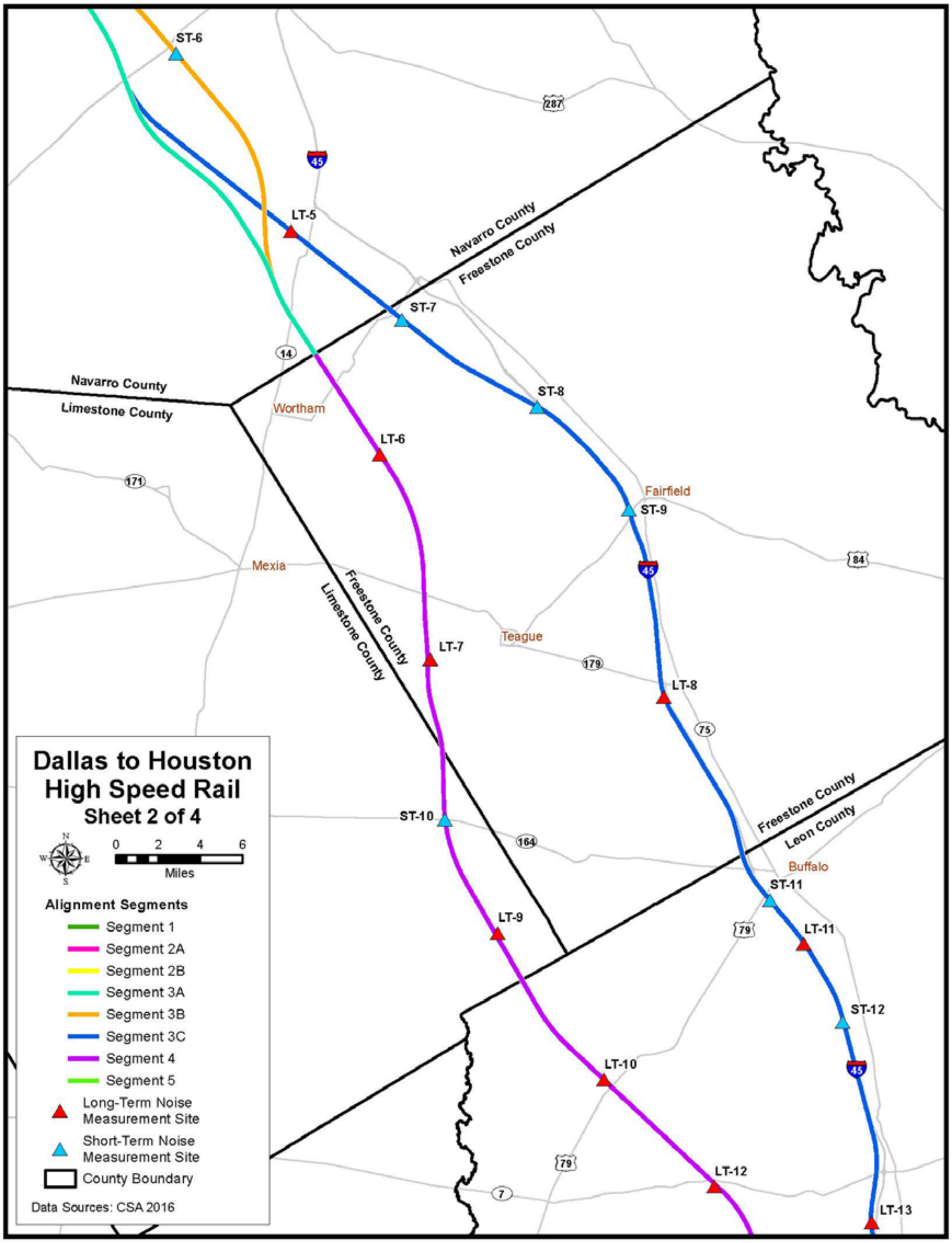


Figure 4-3: Existing Noise Measurement Locations (Sheet 3 of 4)

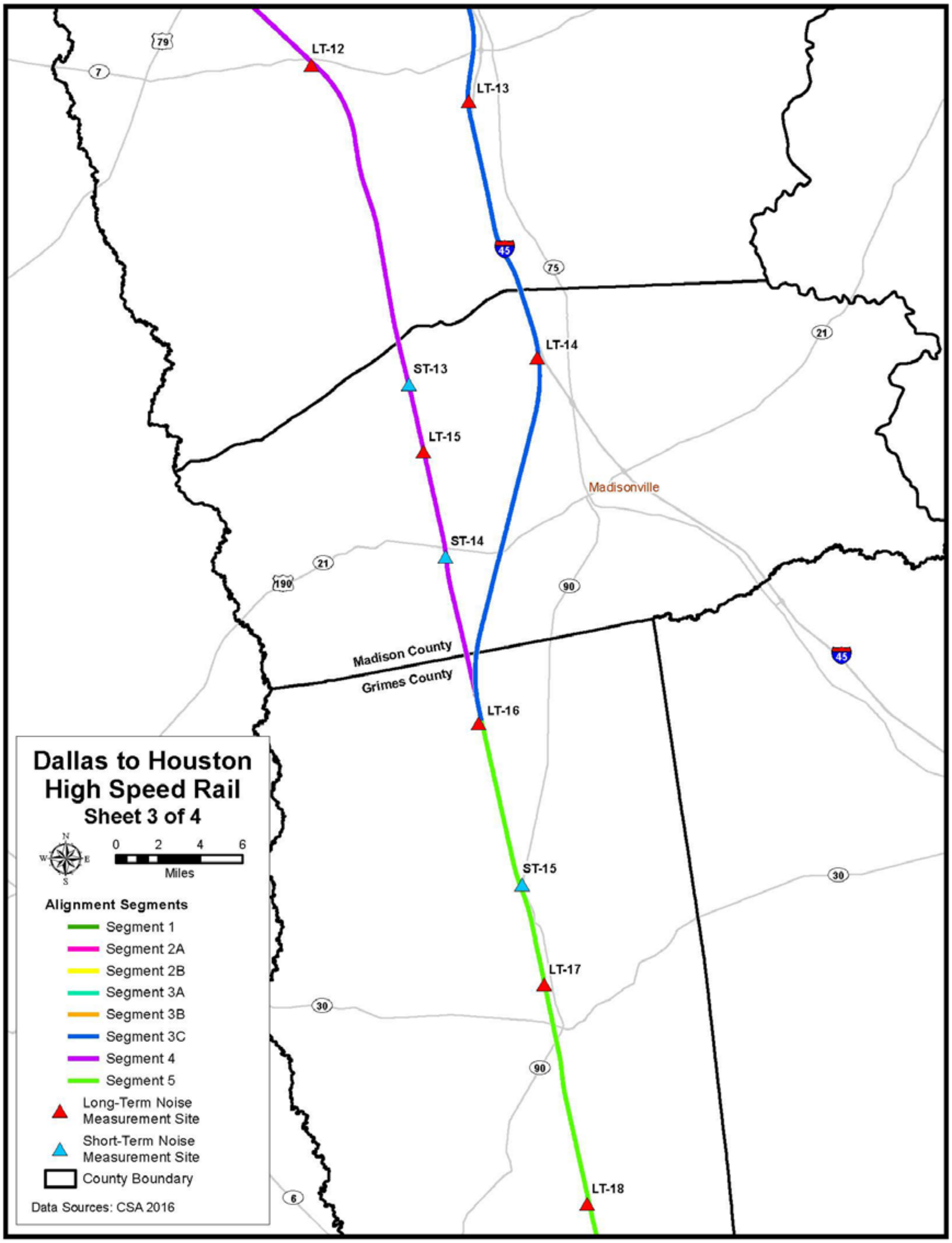
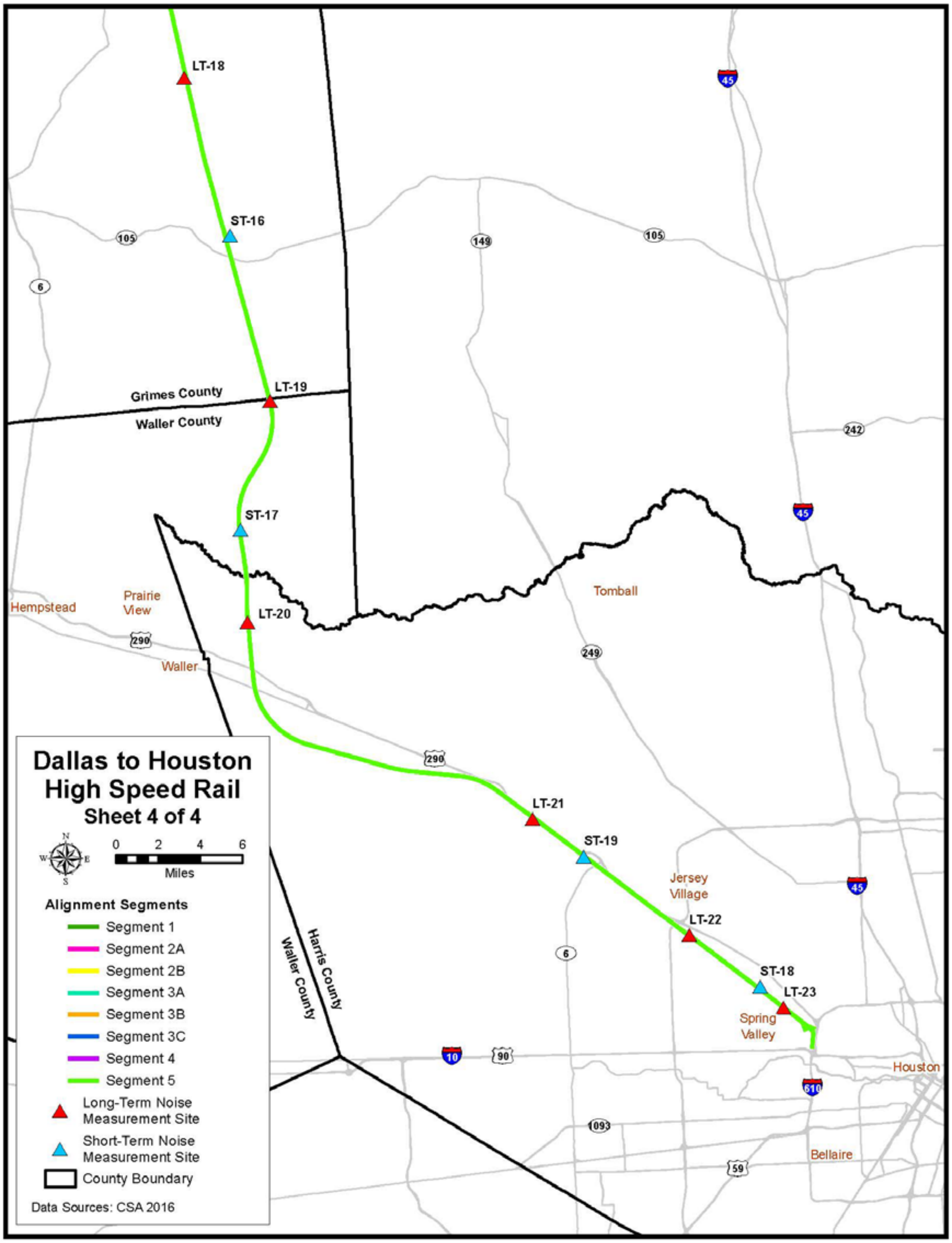


Figure 4-4: Existing Noise Measurement Locations (Sheet 4 of 4)



Dallas County

Segment 1

The noise-sensitive land use along the proposed alignment in Dallas County from the northern terminus to Route 12 (South Great Trinity Forest Avenue) is typically dense, urban commercial/industrial land use along the existing freight tracks and IH-45. Several urban residential neighborhoods are located in the areas north of South Lamar Street, along Kolloch Drive from East Illinois Avenue to Route 12, and along Le May and Le Forge Avenues. Multi-family residential complexes are located near East Overton Rd and Southern Oaks Boulevard and at Kolloch Drive and Linfield Road.

The Imperial Institute of America, a school with institutional land use, is located on Mayforge Drive near East Illinois Avenue. South of Route 12 to IH-20, the proposed alignment runs parallel to existing freight tracks and IH-45 through a largely wooded area with a few dense suburban residential neighborhoods to the west along Golden Gate Drive and J.J. Lemmon Road. Several parks and churches are located in this suburban area as well. South of IH-20 to the Dallas/Ellis County line is typically rural farm land with scattered single-family residences along the proposed alignment.

Descriptions of the noise measurements conducted along Segment 1 in Dallas are as follows:

Site LT-1: 4019-4099 Bulova Street, Dallas. The Ldn measured at this location was 72 dBA. The dominant noise source was traffic on IH-45. Noise levels were measured for 24 hours near the gate to this parcel.

Site LT-1A: 5125 Cleveland Rd, Dallas. The Ldn measured at this location was 53 dBA. The dominant noise sources were rural sounds and local traffic. Noise levels were measured during three separate one hour periods throughout the day along Cleveland Rd in front of the property.

Site LT-1B: 1345 E. Beltline Road, Lancaster. The Ldn measured at this location was 70 dBA. The dominant noise source was traffic on E Beltline Rd. Noise levels were measured during three separate one hour periods throughout the day along E Beltline Rd in front of the property.

Site LT-1C: 1786 Nail Drive, Lancaster. The Ldn measured at this location was 45 dBA. The dominant noise source was rural sounds. Noise levels were measured during three separate one hour periods throughout the day along Nail Drive in front of the property.

Site ST-1: 1213 Coleman Avenue, Dallas. The Leq measured at this location was 63 dBA. The dominant noise sources were traffic on Lamar Street, traffic on Cedar Crest Boulevard and freight train activity. Noise levels were measured for one hour on the side of the road within the public right-of-way (ROW).

Site ST-2: 4412 Kolloch Drive, Dallas. The Leq measured at this location was 62 dBA. The dominant noise sources were traffic on IH-45 and freight train activity. Noise levels were measured for one hour in the side yard of this residence.

Site ST-3: 6350 J.J. Lemmon Road, Dallas (College Park Baptist Church). The Leq measured at this location was 54 dBA. The dominant noise sources were traffic on J.J. Lemmon Road and distant traffic on IH-45. Noise was measured for one hour in the rear parking area of the church.

Ellis County

Segment 2A

The noise and vibration sensitive land use along the proposed Segment 2A in Ellis County is typically rural farm land with scattered single family residences. Descriptions of the noise measurements conducted along Segment 2A in Ellis County are as follows:

Site LT-2: FM 813, Palmer. The Ldn measured at this location was 55 dBA. The dominant noise source was local community traffic. Noise levels were measured for 24 hours in the back yard of this residence.

Site LT-3: 508 Old Waxahachie Road, Waxahachie. The Ldn measured at this location was 53 dBA. The dominant noise sources were local traffic on Old Waxahachie Road and distant traffic on Route 287. Noise levels were measured for 24 hours in the front yard of the residence.

Site ST-4: 2607 Ferris Road, Lancaster. The Leq measured at this location was 52 dBA. The dominant noise sources were wind and livestock. Noise levels were measured for one hour in the field behind the residence.

Site ST-5: 369 Farmer Rd, Ennis. The Leq measured at this location was 62 dBA. The dominant noise source was traffic on Route 34. Noise levels were measured for one hour on the side of the road within the public ROW.

Segment 2B

The noise-sensitive land use along the proposed Segment 2B in Ellis County is typically rural farm land with scattered single family residences. The noise measurement sites used to characterize Segment 2B in Ellis County are the same as those used for Segment 2A.

Navarro County

Segment 3A

The noise-sensitive land use along the proposed Segment 3A in Navarro County is typically rural farm land with scattered single family residences. A description of the noise measurement conducted along Segment 3A in Navarro County is as follows:

Site LT-4: NW County Road 1320, Ennis. The Ldn measured at this location was 36 dBA. The dominant noise sources were distant traffic and livestock. Noise levels were measured for 24 hours in the front yard of the residence.

Segment 3B

The noise-sensitive land use along the proposed Segment 3B in Navarro County is typically rural farm land with scattered single family residences. A description of the noise measurement conducted along Segment 3B in Navarro County is as follows:

Site ST-6: SW 1000, Corsicana. The Leq measured at this location was 41 dBA. The dominant noise source was traffic from Route 31. Noise levels were measured for one hour in the back yard of the residence.

Segment 3C

The noise-sensitive land use along the proposed Segment 3C in Navarro County is typically rural farm land with scattered single family residences. A description of the noise measurement conducted along Segment 3C in Navarro County is as follows:

Site LT-5: SW 2120, Richland. The Ldn measured at this location was 46 dBA. The dominant noise sources were farm activity and distant freight trains/horns. Noise levels were measured for 24 hours in the field behind the ranch house.

Segment 4

The noise-sensitive land use along the proposed Segment 4 in Navarro County is typically rural farm land with scattered single family residences.

The noise measurement site used to characterize Segment 4 in Navarro County is the same as for Segment 3C.

Freestone County

Segment 3C

The noise-sensitive land use along the proposed Segment 3C in Freestone County is typically rural farm land with scattered single family residences. Segment 3C runs parallel to IH-45 from just south of FM 833 until the Freestone/Leon County line. This area remains typically rural farm land until the City of Fairfield, where the land use becomes slightly denser and largely commercial/industrial. South of Fairfield, the land use returns to rural farm land and oil fields with scattered single family residences. Descriptions of the noise measurements conducted along Segment 3C in Freestone County are as follows:

Site LT-8: N Fwy Service Road, Teague. The Ldn measured at this location was 50 dBA. The dominant noise sources were traffic on IH-45 and farm activity. Noise levels were measured for 24 hours adjacent to the pond on this ranch.

Site ST-7: 117-123 County Road 1041, Wortham. The Leq measured at this location was 31 dBA. The dominant noise source was distant wildlife. Noise levels were measured for one hour on the side of the road within the public ROW.

Site ST-8: N Freeway Service Road at County Road 1090, Streetman. The Leq measured at this location was 54 dBA. The dominant noise source was traffic on IH-45. Noise levels were measured for one hour on the side of the road within the public ROW.

Site ST-9: N Freeway Service Road at Old Mexia-Fairfield Road, Fairfield. The Leq measured at this location was 70 dBA. The dominant noise source was traffic on IH-45. Noise levels were measured for one hour on the side of the road within the public ROW.

Segment 4

The noise-sensitive land use along the proposed Segment 4 in Freestone County is typically rural farm land with scattered single family residences. Descriptions of the noise measurements conducted along Segment 4 in Freestone County are as follows:

Site LT-6: FM 1366, Wortham. The Ldn measured at this location was 43 dBA. The dominant noise sources were local community traffic and farm activity. Noise levels were measured for 24 hours adjacent to the back house on this parcel.

Site LT-7: Approx. 132-264 CR 890, Teague. The Ldn measured at this location was 42 dBA. The dominant noise sources were local community traffic and farm activity. Noise levels were measured for 24 hours adjacent to the ranch house.

Limestone County

Segment 4

The noise-sensitive land use along the proposed Segment 4 in Limestone County is typically rural farm land/oil fields with scattered single family residences. Descriptions of the noise measurements conducted along Segment 4 in Limestone County are as follows:

Site LT-9: 633 Local County Road 882, Jewett. The Ldn measured at this location was 48 dBA. The dominant noise sources were local community traffic and farm activity. Noise levels were measured for 24 hours adjacent to the ranch house.

Site ST-10: FM 39 at East Yeagua Street, Groesbeck. The Leq measured at this location was 63 dBA. The dominant noise sources were traffic on FM 39 and traffic on East Yeagua Street. Noise levels were measured for one hour on the side of the road within the public ROW.

Leon County

Segment 3C

The noise-sensitive land uses for Segment 3C in Leon County include mostly rural areas with single family residences and the cities of Buffalo and Centerville. The City of Buffalo is a mixture of single family houses and commercial areas with a church close to the proposed route. Descriptions of the noise measurements conducted along Segment 3C in Leon County are as follows:

Site LT-11: N Freeway Service Road, Buffalo. The Ldn measured at this location was 55 dBA. The dominant noise sources were traffic on IH-45 and distant freight trains/horns. Noise levels were measured for 24 hours adjacent to the driveway of this ranch.

Site LT-13: 2076-2765 West Feeder Road. The measured Ldn at this location was 53 dBA. This 24-hour measurement was taken at the southern edge of the property facing a small pond. The dominant noise sources were local traffic from West Feeder Road, IH-45 and neighborhood activity.

Site ST-11: N Freeway Service Road at County Road 306, Buffalo. The Leq measured at this location was 68 dBA. The dominant noise source was traffic on IH-45. Noise levels were measured for one hour on the side of the road within the public ROW.

Site ST-12: 20559 IH-45 Frontage Road. The measured Leq at this location was 61 dBA. The dominant noise sources were local traffic from the frontage road and IH-45. Noise levels were measured in the front yard of the property for a period of one hour.

Segment 4

The noise-sensitive land uses for Segment 4 in Leon County include scattered single family residences. This segment also includes Leon High School. Descriptions of the noise measurements conducted along Segment 4 in Leon County are as follows:

Site LT-10: Beddingfield Road, Marquez. The Ldn measured at this location was 42 dBA. The dominant noise sources were local community traffic and farm activity. Noise levels were measured for 24 hours in the back yard of the residence.

Site LT-12: 534 FM 39. The measured Ldn at this location was 60 dBA. The dominant noise source was distant local traffic. Noise levels were measured for 24 hours on the north side of a dirt road that accesses the property.

Madison County

Segment 3C

The noise-sensitive land uses for Segment 3C in Madison County include rural areas with scattered single family residences. A description of the noise measurement conducted along Segment 3C in Madison County is as follows:

Site LT-14: 7652 Greenbrier Road. The measured Ldn at this location was 63 dBA. Noise levels were measured for 24 hours. This measurement was taken in the front yard of the property. The major noise sources were local traffic on IH-45, farming activity and noise from the manufacturing facility located at the northern edge of the property.

Segment 4

The noise-sensitive land uses for Segment 3C in Madison County include rural areas with scattered single family residences. Descriptions of the noise measurements conducted along Segment 4 in Madison County are as follows:

Site LT-15: 1977 Poteet Road. The measured Ldn at this location was 48 dBA. The dominant noise source was local traffic on Poteet Road. Noise levels were measured for 24 hours on the south side of the property facing a corral.

Site ST- 13: 5192 Dawkins Road. The measured Leq at this location was 54 dBA. The dominant noise source was local traffic. Noise levels were measured in front of the residence by the gate facing Dawkins Road for a period of one hour.

Site ST-14: 3159 Clark Road. The measured Leq at this location was 56 dBA. The dominant noise sources were local traffic on Clark Road, wind, farming activities and electrical noise from power lines. Noise levels were measured at the main gate for a period of one hour.

Grimes County

Segment 3C

The noise-sensitive land uses for Segment 3C in Grimes County include rural areas with scattered single family residences. A description of the noise measurement conducted along Segment 3C in Grimes County is as follows:

Site LT-16: 6113 FM 1696. The Ldn measured at this location was 45 dBA. Noise levels were measured for 24 hours and the measurement was performed at northeast edge of the property overlooking at the power lines. The dominant noise sources were wind and farming activities.

Segment 4

The noise-sensitive land uses for Segment 4 in Grimes County include rural areas with scattered single family residences. The noise measurement sites used to characterize Segment 4 in Grimes County are the same as those used for Segment 3C.

Segment 5

The noise-sensitive land uses for Segment 5 in Grimes County include rural areas with scattered single family residences and the Town of Singleton. Singleton is a mixture of single family residences and commercial and industrial areas. Descriptions of the noise measurements conducted along Segment 5 in Grimes County are as follows:

Site LT-17: 10735 Route 90. The Ldn measured at this location was 47 dBA. Noise levels were measured for 24 hours and the measurement was conducted at the eastern side of the property at a distance of about 150 feet from a metallic shed. The dominant noise source was distant local traffic.

Site LT-18: 5126 FM 1774. The measured Ldn at this location was 60 dBA. The dominant noise sources were barking dogs and local traffic from FM 1774. Noise levels were measured for 24 hours on the northern side of the property at a distance of 150 feet from FM 1774.

Site ST-15: 15619 TX-90. The measured Leq at this location was 53 dBA. The dominant noise source was local traffic from TX 90, livestock and other farm animals and farming activities. Noise levels were measured in front of the house near the driveway for a period of one hour.

Site ST-16: County Road 341, Plantersville. The measured Leq at this location was 50 dBA. The dominant noise source was local traffic from County Road 341. Noise levels were measured at the back of the property near a shed for a period of one hour.

Waller County

Segment 5

The noise-sensitive land uses for Segment 5 in Waller County include rural areas with scattered single family residences. Descriptions of the noise measurements along Segment 5 in Waller County are as follows:

Site LT-19: 119 Plantation Drive, Todd Mission. The measured Ldn at this location was 47 dBA. Noise levels were measured for 24 hours at the front northern edge of the property. The dominant noise sources were local traffic from Plantation Drive and neighborhood activity.

Site ST-17: 31205 Hegar Road. The measured Leq at this location was 47 dBA. The major noise sources were local traffic from Hegar Road and Joseph Road. Noise levels were measured in the front yard of the residence for a period of one hour.

Harris County

<u>*Segment 5*</u>

The noise-sensitive land uses for Segment 5 in Harris County include some rural areas, industrial and commercial areas and residential neighborhoods. Between the county's northern boundaries where the proposed route crosses SH 99, the land use is mostly rural with scattered single family residences. Between SH 99 and Fry Road, the segment runs through a mostly rural area with scattered single-family residences and commercial uses.

Between Fry Road and SH 6 North, both sides of the proposed route include a mixture of commercial and industrial areas with residential neighborhoods. The neighborhoods have both single and multi-family residences. Within this vicinity are four churches and Cy-Fair High School. Between SH 6 North and the West Sam Houston Parkway, there is a mix of commercial and residential areas north of the proposed route. The residential areas are a mixture of single- and multi-family housing. South of the route is a mixture of industrial and commercial usage. There are also two churches along this stretch of the segment.

Between the West Sam Houston Parkway and IH-610, the land use around the segment is mostly commercial and industrial with a few residential areas with single-family houses. Also within this section are six places of worship and Bane Elementary School. Along IH-610, the route passes through a mixture of industrial and commercial areas.

Descriptions of the noise measurements conducted along Segment 5 in Harris County are as follows:

Site LT-20: 21512 Binford Road. The measured Ldn at this location was 49 dBA. Noise levels were measured for 24 hours at the northern edge of the property at the setback distance of the residence. Traffic noise from Binford Road was not significant during the measurement period.

Site LT-21: 12118 Canyon Arbor Way. The measured Ldn at this location was 67 dBA. Noise levels were measured for 24 hours at the northern edge of the property near a residence. The dominant noise source was local traffic from US-290.

Site LT-22: 14812 Hempstead Road. The measured Ldn at this location was 44 dBA. Noise levels were measured for 24 hours at the front yard of the property facing Hempstead Road. The dominant noise sources were local traffic on Hempstead Road and Union Pacific trains, located parallel to Hempstead Road.

Site LT-23: 11217 Todd Street. The measured Ldn at this location was 47 dBA. The dominant noise sources were local traffic on Todd Street, Harland Drive and Hempstead Road, plus Union Pacific trains. Noise levels were measured for 24 hours on the northern edge of the property.

Site ST-18: 6734 Limestone Street. The measured Leq at this location was 57 dBA. The dominant noise source was local traffic on Limestone Street and Hempstead Road. Noise levels were measured in front of the residence for a period of one hour.

Site ST-19: 20710 May Showers Circle. The measured Leq at this location was 61 dBA. The major noise sources were local traffic on Hempstead Road, Huffmeister Road and residential activities in May Showers Circle. Noise levels were measured in the front yard of the property for a period of one hour.

Existing Vibration Conditions

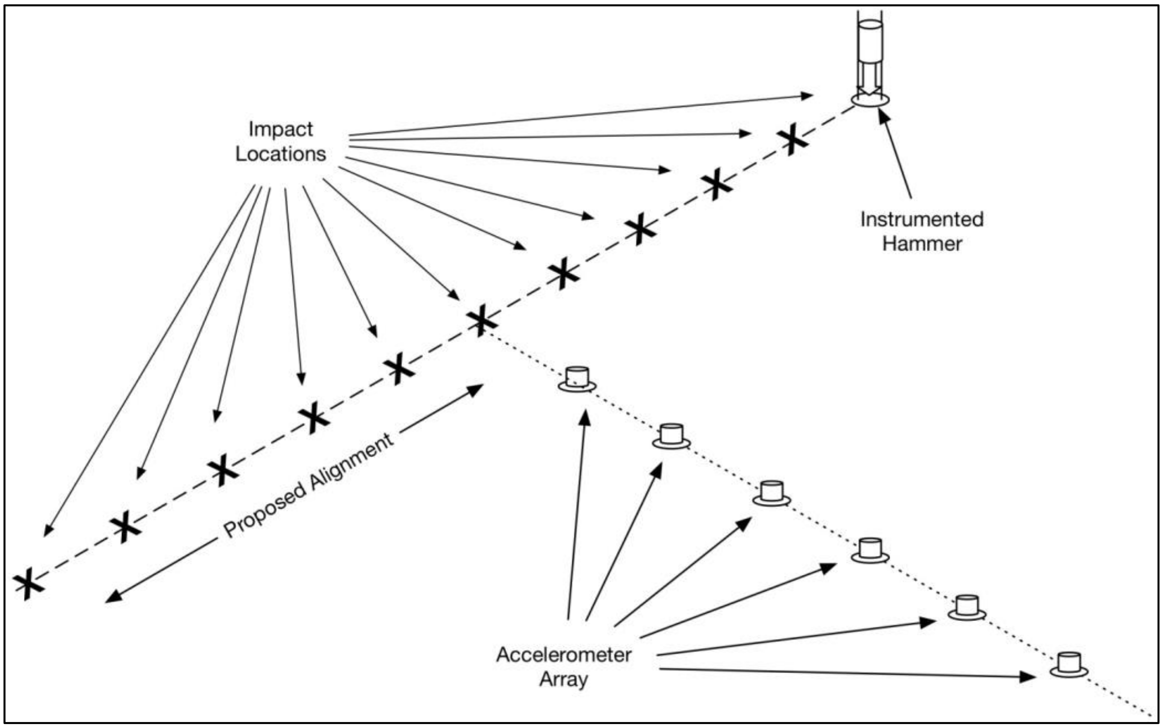
Vibration Measurement Procedures and Equipment

Vibration-sensitive land use for the project was identified based on GIS data, aerial photography, drawings, plans and a field survey. Except for parks and other exterior areas, the vibration sensitive land uses along the routes of the Build Alternatives are the same as described above in **Section 4.1** (Existing Noise Conditions).

Vibration propagation measurements were conducted in the Study Area during January 2016 to determine the vibration response characteristics of the ground near vibration-sensitive locations. A custom-built instrumented hammer was used to impart an impulsive force to the ground. The magnitude of the force was calculated based on the acceleration and mass of the falling hammer. The resulting vibration signals were measured using high-sensitivity accelerometers (PCB Model 393C and 393B05) mounted in a vertical direction on pavement or on steel spikes driven into the ground. The signals from the hammer and accelerometers were recorded using Data Translation DT9837A digital acquisition hardware. Data Translation's QuickDAQ software, running on a laptop computer, was used to review the measurement data.

The vibration propagation test procedure is shown schematically in **Figure 4-5**. The instrumented hammer was used to generate impulses at specific locations spaced 15 feet apart along a line on or parallel to the proposed HSR alignment. A line of accelerators was placed perpendicular to the line of impacts as shown in the figure. The relationship between the input force and the resulting vibration measured by the accelerometers, called the transfer mobility (TM), was calculated using proprietary software in the Cross-Spectrum Acoustics (CSA) laboratory. The transfer mobility represents the vibration propagation characteristics of the ground at the measurement site and at other sites with similar geology. Vibration levels from a HSR vehicle were estimated by mathematically combining the force generated by a train (the force density) with the transfer mobility as described in the Detailed Vibration Assessment methodology provided in the FRA guidance manual.

Figure 4-5: Vibration Propagation Measurement Schematic



Source: Cross-Spectrum Acoustics, 2016.

For the laboratory analysis, the following steps were used to calculate the transfer mobility at each measurement site:

- Narrow-band transfer functions for each accelerometer/force pair were computed using custom CSA software. Signal processing and averaging techniques were used to maximize the signal-to-noise ratio for each measurement. Numerical integration was used to convert the acceleration data into velocity.
- The narrowband data were converted to one-third-octave band data.
- Numerical integration was used to convert the measured point source transfer mobility (PSTM) data into line source transfer mobilities (LSTM).
- For each one-third-octave band, linear or quadratic regression was used to determine smoothed estimates for each line source transfer mobility as a function of distance from the source.

The FRA manual provides more details regarding the propagation test and analysis procedures.

Vibration Measurement Locations

Table 4-2 and **Figures 4-6 through 4-9** describe the locations of the eleven vibration measurement sites. Photographs of each site are included in Appendix A.

Table 4-2: Summary of Vibration Propagation Measurement Sites				
Site No.	**Measurement Location**	**County**	**Segments**	**Date**
V-1	4360 Kolloch Drive, Dallas (Church)	Dallas	1	1/18/2016
V-2	103 Coffee Rd.	Ellis	2A, 2B	1/18/2016
V-3	710 FM 2100	Navarro	3A, 3B, 3C	1/19/2016
V-4	N Fwy Service Rd., Fairfield	Freestone	3C, 4	1/19/2016
V-5	LCR 828, Personville	Limestone	4	1/20/2016
V-6	6734 FM 977 (Residence)	Leon	4	1/20/2016
V-7	10290 Greenbriar Rd. (Residential Parcel)	Madison	3C	1/20/2016
V-8	10063 CR 311 (Residence)	Grimes	5	1/21/2016
V-9	Plantation Dr., Todd Mission	Waller	5	1/21/2016
V-10	Josey Ranch Rd., Houston	Harris	5	1/22/2016
V-11	21610 U.S. 290 Frontage Rd., Houston	Harris	5	1/22/2016

Source: Cross-Spectrum Acoustics, 2016.

Descriptions of the vibration measurement sites and the areas they represent are provided below by county and segment.

Dallas County

Segment 1

Site V-1: 4360 Kolloch Dr. The vibration propagation measurement was conducted in the parking lot of Friendship Missionary Baptist Church. The measurement results at this site are representative of the ground-borne vibration propagation conditions of the soil this area, including all vibration-sensitive land use along the I-45 corridor in Dallas between S Lamar St. and the I-20 junction along Segment 1.

Ellis County

Segment 2A

Site V-2: 103 Coffee Rd. The vibration propagation measurement was conducted along Coffee Rd. with the sensors placed in the adjacent field. The measurement results at this site are representative of the ground-borne vibration propagation conditions of the soil this area, including all vibration-sensitive land use west of I-45 from Hutchins to Bardwell along both Segments 2A and 2B.

Segment 2B

The vibration measurement results used to characterize the vibration propagation conditions along Segment 2B in Ellis County are the same as those used for Segment 2A.

Figure 4-6: Vibration Propagation Measurement Locations (Sheet 1 of 4)

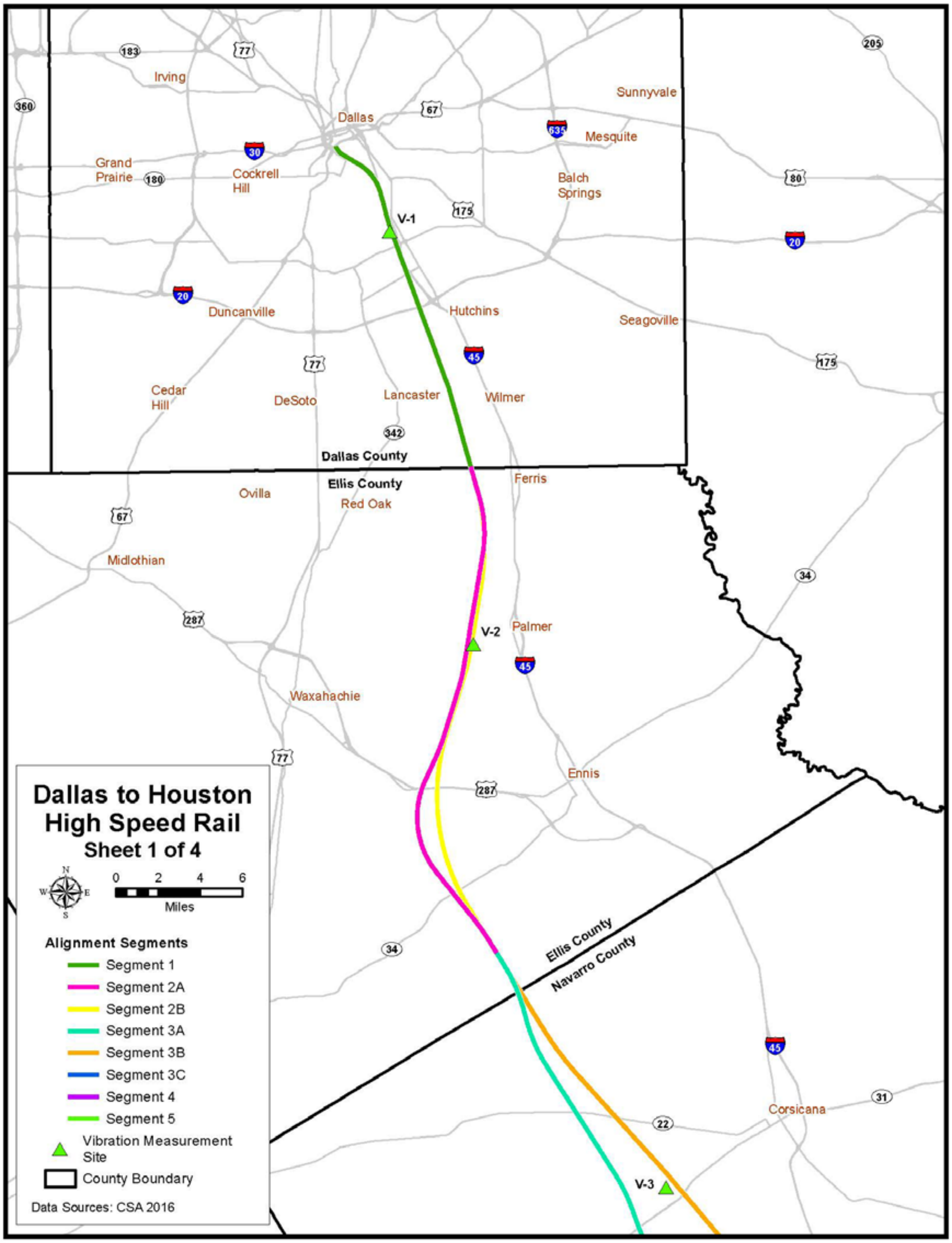


Figure 4-7: Vibration Propagation Measurement Locations (Sheet 2of 4)

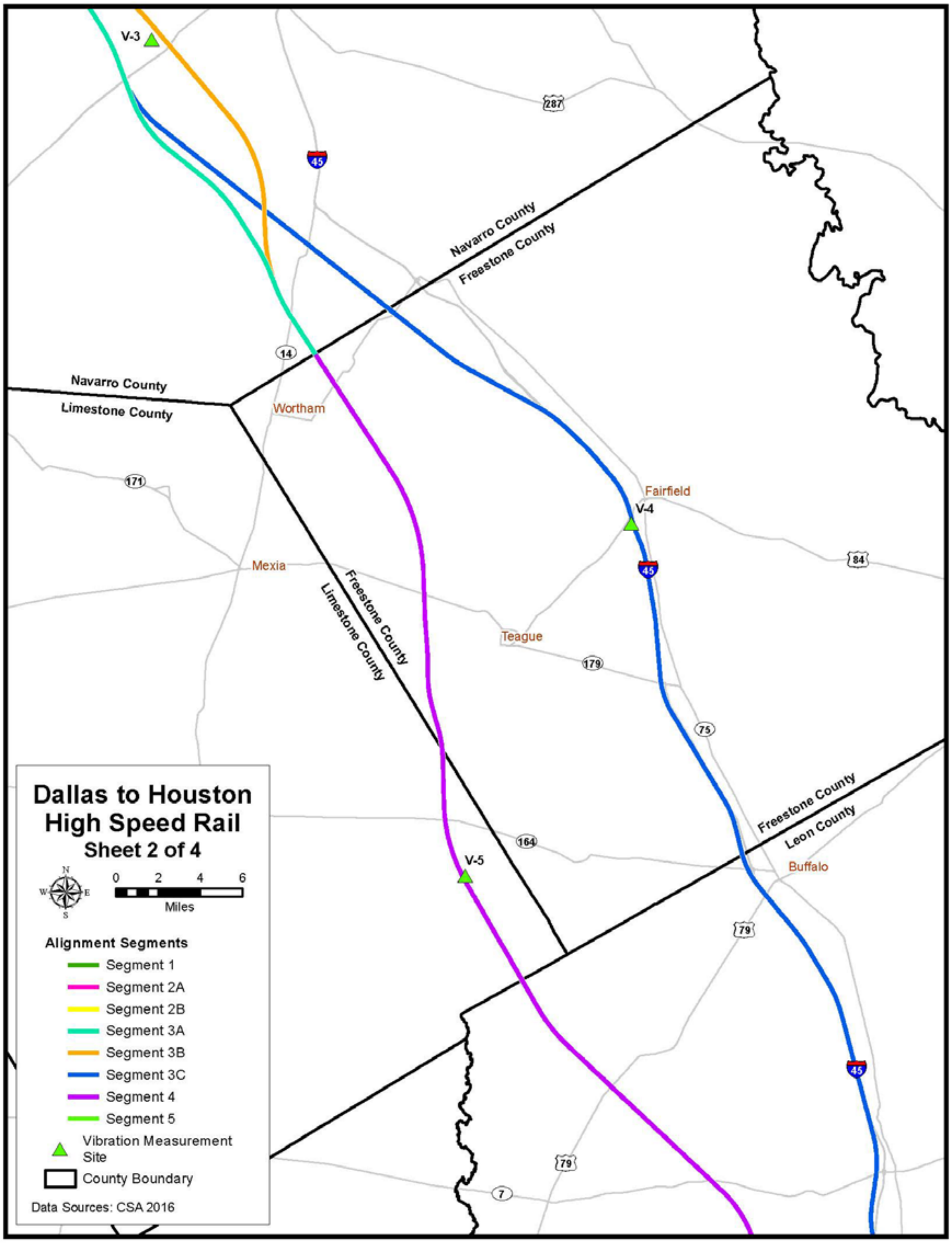


Figure 4-8: Vibration Propagation Measurement Locations (Sheet 3 of 4)

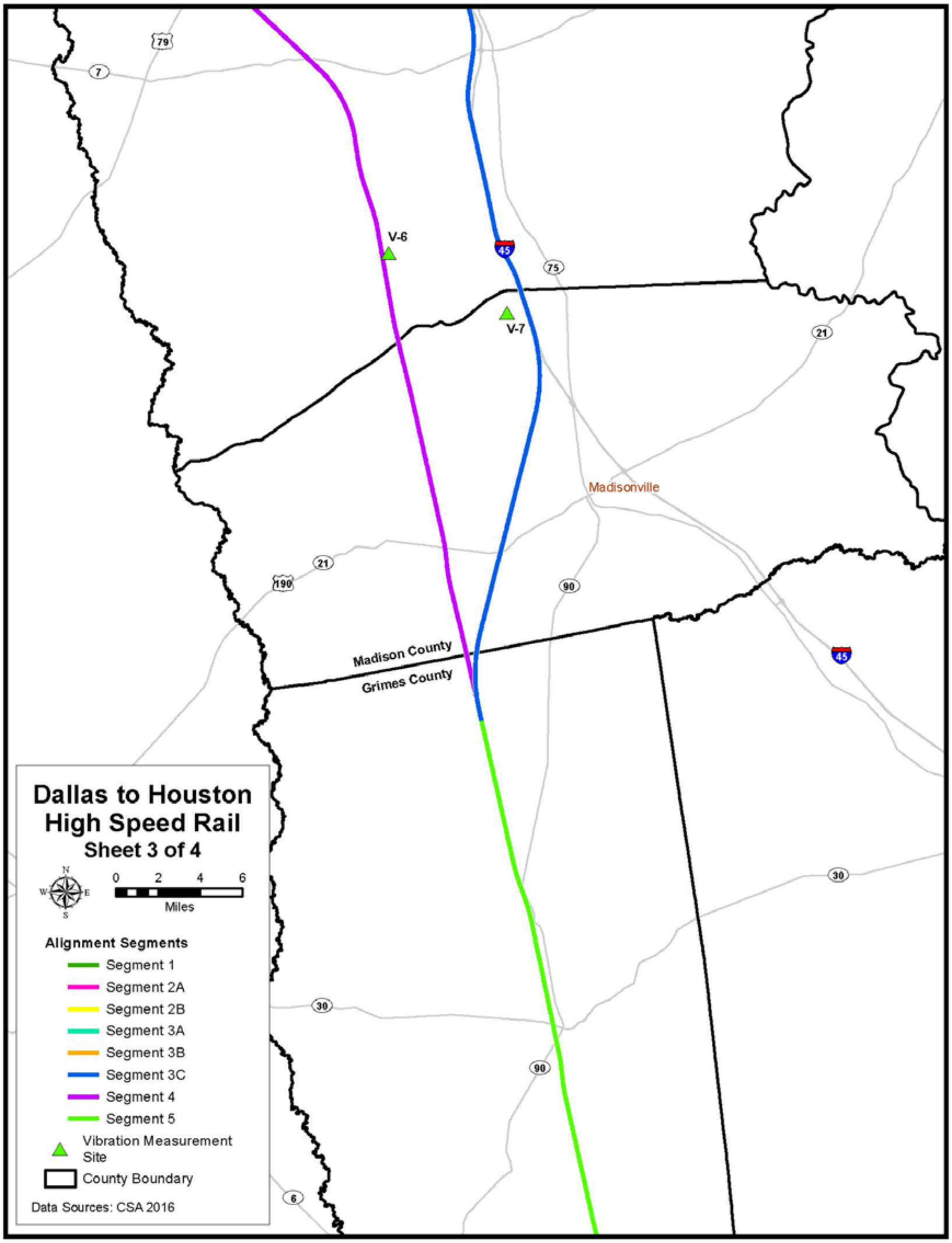
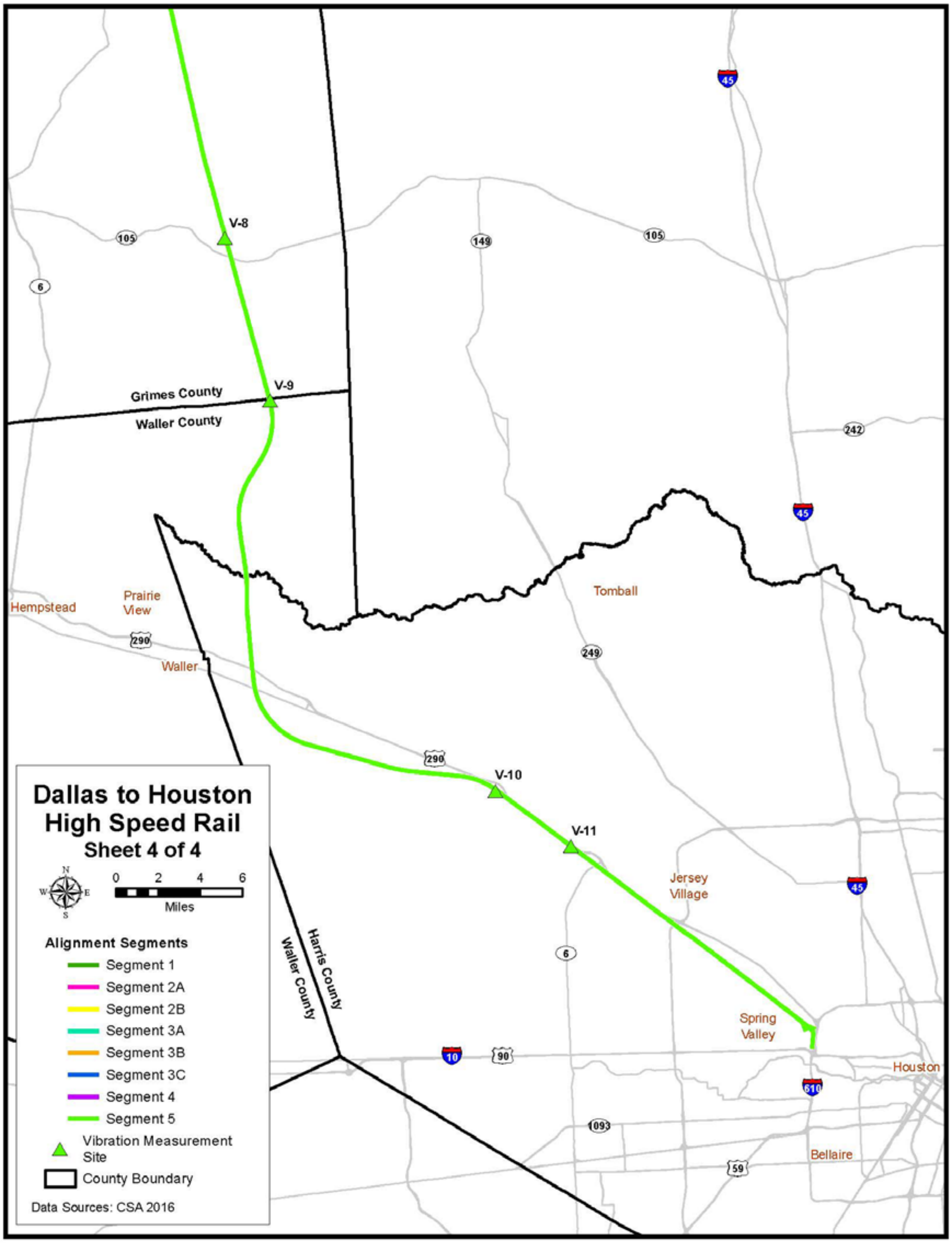


Figure 4-9: Vibration Propagation Measurement Locations (Sheet 4 of 4)



Navarro County

Segment 3A

Site V-3: 710 FM 2100. The vibration propagation measurement was conducted along FM 2100 with the sensors in the front yard of the property. The measurement results at this site are representative of the ground-borne vibration propagation conditions of the soil this area, including all vibration-sensitive land use in Navarro County along the northern portions of Segments 3A, 3B, 3C and 4 including the towns of Barry and Oak Valley.

Segment 3B

The vibration measurement results used to characterize the vibration propagation conditions along Segment 3B in Navarro County are the same as those used for Segment 3A.

Segment 3C

The vibration measurement results used to characterize the vibration propagation conditions along Segment 3C in Navarro County are the same as those used for Segment 3A.

Segment 4

The vibration measurement results used to characterize the vibration propagation conditions along Segment 4 in Navarro County are the same as those used for Segment 3A.

Freestone County

Segment 3C

Site V-4: N Fwy Service Rd., Fairfield. The vibration propagation measurement was conducted along the western edge of the gas field with the sensors in the adjoining field. The measurement results at this site are representative of the ground-borne vibration propagation conditions of the soil this area, including all vibration-sensitive land use between Fairfield and Teague in Freestone County following Route 179 on the east and Segment 4 on the west.

Segment 4

The vibration measurement results used to characterize the vibration propagation conditions along Segment 4 in Freestone County are the same as those used for Segment 3C.

Limestone County

Segment 4

Site V-5: LCR 828, Personville. The vibration propagation measurement was conducted in the front pasture of the property along the driveway. The measurement results at this site are representative of the ground-borne vibration propagation conditions of the soil this area, including all vibration-sensitive land use along Segment 4 west of the towns of Donie and Jewett.

Leon County

Segment 3C

Site V-7: 10290 Greenbriar Rd. The vibration propagation measurement was conducted along Greenbriar Rd. with the sensors located in the field to the north of the house. The measurement results at this site are representative of the ground-borne vibration propagation conditions of the soil this area, including all vibration-sensitive land use along the southern part of Segment 3C in south Leon County and north Madison County, including the towns of Centerville and Leona.

Segment 4

Site V-6: 6734 FM 977. The vibration propagation measurement was conducted in the front yard of the property. The measurement results at this site are representative of the ground-borne vibration propagation conditions of the soil this area, including all vibration-sensitive land use along the southern part of Segment 4 in southern Leon County and northern Madison County.

Madison County

Segment 3C

The vibration measurement results used to characterize the vibration propagation conditions along Segment 3C in Madison County are the same as those used for Segment 3C in Leon County.

Segment 4

The vibration measurement results used to characterize the vibration propagation conditions along Segment 4 in Madison County are the same as those used for Segment 4 in Leon County.

Grimes County

Segment 3C

The vibration measurement results used to characterize the vibration propagation conditions along Segment 3C in Grimes County are the same as those used for Segment 3C in Leon County.

Segment 4

The vibration measurement results used to characterize the vibration propagation conditions along Segment 4 in Grimes County are the same as those used for Segment 4 in Leon County.

Segment 5

Site V-8: 10063 CR 311. The vibration propagation measurement was conducted along CR 311 with the sensors located in the front yard of the property. The measurement results at this site are representative of the ground-borne vibration propagation conditions of the soil this area, including all vibration-sensitive land use along Segment 5 in Grimes co. from Roans Prairie to State Highway 105.

Waller County

Segment 5

Site V-9: Plantation Dr., Todd Mission. The vibration propagation measurement was conducted along Plantation Dr. with the sensors located in an empty lot. The measurement results at this site are representative of the ground-borne vibration propagation conditions of the soil this area, including all vibration-sensitive land use along Segment 5 in south Grimes County and north Waller County.

Harris County

Segment 5

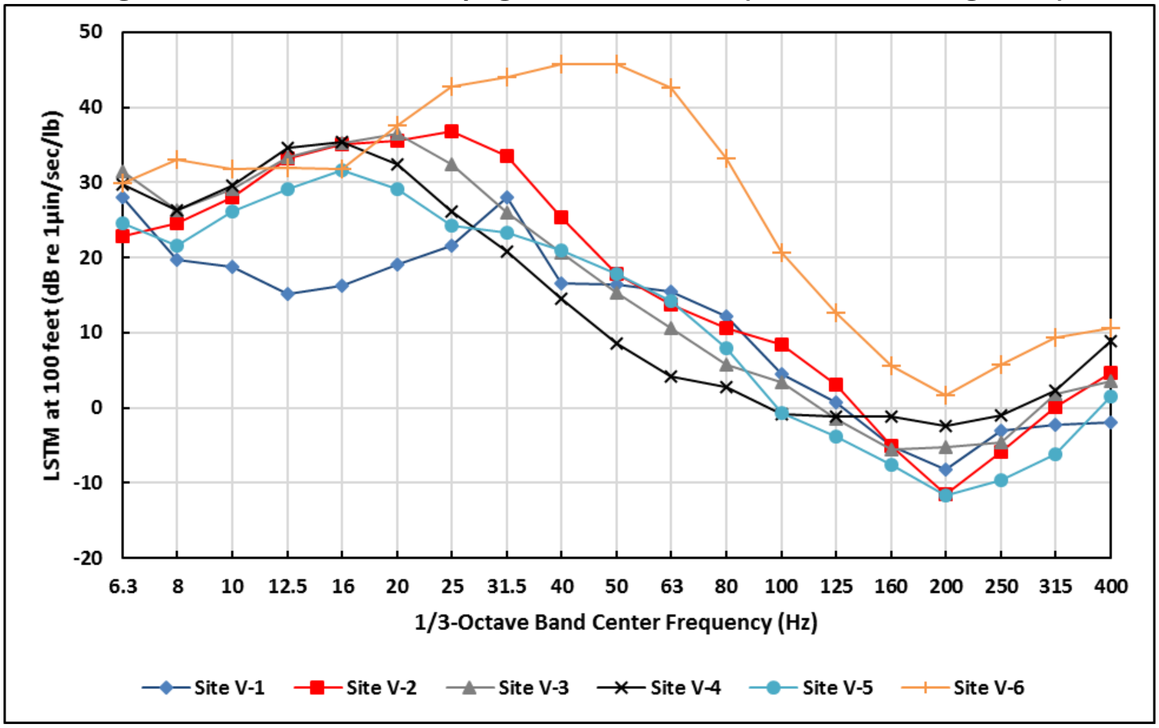
Site V-10: Josey Ranch Rd., Houston. The vibration propagation measurement was conducted along Josey Ranch Rd. with the sensors located in the field to the west. The results at this measurement site are representative of the ground-borne vibration propagation conditions of the soil this area, including all vibration-sensitive land use along US 290 close to Fry Rd for Segment 5.

Site V-11: 21610 U.S. 290 Frontage Rd. The vibration propagation measurement was conducted in the field northeast of the train tracks. The measurement results at this site are representative of the ground-borne vibration propagation conditions of the soil this area, including all vibration-sensitive land use along U.S. 290 between Lee Way Dr. and Huffmeister Rd. in Houston.

4.2.3 Vibration Measurement Results

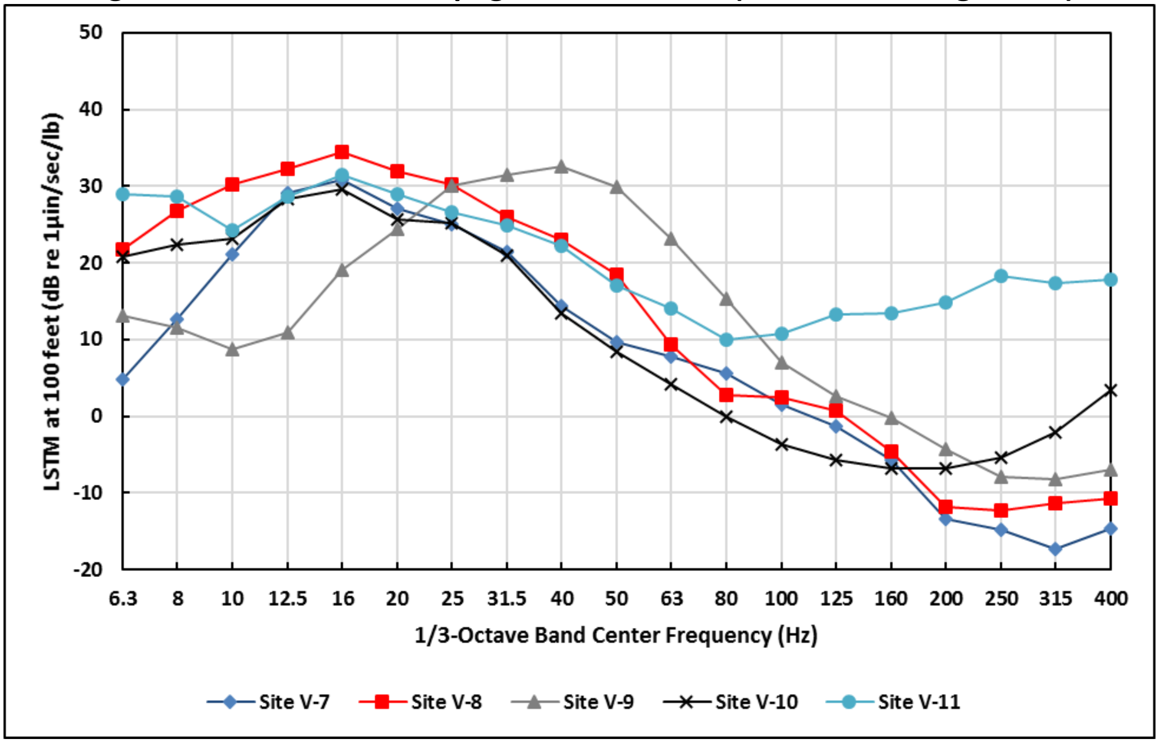
Representative results of the vibration propagation tests are shown in **Figure 4-10** (for Sites V-1 through V-6) and in **Figure 4-11** (for Sites V-7 through V-11) in terms of the measured LSTM as a function of vibration frequency at a distance of 100 feet. Higher LSTM levels in these figures indicate more efficient vibration propagation. Detailed vibration propagation data are provided in Appendix C.

Figure 4-10: Vibration Propagation Test Data (Sites V-1 through V-6)



Source: Cross-Spectrum Acoustics, 2016.

Figure 4-11: Vibration Propagation Test Data (Sites V-7 through V-11)



Source: Cross-Spectrum Acoustics, 2016.

NOISE AND VIBRATION PREDICTION METHODOLOGY

Noise and vibration impacts due to the Project construction and operation were analyzed by using the methodology contained in the FRA and FTA guidance manuals. The FRA Guidance Manual was used as the primary source of guidance for analysis of high speed rail noise and vibration impacts and mitigation and the FTA guidance was used to supplement the FRA guidance for non-high speed rail sources of noise and vibration. The following sections provide additional details regarding the methodology for the noise and vibration impact assessments.

Airborne Noise

Operational Noise

Noise levels from HSR operations were projected based on sound data gathered by Texas Central Railroad (TCRR) in Japan for the Tokaido Shinkansen N700A train, the proposed project's operating plan and the general noise assessment methods included in the FRA guidance manual (Chapter 4, Initial Noise Evaluation). Significant factors are summarized below:

- Based on TCRR measurement data for the Tokaido Shinkansen N700A train, the predictions assume a Reference Sound Exposure Level (SEL) of 87 dBA at a distance of 50 feet from the track centerline in all speed regimes.
- For the Final Operating Scenario (FOS) in the analysis year (2040), it is assumed that trains will run every 10 to 15 minutes in each direction between 05:30 and 23:30, with the last trains departing from Dallas and Houston at 22:00.

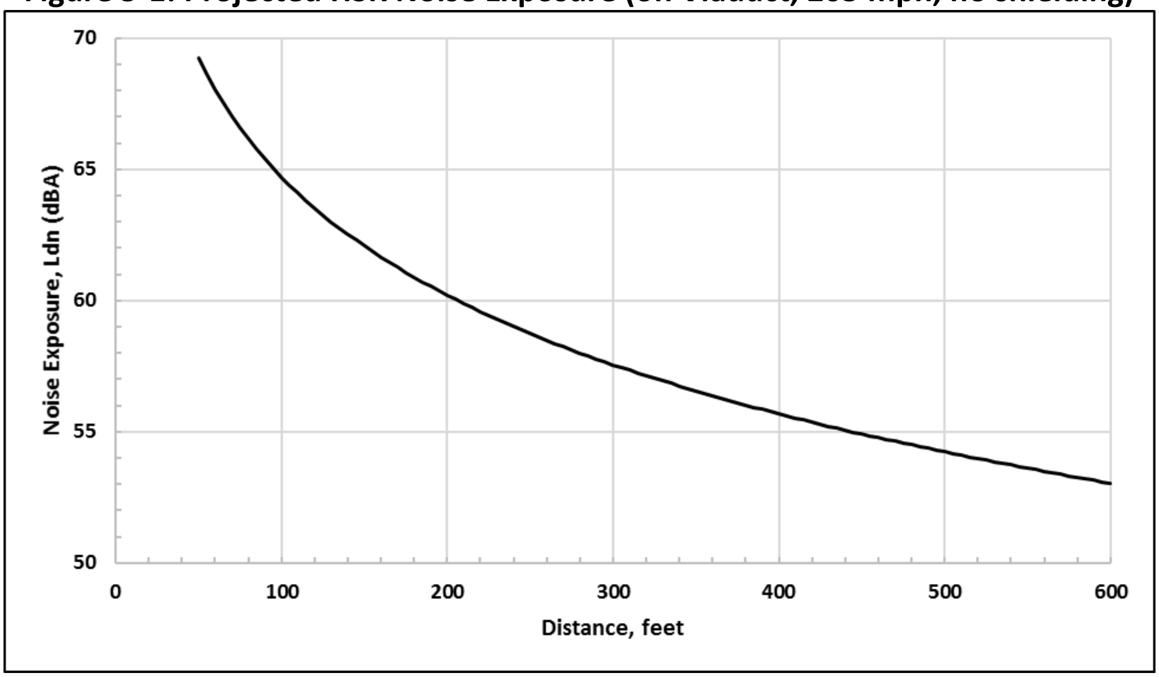
- It is assumed that the trainsets will be 8-car EMU fixed consists with a length of 204.7 meters.
- It is assumed that the trains will operate at a maximum speed of 205 mph along most of the route, except in the vicinity of the stations.

As an example, the projected noise exposure (Ldn) from HSR operations under worst-case conditions (i.e. on viaduct at the maximum speed of 205 mph, without shielding from intervening terrain or structures) is shown in **Figure 5-1** as a function of distance from the near track centerline.

Startle Due to Rapid Onset Rates

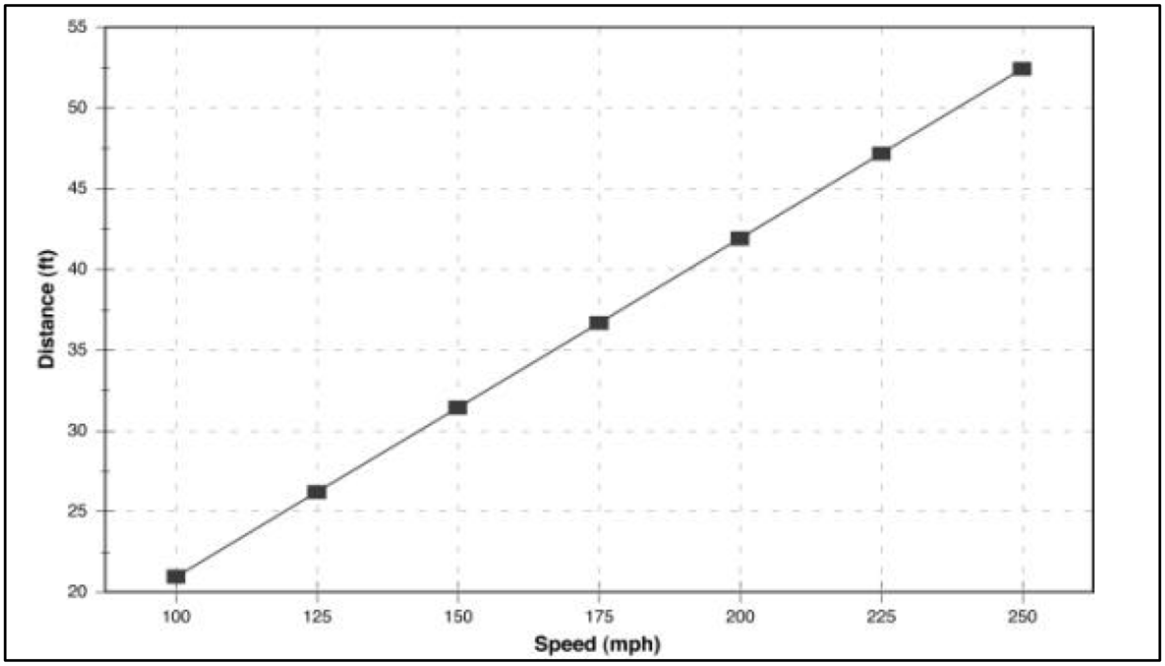
Rapid onset rates (very rapid changes in noise level) due to high speed train noise may cause startle effects at distances very close to the proposed tracks. The onset rate is defined as the rate of change of increasing noise level in decibels per second during a noise event. The duration of such an event is short (typically a few seconds for high-speed trains). For a given speed, onset rates will decrease as the distances from the trains to the noise-sensitive receivers increase. **Figure 5-2** shows the distance from the tracks versus speed relationship for rapid onset rates.

Figure 5-1: Projected HSR Noise Exposure (on Viaduct, 205 mph, no shielding)



Source: Cross-Spectrum Acoustics, 2016.

Figure 5-2: Distance from Tracks within which Startle Can Occur for HSR



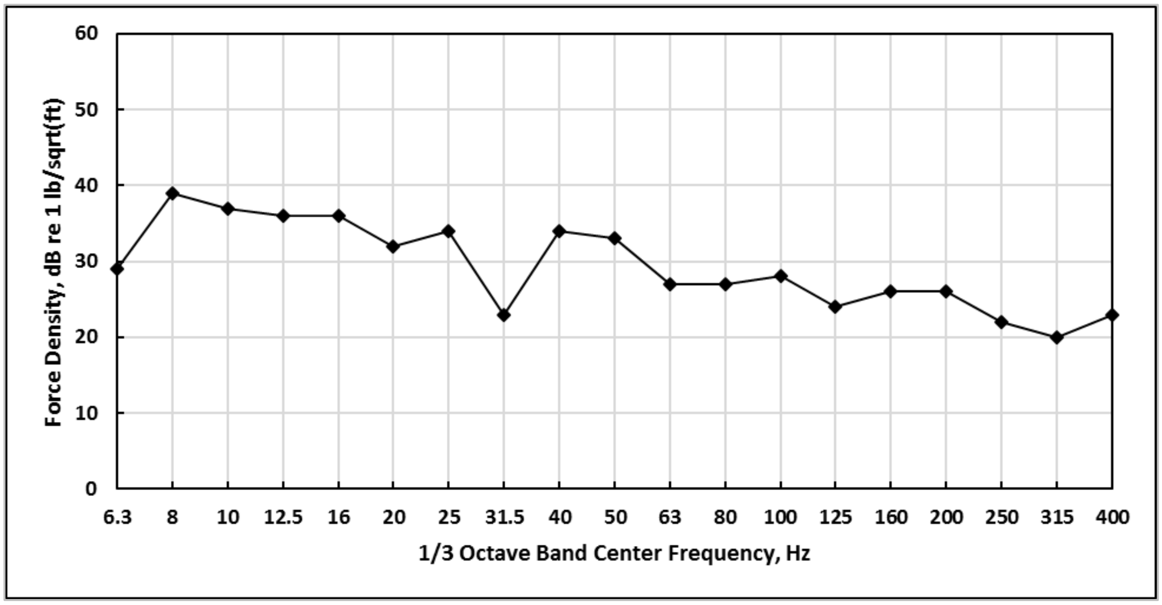
Source: FRA, "High-Speed Ground Transportation Noise and Vibration Impact Assessment," Final Report DOT/FRA/ORD-12/15, September 2012.

Ground-borne Vibration

Ground-borne vibration levels from HSR operations were projected using the detailed vibration assessment prediction methods included in the FRA guidance manual (Chapter 9, Detailed Vibration Assessment). Significant factors are summarized below:

- The train vibration source level was based on the Force Density Level for the Pendolino EMU high-speed train as reported in Figure 9-5 of the FRA guidance manual and shown below in **Figure 5-3**.
- It is assumed that the trains will operate at a maximum speed of 205 mph along most of the route, except in the vicinity of the stations.
- It is assumed that ground-borne noise would be masked by airborne noise from HSR operations at typical structures along the alternative routes and thus ground-borne noise impacts were not assessed.

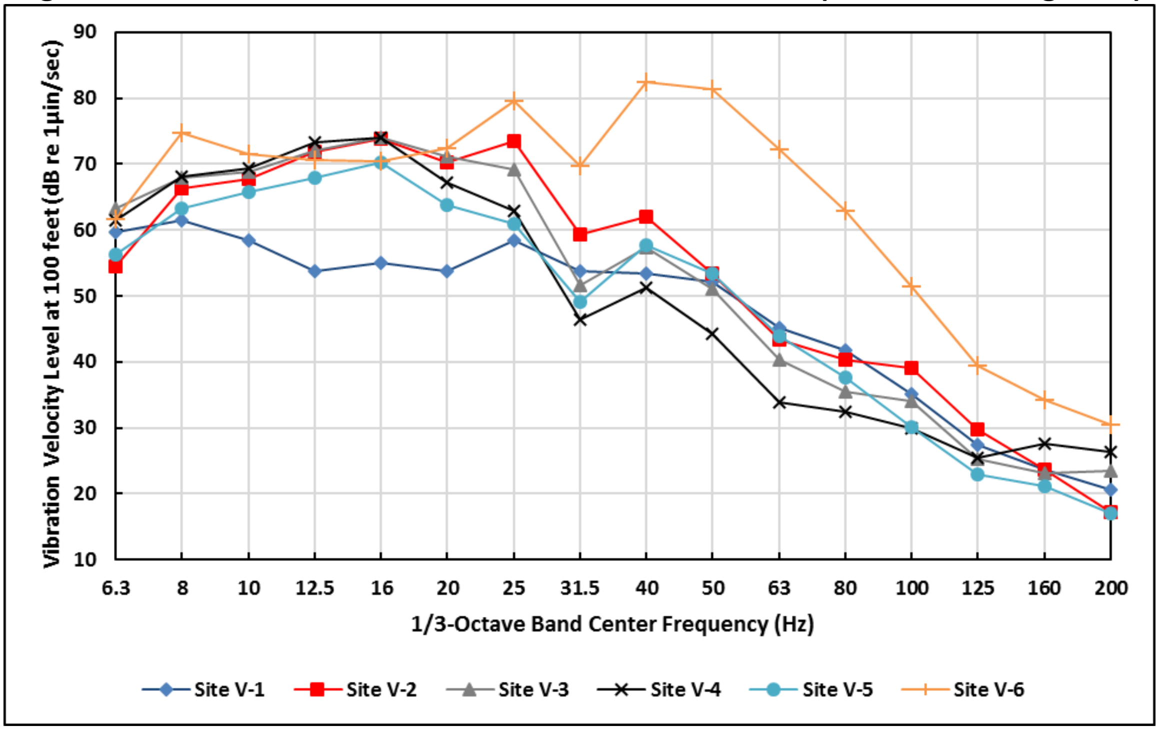
Figure 5-3: Force Density for Pendolino EMU High-Speed Train at 150 mph



Source: FRA, "High-Speed Ground Transportation Noise and Vibration Impact Assessment," Final Report DOT/FRA/ORD-12/15, September 2012.

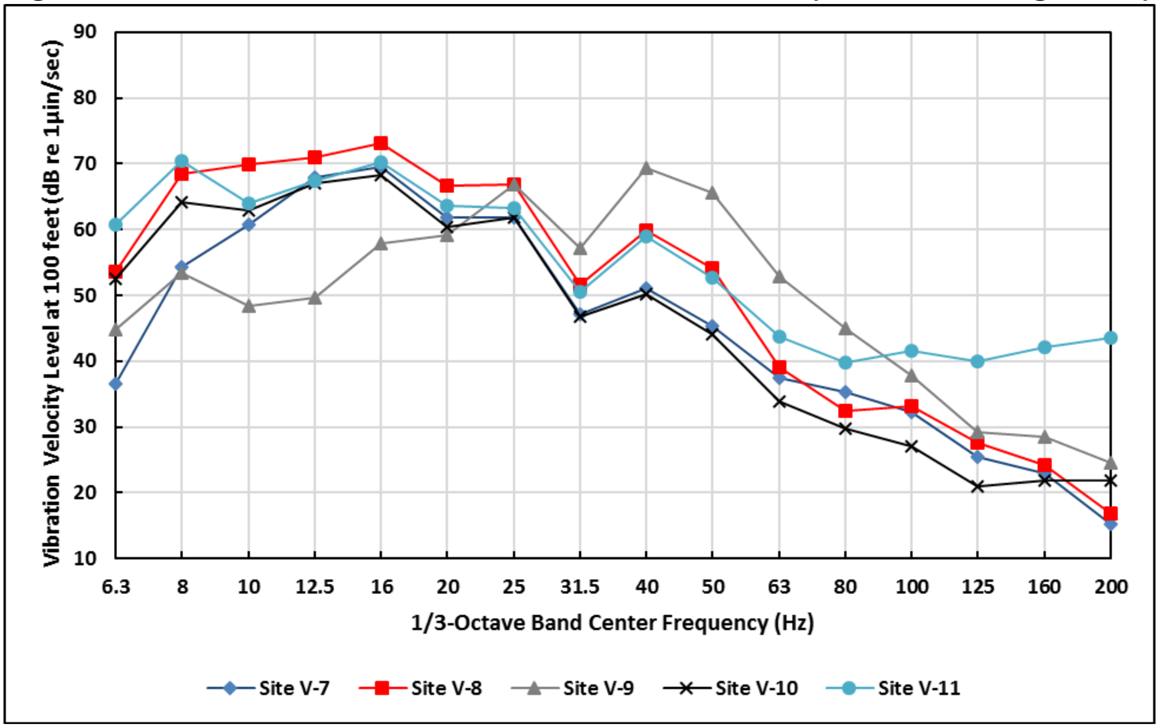
The above force density spectrum was combined with the LSTM data at each vibration measurement site to project ground vibration levels from future HSR operations using the FRA detailed vibration analysis methodology. As an example of the results, the projected ground vibration level spectra from HSR operations at a distance of 100 feet from the near track under worst-case conditions (i.e. at grade and at the maximum speed of 205 mph) are shown in **Figure 5-4** (for Sites V-1 through V-6) and in **Figure 5-5** (for Sites V-7 through V-11). These results suggest that HSR ground vibration levels at 100 feet from the tracks will marginally exceed the FRA vibration criterion of 72 VdB for residential land use in the areas represented by Sites V-2, V-3, V-4 and V-8, but will significantly exceed this criterion in the area represented by Site V-6.

Figure 5-4: Maximum HSR Ground Vibration at 100 feet (Sites V-1 through V-6)



Source: FRA, "High-Speed Ground Transportation Noise and Vibration Impact Assessment," Final Report DOT/FRA/ORD-12/15, September 2012.

Figure 5-5: Maximum HSR Ground Vibration at 100 feet (Sites V-7 through V-11)



Source: FRA, "High-Speed Ground Transportation Noise and Vibration Impact Assessment," Final Report DOT/FRA/ORD-12/15, September 2012.

Construction Noise and Vibration

Construction noise and impacts are assessed using a combination of the methods and construction source data contained in the FRA Manual and the FHWA Roadway Construction Noise Model (RCNM). Typical noise levels generated by representative pieces of equipment are listed in **Table 5-1**.

The noise exposure at a receiver location may be calculated using decibel addition of all operating construction equipment using the following equation:

$$L_{eq}(n) = L_{max} + 10 \times \text{Log}(U.F.) - 20 \times \text{Log}(D/50) - A_{shielding}$$

where:

Leq(n) = noise exposure at a receiver resulting from the operation of a single piece of equipment over n hours,

Lmax = noise emission level of the particular piece of equipment at the reference distance of 50 feet (taken from **Table 5-1**),

Ashielding = shielding provided by barriers, building, or terrain,

D = distance from the receiver to the piece of equipment in feet, and

U.F. = usage factor that accounts for the fraction of time that the equipment is in use over the specified time period. For Leq(1) assume a U.F. equal to 100% and for 8 hours or more use the values in **Table 5-1**.

The combination of noise from several pieces of equipment operating during the same time period is obtained from decibel addition of the Leq of each single piece of equipment calculated using the above equations.

Construction vibration is assessed for areas where there is potential for impact from construction activities. Such activities include blasting, pile driving, demolition, and drilling or excavation in close proximity to sensitive structures. Typical vibration levels generated by representative pieces of equipment are listed in **Table 5-2**.

Table 5-1: Construction Equipment Noise Emission Levels		
Equipment	**Typical Noise Level (dBA) 50 ft from Source**	**Usage Factor (U.F.), %**
Air Compressor	80	40
Backhoe	80	40
Ballast Equalizer	82	50
Ballast Tamper	83	50
Compactor	82	20
Concrete Mixer	85	40
Concrete Pump	82	20
Concrete Vibrator	76	20
Crane, Derrick	88	16
Crane, Mobile	83	16
Dozer	85	16
Generator	82	50
Grader	85	40
Impact Wrench	85	50
Jack Hammer	88	20
Loader	80	40
Paver	85	50
Pile Driver (Impact)	101	20
Pile Driver (Vibratory)	95	20
Pneumatic Tool	85	50
Pump	77	50
Rail Saw	90	20
Rock Drill	85	20
Roller	85	20
Saw	76	20
Scarifier	83	20
Scraper	85	40
Shovel	82	40
Spike Driver	77	20
Tie Cutter	84	20
Tie Handler	80	20
Tie Inserter	85	20
Truck	84	40

Sources: (1) FRA, “High-Speed Ground Transportation Noise and Vibration Impact Assessment,” Final Report DOT/FRA/ORD-12/15, September 2012 and (2) FHWA, “Construction Noise Handbook, Final Report FHWA-HEP-06-015, August 2006.

Table 5-2: Vibration Source Levels for Construction Equipment			
Equipment		**PPV at 25 ft (in/sec)**	**Approximate Lv † at 25 ft**
Pile Driver (impact)	upper range	1.518	112
	typical	0.644	104
Pile Driver (vibratory)	upper range	0.734	105
	typical	0.170	93
Clam shovel drop (slurry wall)		0.202	94
Hydromill (slurry wall)	in soil	0.008	66
	in rock	0.017	75
Vibratory roller		0.210	94
Hoe ram		0.089	87
Large bulldozer		0.089	87
Caisson drilling		0.089	87
Loaded trucks		0.076	86
Jackhammer		0.035	79
Small bulldozer		0.003	58
† RMS velocity in decibels (VdB) re 1 µinch/second			

Source: FRA, "High-Speed Ground Transportation Noise and Vibration Impact Assessment," Final Report DOT/FRA/ORD-12/15, September 2012.

For damage assessment the following equation is used:

$$PPVequip = PPVref \times [(25/D)]^{1.5}$$

where:

PPVequip = the peak particle velocity in in/sec of the equipment adjusted for distance

PPVref = the reference vibration level in in/sec at 25 feet from **Table 5-2**, and

D = the distance from the equipment to the receiver in feet.

For annoyance assessment the following equation is used:

$$Lv\,(D) = Lv\,(25\text{ ft}) - 30 \times \text{Log}(D/25)$$

where:

Lv(D) = RMS vibration level at distance D

Lv(25 ft) = RMS vibration level at 25 ft from **Table 5-2**, and

D = the distance from the equipment to the receiver in feet.

NOISE AND VIBRATION IMPACT ASSESSMENT

Station Noise Assessment

The proposed station locations include one site in Dallas, one site near College Station and three site options in Houston. Excluding noise impacts from train operations (addressed below), sources of potential noise impact in the vicinity of train stations includes auto and bus traffic associated with access roads and parking facilities. For these sources, FTA guidance suggests impact screening distances in the range of 100-225 feet. For the station sites under consideration, however, it does not appear that there is any noise-sensitive land use within these distances. Thus noise impacts are not anticipated due to HSR station activities.

Maintenance Facility Noise Impacts

There are two proposed Trainset Maintenance Facilities (TMF) and five Maintenance-of-Way Facilities (MOWF) along each build alternative. For maintenance facilities, FTA guidance (Chapter 3 of the FTA Guidance Manual)[1] suggests an impact screening distance of 1,000 feet from the center of the facility. If no sensitive receptors are found within that distance, no further noise analysis is required. For all the TMF and MOWF facilities, there are no noise-sensitive land uses within this distance. Thus, noise impacts are not anticipated due to TMF or MOWF operations.

Operational Noise Assessment

The assessment of noise impacts from HSR operations is summarized by county and segment in **Table 6-1** for FTA Category 2 (residential) land use and in **Table 6-2** for FTA Category 3 (institutional) land use. The results include a tabulation of location information for each sensitive receptor group, the existing noise levels, the projections of future noise levels, the impact criteria, and whether there will be noise impacts. The tables also show the total number of moderate and severe noise impacts for each location, without mitigation.

[1] FTA, "Transit Noise and Vibration Impact Assessment," Final Report FTA-VA-90-1003-06, May 2006.

Table 3.4-12: Summary of Noise Impacts for Residential Land Use										
County/ Segment	Location	Side of Track	Near Track Dist. (ft)	Existing Noise Level (Ldn)	Project Noise Levels – Ldn (dBA)			Number and Type of Impacts		Mapbook Page
					HSR	FRA Criteria				
						Mod.	Sev.	Mod.	Sev.	
Dallas (1)	Dallas Station to IH-20	NB	243-415	72	54-57	65	71	0	0	--
				53		54	60	0	0	--
Dallas (1)	Dallas Station to IH-20	SB	348-1001	72	48-55	65	71	0	0	--
				53		54	60	0	0	--
Dallas (1)	IH-20 to Bluff Springs Rd	NB	270-793	53	49-56	54	60	1	0	7
				70		64	69	0	0	--
				45		52	59	5	0	10-11
Dallas (1)	IH-20 to Bluff Springs Rd	SB	223-970	53	48-58	54	60	0	0	--
				70		64	69	0	0	--
				45		52	59	3	0	11
Ellis (1)	IH-20 to Bluff Springs Rd	NB	188-910	45	49-59	52	59	8	1	11-12
Ellis (1)	IH-20 to Bluff Springs Rd	SB	174-2612	45	42-59	52	59	9	1	11-12
Ellis (2A)	Bluff Springs Rd to FM 813	NB	527-2986	45	39-52	52	59	1	0	13
				55		55	61	0	0	--
Ellis (2A)	Bluff Springs Rd to FM 813	SB	199-2715	45	41-59	52	59	4	0	13-16
				55		55	61	4	0	13-16
Ellis (2A)	FM 813 to TX 287	NB	824-1690	55	44-49	55	61	0	0	--
				53		55	61	0	0	--
Ellis (2A)	FM 813 to TX 287	SB	211-989	55	46-58	55	61	1	0	18

Table 3.4-12: Summary of Noise Impacts for Residential Land Use

County/ Segment	Location	Side of Track	Near Track Dist. (ft)	Existing Noise Level (Ldn)	Project Noise Levels – Ldn (dBA)			Number and Type of Impacts		Mapbook Page
					HSR	FRA Criteria				
						Mod.	Sev.	Mod.	Sev.	
Ellis (2A)	FM 813 to TX 287			53		55	61	0	0	--
Ellis (2A)	TX 287 to TX 34	NB	281-2148	53	43-56	55	61	1	0	23
				52		54	60	0	0	--
Ellis (2A)	TX 287 to TX 34	SB	289-805	53	48-56	55	61	1	0	22
				52		54	60	0	0	--
Ellis (2A)	TX 34 to TX 22	NB	No noise sensitive receptors.							--
Ellis (2A)	TX 34 to TX 22	SB	167-905	53	49-60	55	61	2	0	25
				36		50	55	0	0	--
Ellis (2B)	Bluff Springs Rd to FM 813	NB	385-2987	55	39-54	55	61	2	0	29
				45		52	59	0	0	--
Ellis (2B)	Bluff Springs Rd to FM 813	SB	205-2715	55	41-58	55	61	0	0	--
Ellis (2B)	Bluff Springs Rd to FM 813	SB		45		52	59	1	0	30
Ellis (2B)	FM 813 to TX 287	NB	179-947	55	48-59	55	61	1	0	33
Ellis (2B)	FM 813 to TX 287	NB		53		55	61	0	0	--
Ellis (2B)	FM 813 to TX 287	SB	585-1784	55	44-49	55	61	0	0	--
				53		55	61	0	0	--
Ellis (2B)	TX 287 to TX 34	NB	455-2908	53	39-53	55	61	0	0	--
				60		58	63	0	0	--
Ellis (2B)	TX 287 to TX 34	SB	959	53	46	55	61	0	0	--

Table 3.4-12: Summary of Noise Impacts for Residential Land Use

County/ Segment	Location	Side of Track	Near Track Dist. (ft)	Existing Noise Level (Ldn)	Project Noise Levels – Ldn (dBA)			Number and Type of Impacts		Mapbook Page
					HSR	FRA Criteria				
						Mod.	Sev.	Mod.	Sev.	
				60		58	63	0	0	--
Ellis (2B)	TX 34 to TX 22	NB	No noise sensitive receptors.							
Ellis (2B)	TX 34 to TX 22	SB	1388-1556	53	44-46	55	61	0	0	--
Ellis (3A)	TX 34 to TX 22	NB	No noise sensitive receptors.							
Ellis (3A)	TX 34 to TX 22	SB	977	36	46	50	55	0	0	--
Ellis (3B)	TX 34 to TX 22	NB	No noise sensitive receptors.							
Ellis (3B)	TX 34 to TX 22	SB	1311	36	44	50	55	0	0	--
Ellis (3C)	TX 34 to TX 22	NB	No noise sensitive receptors.							
Ellis (3C)	TX 34 to TX 22	SB	977	36	46	50	55	0	0	--
Navarro (3A)	TX 34 to TX 22	NB	396-923	36	47-52	50	55	1	0	45
Navarro (3A)	TX 34 to TX 22	SB	360-2879	36	39-53	50	55	1	0	46
Navarro (3A)	TX 22 to TX 31	NB	290-632	39	49-54	50	55	1	0	51
				36		50	55	0	0	--
Navarro (3A)	TX 22 to TX 31	SB	560-1034	39	46-52	50	55	0	0	--
				36		50	55	0	0	--
Navarro (3A)	TX 31 to FM 3194	NB	261-546	46	50-57	52	59	1	0	55
Navarro (3A)	TX 31 to FM 3194	SB	740	46	45	52	59	0	0	--
Navarro (3A)	FM 3194 to Navarro County Line	NB	656	46	51	52	59	0	0	--
Navarro (3A)	FM 3194 to Navarro County Line	SB	No noise sensitive receivers.							--

Table 3.4-12: Summary of Noise Impacts for Residential Land Use										
County/ Segment	Location	Side of Track	Near Track Dist. (ft)	Existing Noise Level (Ldn)	Project Noise Levels – Ldn (dBA)			Number and Type of Impacts		Mapbook Page
					HSR	FRA Criteria				
						Mod.	Sev.	Mod.	Sev.	
Navarro (3B)	TX 34 to TX 22	NB	611-2905	36	39-51	50	55	1	0	65
Navarro (3B)	TX 34 to TX 22	SB	222-1002	36	46-58	50	55	3	1	65-67
Navarro (3B)	TX 22 to TX 31	NB	261-996	46	48-57	52	59	1	0	70
				39		50	55	0	0	--
Navarro (3B)	TX 22 to TX 31	SB	324-759	46	48-55	52	59	3	0	70
Navarro (3B)	TX 31 to Bonner Ave	NB	228-1001	46	43-56	52	59	2	0	70-73
Navarro (3B)	TX 31 to Bonner Ave	SB	204-1017	46	43-63	52	59	2	0	70
Navarro (3B)	TX 31 to Bonner Ave	SB		39		50	55	4	0	70
Navarro (3B)	Bonner Ave to Navarro County Line	NB	142-1016	46	48-61	52	59	1	1	73-75
Navarro (3B)	Bonner Ave to Navarro County Line	SB	No noise sensitive receptors.							--
Navarro (3C)	TX 34 to TX 22	NB	396-923	36	47-52	50	55	1	0	83
Navarro (3C)	TX 34 to TX 22	SB	360-2879	36	39-53	50	55	1	0	84
Navarro (3C)	TX 22 to TX 31	NB	290-632	36	49-54	50	55	0	0	--
				39		50	55	1	0	89
Navarro (3C)	TX 22 to TX 31	SB	566-1034	39	46-52	20	55	0	0	--
Navarro (3C)	TX 31 to TX 14	NB	786-2780	46	37-50	52	59	0	0	--
Navarro (3C)	TX 31 to TX 14	SB	No noise sensitive receptors.							--
Navarro (3C)	TX 14 to Navarro County Line	NB	176-1000	46	46-59	52	59	0	1	95
Navarro (3C)	TX 14 to Navarro County Line	SB	571-940	46	47-51	52	59	0	0	--
Freestone (3C)	Navarro County Line to FM 1090	NB	177-885	29	47-60	50	55	2	2	99-100

Table 3.4-12: Summary of Noise Impacts for Residential Land Use										
County/ Segment	Location	Side of Track	Near Track Dist. (ft)	Existing Noise Level (Ldn)	Project Noise Levels – Ldn (dBA)			Number and Type of Impacts		Mapbook Page
					HSR	FRA Criteria				
						Mod.	Sev.	Mod.	Sev.	
Freestone (3C)	Navarro County Line to FM 1090	SB	568-989	29	47-50	50	55	0	0	--
Freestone (3C)	FM 1090 to US 84	NB	No noise sensitive receptors.							--
Freestone (3C)	FM 1090 to US 84	SB	232-511	52	51-57	54	60	3	0	102-104
Freestone (3C)	FM 1090 to US 84	SB		68		63	68	0	0	--
Freestone (3C)	US 84 to TX 179	NB	No noise sensitive receptors.							--
Freestone (3C)	US 84 to TX 179	SB	226-452	50	52-58	53	60	1	0	106
Freestone (3C)	US 84 to TX 179	SB		68		63	68	0	0	--
Freestone (3C)	TX 179 to Freestone County Line	NB	No noise sensitive receptors.							--
Freestone (3C)	TX 179 to Freestone County Line	SB								--
Freestone (4)	Navarro County Line to FM 930	NB	785-905	42	47-48	52	57	0	0	--
				43		52	58	0	0	--
Freestone (4)	Navarro County Line to FM 930	SB	739	43	48	52	58	0	0	--
Freestone (4)	FM 930 to Freestone County Line	NB	812-989	42	49-50	52	57	0	0	--
Freestone (4)	FM 930 to Freestone County Line	SB	125-993	42	47-62	52	57	2	4	161-165
Limestone (4)	Limestone County	NB	345-862	48	50-54	53	59	3	0	170-173
Limestone (4)	Limestone County	SB	452-832	48	48-54	53	59	0	0	--
Leon (3C)	Freestone County Line to CR 3051	NB	No noise sensitive receptors.							--

Table 3.4-12: Summary of Noise Impacts for Residential Land Use

County/ Segment	Location	Side of Track	Near Track Dist. (ft)	Existing Noise Level (Ldn)	Project Noise Levels – Ldn (dBA)			Number and Type of Impacts		Mapbook Page
					HSR	FRA Criteria				
						Mod.	Sev.	Mod.	Sev.	
Leon (3C)	Freestone County Line to CR 3051	SB	322-503	55	51-56	55	61	1	0	118
Leon (3C)	CR 3051 to TX 7	NB	221-334	55	54-56	55	61	1	0	126
Leon (3C)	CR 3051 to TX 7	SB	220-428	55	52-58	55	61	3	0	121-122
Leon (3C)	TX 7 to FM 977	NB	500	55	53	55	61	0	0	--
Leon (3C)	TX 7 to FM 977	SB	No noise sensitive receptors.							--
Leon (4)	Limestone County Line to US 79	NB	708	42	49	51	57	0	0	--
Leon (4)	Limestone County Line to US 79	SB	883-1003	42	47-49	51	57	0	0	--
Leon (4)	US 79 to TX 7	NB	296-885	42	47-57	51	57	0	1	177
Leon (4)	US 79 to TX 7	SB	519	42	53	51	57	1	0	179
				62		59	64	0	0	--
Leon (4)	TX 7 to FM 977	NB	347-797	42	49-54	51	57	1	0	180
				62		59	64	0	0	--
Leon (4)	TX 7 to FM 977	SB	211-843	62	49-59	59	64	0	0	--
				52		54	60	0	0	--
Leon (4)	FM 977 to FM 2289	NB	307-604	52	50-54	54	60	1	0	187
Leon (4)	FM 977 to FM 2289	SB	386-907	52	47-53	54	60	0	0	--
Madison (3C)	FM 977 to Waldrip Rd	NB	No noise sensitive receptors.							--
Madison (3C)	FM 977 to Waldrip Rd	SB	158-379	65	55-61	61	66	0	0	--
Madison (3C)	Waldrip Rd to FM 1452	NB	338	50	56	53	60	1	0	144
Madison (3C)	Waldrip Rd to FM 1452	SB	532-640	50	51	53	60	0	0	--
Madison (3C)	FM 1452 to FM 1696	NB	787-970	54	47-50	55	61	0	0	--

Table 3.4-12: Summary of Noise Impacts for Residential Land Use

County/ Segment	Location	Side of Track	Near Track Dist. (ft)	Existing Noise Level (Ldn)	Project Noise Levels – Ldn (dBA)			Number and Type of Impacts		Mapbook Page
					HSR	FRA Criteria				
						Mod.	Sev.	Mod.	Sev.	
Madison (3C)	FM 1452 to FM 1696	SB	No noise sensitive receivers.							--
Madison (4)	FM 977 to FM 2289	NB	288-420	52	52-55	54	60	1	0	190
Madison (4)	FM 977 to FM 2289	SB	338-982	52	47-54	54	60	0	0	--
Madison (4)	FM 2289 to US 190	NB	353-714	50	50-55	53	60	0	0	--
				54		55	61	1	0	196
Madison (4)	FM 2289 to US 190	SB	213-693	50	49-57	53	60	1	0	192
Madison (4)	US 190 to FM 1696	NB	182-909	54	49-60	55	61	3	0	196-197
Madison (4)	US 190 to FM 1696	SB	436-990	54	46-54	55	61	0	0	--
Grimes (5)	FM 1696 to FM 39	NB	231-589	47	52-58	52	59	1	0	210
Grimes (5)	FM 1696 to FM 39	NB		49		53	59	0	0	--
Grimes (5)	FM 1696 to FM 39	SB	No noise sensitive receptors.							--
Grimes (5)	FM 39 to TX 90	NB	313-1014	49	46-56	53	59	3	0	211-212
Grimes (5)	FM 39 to TX 90	SB	332-852	49	47-56	53	59	1	0	211
Grimes (5)	TX 90 to CR 215	NB	329-1001	49	44-55	53	59	0	0	--
Grimes (5)	TX 90 to CR 215	SB	422-798	49	45-53	53	59	1	0	214
Grimes (5)	CR 215 to TX 105	NB	395-850	48	48-54	53	59	1	0	222
Grimes (5)	CR 215 to TX 105	SB	391-1749	48	44-54	53	59	3	0	222-223
Grimes (5)	TX 105 to Grimes County Line	NB	157-1010	49	46-60	53	59	5	1	227
				48		53	59	0	0	--
Grimes (5)	TX 105 to Grimes County Line	SB	563-1958	49	42-52	53	59	0	0	--

Table 3.4-12: Summary of Noise Impacts for Residential Land Use										
County/ Segment	Location	Side of Track	Near Track Dist. (ft)	Existing Noise Level (Ldn)	Project Noise Levels – Ldn (dBA)			Number and Type of Impacts		Mapbook Page
					HSR	FRA Criteria				
						Mod.	Sev.	Mod.	Sev.	
Waller (5)	Waller County	NB	209-994	45	46-58	52	59	5	0	228
Waller (5)	Waller County	NB		49		53	59	3	0	231-232
Waller (5)	Waller County	SB	157-1000	45	46-60	52	59	3	0	228-229
Waller (5)	Waller County	SB		49		53	59	13	1	231
Harris (5)	Harris County Line to Old Hwy 290	NB	190-1006	51	48-59	54	60	3	0	235
Harris (5)	Harris County Line to Old Hwy 290	SB	330-995	51	47-55	54	60	1	0	235
Harris (5)	Old Hwy 290 to Grand Pkwy	NB	356-1009	51	46-54	54	60	1	0	238
Harris (5)	Old Hwy 290 to Grand Pkwy	SB	210-1010	51	46-56	54	60	7	0	239
Harris (5)	Grand Pkwy to TX 6	NB	155-520	59	52-60	57	63	0	0	--
Harris (5)	Grand Pkwy to TX 6	NB		69		64	69	0	0	--
Harris (5)	Grand Pkwy to TX 6	SB	81-518	59	52-64	57	63	1	0	244
Harris (5)	Grand Pkwy to TX 6	SB		69		64	69	16	0	246-247
Harris (5)	TX 6 to Blalock Rd	NB	262-501	46	52-56	52	59	3	0	247-250
Harris (5)	TX 6 to Blalock Rd	SB	No noise sensitive receptors.							--
Harris (5)	Blalock Rd to Houston Station	NB	110-510	55	52-62	55	64	23	0	251-252
Harris (5)	Blalock Rd to Houston Station	NB		46		52	59	2	1	251
Harris (5)	Blalock Rd to Houston Station	NB		49		53	59	62	7	251-252

Table 3.4-12: Summary of Noise Impacts for Residential Land Use										
County/ Segment	Location	Side of Track	Near Track Dist. (ft)	Existing Noise Level (Ldn)	Project Noise Levels – Ldn (dBA)			Number and Type of Impacts		Mapbook Page
					HSR	FRA Criteria				
						Mod.	Sev.	Mod.	Sev.	
Harris (5)	Blalock Rd to Houston Station	SB	227-524	55	52-57	55	64	81	0	251-252
Harris (5)	Blalock Rd to Houston Station	SB		49		49	56	5	0	252

Source: Cross-Spectrum Acoustics, 2016.

Table 6-2: Summary of Noise Impacts for Institutional Land Use												
County	**Seg.**	**Location**	**Side of Track**	**Near Track Dist. (ft.)**	**Speed (mph)**	**Existing Noise Level Leq (dBA)**	**TX HSR Noise Levels – Leq (dBA)**			**Type and # of Impacts**		**Mapbook Page**
							TX HSR Project	**FTA Criteria**				
								Mod.	**Sev.**	**Mod.**	**Sev.**	
Dallas	1	Friendship Missionary Baptist Church	SB	362	205	75	53	70	73	0	0	4
Dallas	1	The Church of Revelation	SB	411	205	75	52	70	73	0	0	4
Dallas	1	College Park Baptist Church	SB	670	205	50	49	58	60	0	0	6
Dallas	1	Full Faith Deliverance Church	SB	463	205	50	52	58	60	0	0	6
Ellis	2B	Palmyra Studios	NB	963	205	62	45	64	65	0	0	31
Freestone	4	Lebanon Church	NB	454	205	44	50	57	59	0	0	156
Freestone	4	Furney-Richardson School	NB	837	205	49	48	58	59	0	0	162
Grimes	5	Shiloh Church Cemetery	SB	988	205	45	46	57	59	0	0	202
Harris	5	Fairbanks United Methodist Church	NB	451	205	44	52	57	59	0	0	250
Harris	5	Christian Family Church	NB	177	205	44	58	57	59	1	0	250
Harris	5	Pentecostal Church New Jerusalem	SB	199	205	47	57	57	59	0	0	252

Source: Cross-Spectrum Acoustics, 2016.

The noise impact locations are shown graphically in **Appendix D, Cultural Resources and Community Facilities Mapbook** and the projected noise impacts are described below by county and segment.

<u>Dallas County</u>

- **Segment 1**
  - **I-20 to Bluff Springs Rd (NB) (Mapbook Page 1-6):** There are six single-family residences along the northbound side of the proposed alignment between Interstate-20 and Bluff Springs Rd along Segment 1 projected to have moderate noise impacts. The noise impacts at this location are due to HSR operations and low existing noise levels.
  - **I-20 to Bluff Springs Rd (SB) (Mapbook Page 1-6):** There are three single-family residences along the southbound side of the proposed alignment between Interstate-20 and the Bluff Springs Rd along Segment 1 projected to have moderate noise impacts. The noise impacts at this location are due to HSR operations and low existing noise levels.

<u>Ellis County</u>

- **Segment 1**
  - **I-20 to Bluff Springs Rd (NB) (Mapbook Page 6-12):** There are nine single-family residences along the northbound side of the proposed alignment between Interstate-20 and Bluff Springs Rd along Segment 1 projected to have moderate or severe noise impacts. The noise impacts at this location are due to HSR operations and low existing noise levels.
  - **I-20 to Bluff Springs Rd (SB) (Mapbook Page 6-12):** There are ten single-family residences along the southbound side of the proposed alignment between Interstate-20 and Bluff Springs Rd along Segment 1 projected to have moderate or severe noise impacts. The noise impacts at this location are due to HSR operations and low existing noise levels.
- **Segment 2A**
  - **Bluff Springs Rd to FM 813 (NB) (Mapbook Page 12-16):** There is one single-family residence along the northbound side of the proposed alignment between the Bluff Springs Rd and Farm to Market 813 along Segment 2A projected to have moderate noise impacts. The noise impact at this location is due to HSR operations and low existing noise levels.
  - **Bluff Springs Rd to FM 813 (SB) (Mapbook Page 12-16):** There are eight single-family residences along the southbound side of the proposed alignment between the Bluff Springs Rd and Farm to Market 813 along Segment 2A projected to have moderate noise impacts. The noise impacts at this location are due to HSR operations and low existing noise levels.
  - **FM 813 to TX 287 (SB) (Mapbook Page 16-22):** There is one single-family residence along the southbound side of the proposed alignment between Farm to Market 813 and TX 287 along Segment 2A projected to have a moderate

noise impact. The noise impact at this location is due to HSR operations and low existing noise levels.

- **TX 287 to TX 34 (NB) (Mapbook Page 16-22):** There is one single-family residence along the northbound side of the proposed alignment between TX 287 and TX 34 along Segment 2A projected to have a moderate noise impact. The noise impact at this location is due to HSR operations and low existing noise levels.
- **TX 287 to TX 34 (SB) (Mapbook Page 22-25):** There is one single-family residence along the southbound side of the proposed alignment between TX 287 and TX 34 along Segment 2A projected to have a moderate noise impact. The noise impact at this location is due to HSR operations and low existing noise levels.
- **TX 34 to TX 22 (SB) (Mapbook Page 22-25):** There are two single-family residences along the southbound side of the proposed alignment between TX 34 and TX 22 along Segment 2A projected to have moderate noise impacts. The noise impacts at this location are due to HSR operations and low existing noise levels.

- **Segment 2B**
  - **Bluff Springs Rd to FM 813 (NB) (Mapbook Page 28-32):** There are two single-family residences along the northbound side of the proposed alignment between Bluff Springs Rd and Farm to Market 813 along Segment 2B projected to have moderate noise impacts. The noise impacts at this location are due to HSR operations and low existing noise levels.
  - **Bluff Springs Rd to FM 813 (SB) (Mapbook Page 28-32):** There is one single-family residence along the southbound side of the proposed alignment between Bluff Springs Rd and Farm to Market 813 along Segment 2B projected to have a moderate noise impact. The noise impact at this location is due to HSR operations and low existing noise levels.
  - **FM 813 to TX 287 (NB) (Mapbook Page 32-38):** There is one single-family residence along the northbound side of the proposed alignment between Farm to Market 813 and TX 287 along Segment 2B projected to have a moderate noise impact. The noise impact at this location is due to HSR operations and low existing noise levels.

<u>Navarro County</u>

- **Segment 3A**
  - **TX 34 to TX 22 (NB) (Mapbook Page 43-48):** There is one single-family residence along the northbound side of the proposed alignment between TX 34 and TX 22 along Segment 3A in Navarro County projected to have a moderate noise impact. The noise impact at this location is due to HSR operations and low existing noise levels.
  - **TX 34 to TX 22 (SB) (Mapbook Page 43-48):** There is one residence along the southbound side of the proposed alignment between TX 34 and TX 22 along Segment 3A in Navarro County projected to have a moderate noise impact. The noise impact at this location is due to HSR operations and low existing noise levels.

- **TX 22 to TX 31 (NB) (Mapbook Page 48-52):** There is one residence along the northbound side of the proposed alignment between TX 22 and TX 31 along Segment 3A projected to have a moderate noise impact. The noise impact at this location is due to HSR operations and low existing noise levels.
- **TX 31 to FM 3194 (NB) (Mapbook Page 52-57):** There is one residence along the northbound side of the proposed alignment between TX 31 to Farm to Market 3194 along Segment 3A in Navarro County projected to have a moderate noise impact. The noise impact at this location is due to HSR operations and low existing noise levels.

- **Segment 3B**
  - **TX 34 to TX 22 (NB) (Mapbook Page 63-67):** There is one residence along the northbound side of the proposed alignment between TX 34 and TX 22 along Segment 3B projected to have a moderate noise impact. The noise impact at this location is due HSR operations and low existing noise levels.
  - **TX 34 to TX 22 (SB) (Mapbook Page 63-67):** There are four residences along the southbound side of the proposed alignment between TX 34 and TX 22 along Segment 3B projected to have moderate or severe noise impacts. The noise impacts at this location are due to HSR operations and low existing noise levels.
  - **TX 22 to TX 31 (NB) (Mapbook Page 67-70):** There is one residence along the northbound side of the proposed alignment between TX 22 and TX 31 along Segment 3B projected to have a moderate noise impact. The noise impact at this location is due to HSR operations and low existing noise levels.
  - **TX 22 to TX 31 (SB) (Mapbook Page 67-70):** There are three residences along the southbound side of the proposed alignment between TX 22 and TX 31 along Segment 3B projected to have moderate noise impacts. The noise impacts at this location are due to HSR operations and low existing noise levels.
  - **TX 31 to Bonner Ave (NB) (Mapbook Page 70-73):** There are two single-family residences along the northbound side of the proposed alignment between TX 31 and Bonner Ave along Segment 3B projected to have moderate noise impacts. The noise impacts at this location are due to HSR operations and low existing noise levels.
  - **TX 31 to Bonner Ave (SB) (Mapbook Page 70-73):** There are six single-family residences along the southbound side of the proposed alignment between TX 31 and Bonner Ave along Segment 3B projected to have moderate noise impacts. The noise impacts at this location are due to HSR operations and low existing noise levels.
  - **Bonner Ave to Navarro County Line (NB) (Mapbook Page 73-80):** There are two single-family residences along the northbound side of the proposed alignment between Bonner Ave and Navarro County Line along Segment 3B projected to have moderate or severe noise impacts. The noise impacts at this location are due to HSR operations and low existing noise levels.
- **Segment 3C**
  - **TX 34 to TX 22 (NB) (Mapbook Page 82-86):** There is one single-family residence along the northbound side of the proposed alignment between TX 34 and TX 22 along Segment 3C projected to have a moderate noise impact. The noise impact at this location is due to HSR operations and low existing noise levels.

- **TX 34 to TX 22 (SB) (Mapbook Page 82-86):** There is one single-family residence along the southbound side of the proposed alignment between TX 34 and TX 22 along Segment 3C projected to have a moderate noise impact. The noise impact at this location is due to HSR operations and low existing noise levels.
- **TX 22 to TX 31 (NB) (Mapbook Page 86-90):** There is one single-family residence along the northbound side of the proposed alignment between TX 22 and TX 31 along Segment 3C projected to have a moderate noise impact. The noise impact at this location is due to HSR operations and low existing noise levels.
- **TX 14 to Navarro County Line (NB) (Mapbook Page 95-97):** There is one single-family residence along the northbound side of the proposed alignment between TX 14 and the Navarro County Line along Segment 3C projected to have a severe noise impact. The noise impact at this location is due to HSR operations and low existing noise levels.

<u>Freestone County</u>

- **Segment 3C**
  - **Navarro County Line to FM 1090 (NB) (Mapbook Page 97-102):** There are four single-family residences along the northbound side of the proposed alignment between Navarro County Line and FM 1090 projected to have moderate or severe noise impacts. The noise impacts at this location are due to HSR operations and low existing noise levels.
  - **FM 1090 to US 84 (SB) (Mapbook Page 102-106):** There are three single-family residences along the southbound side of the proposed alignment between Farm to Market 1090 and US 84 projected to have moderate noise impacts. The noise impacts at this location are due to HSR operations and low existing noise levels.
  - **US 84 to TX 179 (SB) (Mapbook Page 106-111):** There is one single-family residence along the southbound side of the proposed alignment between US 84 and TX 179 projected to have a moderate noise impact. The noise impact at this location is due to HSR operations and low existing noise levels.
- **Segment 4**
  - **FM 930 to Freestone County Line (SB) (Mapbook Page 160-166):** There are six residences along the southbound side of the proposed alignment between Farm to Market 930 and the Freestone County Line projected to have moderate or severe noise impacts. The noise impacts at this location are due to HSR operations and low existing noise levels.

<u>Limestone County</u>

- **Segment 4**
  - **NB (Mapbook Page 166-173):** There are three residences along the northbound side of the proposed alignment in Limestone County projected to have moderate noise impacts. The noise impacts at this location are due to HSR operations and low existing noise levels.

<u>Leon County</u>

- **Segment 3C**

- **Freestone County Line to CR 3051 (SB) (Mapbook Page 116-121):** There is one residence along the southbound side of the proposed alignment between the Freestone County Line and CR 3051 projected to have a moderate noise impact. The noise impact at this location is due to HSR operations and low existing noise levels.
- **CR 3051 to TX 7 (NB) (Mapbook Page 121-127):** There is one residence along the northbound side of the proposed alignment between County Road 3051 and TX 7 projected to have a moderate noise impact. The noise impact at this location is due to HSR operations and low existing noise levels.
- **CR 3051 to TX 7 (SB) (Mapbook Page 121-127):** There are three residences along the southbound side of the proposed alignment between County Road 3051 and TX 7 projected to have moderate noise impacts. The noise impacts at this location are due to HSR operations and low existing noise levels.

- **Segment 4**
  - **US 79 to TX 7 (NB) (Mapbook Page 177-180):** There is one residence along the northbound side of the proposed alignment between US 79 and TX 7 projected to have a severe noise impact. The noise impact at this location is due to HSR operations and low existing noise levels.
  - **US 79 to TX 7 (SB) (Mapbook Page 177-180):** There is one residence along the southbound side of the proposed alignment between US 79 and TX 7 projected to have a moderate noise impact. The noise impact at this location is due to HSR operations and low existing noise levels.
  - **TX 7 to FM 977 (NB) (Mapbook Page 180-186):** There is one single-family residence along the northbound side of the proposed alignment between TX 7 and Farm to Market 977 projected to have a moderate noise impact. The noise impact at this location is due to HSR operations and low existing noise levels.
  - **FM 977 to FM 2289 (NB) (Mapbook Page 186-189):** There is one single-family residences along the northbound side of the proposed alignment between Farm to Market 977 and Farm to Market 2289 along Segment 4 projected to have a moderate noise impact. The noise impact at this location is due to HSR operations and low existing noise levels.

<u>Madison County</u>

- **Segment 3C**
  - **Waldrip Rd to FM 1452 (NB) (Mapbook Page 140-149):** There is one single-family residence along the northbound side of the proposed alignment between Waldrip Rd and Farm to Market 1452 projected to have a moderate noise impact. The noise impact at this location is due to HSR operations and low existing noise levels.
- **Segment 4**
  - **FM 977 to FM 2289 (NB) (Mapbook Page 189-191):** There is one single-family residences along the northbound side of the proposed alignment between Farm to Market 977 and Farm to Market 2289 projected to have a moderate noise impact. The noise impact at this location is due to HSR operations and low existing noise levels.

- **FM 2289 to US 190 (NB) (Mapbook Page 191-196):** There is one single-family residence along the northbound side of the proposed alignment between Farm to Market 2289 and US 190 projected to have a moderate noise impact. The noise impact at this location is due to HSR operations and low existing noise levels.
- **FM 2289 to US 190 (SB) (Mapbook Page 191-196):** There is one single-family residence along the southbound side of the proposed alignment between Farm to Market 2289 and US 190 projected to have a moderate noise impact. The noise impact at this location is due to HSR operations and low existing noise levels.
- **US 190 to FM 1696 (NB) (Mapbook Page 196-201):** There are three single-family residences along the northbound side of the proposed alignment between US 290 and Farm to Market 1696 projected to have moderate noise impacts. The noise impacts at this location are due to HSR operations and low existing noise levels.

<u>Grimes County</u>

- **Segment 5**
  - **FM 1696 to FM 39 (NB) (Mapbook Page 201-208):** There is one single-family residence along the northbound side of the proposed alignment between Farm to Market 1696 and Farm to Market 39 projected to have a moderate noise impact. The noise impact at this location is due to HSR operations and low existing noise levels.
  - **FM 39 to TX 90 (NB) (Mapbook Page 208-212):** There are three single-family residences along the northbound side of the proposed alignment between Farm to Market 39 and TX 90 projected to have moderate noise impacts. The noise impacts at this location are due to HSR operations and low existing noise levels.
  - **FM 39 to TX 90 (SB) (Mapbook Page 208-212):** There is one single-family residence along the southbound side of the proposed alignment between Farm to Market 39 and TX 90 projected to have a moderate noise impact. The noise impact at this location is due to HSR operations and low existing noise levels.
  - **TX 90 to CR 215 (SB) (Mapbook Page 212-218):** There is one single-family residence along the southbound side of the proposed alignment between TX 90 and County Road 215 projected to have a moderate noise impact. The noise impact at this location is due to HSR operations and low existing noise levels.
  - **CR 215 to TX 105 (NB) (Mapbook Page 218-223):** There is one single-family residence along the northbound side of the proposed alignment between County Road 215 and TX 105 projected to have a moderate noise impact. The noise impact at this location is due to HSR operations and low existing noise levels.
  - **CR 215 to TX 105 (SB) (Mapbook Page 218-223):** There are three single-family residences along the northbound side of the proposed alignment between County Road 215 and TX 105 projected to have moderate noise impacts. The noise impacts at this location are due to HSR operations and low existing noise levels.
  - **TX 105 to Grimes County Line (NB) (Mapbook Page 223-228):** There are six single-family residences along the northbound side of the proposed alignment

between TX 105 and Grimes County Line that are projected to have moderate or severe noise impacts. The noise impacts at this location are due to HSR operations and low existing noise levels.

Waller County

- **Segment 5**
  - **NB (Mapbook Page 228-233):** There are eight single-family residences along the northbound side of the proposed alignment in Waller County projected to have moderate noise impacts. The noise impacts at this location are due to HSR operations and low existing noise levels.
  - **SB (Mapbook Page 228-233):** There are 17 single-family residences along the southbound side of the proposed alignment in Waller County projected to have moderate or severe noise impacts. The noise impacts at this location are due to HSR operations and low existing noise levels.

Harris County

- **Segment 5**
  - **Harris County Line to Old Hwy 290 (NB) (Mapbook Page 233-237):** There are three single-family residences along the northbound side of the proposed alignment between the Harris County line and Old Hwy 290 projected to have moderate noise impacts. The noise impacts at this location are due to HSR operations and low existing noise levels.
  - **Harris County Line to Old Hwy 290 (NB) (Mapbook Page 233-237):** There is one single-family residence along the northbound side of the proposed alignment between the Harris County line and Old Hwy 290 projected to have a moderate noise impact. The noise impact at this location is due to HSR operations and low existing noise levels.
  - **Old Hwy 290 to Grand Pkwy (NB) (Mapbook Page 237-242):** There is one single-family residence along the northbound side of the proposed alignment between Old Hwy 290 and Grand Pkwy projected to have moderate noise impact. The noise impact at this location are due to HSR operations and low existing noise levels.
  - **Old Hwy 290 to Grand Pkwy (SB) (Mapbook Page 237-242):** There are seven single-family residences along the southbound side of the proposed alignment between Old Hwy 290 and Grand Pkwy projected to have moderate noise impacts. The noise impacts at this location are due to HSR operations and low existing noise levels.
  - **Grand Pkwy to TX 6 (SB) (Mapbook Page 242-247):** There are 17 single-family residences along the southbound side of the proposed alignment between Grand Pkwy and TX 6 projected to have moderate noise impacts. The noise impacts at this location are due to HSR operations and low existing noise levels.
  - **TX 6 to Blalock Rd (NB) (Mapbook Page 247-251):** There is one single-family residence and two hotels along the northbound side of the proposed alignment between TX 6 and Blalock Rd projected to have moderate noise impacts. The noise impacts at this location are due to HSR operations and low existing noise levels.

- **Blalock Rd to Houston Station (NB) (Mapbook Page 251-257):** There are 95 single and multi-family residences along the northbound side of the proposed alignment between Blalock Rd to the Houston Station projected to have moderate or severe noise impacts. The noise impacts at this location are due to HSR operations and low existing noise levels.
- **Blalock Rd to Houston Station (SB) (Mapbook Page 251-257):** There are 86 single and multi-family residences along the southbound side of the proposed alignment between Blalock Rd and the Houston Station projected to have moderate noise impacts. The noise impacts at this location are due to HSR operations and low existing noise levels.
- **Christian Family Church (Mapbook Page 250):** The Christian Family Church is projected to have a moderate noise impact. The noise impact at this location is due to HSR operations.

With regard to potential increased annoyance due to the startle effect of noise from passing trains, at the maximum train speed of 205 mph this effect would only occur within about 45 feet from the tracks which is within the ROW. Therefore, increased noise annoyance due to startle should not be an issue.

Finally, with regard to the effects of noise from passing trains on animals, the FRA noise exposure criterion limit is a Sound Exposure Level (SEL) of 100 dBA. For the TX HSR trains operating on viaduct at the maximum speed of 205 mph, this limit would only be exceeded within about 15 feet from the tracks and within the HSR ROW. Because no animals would be this close to the tracks, noise impact on wildlife is not anticipated.

Operational Vibration Assessment

Based on a Detailed Vibration Analysis, the assessment of vibration impacts from HSR operations is summarized by county and segment in **Table 6-3** for FTA Category 2 (residential) land use and in **Table 6-4** for FTA Category 3 (institutional) land use. The results include a tabulation of location information for each sensitive receptor group, the projections of future vibration levels, the impact criteria, and whether there will be vibration impacts.

Table 6-3: Summary of Vibration Impacts for Residential Land Use									
County	Segment	Location	Side of Track	Near Track Dist (ft.)	Speed (mph)	TX HSR Vibration Levels (VdB)		Number of Impacts	Mapbook Page
						TX HSR Project	FTA Impact Criterion		
DALLAS	1	Dallas Station to I-20	NB	243-415	205	41	72	0	1-6
DALLAS	1	Dallas Station to I-20	SB	348-1001	205	37	72	0	1-6
DALLAS	1	IH-20 to Bluff Springs Rd	NB	270-793	205	53	72	0	6-12
DALLAS	1	IH-20 to Bluff Springs Rd	SB	223-970	205	53	72	0	6-12
ELLIS	1	IH-20 to Bluff Springs Rd	NB	188-910	205	53	72	0	6-12
ELLIS	1	IH-20 to Bluff Springs Rd	SB	174-2612	205	53	72	0	6-12
ELLIS	2A	Bluff Springs Rd to FM 813	NB	527-2986	205	63	72	0	12-16
ELLIS	2A	Bluff Springs Rd to FM 813	SB	199-2715	205	66	72	0	12-16
ELLIS	2A	FM 813 to TX 287	NB	824-1690	205	54	72	0	16-22
ELLIS	2A	FM 813 to TX 287	SB	211-989	205	67	72	0	16-22
ELLIS	2A	TX 287 to TX 34	NB	281-2148	205	65	72	0	22-25
ELLIS	2A	TX 287 to TX 34	SB	289-805	205	65	72	0	22-25
ELLIS	2A	TX 34 to TX 22	NB	No sensitive receptors.					--
ELLIS	2A	TX 34 to TX 22	SB	167-905	205	71	72	0	25-27
ELLIS	2B	Bluff Springs Rd to FM 813	NB	385-2987	205	67	72	0	28-32
ELLIS	2B	Bluff Springs Rd to FM 813	SB	205-2715	205	62	72	0	28-32
ELLIS	2B	FM 813 to TX 287	NB	179-947	205	61	72	0	32-38
ELLIS	2B	FM 813 to TX 287	SB	585-1784	205	66	72	0	32-38
ELLIS	2B	TX 287 to TX 34	NB	455-2908	205	62	72	0	38-41

County	Segment	Location	Side of Track	Near Track Dist (ft.)	Speed (mph)	TX HSR Vibration Levels (VdB)		Number of Impacts	Mapbook Page
						TX HSR Project	FTA Impact Criterion		
ELLIS	2B	TX 287 to TX 34	SB	959	205	64	72	0	38-41
ELLIS	2B	TX 34 to TX 22	NB	No sensitive receptors.					--
ELLIS	2B	TX 34 to TX 22	SB	1388-1556	205	68	72	0	41-43
ELLIS	3A	TX 34 to TX 22	NB	No sensitive receptors.					--
ELLIS	3A	TX 34 to TX 22	SB	977	205	70	72	0	43-44
ELLIS	3B	TX 34 to TX 22	NB	No sensitive receptors.					--
ELLIS	3B	TX 34 to TX 22	SB	1311	205	70	72	0	62-63
ELLIS	3C	TX 34 to TX 22	NB	No sensitive receptors.					--
ELLIS	3C	TX 34 to TX 22	SB	977	205	70	72	0	81-82
NAVARRO	3A	TX 34 to TX 22	NB	396-923	205	66	72	0	43-48
NAVARRO	3A	TX 34 to TX 22	SB	360-2879	205	66	72	0	43-48
NAVARRO	3A	TX 22 to TX 31	NB	290-632	205	67	72	0	48-52
NAVARRO	3A	TX 22 to TX 31	SB	560-1034	205	64	72	0	48-52
NAVARRO	3A	TX 31 to FM 3194	NB	261-546	205	67	72	0	52-57
NAVARRO	3A	TX 31 to FM 3194	SB	740	205	64	72	0	52-57
NAVARRO	3A	FM 3194 to Navarro County Line	NB	656	205	54	72	0	57-61
NAVARRO	3A	FM 3194 to Navarro County Line	SB	No sensitive receptors.					--
NAVARRO	3B	TX 34 to TX 22	NB	611-2905	205	64	72	0	63-67
NAVARRO	3B	TX 34 to TX 22	SB	222-1002	205	64	72	0	63-67

Table 6-3: Summary of Vibration Impacts for Residential Land Use

Table 6-3: Summary of Vibration Impacts for Residential Land Use									
County	Segment	Location	Side of Track	Near Track Dist (ft.)	Speed (mph)	TX HSR Vibration Levels (VdB)		Number of Impacts	Mapbook Page
						TX HSR Project	FTA Impact Criterion		
NAVARRO	3B	TX 22 to TX 31	NB	261-996	205	64	72	0	67-70
NAVARRO	3B	TX 22 to TX 31	SB	324-759	205	64	72	0	67-70
NAVARRO	3B	TX 31 to Bonner Ave	NB	228-1001	205	68	72	0	70-73
NAVARRO	3B	TX 31 to Bonner Ave	SB	204-1017	205	69	72	0	70-73
NAVARRO	3B	Bonner Ave to Navarro County Line	NB	142-1016	205	61	72	0	73-80
NAVARRO	3B	Bonner Ave to Navarro County Line	SB	No sensitive receptors.					--
NAVARRO	3C	TX 34 to TX 22	NB	396-923	205	66	72	0	82-86
NAVARRO	3C	TX 34 to TX 22	SB	360-2879	205	66	72	0	82-86
NAVARRO	3C	TX 22 to TX 31	NB	290-632	205	67	72	0	86-90
NAVARRO	3C	TX 22 to TX 31	SB	566-1034	205	64	72	0	86-90
NAVARRO	3C	TX 31 to TX 14	NB	786-2780	205	56	72	0	90-95
NAVARRO	3C	TX 31 to TX 14	SB	No sensitive receptors.					--
NAVARRO	3C	TX 14 to Navarro County Line	NB	176-1000	205	66	72	0	95-97
NAVARRO	3C	TX 14 to Navarro County Line	SB	571-940	205	69	72	0	95-97
FREESTONE	3C	Navarro County Line to FM 1090	NB	177-885	205	56	72	0	97-102
FREESTONE	3C	Navarro County Line to FM 1090	SB	568-989	205	58	72	0	97-102
FREESTONE	3C	FM 1090 to US 84	NB	No sensitive receptors.					--
FREESTONE	3C	FM 1090 to US 84	SB	232-511	205	63	72	0	102-106

Table 6-3: Summary of Vibration Impacts for Residential Land Use									
County	Segment	Location	Side of Track	Near Track Dist (ft.)	Speed (mph)	TX HSR Vibration Levels (VdB)		Number of Impacts	Mapbook Page
						TX HSR Project	FTA Impact Criterion		
FREESTONE	3C	US 84 to TX 179	NB	No sensitive receptors.					--
FREESTONE	3C	US 84 to TX 179	SB	226-452	205	60	72	0	106-111
FREESTONE	3C	TX 179 to Freestone County Line	NB	No sensitive receptors.					--
FREESTONE	3C	TX 179 to Freestone County Line	SB						--
FREESTONE	4	Navarro County Line to FM 930	NB	785-905	205	56	72	0	153-160
FREESTONE	4	Navarro County Line to FM 930	SB	739	205	56	72	0	153-160
FREESTONE	4	FM 930 to Freestone County Line	NB	812-989	205	45	72	0	160-166
FREESTONE	4	FM 930 to Freestone County Line	SB	125-993	205	65	72	0	160-166
LIMESTONE	4	Limestone County	NB	345-862	205	60	72	0	166-173
LIMESTONE	4	Limestone County	SB	452-832	205	55	72	0	166-173
LEON	3C	Freestone County Line to CR 3051	NB	No sensitive receptors.					--
LEON	3C	Freestone County Line to CR 3051	SB	322-503	205	58	72	0	116-121
LEON	3C	CR 3051 to TX 7	NB	221-334	205	72	72	0	121-127
LEON	3C	CR 3051 to TX 7	SB	220-428	205	71	72	0	121-127
LEON	3C	TX 7 to FM 977	NB	500	205	64	72	0	127-136
LEON	3C	TX 7 to FM 977	SB	No sensitive receptors.					--

Table 6-3: Summary of Vibration Impacts for Residential Land Use									
County	Segment	Location	Side of Track	Near Track Dist (ft.)	Speed (mph)	TX HSR Vibration Levels (VdB)		Number of Impacts	Mapbook Page
						TX HSR Project	FTA Impact Criterion		
LEON	4	Limestone County Line to US 79	NB	708	205	56	72	0	173-177
LEON	4	Limestone County Line to US 79	SB	883-1003	205	54	72	0	173-177
LEON	4	US 79 to TX 7	NB	296-885	205	66	72	0	177-180
LEON	4	US 79 to TX 7	SB	519	205	58	72	0	177-180
LEON	4	TX 7 to FM 977	NB	347-797	205	70	72	0	180-186
LEON	4	TX 7 to FM 977	SB	211-843	205	67	72	0	180-186
LEON	4	FM 977 to FM 2289	NB	307-604	205	70	72	0	186-189
LEON	4	FM 977 to FM 2289	SB	386-907	205	69	72	0	186-189
MADISON	3C	FM 977 to Waldrip Rd	NB	No sensitive receptors.					--
MADISON	3C	FM 977 to Waldrip Rd	SB	158-379	205	51	72	0	136-140
MADISON	3C	Waldrip Rd to FM 1452	NB	338	205	34	72	0	140-149
MADISON	3C	Waldrip Rd to FM 1452	SB	532-640	205	37	72	0	140-149
MADISON	3C	FM 1452 to FM 1696	NB	787-970	205	28	72	0	149-152
MADISON	3C	FM 1452 to FM 1696	SB	No sensitive receptors.					--
MADISON	4	FM 977 to FM 2289	NB	288-420	205	70	72	0	189-191
MADISON	4	FM 977 to FM 2289	SB	338-982	205	67	72	0	189-191
MADISON	4	FM 2289 to US 190	NB	353-714	205	35	72	0	191-196
MADISON	4	FM 2289 to US 190	SB	213-693	205	55	72	0	191-196
MADISON	4	US 190 to FM 1696	NB	182-909	205	48	72	0	196-201

Table 6-3: Summary of Vibration Impacts for Residential Land Use									
County	Segment	Location	Side of Track	Near Track Dist (ft.)	Speed (mph)	TX HSR Vibration Levels (VdB)		Number of Impacts	Mapbook Page
						TX HSR Project	FTA Impact Criterion		
MADISON	4	US 190 to FM 1696	SB	436-990	205	34	72	0	196-201
GRIMES	5	FM 1696 to FM 39	NB	231-589	205	60	72	0	201-208
GRIMES	5	FM 1696 to FM 39	SB	No sensitive receptors.					--
GRIMES	5	FM 39 to TX 90	NB	313-1014	205	62	72	0	208-212
GRIMES	5	FM 39 to TX 90	SB	332-852	205	60	72	0	208-212
GRIMES	5	TX 90 to CR 215	NB	329-1001	205	59	72	0	212-218
GRIMES	5	TX 90 to CR 215	SB	422-798	205	60	72	0	212-218
GRIMES	5	CR 215 to TX 105	NB	395-850	205	60	72	0	218-223
GRIMES	5	CR 215 to TX 105	SB	391-1749	205	51	72	0	218-223
GRIMES	5	TX 105 to Grimes County Line	NB	157-1010	205	55	72	0	223-228
GRIMES	5	TX 105 to Grimes County Line	SB	563-1968	205	51	72	0	223-228
WALLER	5	Waller County	NB	209-994	205	54	72	0	228-233
WALLER	5	Waller County	SB	157-1000	205	54	72	0	228-233
HARRIS	5	Harris County Line to Old Hwy 290	NB	190-1006	205	47	72	0	233-237
HARRIS	5	Harris County Line to Old Hwy 290	SB	330-995	205	42	72	0	233-237
HARRIS	5	Old Hwy 290 to Grand Pkwy	NB	356-1009	205	59	72	0	237-242
HARRIS	5	Old Hwy 290 to Grand Pkwy	SB	210-1010	205	62	72	0	237-242
HARRIS	5	Grand Pkwy to TX 6	NB	155-520	205	54	72	0	242-247

Table 6-3: Summary of Vibration Impacts for Residential Land Use									
County	**Segment**	**Location**	**Side of Track**	**Near Track Dist (ft.)**	**Speed (mph)**	**TX HSR Vibration Levels (VdB)**		**Number of Impacts**	**Mapbook Page**
						TX HSR Project	**FTA Impact Criterion**		
HARRIS	5	Grand Pkwy to TX 6	SB	81-518	205	60	72	0	242-247
HARRIS	5	TX 6 to Blalock Rd	NB	262-501	205	52	72	0	247-251
HARRIS	5	TX 6 to Blalock Rd	SB	No sensitive receptors.					
HARRIS	5	Blalock Rd to Houston Station	NB	110-510	205	60	72	0	251-257
HARRIS	5	Blalock Rd to Houston Station	SB	227-524	205	53	72	0	251-257

Source: Cross-Spectrum Acoustics, 2016.

Table 6-4: Summary of Vibration Impacts for Institutional Land Use									
County	Segment	Location	Side of Track	Near Track Dist (ft.)	Speed (mph)	TX HSR Vibration Levels (VdB)		Number of Impacts	Mapbook Page
						TX HSR Project	FTA Impact Criterion		
DALLAS	1	Friendship Missionary Baptist Church	SB	363	205	37	78	0	4
DALLAS	1	The Church of Revelation	SB	412	205	36	78	0	4
DALLAS	1	College Park Baptist Church	SB	670	205	31	78	0	6
DALLAS	1	Full Faith Deliverance Church	SB	463	205	34	78	0	6
ELLIS	2B	Palmyra Studios	NB	963	205	64	65	0	31
FREESTONE	4	Lebanon Church	NB	454	205	59	78	0	156
FREESTONE	4	Furney-Richardson School	NB	837	205	45	78	0	162
GRIMES	5	Shiloh Church Cemetery	SB	988	205	18	78	0	202
HARRIS	5	Fairbanks United Methodist Church	NB	451	205	48	78	0	250
HARRIS	5	Christian Family Church	NB	177	205	55	78	0	250
HARRIS	5	Pentecostal Church New Jerusalem	SB	199	205	55	78	0	252

Source: Cross-Spectrum Acoustics, 2016.

As shown in **Table 6-3**, HSR operations will result in no vibration impacts.

Construction Assessment

Construction noise and vibration assessment criteria were taken from the 2012 FRA guidance manual, “High=Speed Ground Transportation Noise and Vibration Impact Assessment”. The impact criteria are based on maintaining a noise environment considered acceptable for land uses where noise may have an effect, and FRA’s construction vibration criteria are designed primarily to prevent building damage, and to assess whether vibration might interfere with vibration-sensitive building activities or temporarily annoy building occupants during the construction period.

Noise-sensitive and vibration-sensitive land uses in the Study Area were initially identified based on GIS data, aerial photography, drawings, plans and a field survey. Procedures from the FRA guidance manual[2] were applied for establishing the extent of the Study Area to be evaluated for the noise and vibration impact analyses. The screening distances applicable to these analyses are 1,300 feet for noise impact (new HSR corridor in a rural area) and 275 feet for vibration (frequent operation at speeds of 200 to300 mph near residential land use). These distances

[2] FRA, “High-Speed Ground Transportation Noise and Vibration Impact Assessment,” Final Report DOT/FRA/ORD-12/15, September 2012.

from the FRA guidance manual are based on assumptions for the HSR operations and existing environment, and are meant to provide a distance within which any potential impacts from HSR operations would be identified. Beyond these distances, no impacts would occur.

Noise measurements of the A-weighted sound level for both long-term (24-hour) and short-term (one-hour) periods were then collected at representative locations to document existing noise conditions at sensitive receivers (e.g., residences and institutional sites). The measurement locations were selected to represent the existing noise conditions in areas adjacent to each segment of the Build Alternatives in each county within the Study Area (see **Figures 3.4-5 through 3.4-8** for noise measurement locations). Because the FRA noise criteria (see **Section 3.4.3.2**) are based on the existing noise levels, measuring the existing noise and characterizing noise levels at sensitive locations in the Study Area was the first step in the impact assessment.

Ground-borne vibration tests were also performed at representative locations in the Study Area to determine how vibration travels through the ground near vibration-sensitive locations (e.g., residential or institutional buildings). The test sites were selected to represent the soil conditions along the Build Alternatives in each county within the Study Area (see **Figures 3.4-9 through 3.4-12** for vibration measurement locations). At each location, tests were conducted by impacting the ground with an instrumented weight and measuring the response of the soil at various distances. The results of the ground vibration tests were combined with vehicle (train) information to predict vibration levels from operations at sensitive locations along each of the Build Alternatives. More information about the vibration testing procedures, instrumentation and detailed results is provided in the **Appendix E, Noise and Vibration Technical Memorandum**.

Project information for use in the analysis was obtained from TCRR[3], consisting of: (1) plan and profile maps of the Build Alternatives including crossover locations, MOW facility plans, layover/storage locations, station locations and TPSS locations; (2) trainset characteristics and operational data and; (3) sound data gathered in Japan for the Tokaido Shinkansen N700-A train. Available information about the Shinkansen system and the results of field noise and vibration measurements were used in the prediction and assessment when applying the methodology from the FRA guidance manual.[4] The FTA guidance manual[5] was used to supplement the FRA guidance manual.

Construction Noise

By using the FRA criteria provided in **Table 3-1** and the construction equipment noise emission levels in **Table 5-1**, and assuming that construction noise is reduced by 6 dB for each doubling of distance from the center of the work site, it is possible to estimate the screening distances for potential construction noise impact at residential locations for various construction activities. These estimates, shown in **Table 6-5**, suggest that the potential for construction noise impact at residential sites would extend to distances of 40-200 feet from daytime construction and to

[3] TCRR, "*Texas Central Partners Texas High Speed Rail Final Draft Conceptual Engineering Report-FDCERv7*," September 15, 2017.
[4] FRA, "High-Speed Ground Transportation Noise and Vibration Impact Assessment," Final Report DOT/FRA/ORD-12/15, September 2012.
[5] FTA, "Transit Noise and Vibration Impact Assessment," Final Report FTA-VA-90-1003-06, May 2006.

distances of 125-630 feet from nighttime construction, depending on the activity. The greater impact distances apply to those construction activities that include pile driving. Descriptions of the types of equipment that would be used for each construction activity are provided below.

Table 6-5: Construction Noise Impact Screening Distances for Residences

Construction Activity	1-Hr Leq at 50 feet (dBA)	Residential Noise Impact Screening Distance (feet)	
		Daytime (90 dBA Limit)	Nighttime (80 dBA Limit)
Clearing and Grubbing	88	40	125
Demolition	91	55	175
Earthworks	88	40	125
Highways/Roadways	88	40	125
Drainage	88	40	125
Structures	102	200	630
Utility Relocations	88	40	125
Trackwork	88	40	125
Stations	102	200	630
MOW Facilities	102	200	630
Trainset Maintenance	102	200	630

Source: Cross-Spectrum Acoustics, 2016

Clearing and Grubbing

Clearing and grubbing will involve the use of backhoes, loaders, dozers, excavators, manlifts, trucks, air compressors and generators. The two noisiest items will be dozers and excavators, each with a noise emission level of 85 dBA at 50 feet, yielding a combined 1-hour Leq of 88 dBA at 50 feet. It is estimated that residences within a distance of 40 feet will be exposed to noise levels exceeding the 90 dBA criterion for daytime construction and that residences within a distance of 125 feet will be exposed to noise levels exceeding the 80 dBA nighttime criterion.

Demolition

Demolition will involve the use of hydraulic hammers, dozers, excavators, graders, loaders, cranes, manlifts, trucks, air compressors, generators and welders. The noisiest items will be the hydraulic hammers, with a noise emission level of 90 dBA at 50 feet, followed by dozers, excavators and graders, with noise emission levels of 85 dBA at 50 feet, yielding a combined 1-hour Leq of 91 dBA at 50 feet for the two noisiest equipment items operating together. It is estimated that residences within a distance of 55 feet will be exposed to noise levels exceeding the 90 dBA criterion for daytime construction and that residences within a distance of 175 feet will be exposed to noise levels exceeding the 80 dBA nighttime criterion.

Earthworks

Earthworks construction will involve the use of backhoes, loaders, dozers, excavators, graders, manlifts, rollers, compactors, trucks, air compressors and generators. The noisiest items will be the dozers, excavators, graders, rollers and compactors, each with a noise emission level of 85 dBA at 50 feet, yielding a combined 1-hour Leq of 88 dBA for the two noisiest equipment items operating together. It is estimated that residences within a distance of 40 feet will be exposed to noise levels exceeding the 90 dBA criterion for daytime construction and that residences within a distance of 125 feet will be exposed to noise levels exceeding the 80 dBA nighttime criterion.

Highways/Roadways
Highway and roadway construction will involve the use of backhoes, loaders, dozers, excavators, graders, rollers, compactors, trucks, air compressors and generators. The noisiest items will be the dozers, excavators, graders, rollers and compactors, each with a noise emission level of 85 dBA at 50 feet, yielding a combined 1-hour Leq of 88 dBA for the two noisiest equipment items operating together. It is estimated that residences within a distance of 40 feet will be exposed to noise levels exceeding the 90 dBA criterion for daytime construction and that residences within a distance of 125 feet will be exposed to noise levels exceeding the 80 dBA nighttime criterion.

Drainage
Drainage construction will involve the use of backhoes, dozers, excavators, graders, cranes, rollers, compactors, trucks, air compressors and generators. The noisiest items will be the dozers, excavators, graders, rollers and compactors, each with a noise emission level of 85 dBA at 50 feet, yielding a combined 1-hour Leq of 88 dBA for the two noisiest equipment items operating together. It is estimated that residences within a distance of 40 feet will be exposed to noise levels exceeding the 90 dBA criterion for daytime construction and that residences within a distance of 125 feet will be exposed to noise levels exceeding the 80 dBA nighttime criterion.

Structures
The construction of structures will involve the use of pile drivers, hydraulic hammers, backhoes, dozers, excavators, graders, loaders, cranes, rollers, compactors, manlifts, trucks, air compressors, generators and welders. The noisiest two items will be an impact pile driver, with a noise emission level of 101 dBA at 50 feet, and a vibratory pile driver, with a noise emission level of 95 dBA at 50 feet, yielding a combined 1-hour Leq of 102 dBA at 50 feet. It is estimated that residences within a distance of 200 feet will be exposed to noise levels exceeding the 90 dBA criterion for daytime construction and that residences within a distance of 630 feet will be exposed to noise levels exceeding the 80 dBA nighttime criterion.

Utility Relocations
The relocation of utilities will involve the use of backhoes, dozers, excavators, graders, cranes, manlifts, rollers, compactors, trucks, air compressors and generators. The noisiest items will be the dozers, excavators, graders, rollers and compactors, each with a noise emission level of 85 dBA at 50 feet, yielding a combined 1-hour Leq of 88 dBA for the two noisiest equipment items operating together. It is estimated that residences within a distance of 40 feet will be exposed to noise levels exceeding the 90 dBA criterion for daytime construction and that residences within a distance of 125 feet will be exposed to noise levels exceeding the 80 dBA nighttime criterion.

Trackwork
Trackwork construction will involve the use of backhoes, dozers, excavators, graders, cranes, loaders, rollers, compactors, trucks, air compressors and generators. The noisiest items will be the dozers, excavators, graders, rollers and compactors, each with a noise emission level of 85 dBA at 50 feet, yielding a combined 1-hour Leq of 88 dBA for the two noisiest equipment items operating together. It is estimated that residences within a distance of 40 feet will be exposed to

noise levels exceeding the 90 dBA criterion for daytime construction and that residences within a distance of 125 feet will be exposed to noise levels exceeding the 80 dBA nighttime criterion.

Stations

Station construction will involve the use of pile drivers, hydraulic hammers, backhoes, dozers, excavators, graders, loaders, cranes, rollers, compactors, manlifts, trucks, air compressors, generators and welders. The noisiest two items will be an impact pile driver, with a noise emission level of 101 dBA at 50 feet, and a vibratory pile driver, with a noise emission level of 95 dBA at 50 feet, yielding a combined 1-hour Leq of 102 dBA at 50 feet. It is estimated that residences within a distance of 200 feet will be exposed to noise levels exceeding the 90 dBA criterion for daytime construction and that residences within a distance of 630 feet will be exposed to noise levels exceeding the 80 dBA nighttime criterion.

MOW Facilities

The construction of MOW facilities will involve the use of pile drivers, hydraulic hammers, backhoes, dozers, excavators, graders, loaders, cranes, rollers, compactors, manlifts, trucks, air compressors, generators and welders. The noisiest two items will be an impact pile driver, with a noise emission level of 101 dBA at 50 feet, and a vibratory pile driver, with a noise emission level of 95 dBA at 50 feet, yielding a combined 1-hour Leq of 102 dBA at 50 feet. It is estimated that residences within a distance of 200 feet will be exposed to noise levels exceeding the 90 dBA criterion for daytime construction and that residences within a distance of 630 feet will be exposed to noise levels exceeding the 80 dBA nighttime criterion.

Trainset Maintenance

The construction of trainset maintenance facilities will involve the use of pile drivers, hydraulic hammers, backhoes, dozers, excavators, graders, loaders, cranes, rollers, compactors, manlifts, trucks, air compressors, generators and welders. The noisiest two items will be an impact pile driver, with a noise emission level of 101 dBA at 50 feet, and a vibratory pile driver, with a noise emission level of 95 dBA at 50 feet, yielding a combined 1-hour Leq of 102 dBA at 50 feet. It is estimated that residences within a distance of 200 feet will be exposed to noise levels exceeding the 90 dBA criterion for daytime construction and that residences within a distance of 630 feet will be exposed to noise levels exceeding the 80 dBA nighttime criterion.

Construction Vibration

During construction, some activities may cause ground-borne vibration, most notably pile driving for structures and vibratory compaction for ground improvements. While it is unlikely that such activities will occur within 50 feet of sensitive structures where damage effects could be of concern, there could be some potential for vibration annoyance or interference with the use of sensitive equipment. **Table 6-6** provides the approximate distances within which receivers could experience construction-related vibration annoyance effects. Descriptions of the types of construction equipment that would generate the highest levels of ground-borne vibration for each construction activity are provided below.

Table 6-6: Construction Vibration Impact Screening Distances				
Construction Activity	**Maximum Vibration Level at 25 feet (VdB)**	**Vibration Impact Screening Distance (feet)**		
		Category 1 (65 VdB Limit)	**Category 2 (72 VdB Limit)**	**Category 3 (75 VdB Limit)**
Clearing and Grubbing	87	135	80	65
Demolition	87	135	80	65
Earthworks	94	230	135	105
Highways/Roadways	94	230	135	105
Drainage	94	230	135	105
Structures	104	500	290	230
Utility Relocations	94	230	135	105
Trackwork	94	230	135	105
Stations	104	500	290	230
MOW Facilities	104	500	290	230
Trainset Maintenance	104	500	290	230

Source: Cross-Spectrum Acoustics, 2016

Clearing and Grubbing

Clearing and grubbing will involve the use of backhoes, loaders, dozers, excavators, manlifts, trucks, air compressors and generators. The items that will generate the highest levels of ground- borne vibration are backhoes, dozers and excavators, each with a vibration source level of 87 VdB at 25 feet. It is estimated that receivers within a distances of 135 feet, 80 feet and 65 feet will be exposed to vibration levels exceeding the criteria for Category 1, Category 2 and Category 3 land use, respectively.

Demolition

Demolition will involve the use of hydraulic hammers, dozers, excavators, graders, loaders, cranes, manlifts, trucks, air compressors, generators and welders. The items that will generate the highest levels of ground- borne vibration are hydraulic hammers, backhoes, dozers and excavators, each with a vibration source level of 87 VdB at 25 feet. It is estimated that receivers within a distances of 135 feet, 80 feet and 65 feet will be exposed to vibration levels exceeding the criteria for Category 1, Category 2 and Category 3 land use, respectively.

Earthworks

Earthworks construction will involve the use of backhoes, loaders, dozers, excavators, graders, manlifts, rollers, compactors, trucks, air compressors and generators. The items that will generate the highest levels of ground- borne vibration are vibratory rollers and compactors, with a vibration source level of 94 VdB at 25 feet. It is estimated that receivers within a distances of 230 feet, 135 feet and 105 feet will be exposed to vibration levels exceeding the criteria for Category 1, Category 2 and Category 3 land use, respectively.

Highways/Roadways
Highway and roadway construction will involve the use of backhoes, loaders, dozers, excavators, graders, rollers, compactors, trucks, air compressors and generators. The items that will generate the highest levels of ground- borne vibration are vibratory rollers and compactors, with a vibration source level of 94 VdB at 25 feet. It is estimated that receivers within a distances of 230 feet, 135 feet and 105 feet will be exposed to vibration levels exceeding the criteria for Category 1, Category 2 and Category 3 land use, respectively.

Drainage
Drainage construction will involve the use of backhoes, dozers, excavators, graders, cranes, rollers, compactors, trucks, air compressors and generators. The items that will generate the highest levels of ground- borne vibration are vibratory rollers and compactors, with a vibration source level of 94 VdB at 25 feet. It is estimated that receivers within a distances of 230 feet, 135 feet and 105 feet will be exposed to vibration levels exceeding the criteria for Category 1, Category 2 and Category 3 land use, respectively.

Structures
The construction of structures will involve the use of pile drivers, hydraulic hammers, backhoes, dozers, excavators, graders, loaders, cranes, rollers, compactors, manlifts, trucks, air compressors, generators and welders. The items that will generate the highest levels of ground-borne vibration are impact pile drivers, with a typical vibration source level of 104 VdB at 25 feet. It is estimated that receivers within a distances of 500 feet, 290 feet and 230 feet will be exposed to vibration levels exceeding the criteria for Category 1, Category 2 and Category 3 land use, respectively.

Utility Relocations
The relocation of utilities will involve the use of backhoes, dozers, excavators, graders, cranes, manlifts, rollers, compactors, trucks, air compressors and generators. The items that will generate the highest levels of ground- borne vibration are vibratory rollers and compactors, with a vibration source level of 94 VdB at 25 feet. It is estimated that receivers within a distances of 230 feet, 135 feet and 105 feet will be exposed to vibration levels exceeding the criteria for Category 1, Category 2 and Category 3 land use, respectively.

Trackwork
Trackwork construction will involve the use of backhoes, dozers, excavators, graders, cranes, loaders, rollers, compactors, trucks, air compressors and generators. The items that will generate the highest levels of ground- borne vibration are vibratory rollers and compactors, with a vibration source level of 94 VdB at 25 feet. It is estimated that receivers within a distances of 230 feet, 135 feet and 105 feet will be exposed to vibration levels exceeding the criteria for Category 1, Category 2 and Category 3 land use, respectively.

Stations
Station construction will involve the use of pile drivers, hydraulic hammers, backhoes, dozers, excavators, graders, loaders, cranes, rollers, compactors, manlifts, trucks, air compressors, generators and welders. The items that will generate the highest levels of ground- borne vibration are impact pile drivers, with a typical vibration source level of 104 VdB at 25 feet. It is estimated that receivers within a distances of 500 feet, 290 feet and 230 feet will be exposed to vibration levels exceeding the criteria for Category 1, Category 2 and Category 3 land use, respectively.

MOW Facilities
The construction of MOW facilities will involve the use of pile drivers, hydraulic hammers, backhoes, dozers, excavators, graders, loaders, cranes, rollers, compactors, manlifts, trucks, air compressors, generators and welders. The items that will generate the highest levels of ground-borne vibration are impact pile drivers, with a typical vibration source level of 104 VdB at 25 feet. It is estimated that receivers within a distances of 500 feet, 290 feet and 230 feet will be exposed to vibration levels exceeding the criteria for Category 1, Category 2 and Category 3 land use, respectively.

Trainset Maintenance
The construction of trainset maintenance facilities will involve the use of pile drivers, hydraulic hammers, backhoes, dozers, excavators, graders, loaders, cranes, rollers, compactors, manlifts, trucks, air compressors, generators and welders. The items that will generate the highest levels of ground- borne vibration are impact pile drivers, with a typical vibration source level of 104 VdB at 25 feet. It is estimated that receivers within a distances of 500 feet, 290 feet and 230 feet will be exposed to vibration levels exceeding the criteria for Category 1, Category 2 and Category 3 land use, respectively.

MITIGATION

Operational Noise Mitigation

Potential noise mitigation measures for HSR operations include the following:

- Install sound barriers. Depending on the height and location relative to the tracks, sound barriers can achieve between 5 and 15 dB of noise reduction. The primary requirements for an effective sound barrier are that the barrier must (1) be high enough and long enough to break the line-of-sight between the sound source and the receiver, (2) be of an impervious material with a minimum surface density of 4 pounds per square foot and (3) not have any gaps or holes between the panels or at the bottom. Because many materials meet these requirements, aesthetics, durability, cost and maintenance considerations usually determine the selection of materials for sound barriers. Depending on the situation, sound barriers can become visually intrusive. Typically, the sound barrier style is selected with input from the public and local jurisdictions to reduce the visual effect of barriers on adjacent lands uses. For example, sound barriers could be solid or transparent, with various colors, materials and surface treatments.

- Install building sound insulation. Sound insulation of residences and institutional buildings to improve the outdoor-to-indoor noise reduction is a mitigation measure that can be provided by the project when the use of sound barriers is not feasible in providing a reasonable level (5 to 7 dB) of noise reduction. Although this approach has no effect on noise in exterior areas, it may be the best choice for sites where sound barriers are not feasible or desirable and for buildings where indoor sensitivity is of most concern. Substantial improvements in building sound insulation (on the order of 5 to 10 dB) can often be achieved by adding an extra layer of glazing to windows, by sealing holes in exterior surfaces that act as sound leaks and by providing forced ventilation and air conditioning so that windows do not need to be opened.

- Acquire limited property rights. In certain cases, it may be possible to acquire limited property rights for the construction of sound barriers at locations where they will be most effective.

The results of the noise impact assessment indicate that that the impact locations tend to be scattered geographically which suggests that the use of sound barriers as a practical mitigation measure may be limited. The application of sound barriers at specific locations will be investigated as the engineering design advances and the alternatives are refined. Where sound barriers are not practical, building sound insulation would be the most likely noise mitigation alternative.

Construction Noise and Vibration Mitigation

The following noise and vibration control mitigation measures will be implemented as necessary during project construction:

- Install temporary construction site sound barriers near noise sources.
- Limit or avoid nighttime construction near residential neighborhoods.
- Locate stationary construction equipment as far as possible from noise-sensitive sites.
- Re-route construction-related truck traffic along roadways that will cause the least disturbance to residents.
- During nighttime work, use smart back-up alarms, which automatically adjust the alarm level based on the background noise level, or switch off back-up alarms and replace with spotters.
- Use low-noise emission equipment.
- Implement noise-deadening measures for truck loading and operations.
- Monitor and maintain equipment to meet noise limits.
- Line or cover storage bins, conveyors, and chutes with sound-deadening material.
- Use acoustic enclosures, shields, or shrouds for equipment and facilities.
- Use high-grade engine exhaust silencers and engine-casing sound insulation.
- Minimize the use of generators to power equipment.
- Limit use of public address systems.
- Grade surface irregularities on construction sites.
- Use moveable sound barriers at the source of the construction activity.

APPENDIX A: NOISE AND VIBRATION MEASUREMENT SITE PHOTOGRAPHS

Figure A-1. Noise Measurement Site LT-1 – 4019-4099 Bulova St, Dallas; Dallas County; Segment 1

Figure A-2. Noise Measurement Site LT-1A – 5125 Cleveland Rd, Dallas; Dallas County; Segment 1

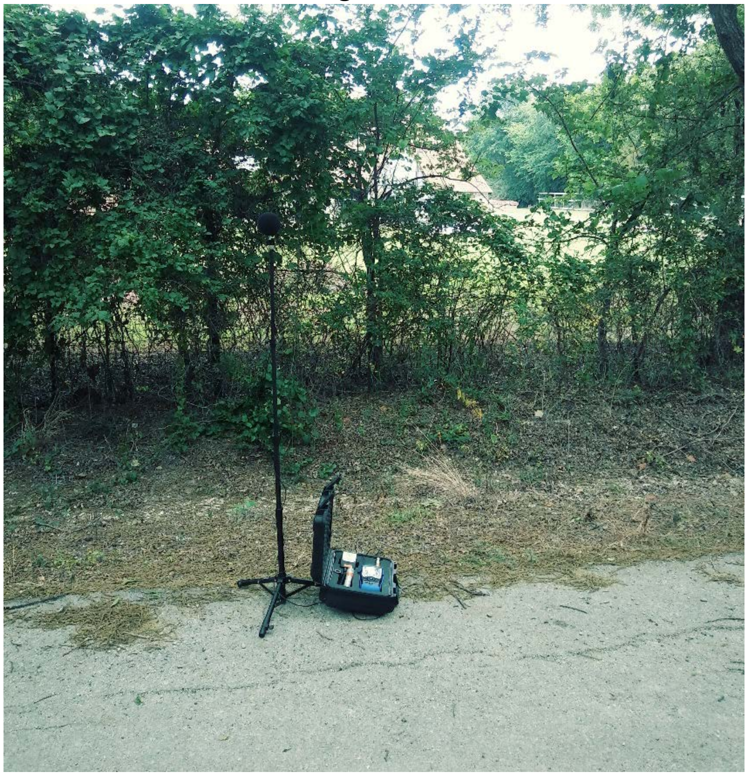


Figure A-3. Noise Measurement Site LT-1B – 1345 E Belt Line Rd, Lancaster; Dallas County; Segment 1

Figure A-4. Noise Measurement Site LT-1C – 1786 Nail Dr, Lancaster; Dallas County; Segment 1

Figure A-5. Noise Measurement Site LT-2 – 911 FM 813, Palmer; Ellis County; Segment 2C

Figure A-6. Noise Measurement Site LT-3 – 508 Old Waxahachie Rd, Waxahachie; Ellis County; Segment 2A

Figure A-7. Noise Measurement Site LT-4 – NW Co Rd 1320, Ennis; Navarro County; Segment 3A

Figure A-8. Noise Measurement Site LT-5 – SW 2120, Richland; Navarro County; Segment 3C

Figure A-9. Noise Measurement Site LT-6 – FM 1366, Wortham; Freestone County; Segment 4

Figure A-10. Noise Measurement Site LT-7 – 132-264 CR 890, Teague; Freestone County; Segment 4

Figure A-11. Noise Measurement Site LT-8 – N Fwy Service Rd, Teague; Freestone County; Segment 3C

Figure A-12. Noise Measurement Site LT-9 – 633 LCR 882, Jewett; Limestone County; Segment 4

Figure A-13. Noise Measurement Site LT-10 -- Beddingfield Rd, Marquez; Leon County; Segment 4

Figure A-14. Noise Measurement Site LT-11 – N Fwy Service Rd, Buffalo; Leon County; Segment 3C

Figure A-15. Noise Measurement Site LT-12 – 534 FM 39; Leon County; Segment 4

Figure A-16. Noise Measurement Site LT-13 – 2076-2765 W Feeder Rd; Leon County; Segment 3C

Figure A-17. Noise Measurement Site LT-14 – 7652 Greenbriar Rd; Madison County; Segment 3C

Figure A-18. Noise Measurement Site LT-15 – 1977 Poteet Rd; Madison County; Segment 4

Figure A-19. Noise Measurement Site LT-16 – 6113 FM 1696; Grimes County; Segment 5

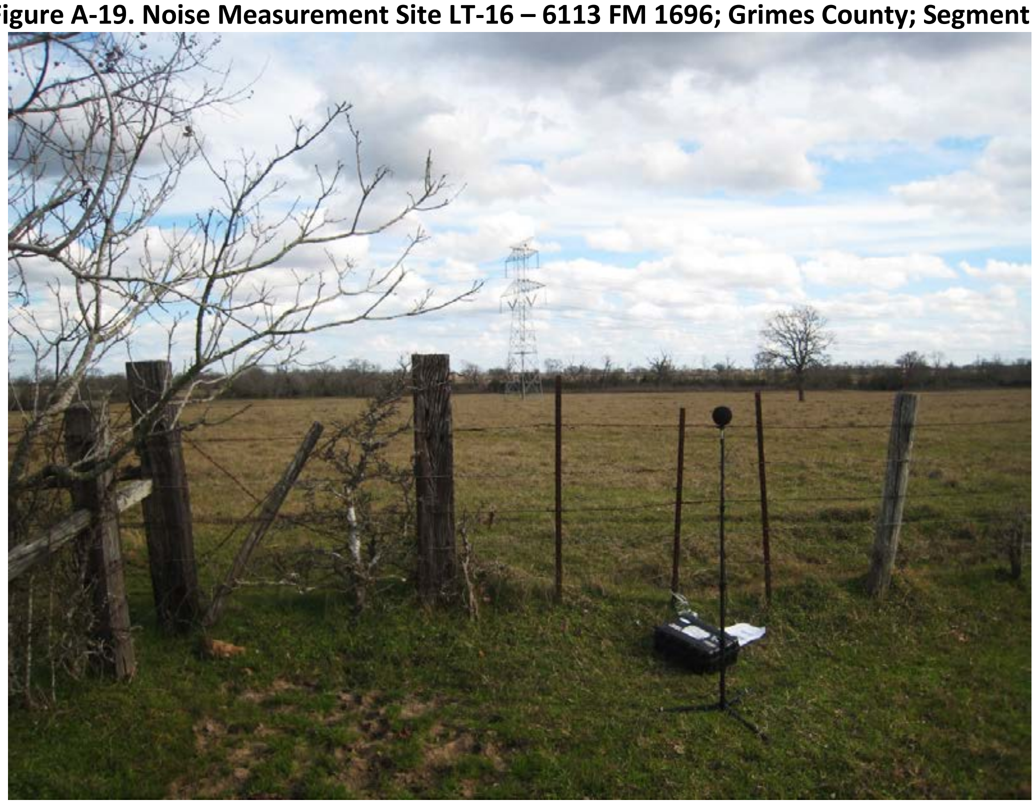


Figure A-20. Noise Measurement Site LT-17 – 10735 TX-90; Grimes County; Segment 5

Figure A-21. Noise Measurement Site LT-18 – 5126 FM 1774; Grimes County; Segment 5

Figure A-22. Noise Measurement Site LT-19 – 119 Plantation Dr; Waller County; Segment 5

Figure A-23. Noise Measurement Site LT-20 – 21512 Binford Rd; Harris County; Segment 5

Figure A-24. Noise Measurement Site LT-21 –1218 Canyon Arbor Way; Harris County; Segment 5

Figure A-25. Noise Measurement Site LT-22 –14812 Hempstead Rd; Harris County; Segment 5

Figure A-26. Noise Measurement Site LT-23 – 11217 Todd St; Harris County; Segment 5

Figure A-27. Noise Measurement Site ST-1 – 1213 Coleman Ave, Dallas; Dallas County; Segment 1

Figure A-28. Noise Measurement Site ST-2 –4412 Kolloch Dr, Dallas; Dallas County; Segment 1

Figure A-29. Noise Measurement Site ST-3 – 6350 J. J. Lemmon Rd, Dallas; Dallas County; Segment 1

Figure A-30. Noise Measurement Site ST-4 –2607 Ferris Rd, Lancaster; Ellis County; Segment 2A

Figure A-31. Noise Measurement Site ST-5 –369 Farmer Rd, Ennis; Ellis County; Segment 2B

Figure A-32. Noise Measurement Site ST-6 – SW 1000, Corsicana; Navarro County; Segment 3B

Figure A-33. Noise Measurement Site ST-7 – 117-123 CR 1041, Wortham; Freestone County; Segment 3C

Figure A-34. Noise Measurement Site ST-8 – N Fwy Service Rd & CR 1090, Streetman; Freestone County; Segment 3C

Figure A-35. Noise Measurement Site ST-9 – Old Mexia-Fairfield Rd, Fairfield; Freestone County; Segment 3C

Figure A-36. Noise Measurement Site ST-10 – 164 & FM 39, Groesbeck

Figure A-37. Noise Measurement Site ST-11 – N Fwy Service Rd & CR 306, Buffalo; Leon County; Segment 3C

Figure A-38. Noise Measurement Site ST-12 – 20559 I-45 Frontage Rd; Leon County; Segment 3C

Figure A-39. Noise Measurement Site ST-13 – 5192 Dawkins Rd; Madison County; Segment 4

Figure A-40. Noise Measurement Site ST-14 – 3159 Clark Rd; Madison County; Segment 4

Figure A-41. Noise Measurement Site ST-15 – 15619 TX-90; Grimes County; Segment 5

Figure A-42. Noise Measurement Site ST-16 – CR 341, Plantersville; Grimes County; Segment 5

Figure A-43. Noise Measurement Site ST-18 – 6734 Limestone St; Harris County; Segment 5

Figure A-44. Noise Measurement Site ST-19 –20710 May Showers Circle; Harris County; Segment 5

Figure A-45. Vibration Propagation Measurement Site V-1 – 4360 Kolloch Drive; Dallas County; Segment 1

Figure A-46. Vibration Propagation Measurement Site V-2 – 103 Coffee Road; Ellis County; Segments 2A and 2B

Figure A-47. Vibration Propagation Measurement Site V-3 – 710 FM 2100; Navarro County; Segments 3A, 3B and 3C

Figure A-48. Vibration Propagation Measurement Site V-4 – N Fwy Service Road, Fairfield; Freestone County; Segments 3C and 4

Figure A-49. Vibration Propagation Measurement Site V-5 – LCR 828, Personville; Limestone County; Segment 4

Figure A-50. Vibration Propagation Measurement Site V-6 – 6734 FM 977; Leon County; Segment 4

Figure A-51. Vibration Propagation Measurement Site V-7 – 10290 Greenbriar Road; Madison County; Segment 3C

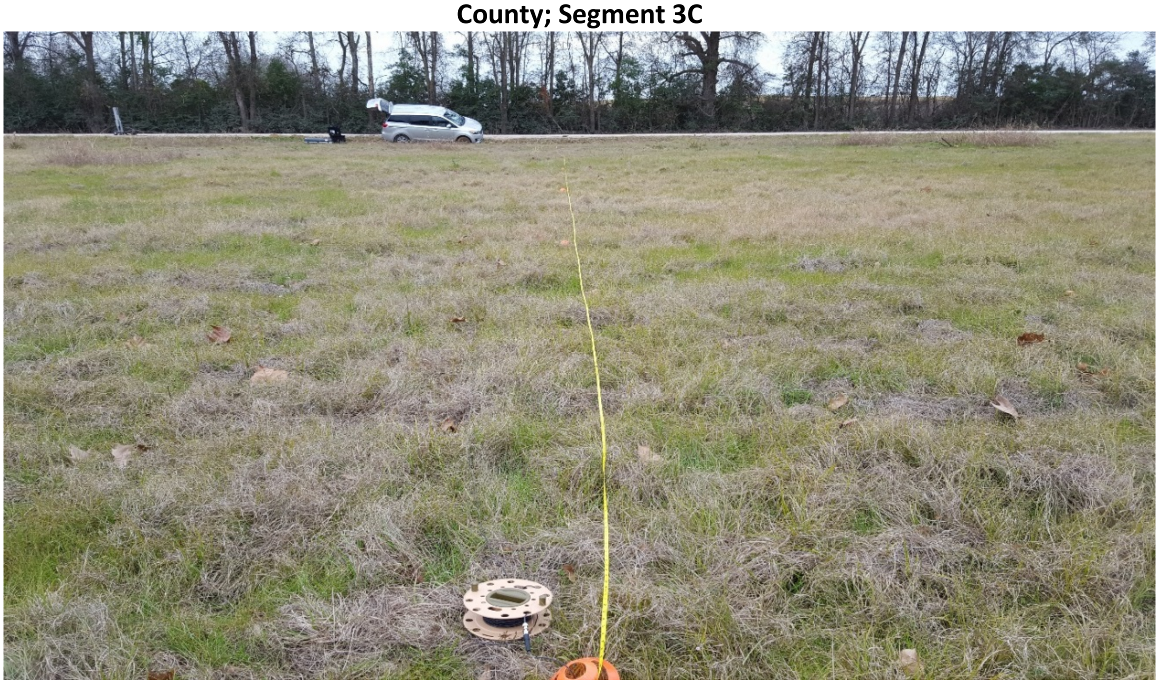


Figure A-52. Vibration Propagation Measurement Site V-8 – 10063 CR 311; Grimes County; Segment 5

Figure A-53. Vibration Propagation Measurement Site V-9 – Plantation Drive, Todd Mission; Waller County; Segment 5

Figure A-54. Vibration Propagation Measurement Site V-10 – Josey Ranch Road, Houston; Harris County; Segment 5

Figure A-55. Vibration Propagation Measurement Site V-11 – 21610 U.S. 290 Frontage Road, Houston; Harris County; Segment 5

APPENDIX B: NOISE MEASUREMENT DATA

Figure B-2. Long-Term Noise Measurement Data – Site LT-1

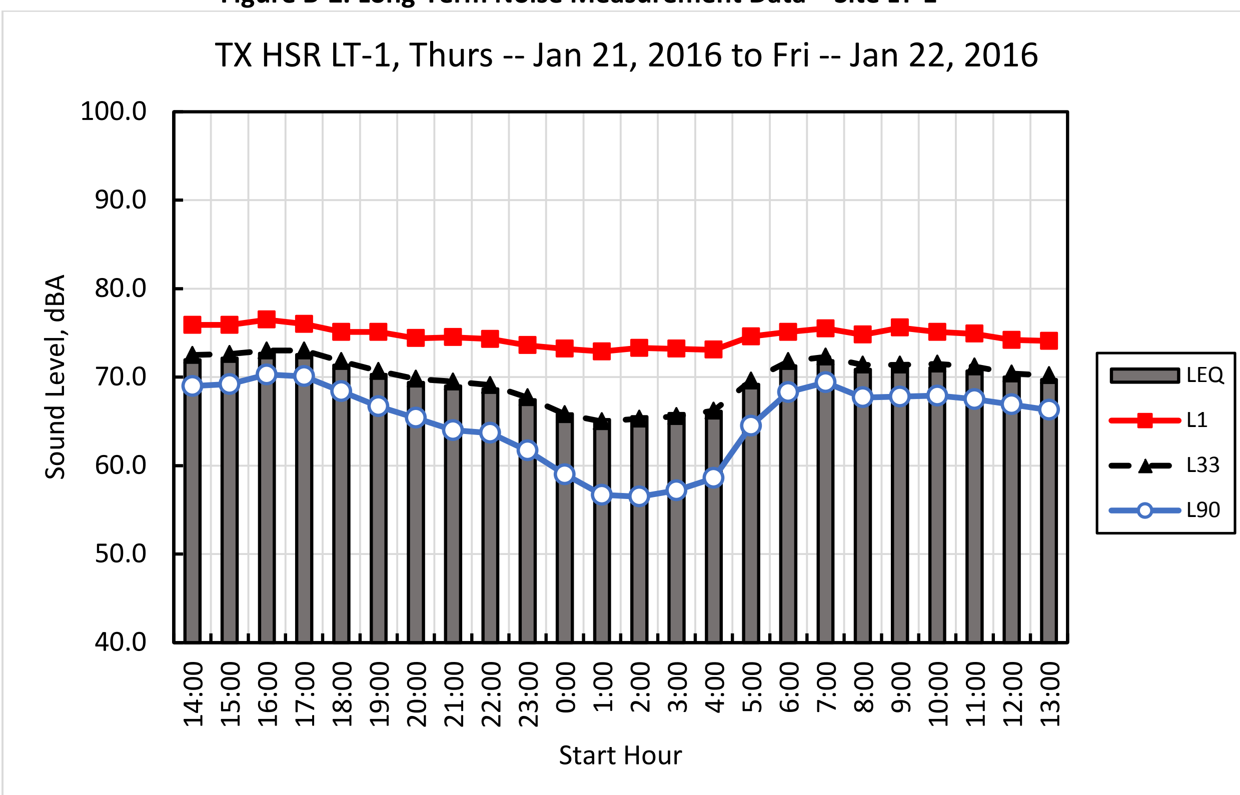


Figure B-3. Long-Term Noise Measurement Data – Site LT-2

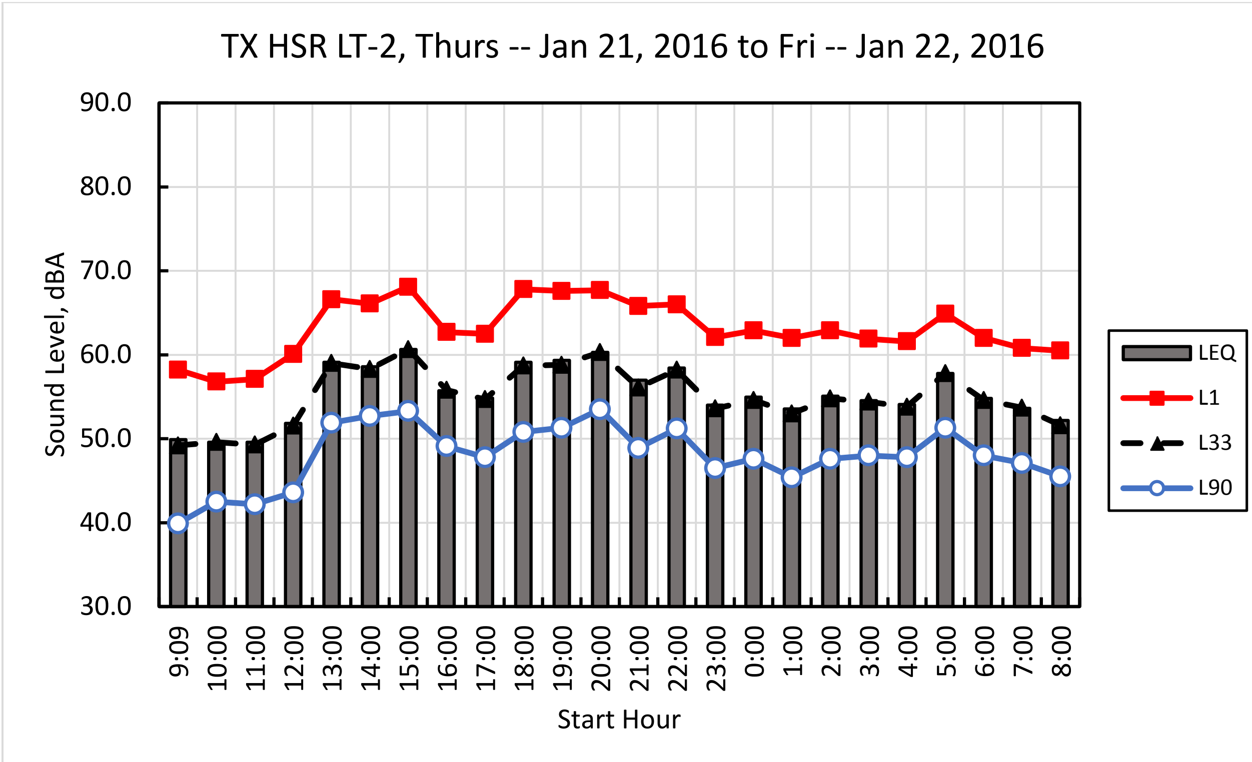


Figure B-4. Long-Term Noise Measurement Data – Site LT-3

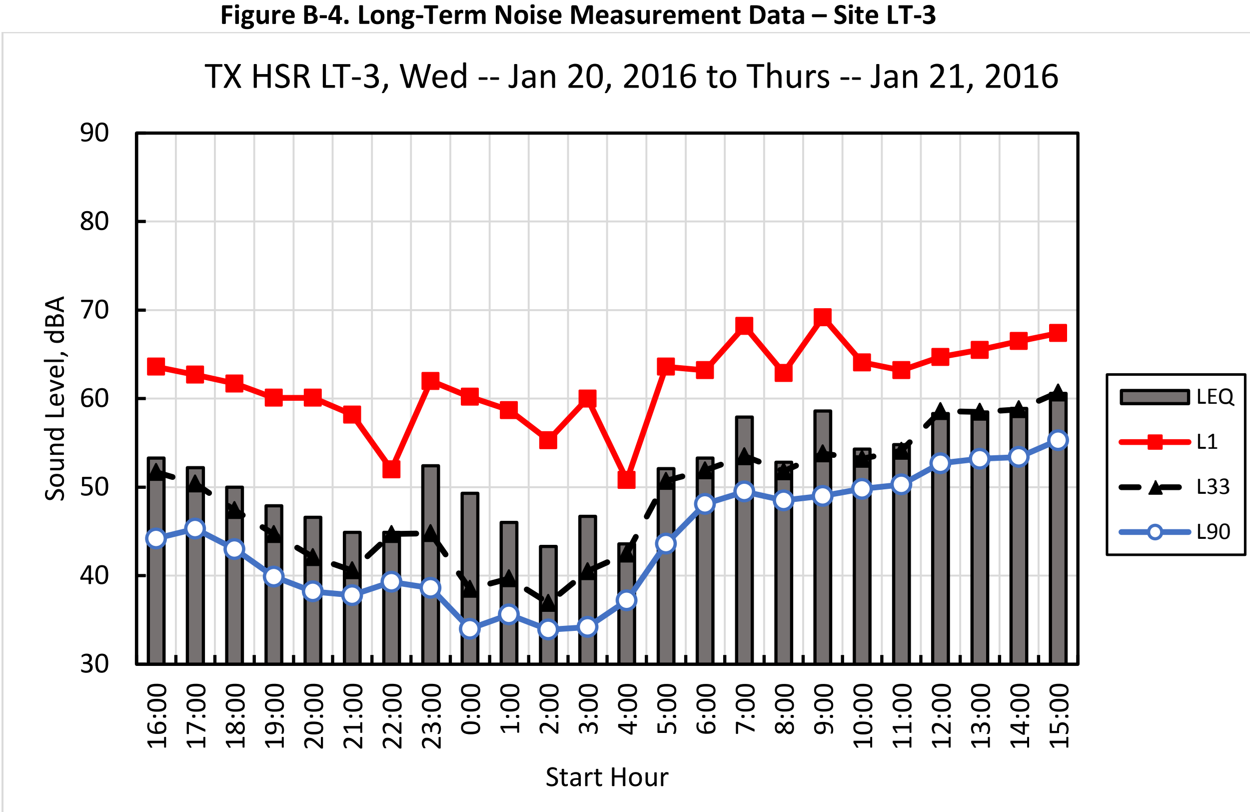


Figure B-5. Long-Term Measurement Data – Site LT-4

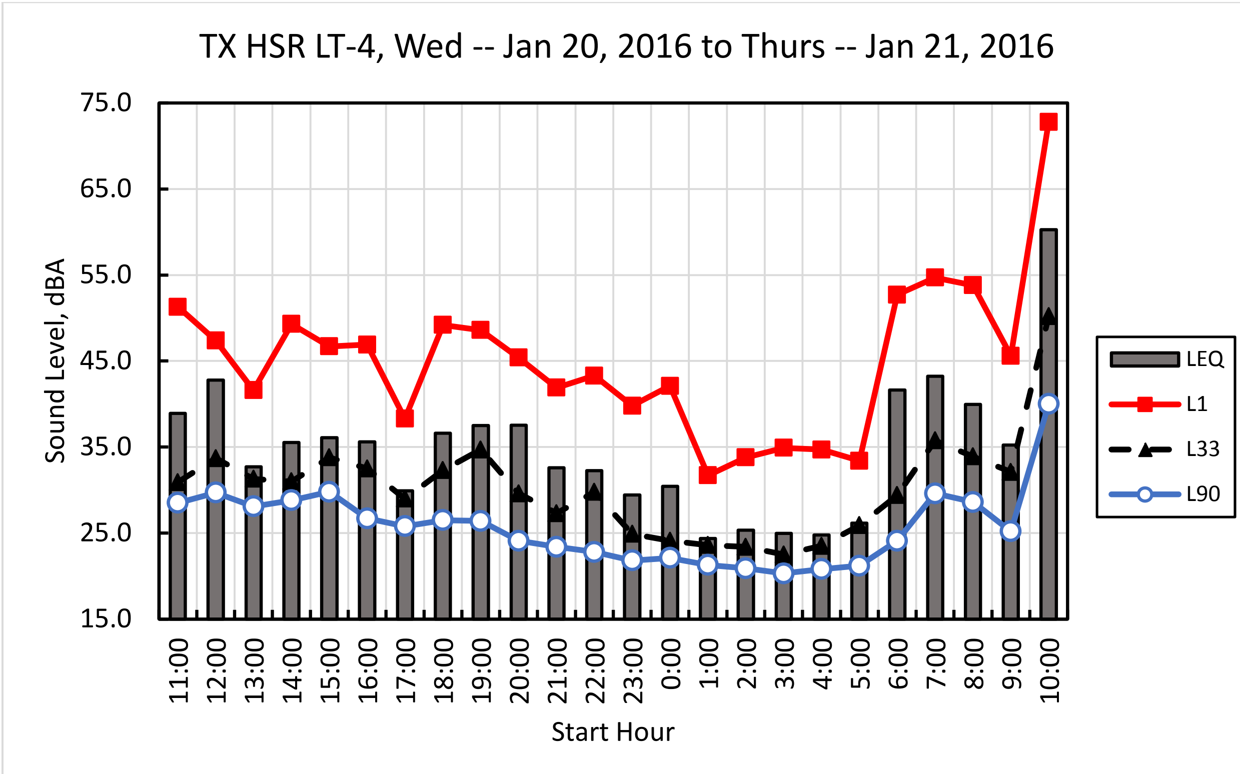


Figure B-6. Long-Term Measurement Data – Site LT-5

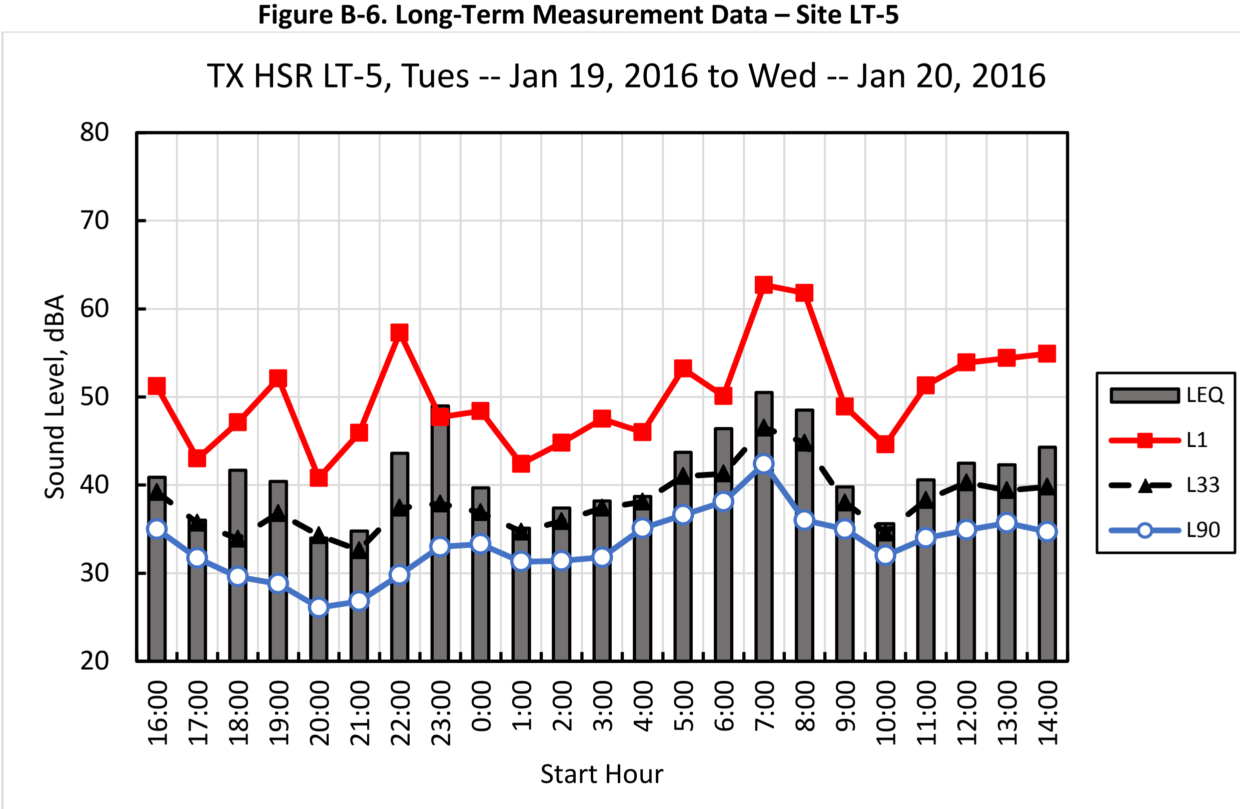


Figure B-7. Long-Term Measurement Data – Site LT-6

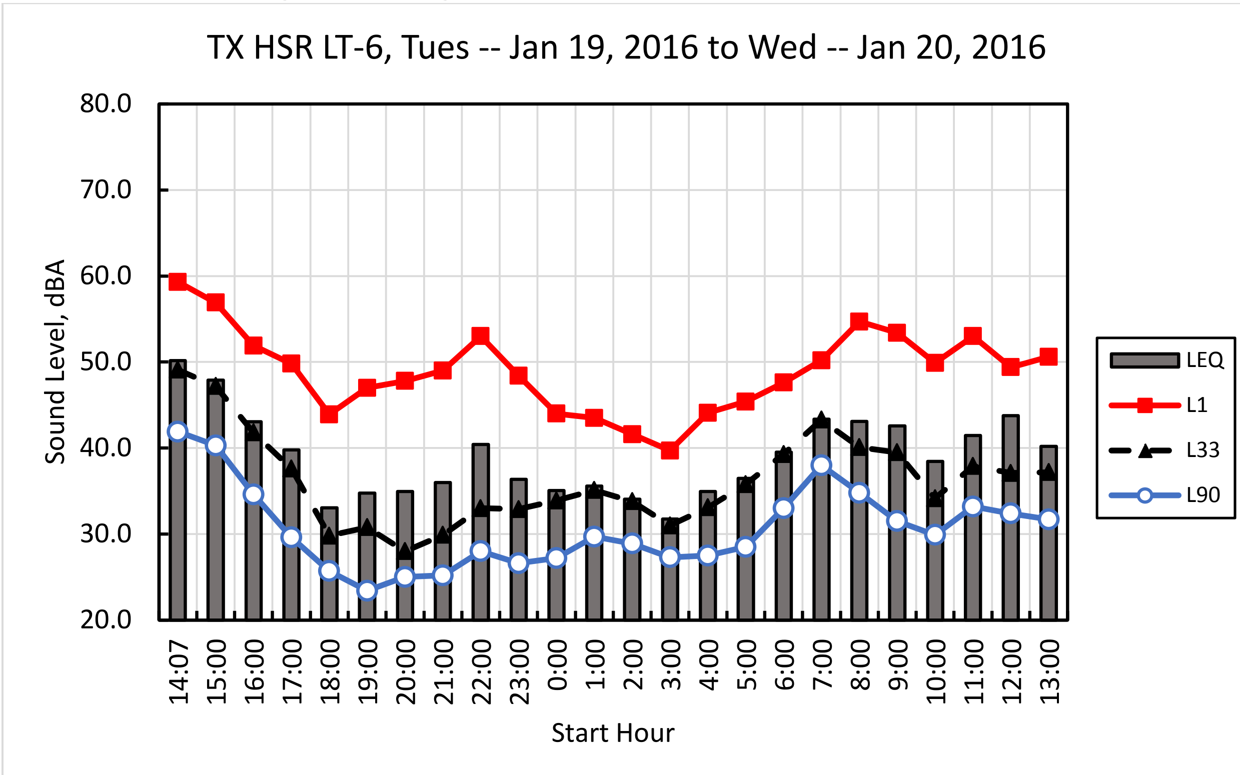


Figure B-8. Long-Term Measurement Data – Site LT-7

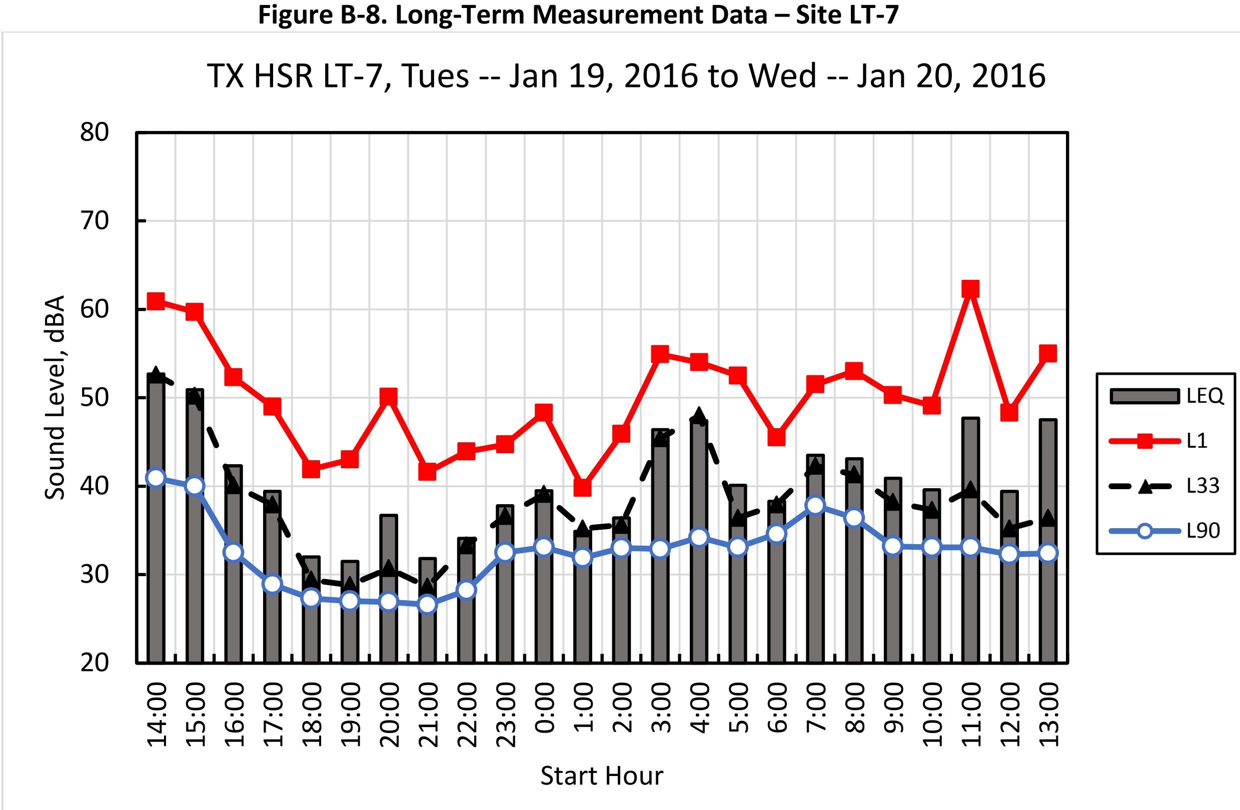


Figure B-9. Long-Term Measurement Data – Site LT-8

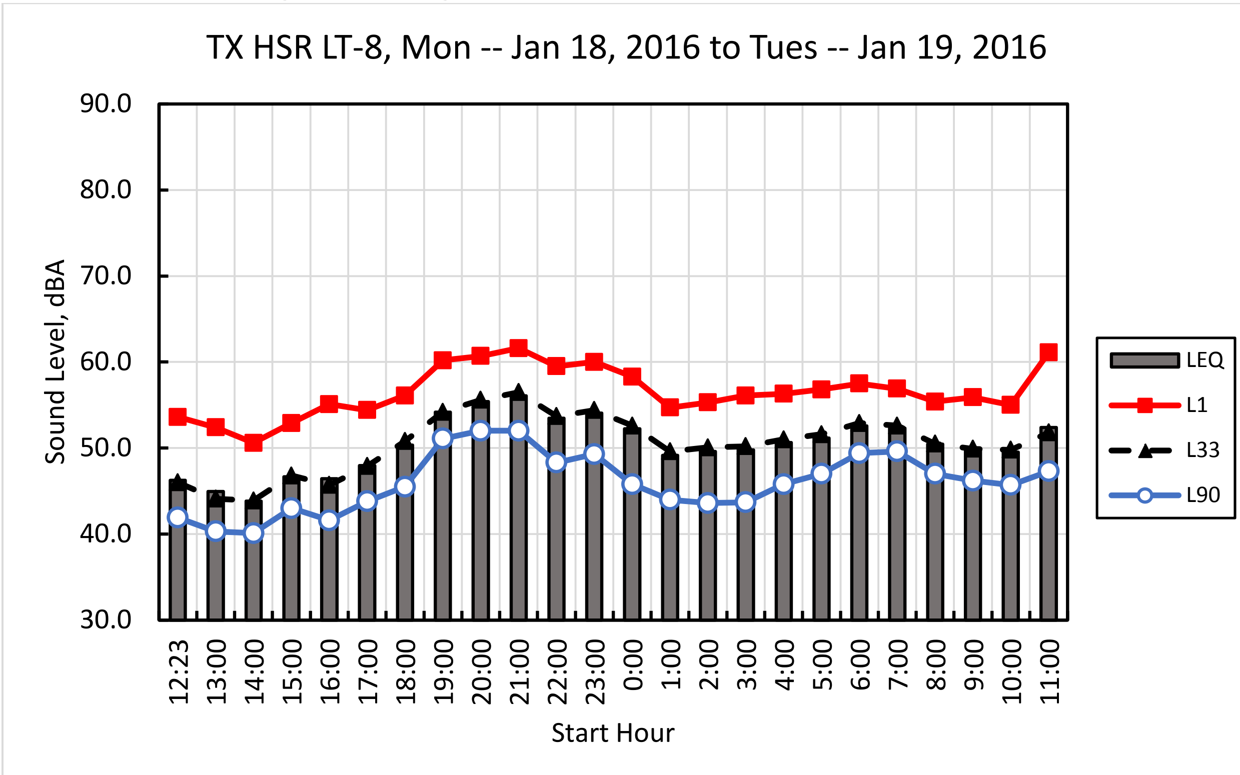


Figure B-10. Long-Term Measurement Data – Site LT-9

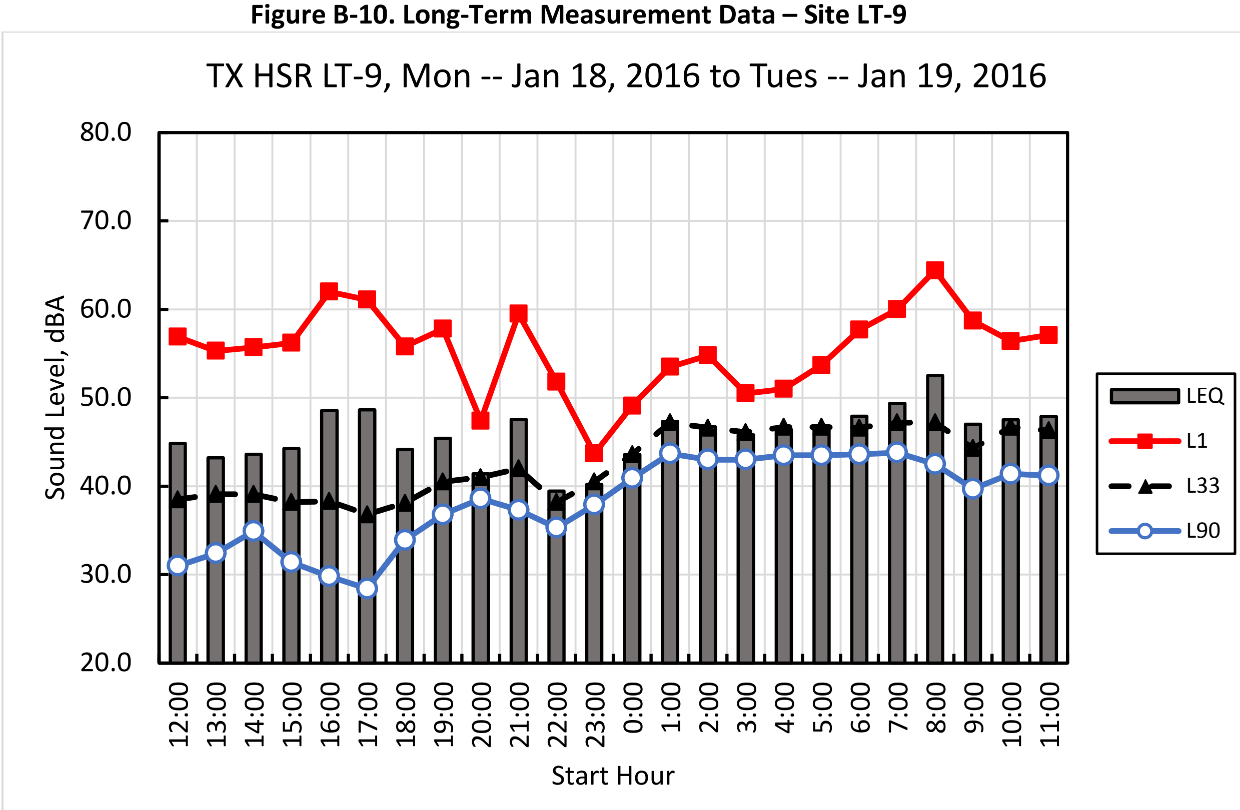


Figure B-11. Long-Term Measurement Data – Site LT-10

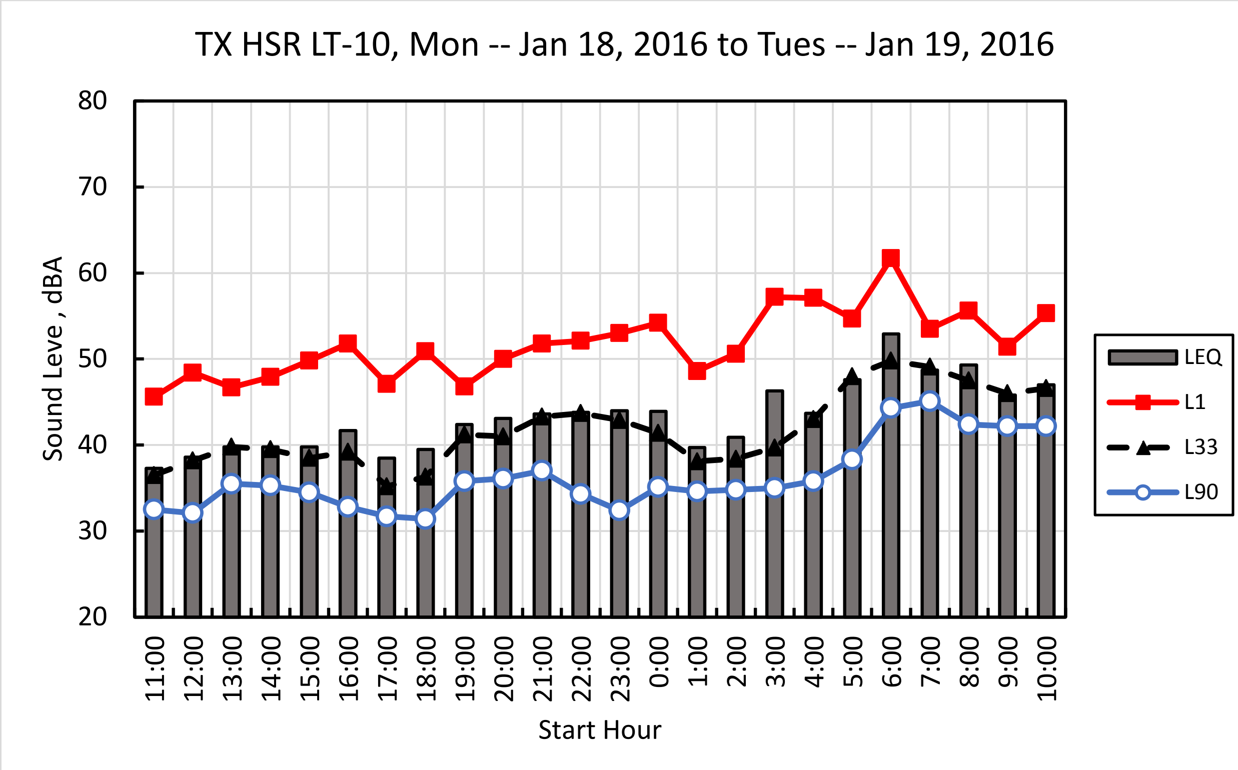


Figure B-12. Long-Term Measurement Data – Site LT-11

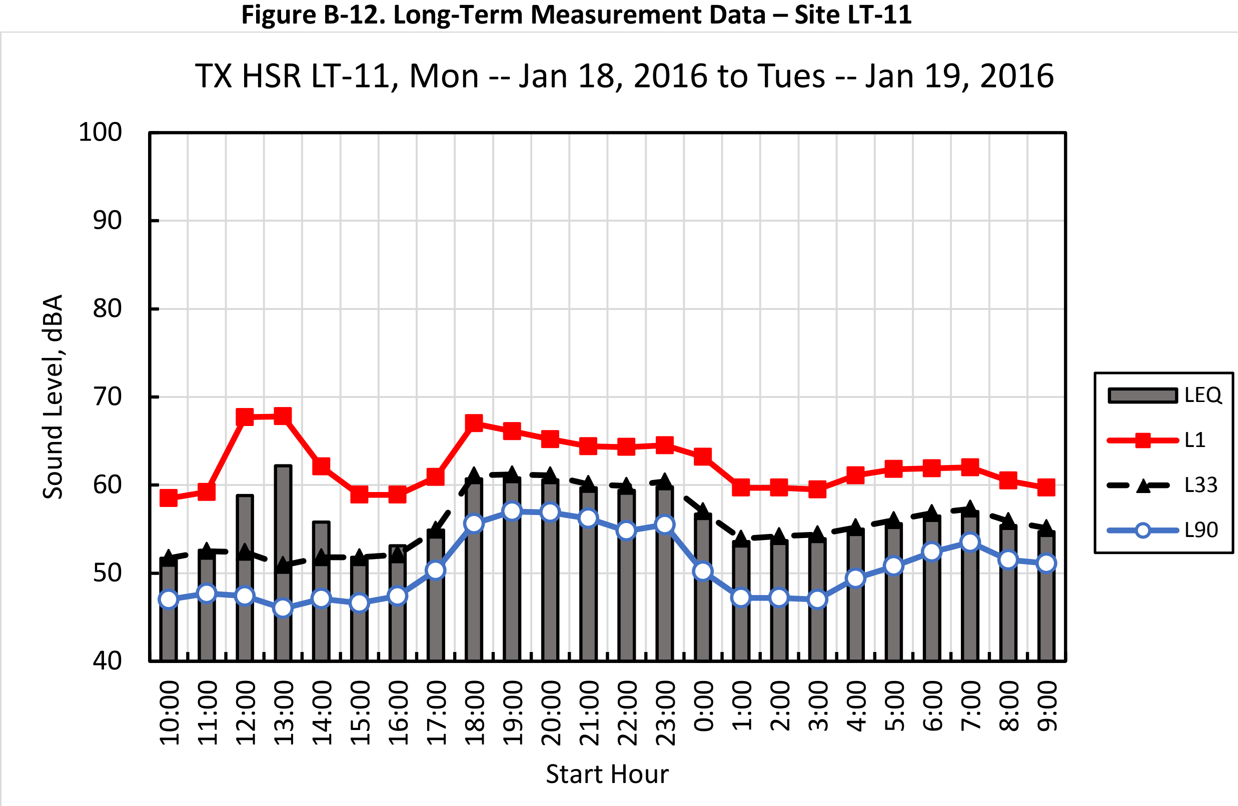


Figure B-13. Long-Term Measurement Data – Site LT-12

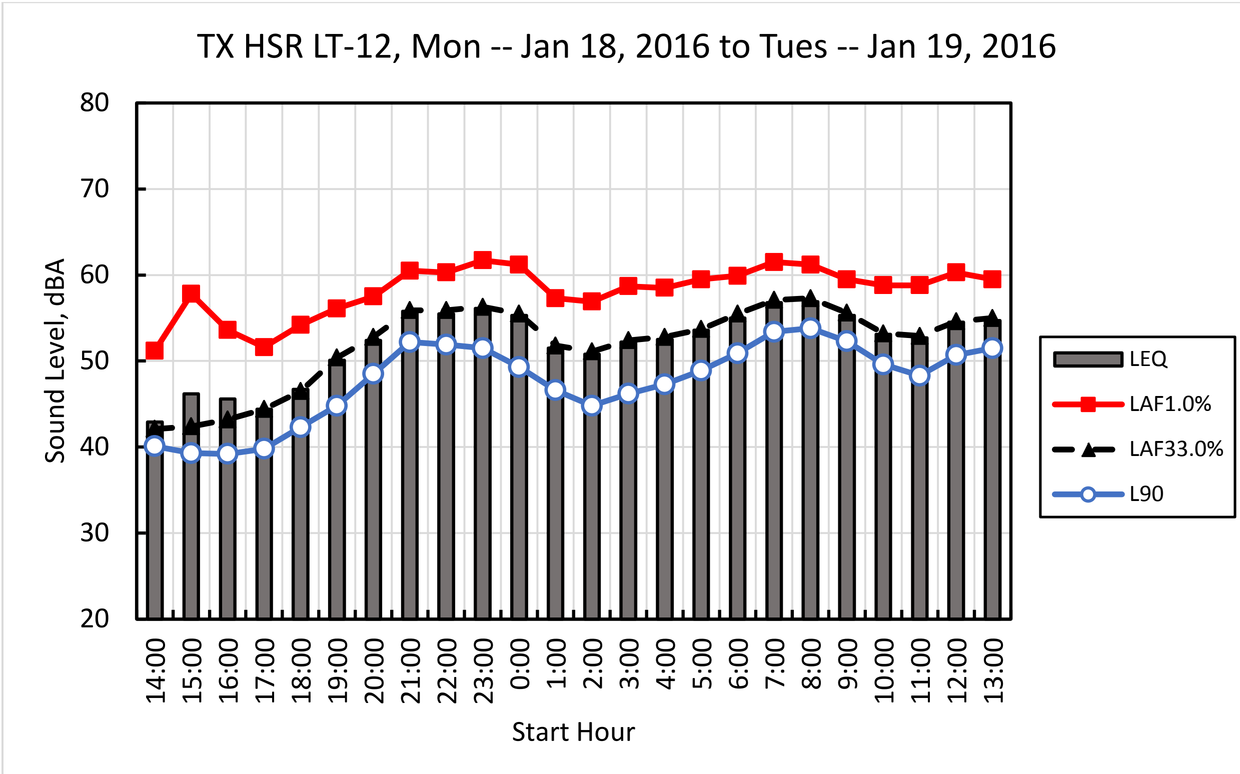


Figure B-14. Long-Term Measurement Data – Site LT-13

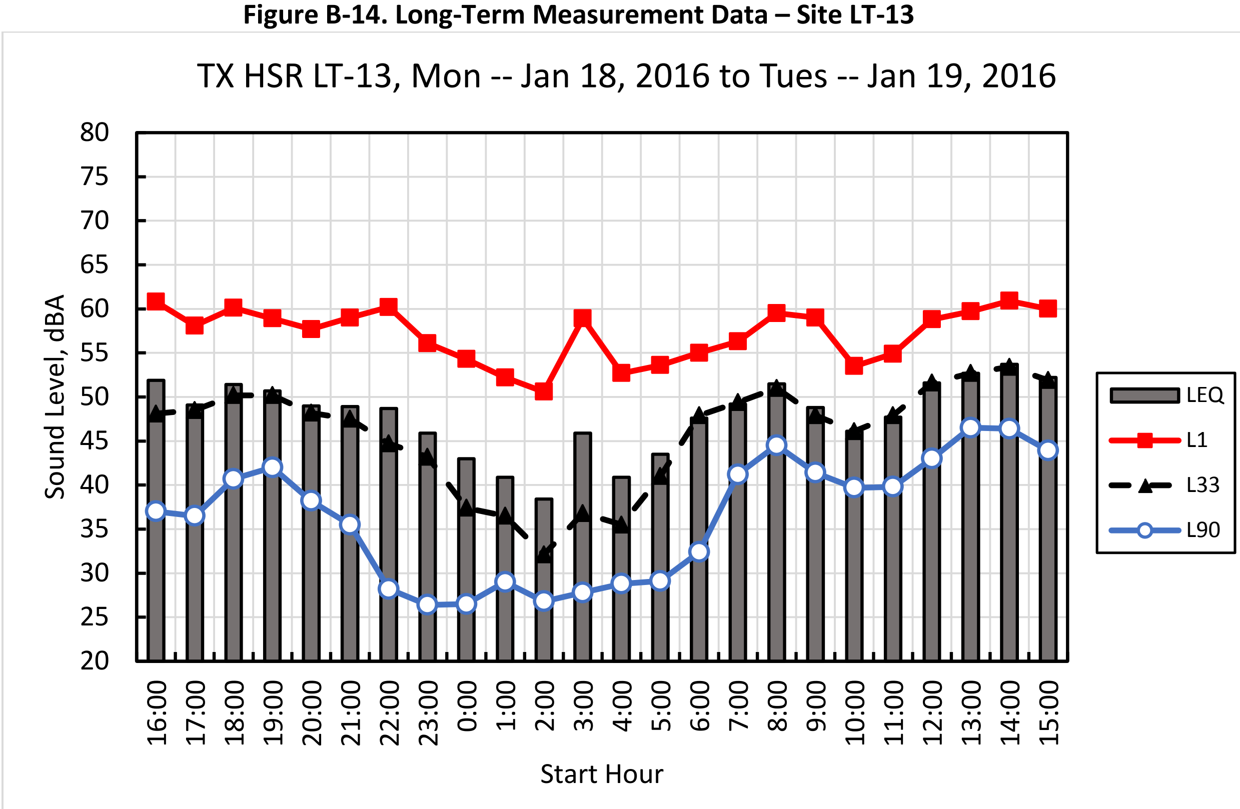


Figure B-15. Long-Term Measurement Data – Site LT-14

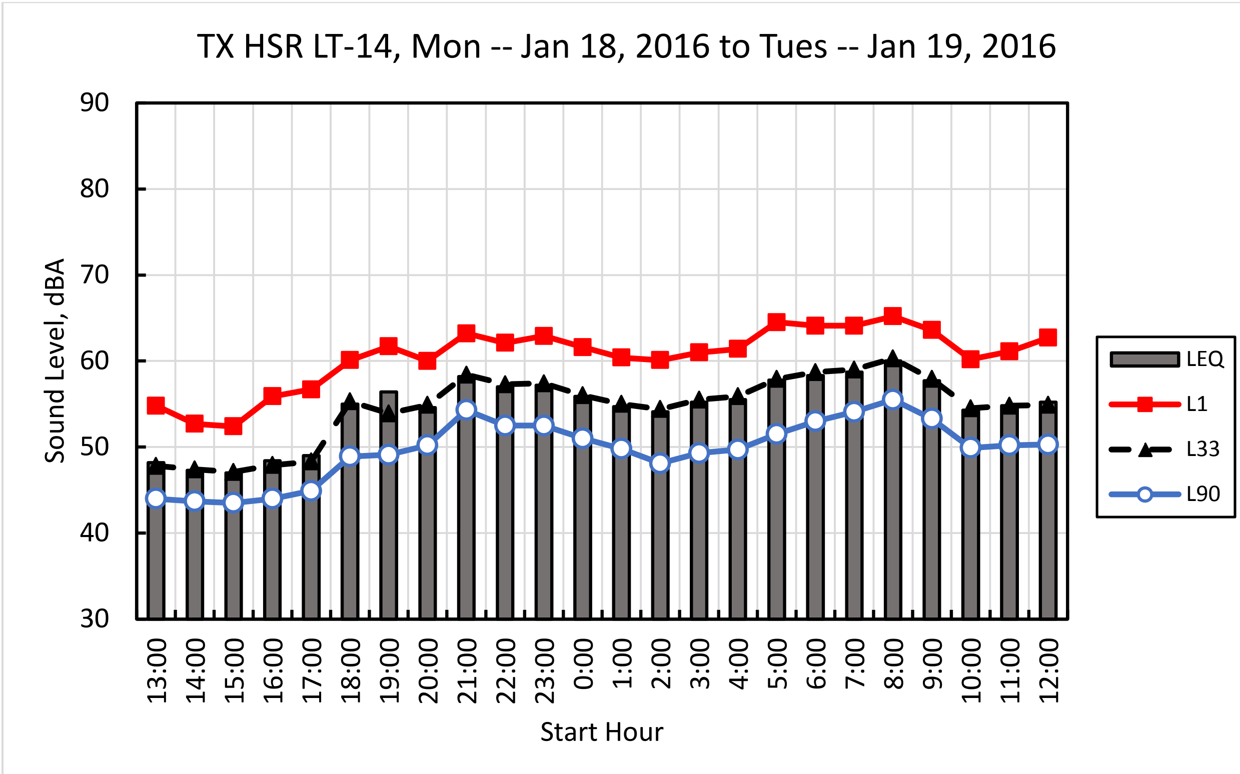


Figure B-16. Long-Term Measurement Data – Site LT-15

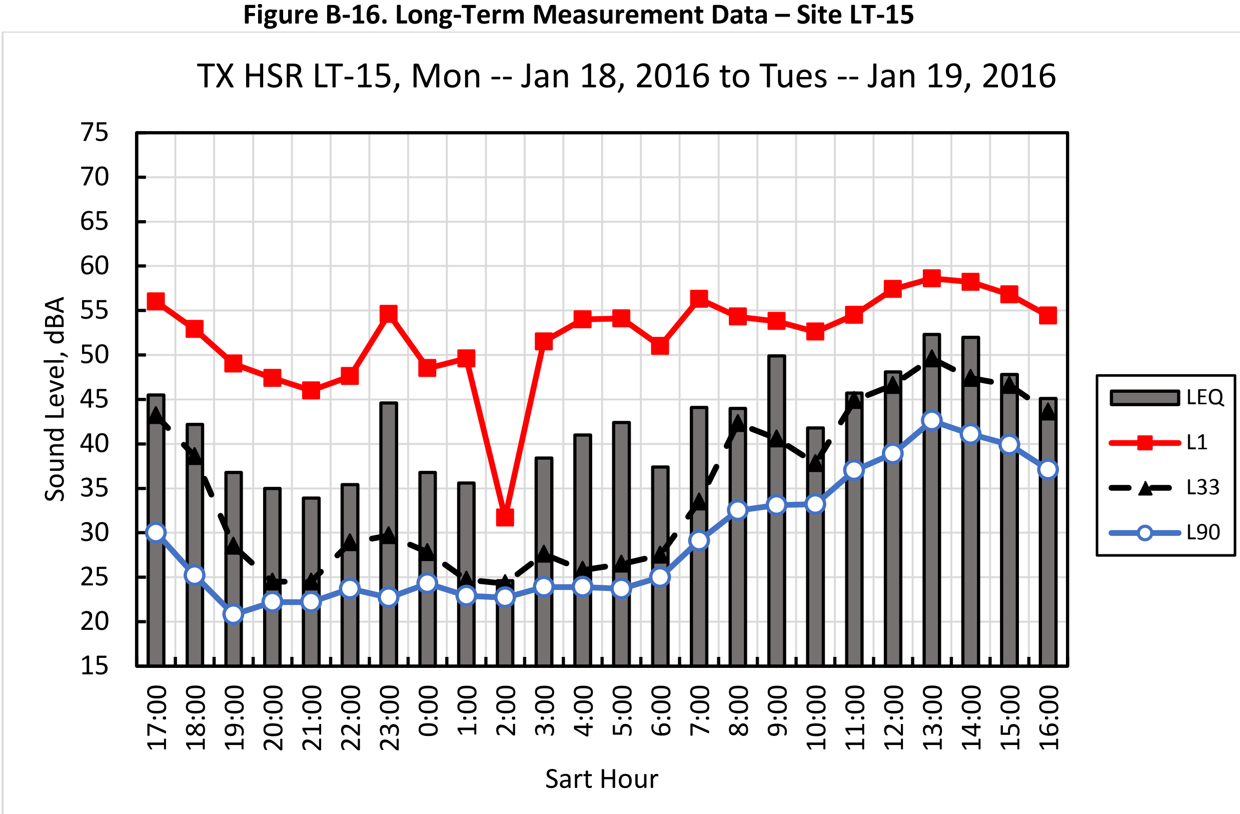


Figure B-17. Long-Term Measurement Data – Site LT-16

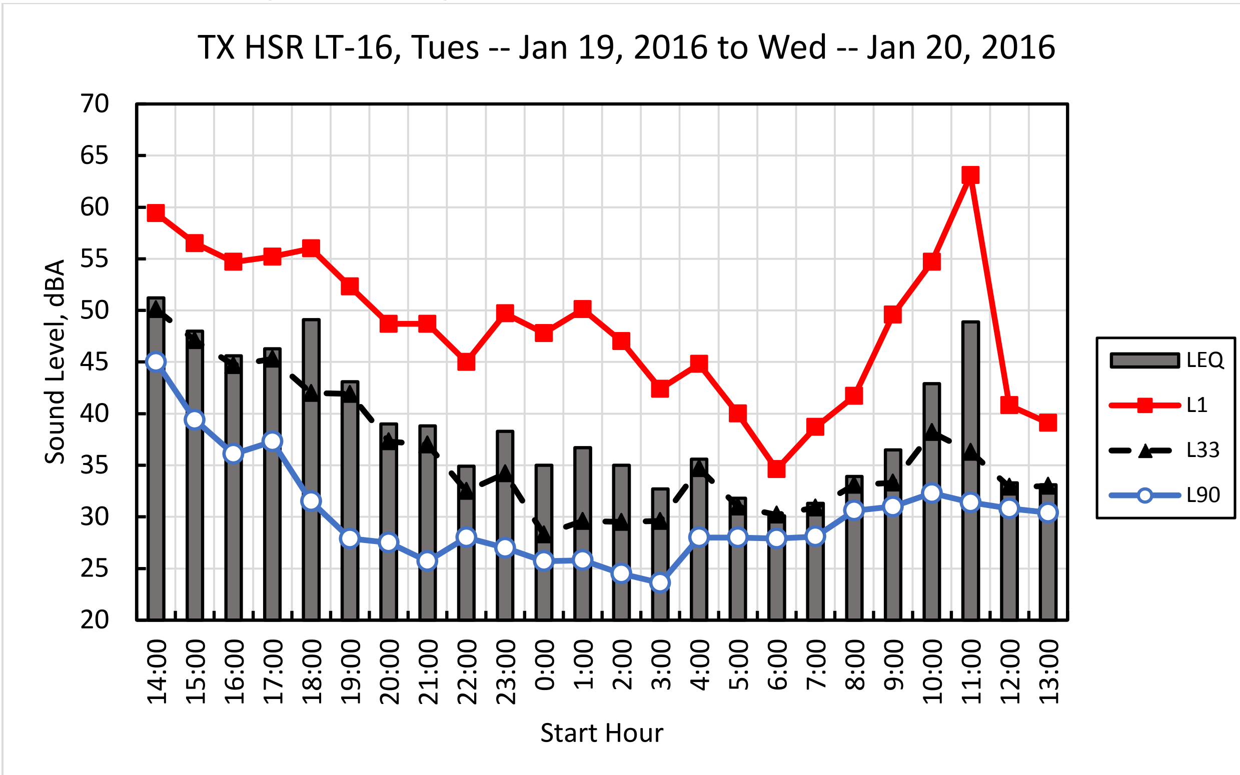


Figure B-18. Long-Term Measurement Data – Site LT-17

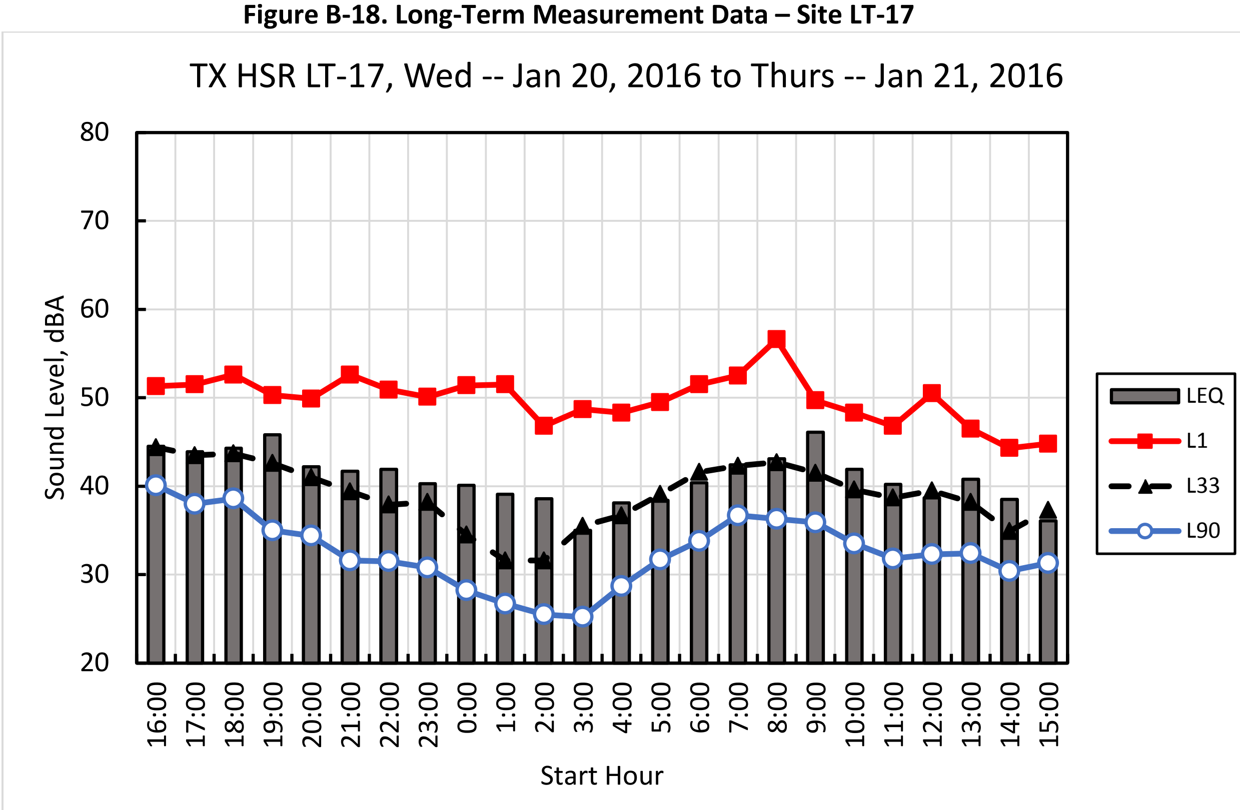


Figure B-19. Long-Term Measurement Data – Site LT-18

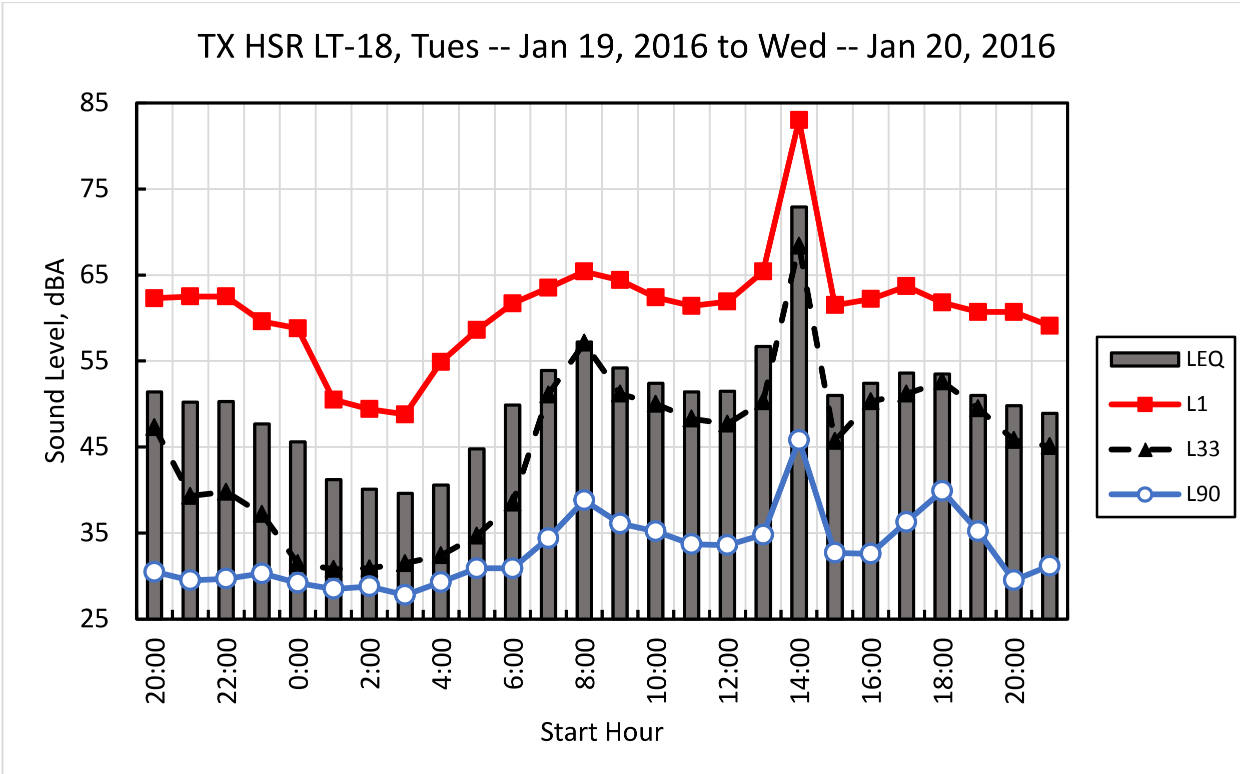
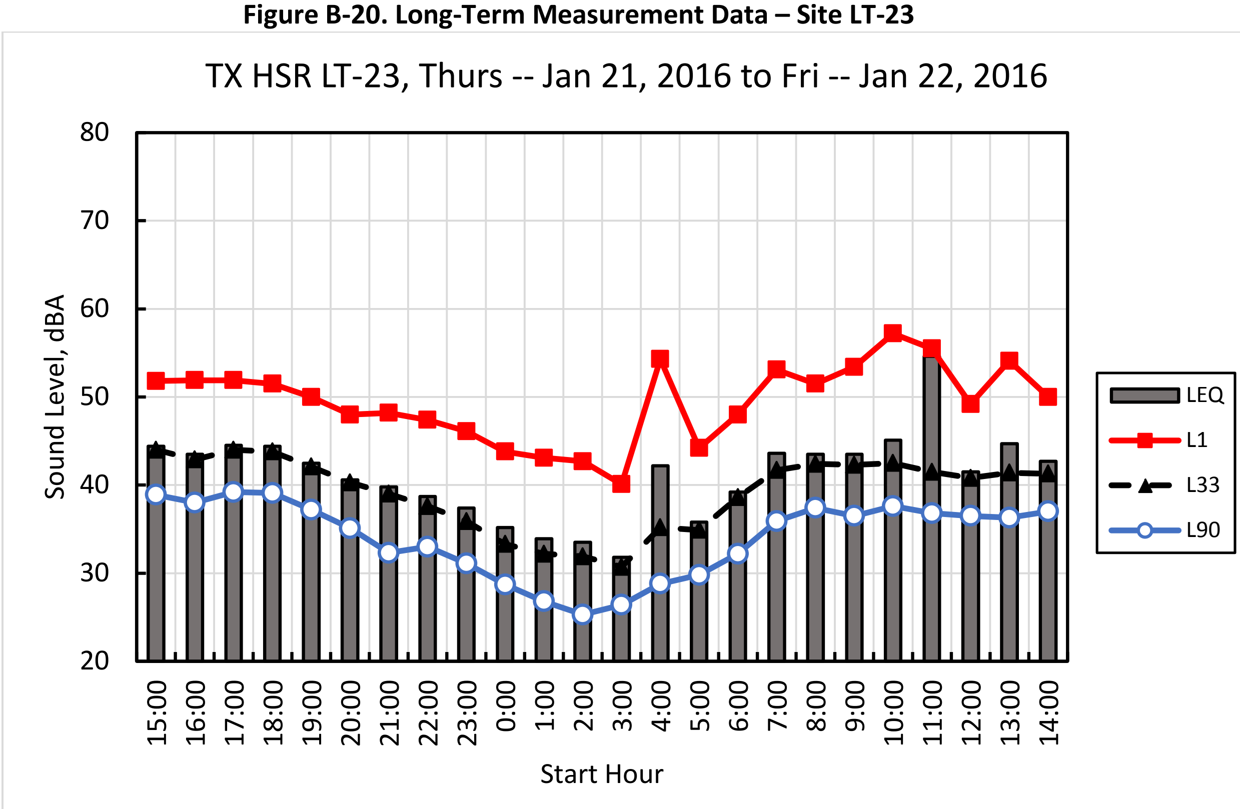


Figure B-20. Long-Term Measurement Data – Site LT-23



APPENDIX C: VIBRATION MEASUREMENT DATA

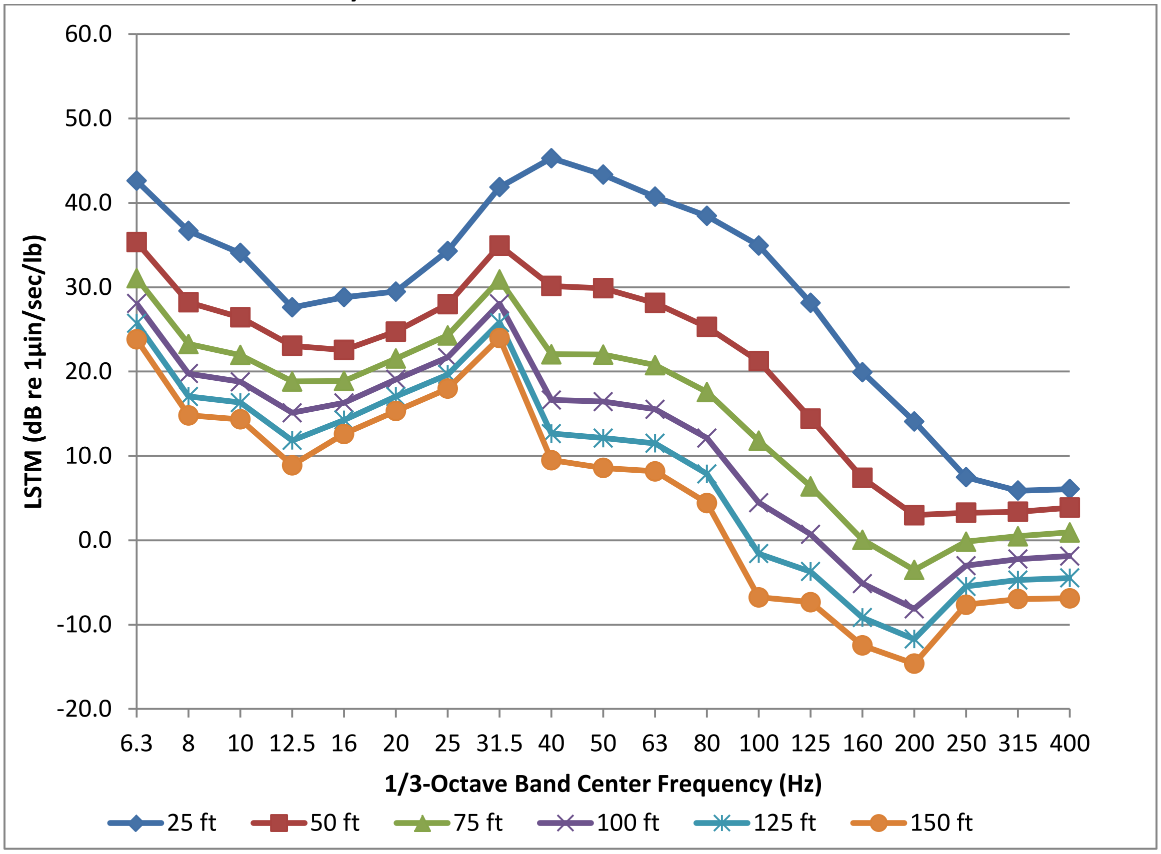
Site V-1

1/3-Octave Band Transfer Mobility Coefficients – Site V-1

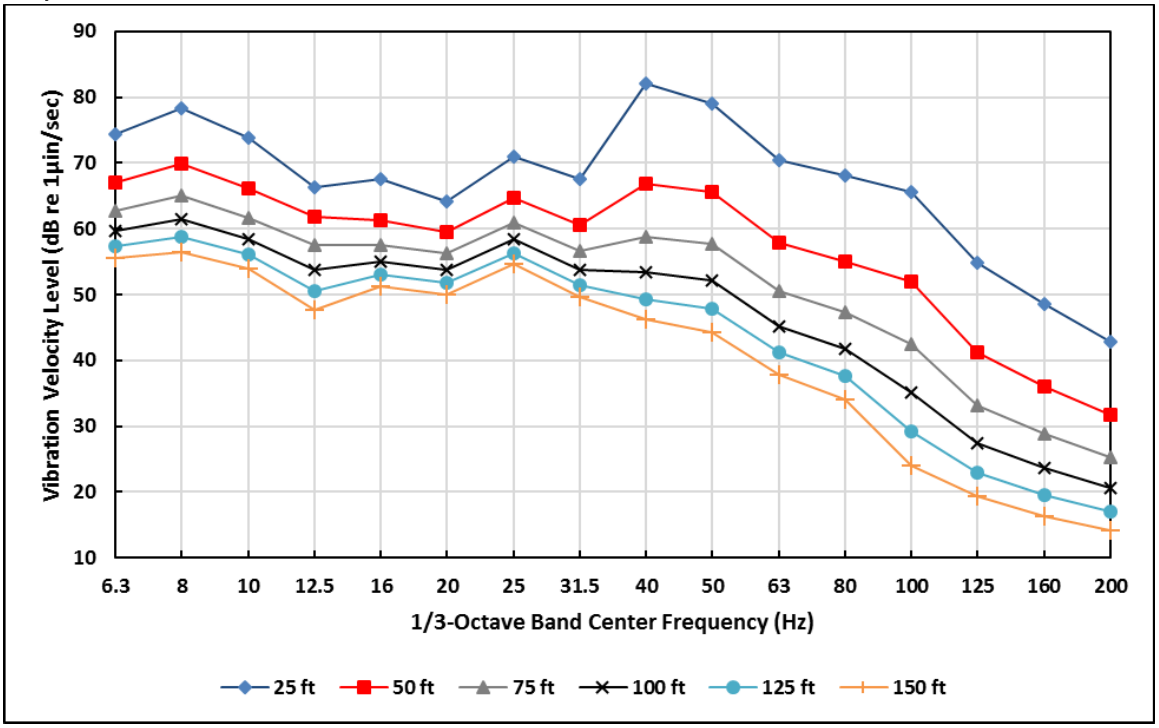
Coefficients	6.3 Hz	8 Hz	10 Hz	12.5 Hz	16 Hz	20 Hz	25 Hz	31.5 Hz	40 Hz	50 Hz	63 Hz	80 Hz	100 Hz	125 Hz	160 Hz	200 Hz
A	76.4	76.0	69.5	4.0	58.0	39.6	63.6	74.0	137.3	105.8	99.2	99.6	58.3	91.9	78.2	65.7
B	24.2	-28.1	-25.4	43.1	-20.8	-0.1	-21.0	-23.0	-78.6	-44.7	-41.8	-43.7	7.0	-45.6	-41.6	-36.9
C	0.0	0.0	0.0	-18.8	0.0	-5.1	0.0	0.0	9.1	0.0	0.0	0.0	-16.9	0.0	0.0	0.0

$$TM = A + B * \log(dist) + C * \log(dist)^2$$

Line Source Transfer Mobility – Site V-1



Projected HSR Ground Vibration Levels – Site V-1



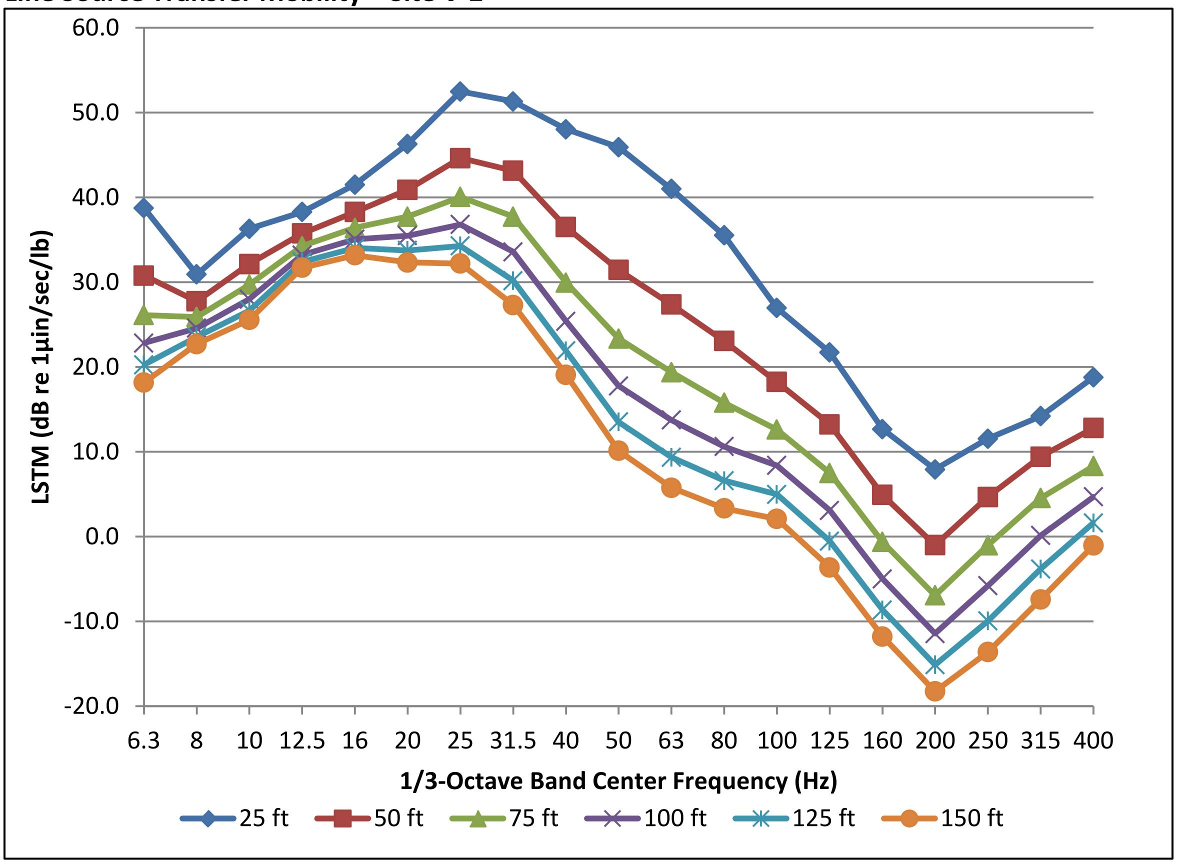
Site V-2

1/3-Octave Band Transfer Mobility Coefficients – Site V-2

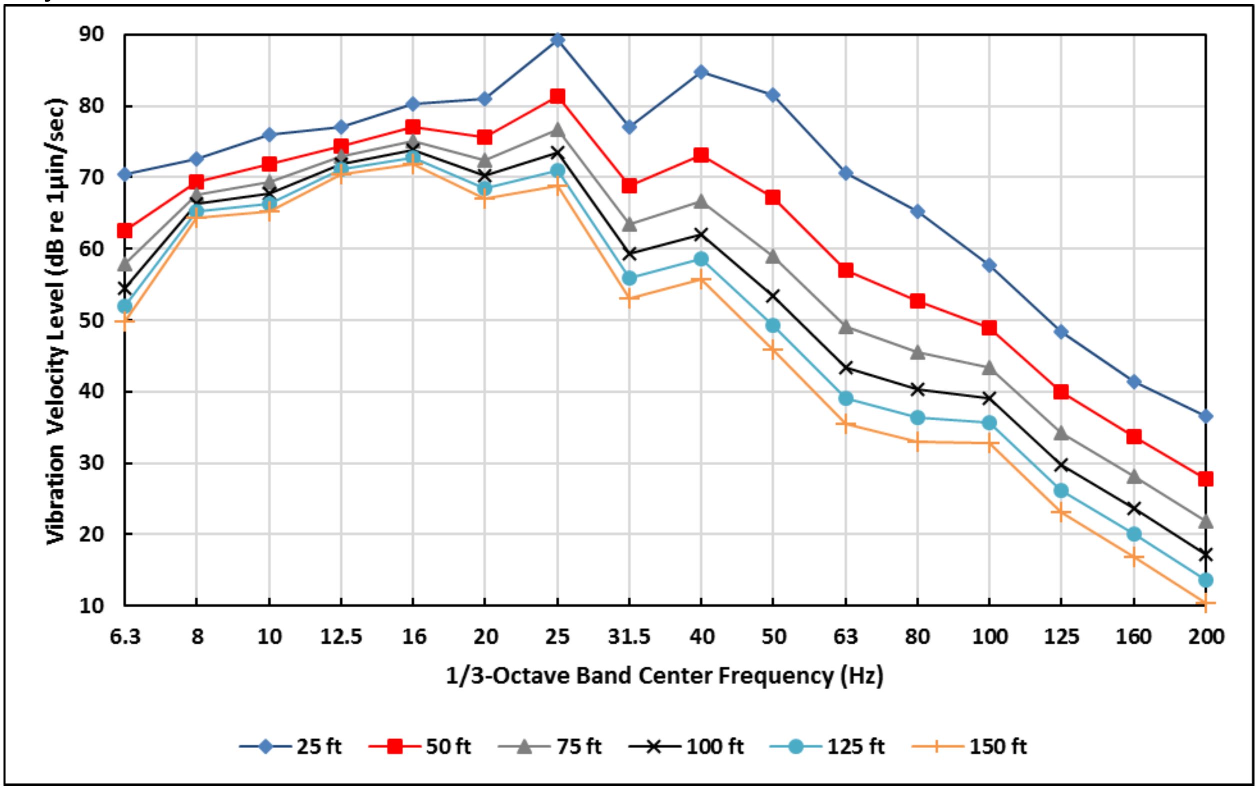
Coefficients	6.3 Hz	8 Hz	10 Hz	12.5 Hz	16 Hz	20 Hz	25 Hz	31.5 Hz	40 Hz	50 Hz	63 Hz	80 Hz	100 Hz	125 Hz	160 Hz	200 Hz
A	75.7	45.7	55.6	50.1	56.5	71.4	88.9	70.6	107.0	123.7	104.3	93.4	52.4	39.4	20.5	29.4
B	26.5	-10.5	-13.8	-8.4	-10.7	-17.9	-26.1	-2.8	-45.4	-61.8	-45.3	-41.4	-9.4	0.1	11.0	-3.6
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-7.8	2.3	4.4	0.0	0.0	-6.3	-9.2	-11.9	-8.4

$$TM = A + B * \log(dist) + C * \log(dist)^2$$

Line Source Transfer Mobility – Site V-2



Projected HSR Ground Vibration Levels – Site V-2



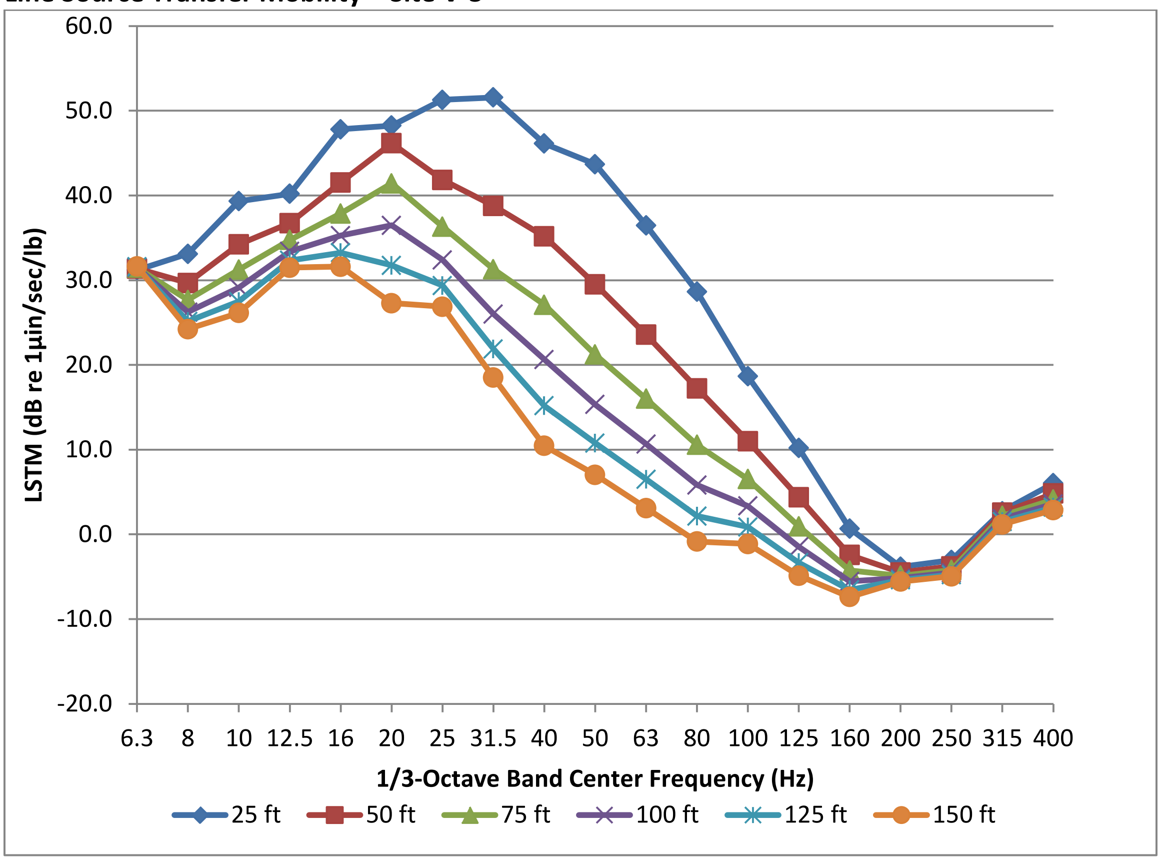
Site V-3

1/3-Octave Band Transfer Mobility Coefficients – Site V-3

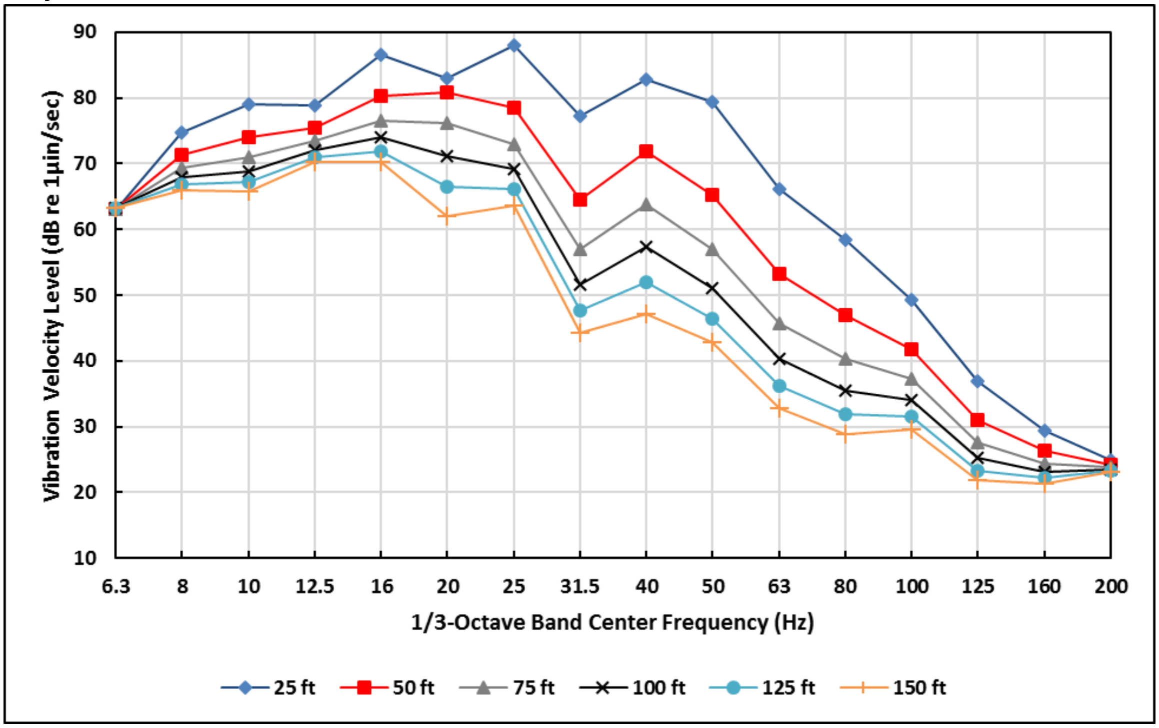
Coefficients	6.3 Hz	8 Hz	10 Hz	12.5 Hz	16 Hz	20 Hz	25 Hz	31.5 Hz	40 Hz	50 Hz	63 Hz	80 Hz	100 Hz	125 Hz	160 Hz	200 Hz
A	30.5	49.1	63.0	57.9	76.9	-41.5	95.2	111.0	49.9	109.6	96.4	81.6	54.2	37.2	15.2	-0.7
B	0.5	-11.4	-16.9	-13.6	-20.8	122.8	-31.4	-42.5	25.0	-47.1	-42.9	-37.9	-25.4	-19.3	-10.4	-2.2
C	0.0	0.0	0.0	0.7	0.0	-41.9	0.0	0.0	-19.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0

$$TM = A + B * \log(dist) + C * \log(dist)^2$$

Line Source Transfer Mobility – Site V-3



Projected HSR Ground Vibration Levels – Site V-3



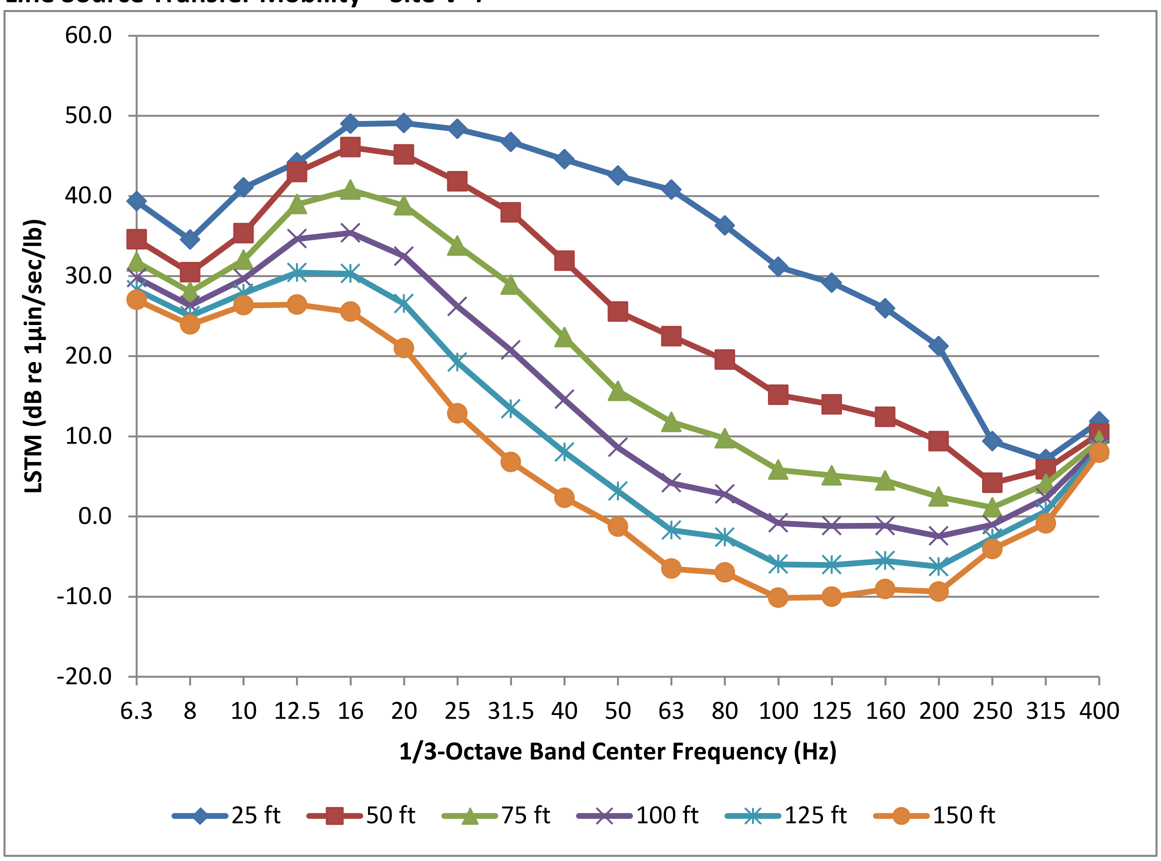
Site V-4

1/3-Octave Band Transfer Mobility Coefficients – Site V-4

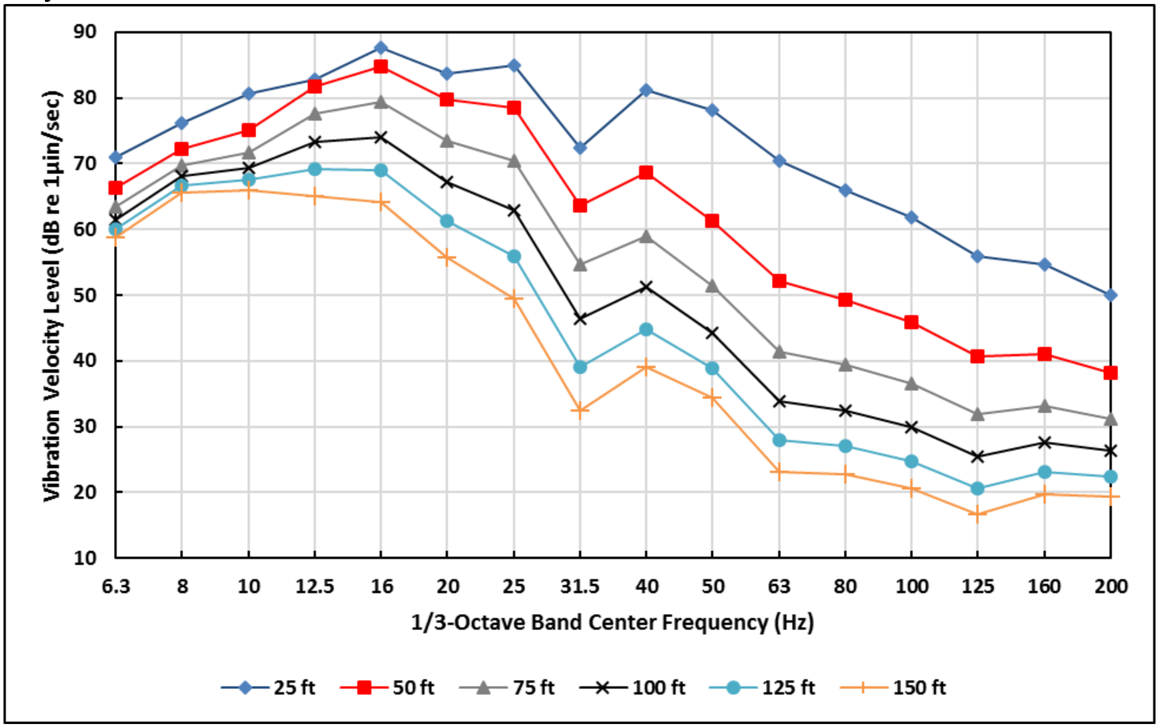
Coefficients	6.3 Hz	8 Hz	10 Hz	12.5 Hz	16 Hz	20 Hz	25 Hz	31.5 Hz	40 Hz	50 Hz	63 Hz	80 Hz	100 Hz	125 Hz	160 Hz	200 Hz
A	61.4	53.6	67.4	-44.0	-38.9	-47.3	-40.5	-22.9	42.3	121.2	125.8	114.1	105.3	99.5	88.9	76.2
B	15.8	-13.6	-18.9	118.1	122.6	136.4	133.6	114.8	37.5	-56.3	-60.8	-55.7	-53.1	-50.3	-45.0	-39.3
C	0.0	0.0	0.0	-39.4	-42.7	-48.3	-50.2	-46.5	-25.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0

$$TM = A + B * \log(dist) + C * \log(dist)^2$$

Line Source Transfer Mobility – Site V-4



Projected HSR Ground Vibration Levels – Site V-4



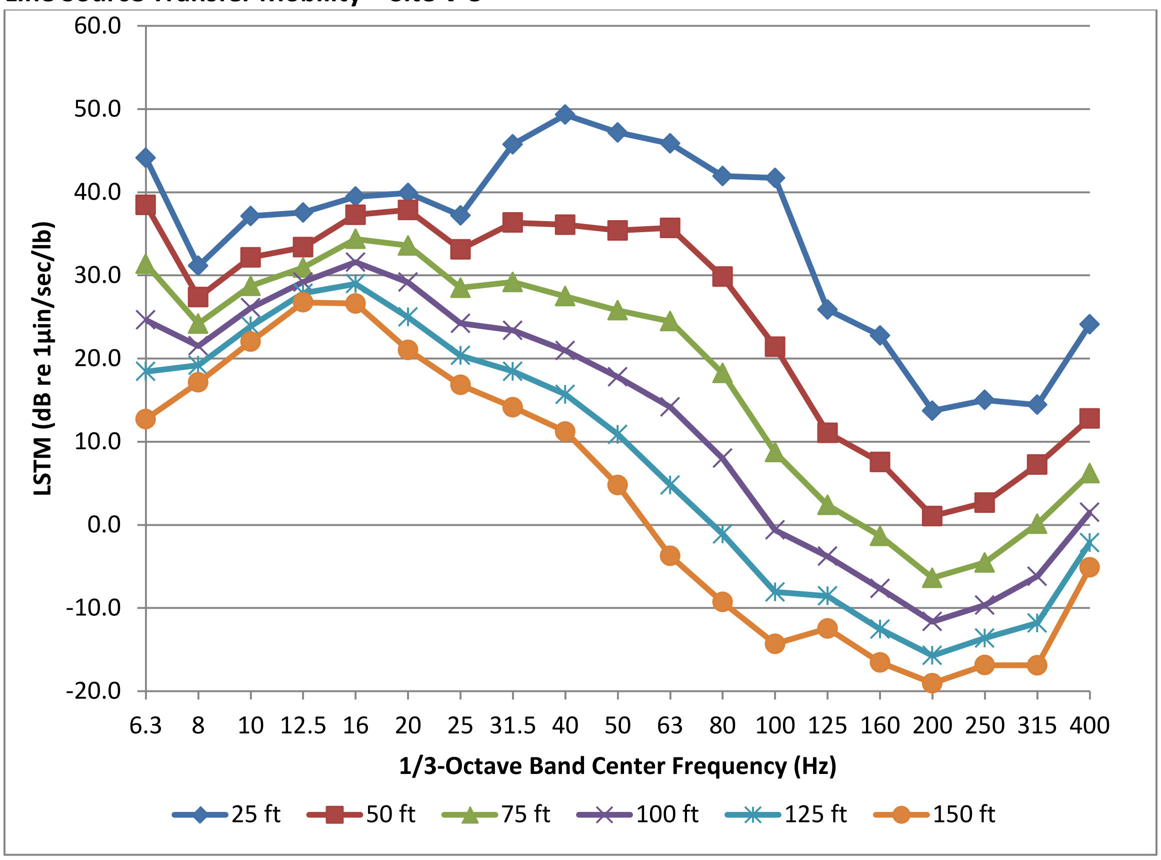
Site V-5

1/3-Octave Band Transfer Mobility Coefficients – Site V-5

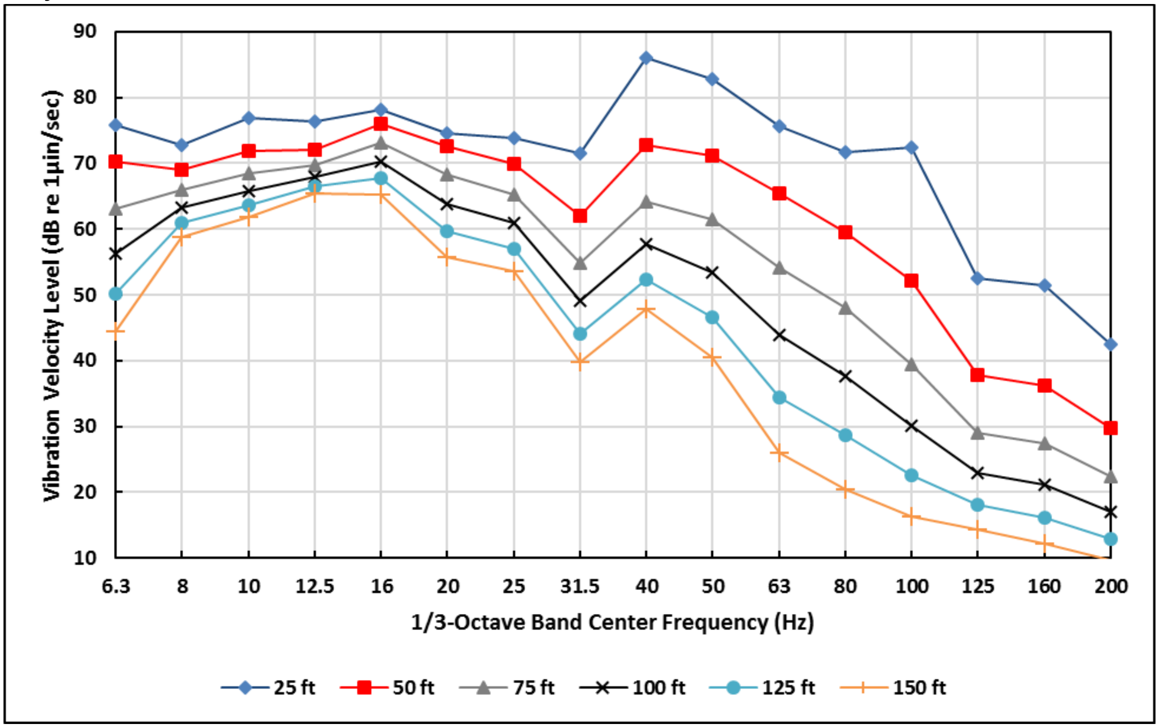
Coefficients	6.3 Hz	8 Hz	10 Hz	12.5 Hz	16 Hz	20 Hz	25 Hz	31.5 Hz	40 Hz	50 Hz	63 Hz	80 Hz	100 Hz	125 Hz	160 Hz	200 Hz
A	-37.3	21.4	46.0	57.0	3.3	-37.6	-6.5	42.7	85.6	25.5	-56.4	-29.3	113.1	94.8	93.4	72.6
B	121.6	23.1	2.0	-13.9	53.1	106.6	68.2	29.6	-11.1	60.4	161.1	126.1	-37.6	-49.3	-50.5	-42.1
C	-45.3	-11.5	-6.0	0.0	-19.5	-36.6	-26.4	-19.7	-10.6	-32.2	-62.9	-53.7	-9.6	0.0	0.0	0.0

$$TM = A + B * \log(dist) + C * \log(dist)^2$$

Line Source Transfer Mobility – Site V-5



Projected HSR Ground Vibration Levels – Site V-5



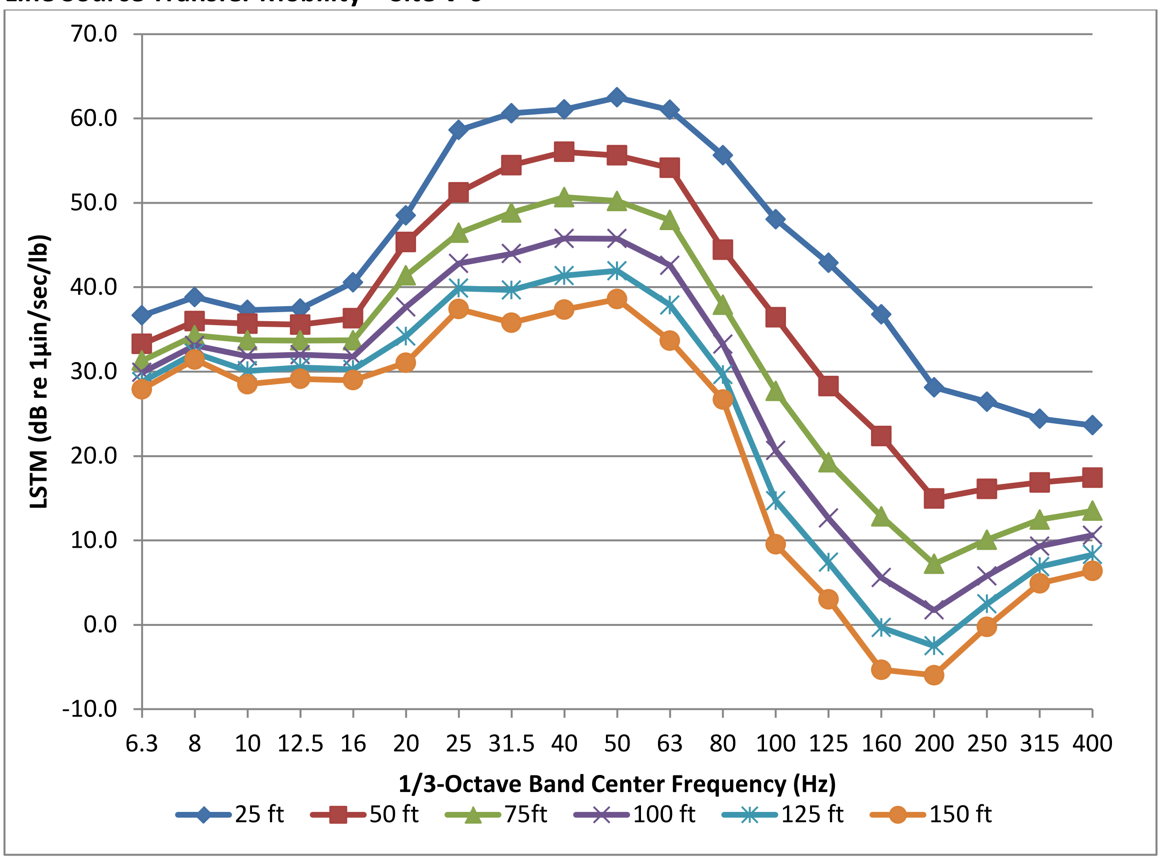
Site V-6

1/3-Octave Band Transfer Mobility Coefficients – Site V-6

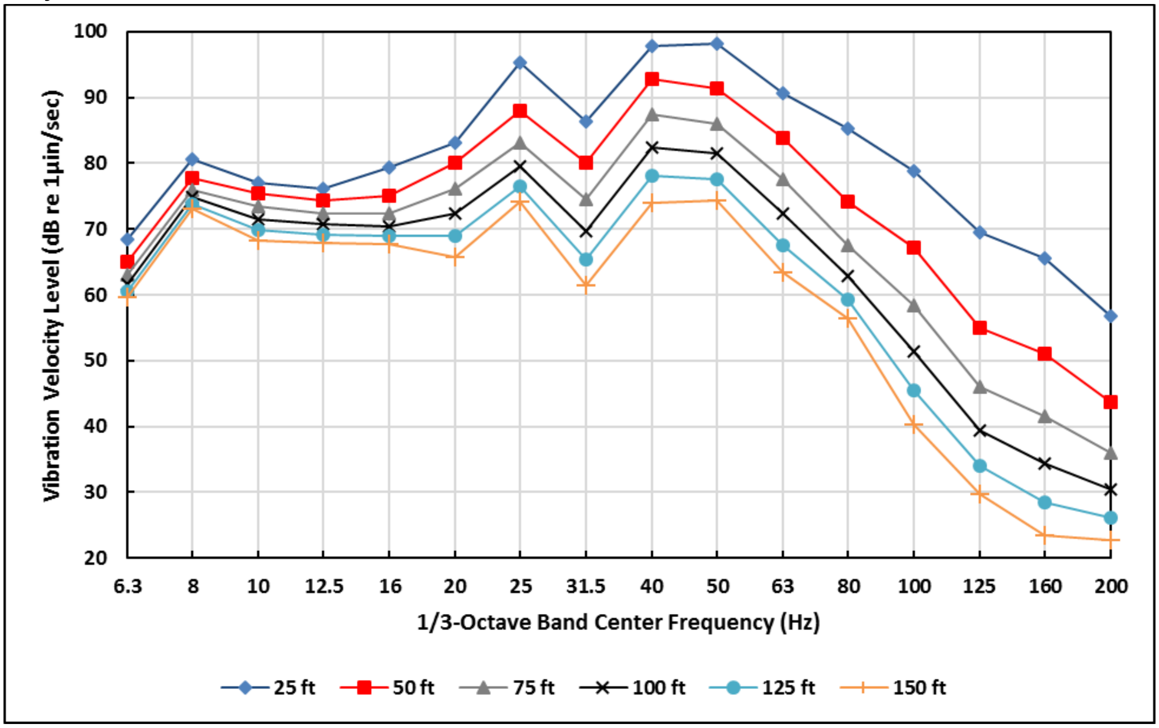
Coefficients	6.3 Hz	8 Hz	10 Hz	12.5 Hz	16 Hz	20 Hz	25 Hz	31.5 Hz	40 Hz	50 Hz	63 Hz	80 Hz	100 Hz	125 Hz	160 Hz	200 Hz
A	52.4	52.1	15.0	24.2	56.5	4.0	79.4	32.1	16.0	55.1	31.5	107.6	47.8	97.3	72.8	89.4
B	-11.2	-9.5	33.5	22.4	-9.1	66.7	-6.9	54.0	72.6	28.4	57.2	-37.2	32.0	-31.1	-7.5	-43.8
C	0.0	0.0	-12.5	-9.3	-1.6	-24.9	-5.7	-24.0	-28.8	-16.6	-25.8	0.0	-22.8	-5.6	-13.0	0.0

$$TM = A + B * \log(dist) + C * \log(dist)^2$$

Line Source Transfer Mobility – Site V-6



Projected HSR Ground Vibration Levels – Site V-6



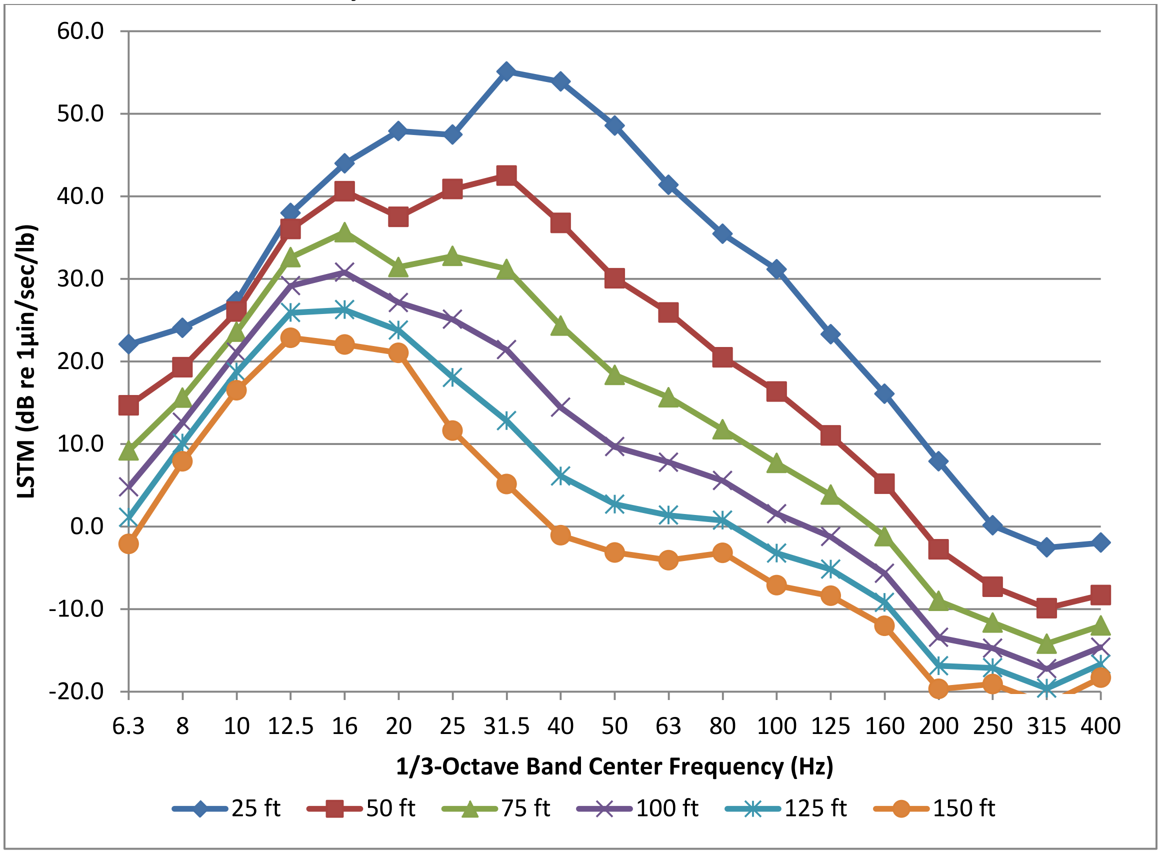
Site V-7

1/3-Octave Band Transfer Mobility Coefficients – Site V-7

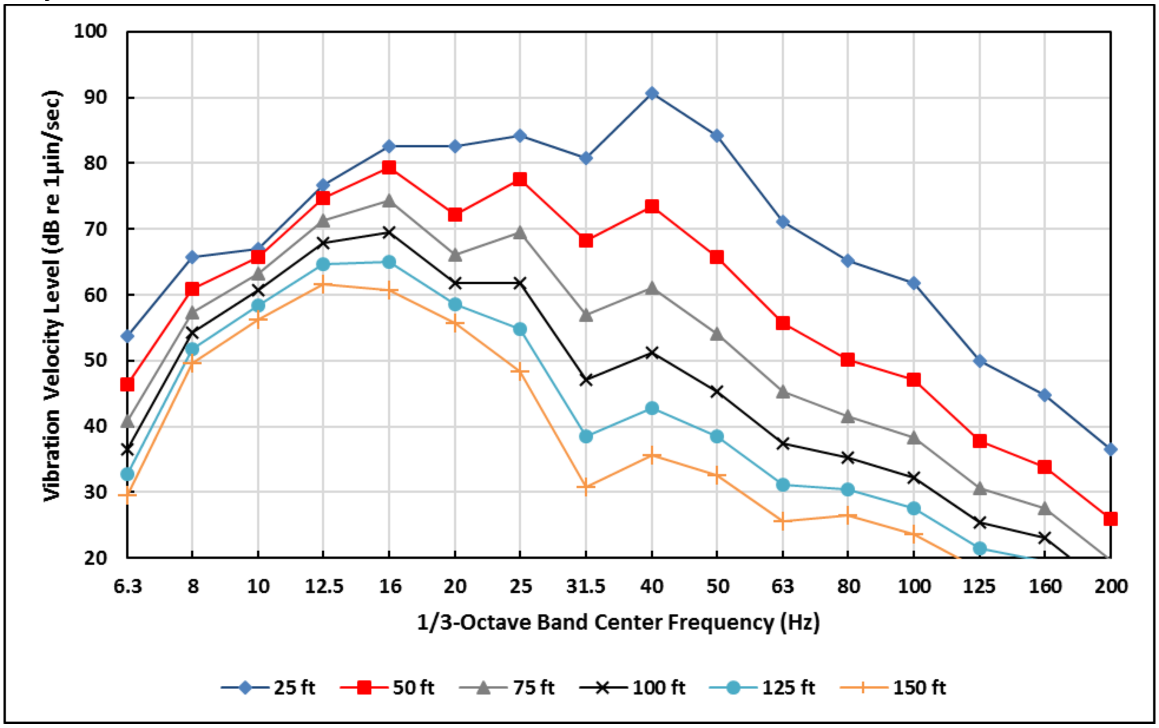
Coefficients	6.3 Hz	8 Hz	10 Hz	12.5 Hz	16 Hz	20 Hz	25 Hz	31.5 Hz	40 Hz	50 Hz	63 Hz	80 Hz	100 Hz	125 Hz	160 Hz	200 Hz
A	24.1	21.9	-14.7	-17.7	-25.4	96.1	-42.4	2.1	64.7	109.6	77.4	104.8	99.9	80.2	66.5	57.4
B	17.6	15.9	58.3	77.9	99.5	-34.5	135.1	103.6	32.7	-29.0	-4.9	-49.6	-49.2	-40.7	-36.1	-35.4
C	-13.6	-10.3	-20.2	-27.2	-35.7	0.0	-50.7	-46.9	-28.9	-10.5	-15.0	0.0	0.0	0.0	0.0	0.0

$$TM = A + B * \log(dist) + C * \log(dist)^2$$

Line Source Transfer Mobility – Site V-7



Projected HSR Ground Vibration Levels – Site V-7



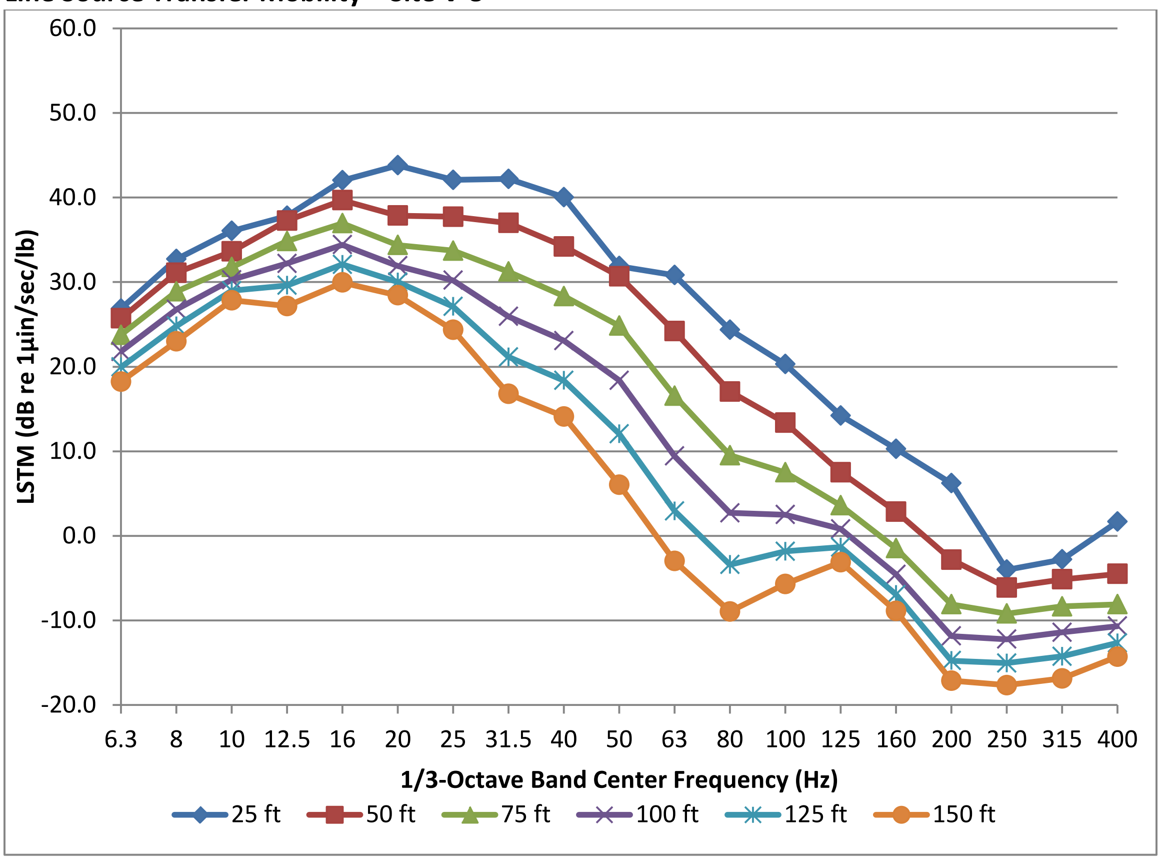
Site V-8

1/3-Octave Band Transfer Mobility Coefficients – Site V-8

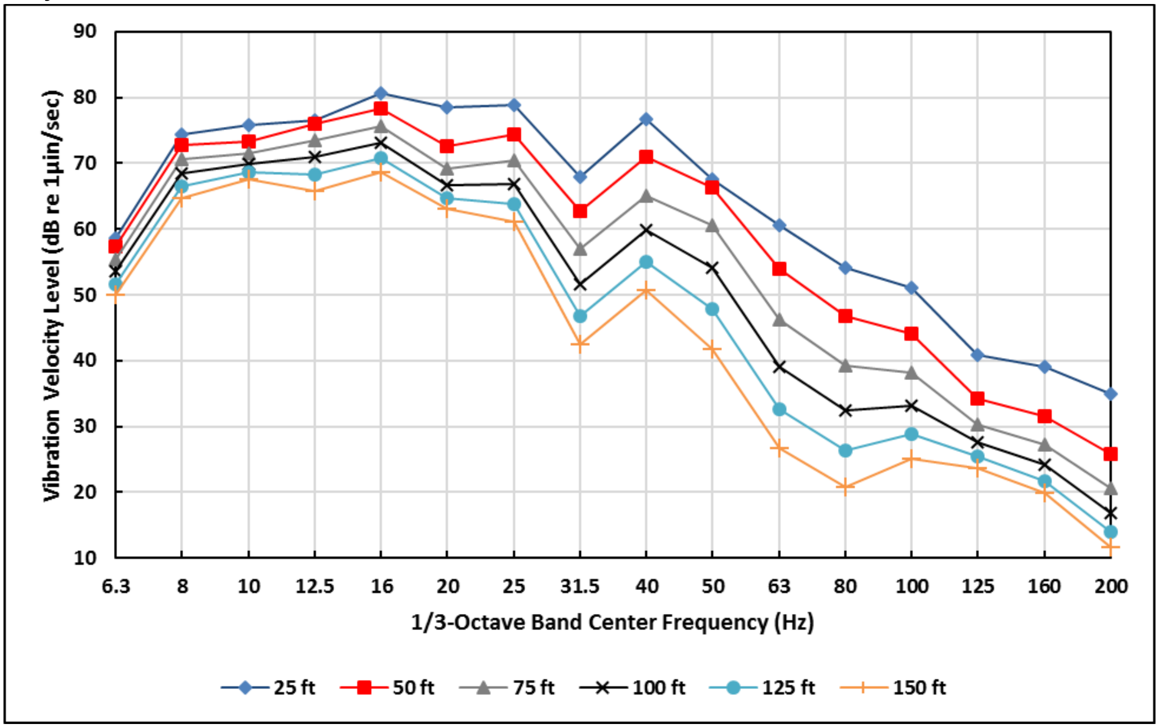
Coefficients	6.3 Hz	8 Hz	10 Hz	12.5 Hz	16 Hz	20 Hz	25 Hz	31.5 Hz	40 Hz	50 Hz	63 Hz	80 Hz	100 Hz	125 Hz	160 Hz	200 Hz
A	-4.1	4.6	34.9	-18.5	14.3	71.4	20.8	-10.1	-2.4	108.1	-45.2	-34.3	0.8	45.4	44.7	48.1
B	43.5	41.0	8.1	74.9	42.6	-19.7	39.7	82.5	71.3	185.8	117.2	96.4	44.4	-22.3	-24.7	-30.0
C	-15.3	-15.0	-5.2	-24.8	-16.2	0.0	-17.5	-32.2	-29.3	-61.3	-44.9	-39.0	-21.8	0.0	0.0	0.0

$$TM = A + B * \log(dist) + C * \log(dist)^2$$

Line Source Transfer Mobility – Site V-8



Projected HSR Ground Vibration Levels – Site V-8



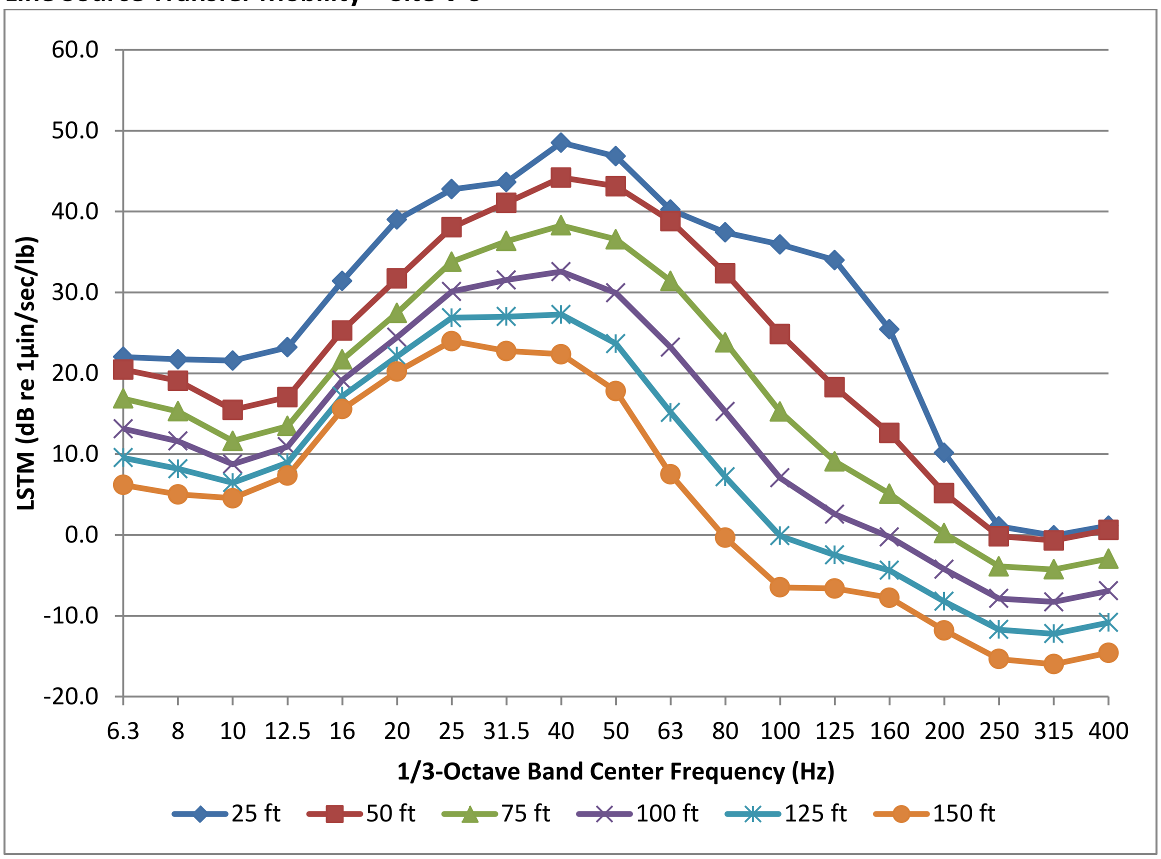
Site V-9

1/3-Octave Band Transfer Mobility Coefficients – Site V-9

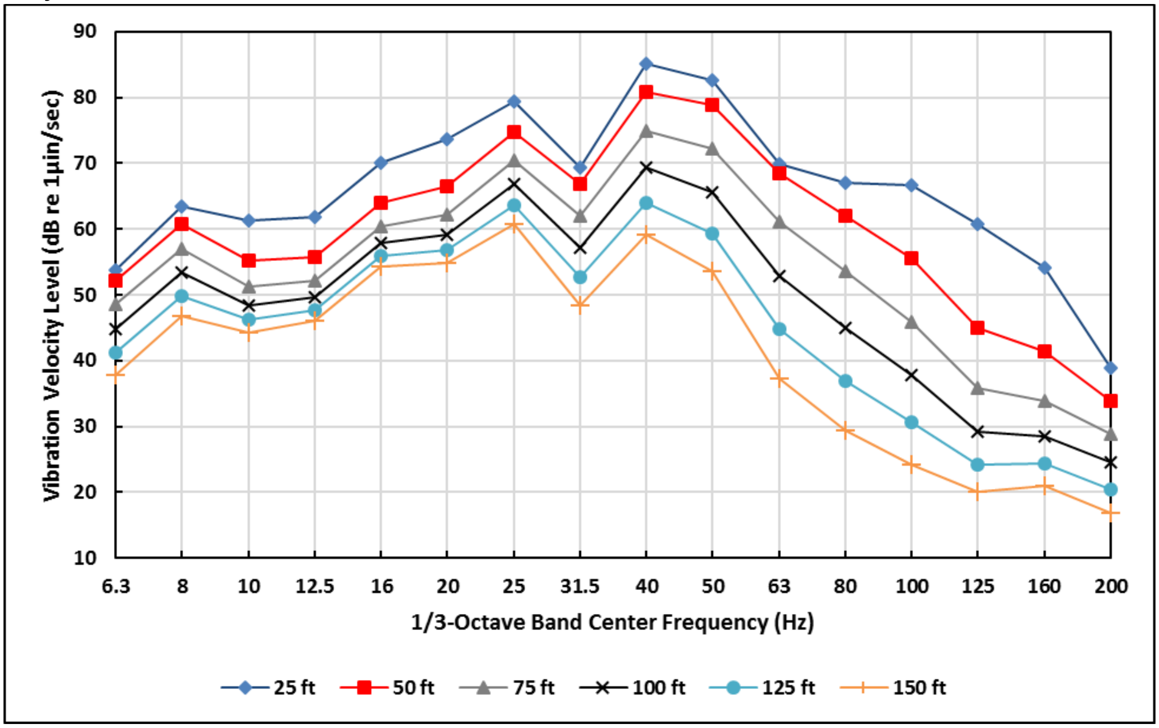
Coefficients	6.3 Hz	8 Hz	10 Hz	12.5 Hz	16 Hz	20 Hz	25 Hz	31.5 Hz	40 Hz	50 Hz	63 Hz	80 Hz	100 Hz	125 Hz	160 Hz	200 Hz
A	-46.1	-28.9	41.8	51.7	59.9	72.8	22.3	-35.3	-27.5	-60.1	139.3	-97.2	-0.6	106.9	85.1	-25.1
B	93.1	73.2	-9.7	-20.4	-20.4	-24.2	39.5	110.0	111.0	149.7	238.0	189.3	78.0	-52.2	-42.7	59.5
C	-31.8	-26.5	-3.4	0.0	0.0	0.0	-17.8	-38.3	-40.4	-52.3	-78.4	-66.5	-37.1	0.0	0.0	-24.5

$$TM = A + B * \log(dist) + C * \log(dist)^2$$

Line Source Transfer Mobility – Site V-9



Projected HSR Ground Vibration Levels – Site V-9



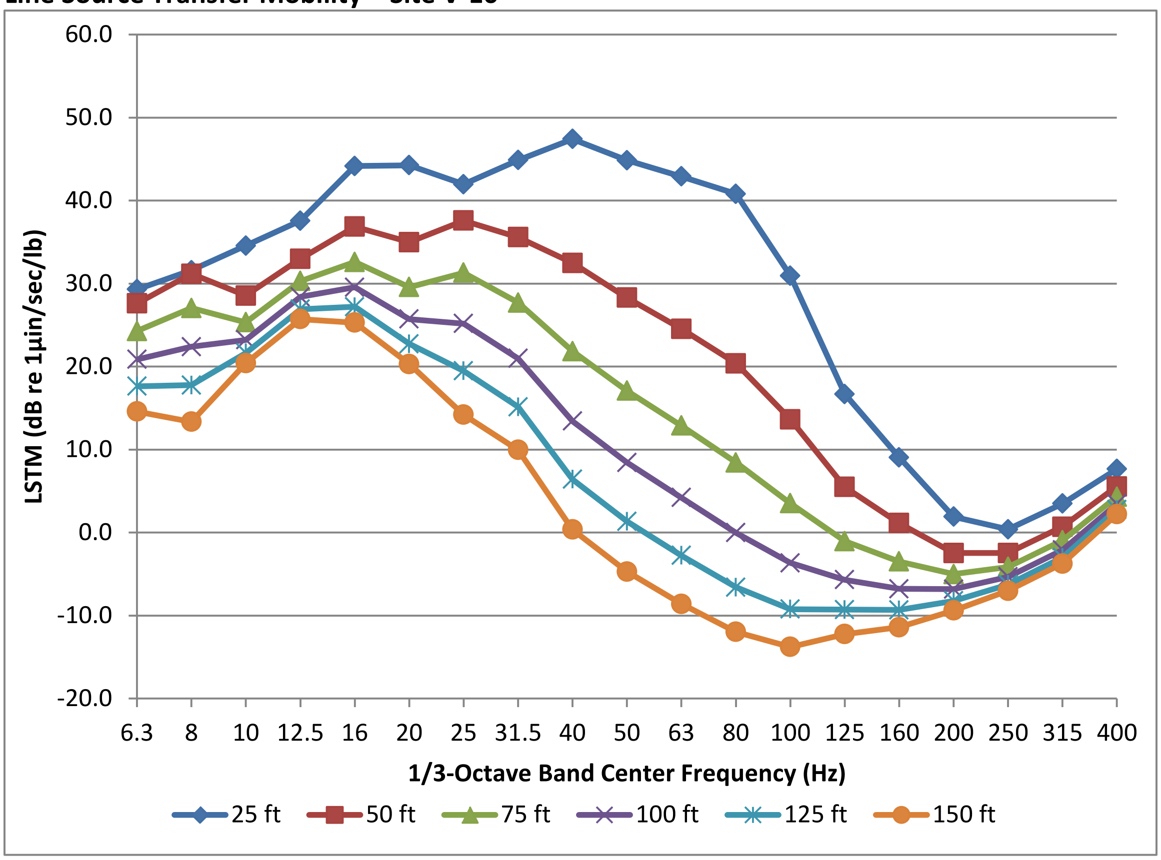
Site V-10

1/3-Octave Band Transfer Mobility Coefficients – Site V-10

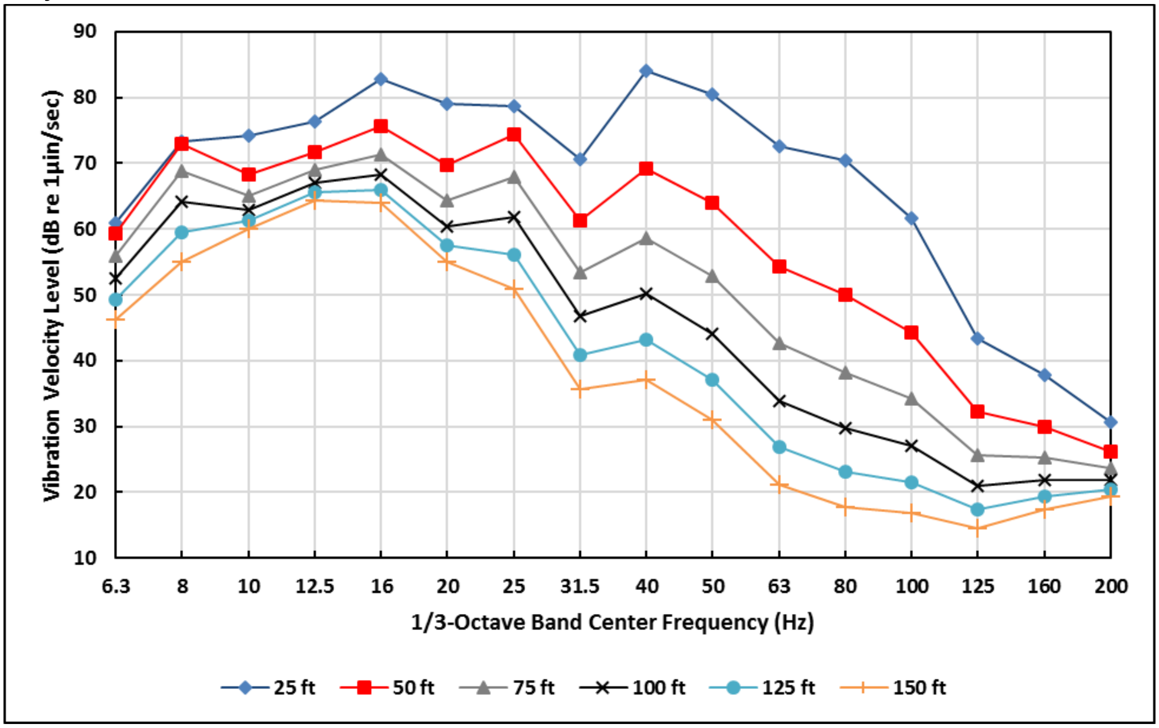
Coefficients	6.3 Hz	8 Hz	10 Hz	12.5 Hz	16 Hz	20 Hz	25 Hz	31.5 Hz	40 Hz	50 Hz	63 Hz	80 Hz	100 Hz	125 Hz	160 Hz	200 Hz
A	-29.1	-76.4	71.3	58.8	78.1	87.3	-43.1	17.9	62.5	78.4	102.5	135.6	111.3	68.6	45.8	22.2
B	80.8	142.0	-31.5	-15.2	-24.3	-30.8	122.9	60.4	21.1	1.5	-27.5	-67.8	-57.5	-37.1	-26.3	-14.5
C	-27.9	-46.3	3.7	0.0	0.0	0.0	-44.4	-29.5	-22.8	-18.2	-10.8	0.0	0.0	0.0	0.0	0.0

$$TM = A + B * \log(dist) + C * \log(dist)^2$$

Line Source Transfer Mobility – Site V-10



Projected HSR Ground Vibration Levels – Site V-10



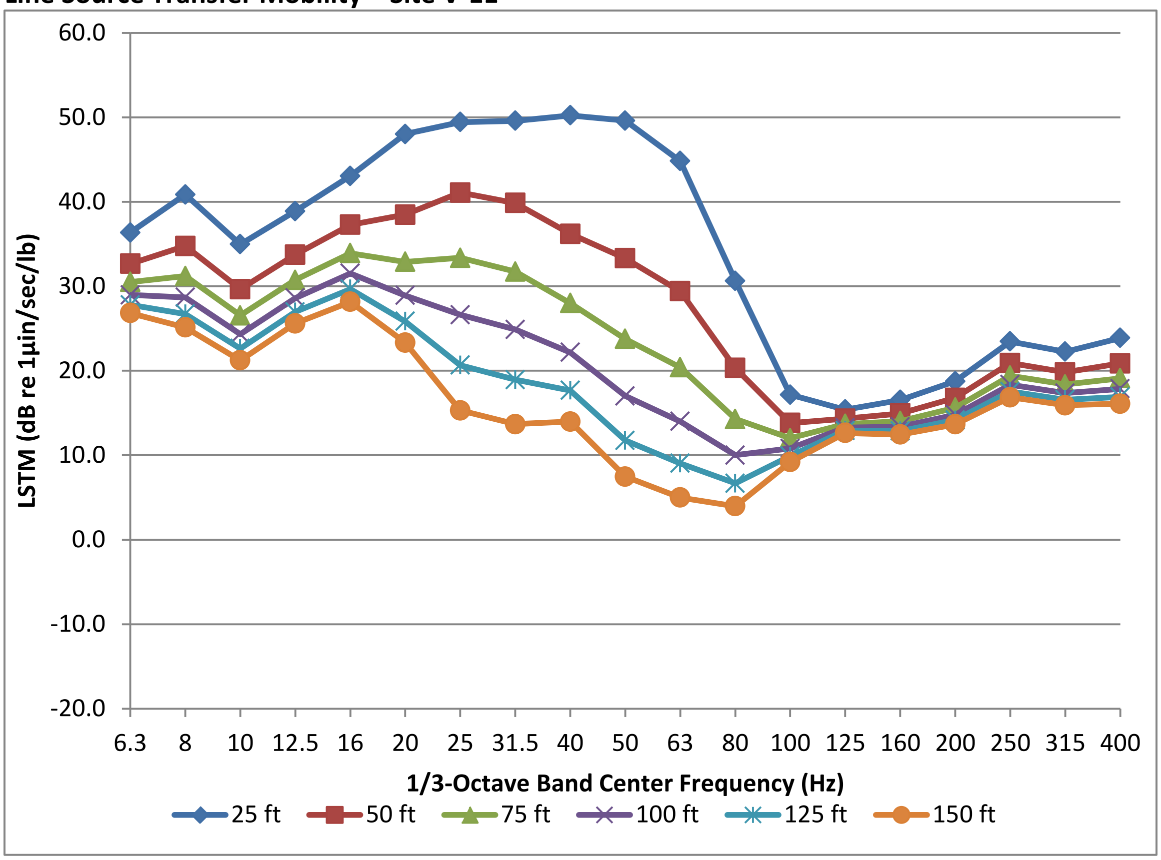
Site V-11

1/3-Octave Band Transfer Mobility Coefficients – Site V-11

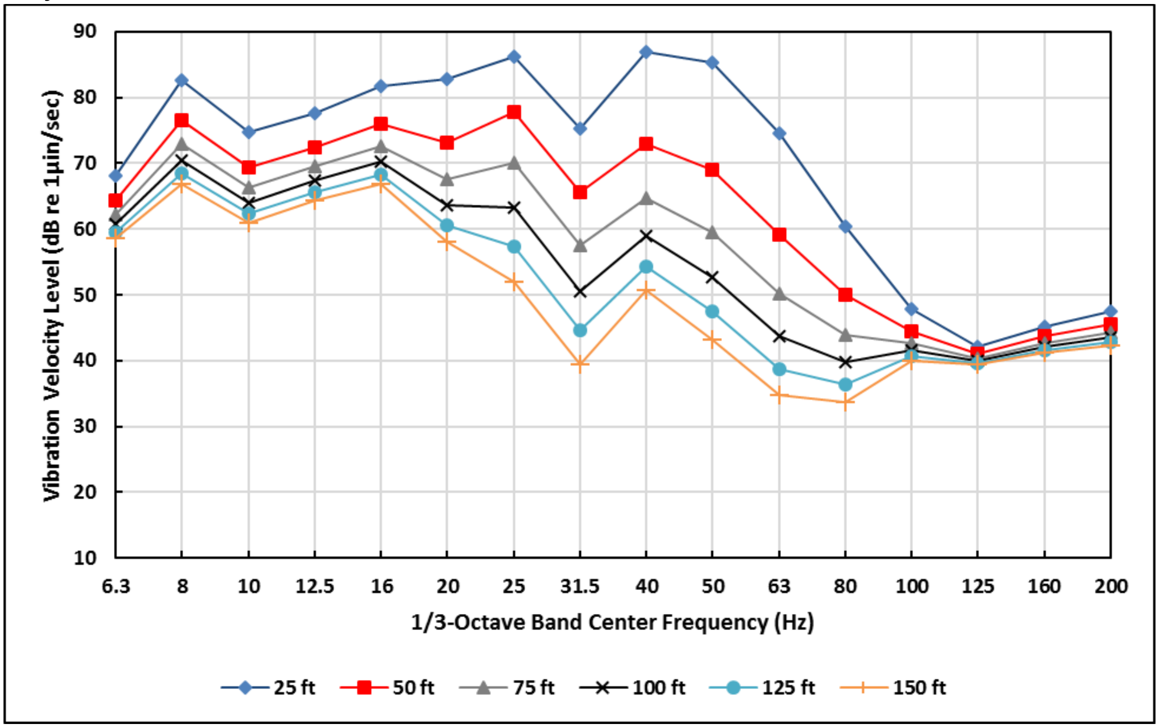
Coefficients	6.3 Hz	8 Hz	10 Hz	12.5 Hz	16 Hz	20 Hz	25 Hz	31.5 Hz	40 Hz	50 Hz	63 Hz	80 Hz	100 Hz	125 Hz	160 Hz	200 Hz
A	53.5	69.1	59.7	62.7	69.8	92.4	8.0	25.7	115.4	125.3	116.4	78.6	37.0	20.4	23.9	27.9
B	-12.2	-20.2	-17.7	-17.1	-19.1	-31.7	76.9	57.7	-46.6	-54.2	-51.2	-34.3	-16.7	-3.5	-5.3	-6.5
C	0.0	0.0	0.0	0.0	0.0	0.0	-33.8	-29.1	0.0	0.0	0.0	0.0	1.8	0.0	0.0	0.0

$$TM = A + B * \log(dist) + C * \log(dist)^2$$

Line Source Transfer Mobility – Site V-11



Projected HSR Ground Vibration Levels – Site V-11



AECOM

TECHNICAL MEMORANDUM
HAZARDOUS MATERIALS INITIAL SITE ASSESSMENT REPORT

To: Jerry Smiley, AICP, AECOM

From: Huda Shihada, AECOM

Date: November 1, 2017

RE: Dallas to Houston HSR – Hazmat Initial Site Assessment

This technical memorandum includes the following sections:

- Hazardous Materials Initial Site Assessment (ISA) Report
- Photographic Log

Hazardous Materials Initial Site Assessment (ISA) Report

TxDOT Environmental Affairs Division
Effective Date: 12/2014
510.02.DS
Version 3

Hazardous Materials Initial Site Assessment (ISA) Report

Completion of the ISA complies with the Federal Highway Administration's (FHWA's) policy dealing with hazardous materials discussed in FHWA's *Supplemental Hazardous Waste Guidance* (January 16, 1997) located at http://www.environment.fhwa.dot.gov/guidebook/vol1/doc7b.pdf.

This FHWA policy emphasizes three objectives: 1) the need to identify and assess potentially contaminated sites early in project development, 2) to coordinate early with federal/ state/ local agencies to assess the contamination and the cleanup needed; and 3) to determine and implement measures early to avoid or minimize involvement with substantially contaminated properties.

In addition, completion of the ISA will reduce construction delays that result from unexpected hazardous material discoveries and reduce the department's liability associated with the purchase of contaminated right of way.

Maintain a copy of the completed ISA report with all applicable attachments in the project administrative record.

For additional information, refer to TxDOT's online manual: *Hazardous Materials in Project Development:* http://onlinemanuals.txdot.gov/txdotmanuals/haz/index.htm

Abbreviations and Acronyms

ACM	Asbestos Containing Material
ASTs	Aboveground Storage Tanks
ASTM	American Society for Testing and Materials
CERCLIS	Comprehensive Environmental Response Compensation and Liability Information System
COG	Council of Government
ECOS	Environmental Compliance Oversight System
ERNS	Emergency Response Notification System
ESA	Environmental Site Assessment
IIR	Issues Identification and Resolution Form in ECOS
ISA	Initial Site Assessment
LPST	Leaking Petroleum Storage Tank
MSWLF	Municipal Solid Waste Landfill
NPL	National Priorities List
PST	Petroleum Storage Tank
RCRA	Resource Conservation and Recovery Act
ROW	Right of Way
RPST	Registered Petroleum Storage Tank
TCEQ	Texas Commission on Environmental Quality
TRC	Texas Railroad Commission
TSD	Treatment Storage and Disposal Facility
USGS	United States Geological Survey
UST	Underground Storage Tank
VCP	Voluntary Cleanup Program

TxDOT Hazardous Materials Initial Site Assessment (ISA) Report

Project Information			
CSJ No:N/A	City:Dallas to Houston	Zip Code:N/A	County:Dallas, Ellis, Navarro, Grimes, Leon, Madision, Waller, Harris, Limestone, and Freestone
HWY:Various Roads between Dallas and Houston Texas	Limits:Dallas to Houston Texas		

Section 1: Identify Previously Completed Environmental Site Assessments, Known Hazmat Conditions, Preliminary Project Design and Right-of-Way Requirements	
Yes/No	**Obtain information/comments from design, right of way, and/or environmental staff. Attach maps and/or details as appropriate.**
☐ Yes ☒ No	Has a Phase I Environmental Site Assessment (ESA) been prepared for this project? If one or more Phase I ESAs have been prepared for this project, please use applicable information from the Phase I ESA(s) to help complete the ISA.
☐ Yes ☒ No ☐ Unknown	Are there any previous environmental assessments, testing or studies performed within the proposed project area related to contamination issues? If yes, explain here if there are any concerns to the proposed project:
☐ Yes ☒ No	Are preliminary plans detailed enough to show excavation, ROW features, pipelines, utilities and storm sewer details? If no, explain here what information is limited or unavailable:

Section 2: Demolition and Renovation Information	
☒Yes ☐No	Are there proposed bridge or building demolition or renovation operations for this project?
If yes, describe the bridge or building locations, anticipated demolitions and/or renovations here:Assuming several instances where roads and structures associated with roads will need to be re-routed in order to complete construction	
If yes, record asbestos and/or lead-in-paint concerns or testing needs on an IIR form in ECOS. Detailed instructions for completing an ECOS IIR Form are located in the Non-Project Documentation section of ECOS under the heading Hazmat. Contact the ECOS help desk for assistance preparing the IIR Form, if necessary.	
Note: ACM inspections are required for all bridge and building renovation and demolition projects. Refer to the guidance found at TxDOT's *Environmental Compliance Toolkit* web page for additional information. **Note:** Contact ENV-HMM staff for assistance with lead-in-paint issues.	

Section 3: Identify Project Activities	
3.1 Yes/No	**Using the preliminary design and ROW information for this project, determine if the project includes any of the activities listed below.**
☒ Yes ☐ No	**Project Excavations:** Will the work consist of substantial excavation operations. Substantial excavation includes, but is not necessarily limited to: • Underpass construction, • Storm sewer installations, • Trenching or tunneling that would require temporary or permanent shoring.
☐ Yes ☒ No	**Dewatering:** Are there proposed de-watering operations. If yes, what is the estimated depth to groundwater?

☒ Yes ☐ No	**Utility Adjustments:** Are there proposed pipeline and underground utility installation or adjustments?
☒ Yes ☐ No	**Encroachments:** Are there known or potential encroachments into the project area? Encroachments include soil and groundwater contamination, dump sites, tanks, and other issues in the ROW.
☒ Yes ☐ No	**ROW and Easements:** Are there any acquisitions of new ROW, easements, temporary construction easements planned for the project?

3.2 Complete the appropriate box below:

☒ If Section 3.1 contains any "Yes" answers, please proceed to Section 4.

☐ If Section 3.1 contains all "No" answers, proceed to Section 6, Site Survey. Please perform a site survey documenting the results in Section 6 and then mark the appropriate box below. If a Phase I ESA has been prepared for this project, you may use the applicable site survey information from the Phase I ESA.

☐ The site survey did not identify evidence of any environmental concerns listed in Section 6. The ISA is complete. Complete section 10 and maintain a copy of the ISA and all applicable attachments in the administrative record.

☐ The site survey identified evidence of environmental concerns listed in Section 6. Continue with Section 4.

Section 4: Current and Past Land Use Information

Reviewed?	Review and assess current and past land use (up to 50 years) in the project area.		
	Review and assess current and past land use (up to 50 years) in the project area. Document and attach sources that were reviewed. If one or more Phase I ESAs were prepared for this project, please use applicable information from the Phase I ESAs to help complete this section of the ISA.		
☒Yes ☐ No ☐ Not Available ☐ Not Applicable	**4.1 Review Current and if possible Past USGS 7.5 Minute Topographic Maps of the project area:** Look for oil & gas pipelines, tanks, landfills or other industrial features. Describe any concerns:Observed on the 1970 Satsuma topo map was a location that used to be a tank farm area. The 1970 Hedwig Village topo showed an area that used to be a sewage disposal pond, and the 1967 Houston Heights topo displayed an area that was a pond in past years.		
	List Topo Maps Reviewed:	Dates:	Comments:
	All available 7.5 minute, 15 minute, and 30 minute maps that were available and not duplications.	Various years through 1891-2013	The time frame listed for topographic coverage does not include a complete coverage of the entire project area for any given year. Coverage was obtained for areas for years available.
☒Yes ☐ No ☐ Not Available ☐ Not Applicable	**4.2 Review Current Aerial Photographs and if possible Past Aerial Photographs of the project area:** Look for oil & gas pipelines, tanks, landfills or other industrial features. Describe any concerns:Aerials displayed areas where former manufacturing site were located that are no longer there or now inactive including a tank farm, metal processsing site, and other non-identifiable manufacturing facilties. Also observed serveral medium sized ponds located in the Houston area in 1971.		
	List All Aerial Photos Reviewed:	Photo Dates:	Comments:

Section 4: Current and Past Land Use Information			
Reviewed?	**Review and assess current and past land use (up to 50 years) in the project area. Document and attach sources that were reviewed.** If one or more Phase I ESAs were prepared for this project, please use applicable information from the Phase I ESAs to help complete this section of the ISA.		
	Obtainable Aerials from EDR	1938, 1939, 1942, 1944, 1952, 1953, 1960, 1961, 1962, 1963, 1964, 1965, 1968, 1972, 1973, 1977, 1978, 1981, 1982, 1983, 1989, 1996, 2004, and 2014	The years listed do not represent an entire coverage of the project area for each year listed.
☐Yes ☒ No ☐ Not Available ☐ Not Applicable	**4.3 Review Current and Past Right-of-Way Maps/Files:** Look for oil & gas pipelines, tanks, landfills, or other industrial features. Describe any concerns:		
	List Maps/ Files & Dates Reviewed:	Comments:	
☒Yes ☐ No ☐ Not Available ☐ Not Applicable	**4.4 Review Sanborn Fire Insurance Maps/Files:** Look for tanks, oil & gas pipelines, landfills, or other industrial features. Describe any concerns:Concerns with certain types of industriess adjacent or in the LOD are Mosher Manufacturing Co-Foundry and Machine Shpo, Trinity Cotton Oil Company, Dallas Cotton Mills, Armstrong Packing Company, Guiberson Corporation Manufacture of Oil, City of Dallas Garbage and Incenerator, Texas Pipeline Company, Brown Brick Compnay, Proctor and Gamble Company Vegetable Oil Refinery and Soap Factory.		
	List Maps/ Files & Dates Reviewed:	Comments:	
	Dallas Maps from 1921 and 1922		
☐Yes ☒ No ☐ Not Available ☐ Not Applicable	**4.5 Review TxDOT As-Built Plans:** Any concerns identified during previous work within the project limits? If yes, explain: If known, what is the previous Project CSJ:		
☐Yes ☒ No ☐ Not Available ☐ Not Applicable	**4.6 Review TxDOT Geotechnical Soil Boring Logs:** Any concerns noted on the boring logs such as unusual odors, visible contamination, trash, waste or debris? If yes explain:		
☐Yes ☒ No ☐ Not Available ☐ Not Applicable	**4.7 Review TxDOT Temporary Use ROW Agreements (permits issued by the district to entities to occupy a portion of the ROW):** Any concerns such as monitor wells or treatment systems within the ROW? If yes, explain:		
☐Yes ☒ No ☐ Not Available ☐ Not Applicable	**4.8 Review Notifications of Contamination to TxDOT** (These are typically letters from TCEQ or third parties explaining the presence of contamination on TxDOT ROW): Any concerns regarding contamination of ROW from off-site sources? If yes, explain:		

Section 5: Complete a Regulatory Records Review (Database Search)

Note: The purpose of the database search is to obtain and review standard sources of environmental information from government agency records that will help identify potential hazardous material issues within the project limits and surrounding properties. A list of standard databases of environmental information from government agency records is included in Section5.1.

To enhance and supplement the standard sources of environmental information, other information such as local records and/or additional state records should be reviewed when, in the judgment of the environmental professional, such additional records are (1) reasonably ascertainable, and (2) are sufficiently useful, accurate, and complete in light of the objective of the regulatory records review.

Standard database source information or other record information from government agencies may be obtained directly from appropriate government agencies or from commercial services.

If one or more Phase I ESAs were prepared for this project, please use applicable information from the Phase I ESAs to help complete this section of the ISA.

Mark the appropriate box below:

☐ A Database search was conducted through a contracted service. Indicate in Section 5.1, and if applicable, Section 5.2, the regulatory records searched and make any comments if potential environmental concerns are identified. A complete copy of the database search findings (contractor's report deliverable) should be maintained in the project administrative record with the ISA.

☒ A Database search was conducted in-house. Include in Section 5.1 the regulatory records searched and make any comments if potential environmental concerns are identified. For in-house database searches, not all databases need to be reviewed for each project, but at a minimum the databases listed in Section 5.1 marked in bold with a star must be reviewed. Include database records that list potential issues in the project administrative record with the ISA. It is not necessary to include records of negative findings in the project administrative record.

Most state and federal databases are located at the following websites:
Federal EPA databases link: http://www.epa.gov/enviro/.
Texas TCEQ databases link: http://www15.tceq.texas.gov/crpub/

Section 5.1 Standard Database Sources of Environmental Information from Government Agency Records

Regulatory Record	Reviewed	Recommended Minimum Search Distance from Project Limits (miles)	Comment Field: Provide any comments related to potential issues discovered within the database.
NPL list*	☒ Yes	1.0	See Table 3.5-2 in Section 3.5 of EIS
Federal Delisted *NPL* list*	☒ Yes	0.5	No findings have been identified within one mile of the Project Area
Federal CERCLIS list*	☒ Yes	0.5	See Table 3.5-2 in Section 3.5 of EIS.
Federal CERCLIS No Further Remedial Action Planned (NFRAP) site list*	☒ Yes	0.5	See Table 3.5-2 in Section 3.5 of EIS.
Federal RCRA Corrective Action (CORRACTS) list	☐ Yes ☒ No	1.0	
Federal RCRA non-CORRACTS Treatment Storage Disposal (TSD) facilities list	☐ Yes ☒ No	0.5	

Federal Institutional Controls/ Engineering Controls Registry http://www.epa.gov/ictssw07/public/export/regionalReport/REGION6.HTM	☐ Yes ☒ No	0.5	
Federal RCRA generators	☒ Yes ☐ No	*property* and *adjoining properties*	See Table 3.5-2 in Section 3.5 of EIS.
Federal ERNS	☐ Yes ☒ No	*property* only	
TCEQ Industrial Hazardous Waste (IHW) Corrective Action sites*	☒ Yes ☐ No	1.0	See Table 3.5-2 in Section 3.5 of EIS.
TCEQ Superfund sites*	☒ Yes	1.0	No findings have been identified within one mile of the Project Area
Closed and abandoned municipal solid waste landfill sites* **http://www.tceq.texas.gov/permitting/waste_permits/msw_permits/msw-data**	☒ Yes	0.5	See Table 3.5-2 in Section 3.5 of EIS.
TCEQ leaking petroleum storage tank remediation lists (LPST)*	☒ Yes	0.5	See Table 3.5-2 in Section 3.5 of EIS.
TCEQ registered petroleum storage tank lists (PST)*	☒ Yes	*property* and *adjoining properties*	See Table 3.5-2 in Section 3.5 of EIS.
TCEQ voluntary cleanup program (VCP) sites*	☒ Yes	0.5	See Table 3.5-2 in Section 3.5 of EIS.
TCEQ Innocent Owner/ Operator (IOP) sites	☒ Yes ☐ No	0.5	See Table 3.5-2 in Section 3.5 of EIS.
TCEQ Dry Cleaners Remediation Database*	☒ Yes ☐ No	0.5	No findings have been identified within one mile of the Project Area
TCEQ Brownfields Database	☒ Yes ☐ No	0.5	See Table 3.5-2 in Section 3.5 of EIS.
Texas Railroad Commission VCP sites* http://www.rrc.state.tx.us/oil-gas/environmental-cleanup-programs/site-remediation/voluntary-cleanup-program/	☒ Yes	0.5	No findings have been identified within one mile of the Project Area

Section 5.2 List below other records reviewed such as local records and/or additional state records	
Record source	Environmental Concerns (If Yes describe)
TCEQ Central File Registry	☒ YesSee Table 3.5-2 in Section 3.5 of EIS describing possible hazardous materials and waste sites located in or adjacent to the project area. ☐ No
EPA Envirofacts website	☒ YesSee Table 3.5-2 in Section 3.5 of EIS describing possible hazardous materials and waste sites located in or adjacent to the project area. ☐ No

Section 6: Complete a Project Site Survey

Note: Document site survey and findings. Describe location, size of concern. Attach site maps and photographs as appropriate. If a Phase I ESA has been prepared for this project, you may use the applicable site survey information from the Phase I ESA.

Site Survey Date(s):1/18 through 1/29 2016

6.1 Current Land Use Type:

☒ Undeveloped to light commercial (agricultural, residential, offices, retail, light commercial).

☒ Developed/commercial (automotive repair, gas stations, manufacturing, dry cleaners, military base, waste collection and handling facilities, other industrial sites).

Describe: Areas in and surrounding the project area consist of a variety activities including, undeveloped, gas stations, oil/gas facilities, quarry, industrial, and commercial

Evidence? (Yes/No)	6.2 Specific Concerns Identified (as necessary provide a description for each "Yes" checked).
☒Yes ☐No	• underground storage tanks.
☐Yes ☒No	• vent pipes, fill pipes, or access ways indicating a fill pipe protruding from the ground.
☒Yes ☐No	• aboveground storage tanks.
☐Yes ☒No	• electrical and transformer equipment storage or evidence of release.
☐Yes ☒No	• injection wells, cisterns, sumps, dry wells. Added information may be attained from the oil/gas section of the DEIS
☒Yes ☐No	• groundwater monitoring wells and/or groundwater treatment systems. located at active LPST sites
☐Yes ☒No	• flooring, drains, or walls stained by substances other than water or emitting foul odors.
☒Yes ☐No	• vats, 55-gallon drums (labeled/unlabeled), canisters, barrels, bottles, etc.
☒Yes ☐No	• stockpiling, storage of material.
☐Yes ☒No	• evidence of liquid spills.
☒Yes ☐No	• surface dumping of trash, garbage, refuse, rubbish, debris half exposed/buried, etc. Witness several areas where dumping was being done along the ROW or adjacent to the ROW
☐Yes ☒No	• damaged or discarded automotive or industrial batteries.
☐Yes ☒No	• stained, discolored, barren, exposed or foreign (fill) soil.
☐Yes ☒No	• dead, damaged or stressed vegetation.
☐Yes ☒No	• oil sheen or films on surface water, seeps, lagoons, ponds, or drainage basins.
☐Yes ☒No	• pits, ponds, or lagoons associated with waste treatment or waste disposal.
☐Yes ☒No	• changes in drainage patterns from possible fill areas.
☒Yes ☐No	• security fencing, protected areas, placards, warning signs.
☐Yes ☒No	• dead animals (fish, birds, etc.) possibly due to contamination.
☐Yes ☒No	• other concerns.

6.3 Describe adjoining properties and any visible hazardous material concerns. List adjacent businesses, factories, abandoned sites, etc. that may be the source of hazardous materials concerns. A variety of commercial, industrial, and manufacturing facilities exists along the route adjacent to the project area. Examples would be gas stations, quarries, oil/gas facilities, auto repair, etc.

6.4 Describe Concerns Observed in the Site Survey. Indicate whether the concern is associated with existing ROW, proposed ROW acquisition or easements. As necessary, provide additional information about the evidence identified; include photographs as an attachment to the ISA. Several locations are inactive/vacant facilities that were identified in one or more of the databases reviewed for contmination or are existing facilities that deal with hazadous materials and wastes. Several facilties are located inside the LOD or directly adjacent to the LOD.

Section 7: Interviews		
Section 7.1 Were interviews conducted? ☐Yes ☒No Possible interviewees include: local residents, TxDOT staff, fire department personnel, city or county department of health/environmental staff; city or county planning staff; TCEQ staff; TRC staff; current and former property owners or operators. If one or more Phase I ESAs were prepared for this project, please use applicable interview information from the Phase I ESAs to help complete this section of the ISA.		
Section 7.2 Interview Summary: Complete this section if interviews were conducted. Add additional rows as needed. Attach record of communications to the ISA.		
Name:	Title:	Date:
Describe any potential concerns:		
Name:	Title:	Date:
Describe any potential concerns:		
Name:	Title:	Date:
Describe any potential concerns:		

Section 8: Identified Hazardous Material Concerns
On the list below, indicate Yes or No whether the hazardous material concern was identified. If Yes, record the hazardous material concern on an Issues Identification and Resolution (IIR) Form in ECOS. If the ISA preparer is unsure how to complete the IIR Form, the responsibility to complete the Hazmat IIR may be assigned within ECOS to ENV Hazmat Staff. *Detailed instructions for completing an ECOS IIR Form are located in the Non-Project Documentation section of ECOS under the heading Hazmat. Contact the ECOS help desk for assistance preparing the IIR Form if necessary.* Hazardous materials concerns identified below will require additional assessment work. In most cases, resolution to the concerns should be completed prior to project letting. For additional information regarding scheduling considerations, internal/external coordination and recommended practices for resolving hazmat issues please refer to TxDOT's *Environmental Tool Kit* web site. Contact ENV Pollution Prevention and Abatement (PPA) for additional assistance.

8.1 Identify the Hazardous Material Concerns		
Concern Identified?	**Type of Concern** Record the hazardous material concerns on an Issues Identification and Resolution (IIR) Form in ECOS.	
☒**Yes** ☐**No** ☐**NA**	**Current or Past Land Use Concern:** This concern is associated with hazardous material issues identified in Section 4. Note: *On the ECOS IIR, the Available Contaminated Media would be "Other".*	
	☒Yes ☐No	One or more concerns identified in Section 4.
	☐Yes ☒No	No obvious concerns were identified but additional research is needed as a result of unique or unusual current or past land use. Request additional assistance from ENV.
☒**Yes** ☐**No**	**Site Visit Concerns:** This is associated with any hazardous material issues discovered following the completion of Section 6. On the *ECOS* IIR, the Available Contaminated Media would be "Other".	
	☒Yes ☐No	One or more concerns identified.
	☐Yes ☒No	No listed concerns identified but additional research is needed as a result of unique or

8.1 Identify the Hazardous Material Concerns		
Concern Identified?	**Type of Concern** Record the hazardous material concerns on an Issues Identification and Resolution (IIR) Form in ECOS.	
		unusual project site conditions. Request assistance from ENV.
☐**Yes** ☐**No** ☒**NA**	**Interview Concerns:** This concern is associated with any hazardous material issues discovered during an interview listed in Section 7. In the IIR, the Available Contaminated Media would be "Other".	
	☐Yes ☐No	One or more concerns identified after completing interviews.
	☐Yes ☐No	No listed concerns identified but additional research is needed as a result of unique or unusual project site conditions. Request assistance from ENV.
☒**Yes** ☐**No**	**Asbestos and/or Lead in Paint Concerns:** The following are related to ACM and LBP identified in Section 2. Select below all that apply.	
	☐Yes ☒No	Bridge Demolition/ Renovation without Steel Structures
	☐Yes ☒No	Bridge Demolition/ Renovation with Steel Structures
	☒Yes ☐No	ROW Structure(s) Demolition
	☐Yes ☐No	Enhancement Project Demolition/Renovation
	☐Yes ☐No	Other- Describe
☒**Yes** ☐**No**	**Petroleum Storage Tank Concerns:** PSTs can be any underground or aboveground storage tanks that are used to store petroleum based fluids. Typically, these are gasoline and diesel refueling facilities. Select below all that apply.	
	☒Yes ☐No	ROW acquisition or partial acquisition of a parcel with one or more PSTs.
	☐Yes ☒No	Other- Describe:
☒**Yes** ☐**No**	**Leaking Petroleum Storage Tank (LPST) Concerns:** An LPST parcel will only need to be identified once in the following list. LPST sites are PSTs that have caused or suspected to have caused a release to the environment.	
	☐Yes ☒No	Additional Research is needed or uncertain of impacts from an LPST. Request assistance from ENV.
	☒Yes ☐No	Acquisition of a Parcel with an LPST.
	☒Yes ☐No	An LPST is located within 0.25 miles of the project.
	☐Yes ☒No	Other- Describe

☒Yes ☐No	**Oil and Gas Production Activity Concerns**: TxDOT is concerned with the acquisition of oil and gas production wells (and ancillary equipment). Typically, these are oil/gas wells, piping, ancillary production equipment, pipelines, etc. Select below all that apply.	
	☒Yes ☐No	Additional Research needed or uncertain of impacts. Request assistance from ENV.
	☐Yes ☒No	Database search identified TRC VCP Site within 0.5 miles of project.
	☒Yes ☐No	Oil/ Gas Wells within future ROW.
	☒Yes ☐No	Pipelines requiring adjustment.
	☒Yes ☐No	Other- Describe:
☒Yes ☐No	**Non-LPST Source Contamination Concerns**: These parcels or locations have a potential for soil and/or groundwater contamination. Typically, they are contaminated locations (even potentially contaminated locations) that are not associated with LPST sites. Select below all that apply.	
	☐Yes ☒No	Additional Research is needed or uncertain of impacts from a Non-LPST site. Request assistance from ENV.
	☐Yes ☒No	Database search identified a CERCLA NPL(s) site within 1 mile of project.
	☒Yes ☐No	Database search identified CERCLA (to include NFRAP) within 0.5 miles of project.
	☐Yes ☒No	Database search identified RCRA Corrective Action(s) site within 1 mile of project.
	☐Yes ☒No	Database search identified RCRA TSD Facilities within 0.5 miles of project.
	☒Yes ☐No	Database search identified TCEQ IHW Corrective Action Sites within 1 mile.
	☐Yes ☒No	Database search identified TCEQ Superfund Sites within 1 mile of project.
	☒Yes ☐No	Database search identified TCEQ VCP Sites within 0.5 miles of project.
	☒Yes ☐No	Database search identified TCEQ IOP Sites within 0.5 miles of project.
	☐Yes ☒No	Other- Describe:
☒Yes ☐No	**Landfills/ Waste Pits/ Dump Site Concerns:** This is associated with any known or unknown (based on visual observations) landfills, dump sites, or waste pits. Typically, the local Council of Governments (COG) should maintain a list of all closed and open landfills in your project area. Select below all that apply.	
	☐Yes ☒No	Additional research is needed or uncertain of impacts. Request assistance from ENV.
	☒Yes ☐No	Database search identified active/closed/abandoned MSW landfill sites within .5 miles of the project.
	☐Yes ☒No	Other- Describe

8.2 Did the ISA identify any potential Hazardous material concerns?

☐ No hazardous materials concerns were identified as a result of the ISA performed for the proposed action. No further hazardous materials action is required. The ISA is complete for this project. Any unanticipated hazardous materials impacts encountered during the project construction phase will be addressed in accordance with regulatory requirements. No further assessment is required. Complete Sections 9 and 10 and maintain a copy of the ISA and all applicable attachments in the project administrative record.

☒ Yes, the ISA identified one or more hazardous materials concerns for this project. An IIR form has been completed in ECOS. Complete Sections 9 and 10 and maintain a copy of the ISA and all applicable attachments in the project administrative record.

Section 9: Reference Materials Utilized (Identify any referenced materials attached to this ISA)			
Referenced Materials Used	☐ Project Map	☐ USGS Topo Maps	☐ Aerial Photographs
	☐ ROW Maps/Files	☐ Sanborn Fire Insurance Maps	☐ Temporary Use Agreements
	☐ TxDOT As-Built Plans	☐ Notifications	☒ Photographs
	☐ Record of Communications	☐ Regulatory Database	☐ Record of Interviews
	☒ Other:Table 3.5-2 in Section 3.5 of EIS describing possible hazardous materials and waste sites located within the study area.		

Section 10: Contact/Completed by		
Name:	Josh Orr	**Tel: 512-571-8662**
Title:	Environmental Scientist	
Firm (District Section):	AECOM	
Address:	9400 Amberglen Blvd. Austin, TX 78729	
Signature:		**Date:6/14/2016**

Appendix A

The following table shows the revision history for this guidance document.

Revision History	
Effective Date Month, Year	**Reason for and Description of Change**
4/2014	Version 1 released in May 2014.
8/2014	Version 2 released in August 2014. Removed introductory note describing ISA threshold criteria. Note was removed because the ISA threshold criteria are located in other TxDOT guidance.
12/2014	Version 3 released in December 2014. Modifications to Section 2: Clarified this section to better define what asbestos and lead-in-paint concerns are. Changes were made due to numerous comments from the end-user. An additional note was added to this section. This note directs end-users to ENV-HMM for further assistance related to lead-in-paint issues. Modifications to Section 3: The question concerning Project Excavations in Section 3.1 was modified to match the definition used in *Scoping Procedure for Categorically Excluded TxDOT Projects* for Hazardous Materials found in the NEPA and Project Development Toolkit. Modifications to Section 5: Web links were modified based on changes made by regulatory agency websites. Modifications to 8.2: Clarified the “Yes” answer in 8.2 to remove the need for additional assessments for all identified hazardous materials concerns. The question was modified due to comments by the end-user.

Attachment 1

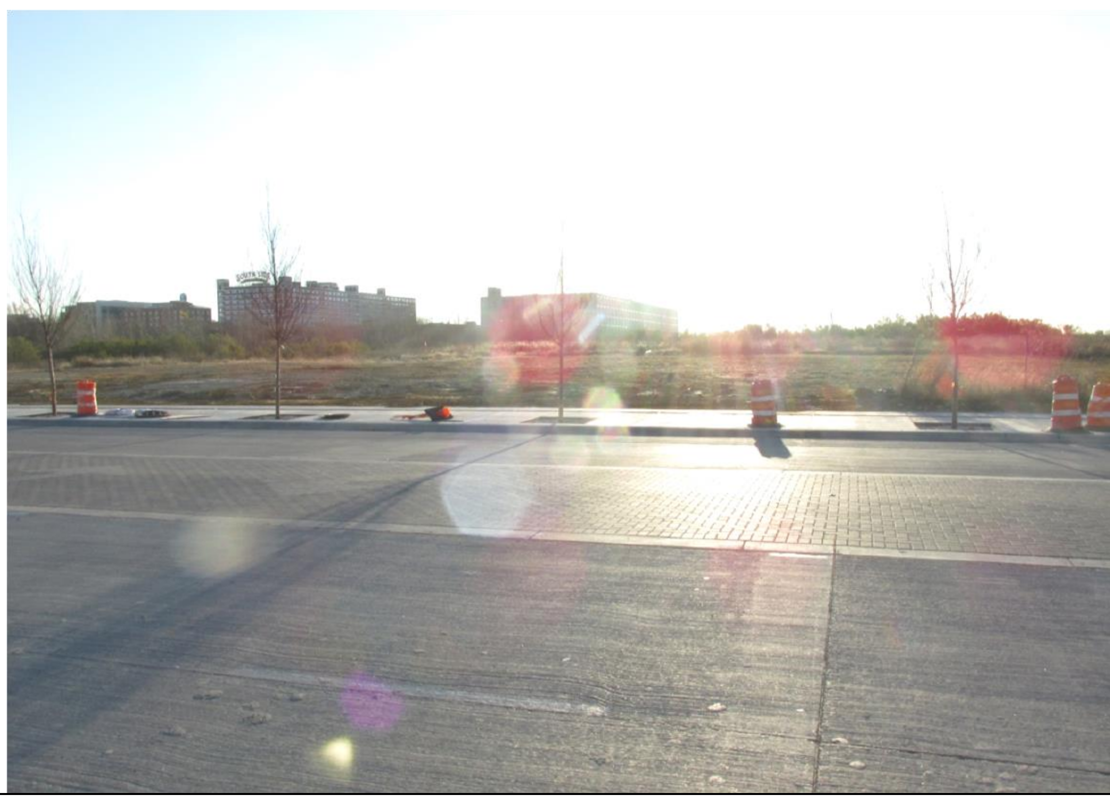
Photographic Log

PHOTOGRAPHIC LOG

Client Name: Texas Central Rail	**Site Location:** Dallas, Ellis, Navarro, Limestone, Freestone, Leon, Grimes, Madison, Waller, and Harris Counties, Texas	**Project No.** 60418787

Photo No. 1	**Date:** January 18, 2016
Direction Photo Taken: North	
Description: Map ID 18 River Liquor store and parking lot	

Photo No. 2	**Date:** January 18, 2016
Direction Photo Taken: South	
Description: Map ID 20 vacant tract of land formerly Jacks Service station	



AECOM

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Texas Central Rail	Dallas, Ellis, Navarro, Limestone, Freestone, Leon, Grimes, Madison, Waller, and Harris Counties, Texas	60418787

Photo No. 3

Date: January 18, 2016

Direction Photo Taken:

North

Description:

Map ID 19 vacant tract of land, formerly Alford Refrigerated Warehouses

Photo No. 4

Date: January 18, 2016

Direction Photo Taken:

Northeast

Description:

Map ID 21 abandoned building

AECOM

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Texas Central Rail	Dallas, Ellis, Navarro, Limestone, Freestone, Leon, Grimes, Madison, Waller, and Harris Counties, Texas	60418787

Photo No. 5

Date: January 18, 2016

Direction Photo Taken:

Northeast

Description:

Map ID 26 vacant property, formerly Refrigerated Transport.

Photo No. 6

Date: January 18, 2016

Direction Photo Taken:

North

Description:

Map ID 33 active storage yard for demo equipment.

AECOM

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Texas Central Rail	Dallas, Ellis, Navarro, Limestone, Freestone, Leon, Grimes, Madison, Waller, and Harris Counties, Texas	60418787

Photo No. 7

Date: January 18, 2016

Direction Photo Taken:

West

Description:

Map ID 36 Quick Stop Liquor store and parking lot

Photo No. 8

Date: January 18, 2016

Direction Photo Taken:

West

Description:

Map ID 37 active gas station

Client Name: Texas Central Rail	**Site Location:** Dallas, Ellis, Navarro, Limestone, Freestone, Leon, Grimes, Madison, Waller, and Harris Counties, Texas	**Project No.** 60418787

Photo No. 9

Date: January 18, 2016

Direction Photo Taken:

Northwest

Description:

Map ID 38 active ASTs on property

Photo No. 10

Date: January 18, 2016

Direction Photo Taken:

Northwest

Description:

Map ID 43 active scrap metal yard entrance

AECOM

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Texas Central Rail	Dallas, Ellis, Navarro, Limestone, Freestone, Leon, Grimes, Madison, Waller, and Harris Counties, Texas	60418787

Photo No.	Date:
11	January 18, 2016

Direction Photo Taken:

North

Description:

Map ID 45 entrance gate to active concrete plant

Photo No.	Date:
12	January 18, 2016

Direction Photo Taken:

West

Description:

Map ID 46 active site yard

AECOM

PHOTOGRAPHIC LOG

Client Name: Texas Central Rail	**Site Location:** Dallas, Ellis, Navarro, Limestone, Freestone, Leon, Grimes, Madison, Waller, and Harris Counties, Texas	**Project No.** 60418787

Photo No. 13 | **Date:** January 18, 2016

Direction Photo Taken:

South

Description:

Map ID 48 entrance of active site

Photo No. 14 | **Date:** January 18, 2016

Direction Photo Taken:

West

Description:

Map ID 49 entrance to active concrete plant

AECOM

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Texas Central Rail	Dallas, Ellis, Navarro, Limestone, Freestone, Leon, Grimes, Madison, Waller, and Harris Counties, Texas	60418787

Photo No. **15a**

Date: January 18, 2016

Direction Photo Taken:

Southwest

Description:

Map ID 52 active OxyChem facility

Photo No. **15b**

Date: March 15, 2016

Direction Photo Taken:

West

Description:

Map ID 52 active OxyChem facility. Soil staining/discoloration at southeastern side of facility

AECOM

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Texas Central Rail	Dallas, Ellis, Navarro, Limestone, Freestone, Leon, Grimes, Madison, Waller, and Harris Counties, Texas	60418787

Photo No. **15c**

Date: March 15, 2016

Direction Photo Taken:

Northwest

Description:

Map ID 52 active OxyChem facility. Spill/release at southeastern side of facility

Photo No. **16**

Date: January 18, 2016

Direction Photo Taken:

South

Description:

Map ID 53 fenced-in property from northern edge

PHOTOGRAPHIC LOG

Client Name: Texas Central Rail	**Site Location:** Dallas, Ellis, Navarro, Limestone, Freestone, Leon, Grimes, Madison, Waller, and Harris Counties, Texas	**Project No.** 60418787

Photo No. **17**

Date: January 18, 2016

Direction Photo Taken:

Northwest

Description:

Map ID 54 entrance to active metals recycling site

Photo No. **18**

Date: January 18, 2016

Direction Photo Taken:

North

Description:

Map ID 66 front gate of property

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Texas Central Rail	Dallas, Ellis, Navarro, Limestone, Freestone, Leon, Grimes, Madison, Waller, and Harris Counties, Texas	60418787

Photo No.	Date:
19	January 18, 2016

Direction Photo Taken:

Southeast

Description:

Map ID 67 active fueling station

Photo No.	Date:
20	January 18, 2016

Direction Photo Taken:

West

Description:

Map ID 68 entrance to current property.

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Texas Central Rail	Dallas, Ellis, Navarro, Limestone, Freestone, Leon, Grimes, Madison, Waller, and Harris Counties, Texas	60418787

Photo No.	Date:
21	January 18, 2016

Direction Photo Taken:

East

Description:

Map ID 86 vacant tract of land from west edge.

Photo No.	Date:
22	January 18, 2016

Direction Photo Taken:

East

Description:

Map ID 90 vacant lot from west edge

AECOM

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Texas Central Rail	Dallas, Ellis, Navarro, Limestone, Freestone, Leon, Grimes, Madison, Waller, and Harris Counties, Texas	60418787

Photo No. 23

Date: January 18, 2016

Direction Photo Taken:

Northeast

Description:

Map ID 93 security fence and on-site building

Photo No. 25

Date: January 18, 2016

Direction Photo Taken:

North

Description:

Map ID 95 current residential tract of land

AECOM

PHOTOGRAPHIC LOG

Client Name: Texas Central Rail	**Site Location:** Dallas, Ellis, Navarro, Limestone, Freestone, Leon, Grimes, Madison, Waller, and Harris Counties, Texas	**Project No.** 60418787

Photo No. **27**	**Date:** January 25, 2016
Direction Photo Taken: North	
Description: Map ID 98 Royal Food and Beverage.	

AECOM

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Texas Central Rail	Dallas, Ellis, Navarro, Limestone, Freestone, Leon, Grimes, Madison, Waller, and Harris Counties, Texas	60418787

Photo No.	Date:
28a	January 25, 2016

Direction Photo Taken:

South

Description:

Map ID 99 Penneco Bardwell Site.

Photo No.	Date:
28b	May 12, 2016

Direction Photo Taken:

East

Description:

Map ID 99 Penneco Bardwell Site.

AECOM

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Texas Central Rail	Dallas, Ellis, Navarro, Limestone, Freestone, Leon, Grimes, Madison, Waller, and Harris Counties, Texas	60418787

Photo No. 29

Date: January 25, 2016

Direction Photo Taken:

North

Description:

Map ID 100 Former Jack Herod Trucking.

Photo No. 30

Date: January 25, 2016

Direction Photo Taken:

East

Description:

Map ID 103 Lone Star Aggregates.

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Texas Central Rail	Dallas, Ellis, Navarro, Limestone, Freestone, Leon, Grimes, Madison, Waller, and Harris Counties, Texas	60418787

Photo No. 31 | **Date:** January 25, 2016

Direction Photo Taken:

West

Description:

Possible Location of Map ID 105.

Photo No. 32 | **Date:** January 25, 2016

Direction Photo Taken:

South

Description:

Map ID 107 Coopers Farm Country Store.

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Texas Central Rail	Dallas, Ellis, Navarro, Limestone, Freestone, Leon, Grimes, Madison, Waller, and Harris Counties, Texas	60418787

Photo No. 33

Date: January 25, 2016

Direction Photo Taken:

North

Description:

Map ID 108 and 118 I-45 Shell Truck Stop and Halliburton Energy Services.

Photo No. 34

Date: January 25, 2016

Direction Photo Taken:

West

Description:

Map ID 110 Professional Wireline Rental Fairfield Facility.

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Texas Central Rail	Dallas, Ellis, Navarro, Limestone, Freestone, Leon, Grimes, Madison, Waller, and Harris Counties, Texas	60418787

Photo No.	Date:
35	January 25, 2016

Direction Photo Taken:

West

Description:

Map ID 112 Loves Country Store 288.

Photo No.	Date:
36	January 25, 2016

Direction Photo Taken:

North

Description:

Map ID 114 Coles One Stop.

AECOM

PHOTOGRAPHIC LOG

Client Name:
Texas Central Rail

Site Location:
Dallas, Ellis, Navarro, Limestone, Freestone, Leon, Grimes, Madison, Waller, and Harris Counties, Texas

Project No.
60418787

Photo No. **37**

Date: January 25, 2016

Direction Photo Taken:

North

Description:

Map ID 120 Jet Travel Plaza.

Photo No. **38**

Date: January 25, 2016

Direction Photo Taken:

South

Description:

Map ID 121 Dew Truck Stop One.

PHOTOGRAPHIC LOG

Client Name: Texas Central Rail	**Site Location:** Dallas, Ellis, Navarro, Limestone, Freestone, Leon, Grimes, Madison, Waller, and Harris Counties, Texas	**Project No.** 60418787

Photo No. 39

Date: January 25, 2016

Direction Photo Taken:

North

Description:

Map ID 122 Lucky J's Travel Center.

Photo No. 40

Date: January 25, 2016

Direction Photo Taken:

North

Description:

Map ID 129 Triangle Petroleum.

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Texas Central Rail	Dallas, Ellis, Navarro, Limestone, Freestone, Leon, Grimes, Madison, Waller, and Harris Counties, Texas	60418787

Photo No. 41

Date: January 25, 2016

Direction Photo Taken:

North

Description:

Map ID 130 Woody's Smokehouse 1.

Photo No. 42

Date: January 25, 2016

Direction Photo Taken:

South

Description:

Map ID's 131 and 132 Exxon RS 63615 and Texan Food Mart.

AECOM

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Texas Central Rail	Dallas, Ellis, Navarro, Limestone, Freestone, Leon, Grimes, Madison, Waller, and Harris Counties, Texas	60418787

Photo No. 43

Date: January 25, 2016

Direction Photo Taken:

North

Description:

Map Id 133 Ryder Oil now Alli Oil Co.

Photo No. 44

Date: January 25, 2016

Direction Photo Taken:

North

Description:

Map Id 134 Centerville Asphalt Plant.

AECOM

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Texas Central Rail	Dallas, Ellis, Navarro, Limestone, Freestone, Leon, Grimes, Madison, Waller, and Harris Counties, Texas	60418787

Photo No. 45

Date: January 25, 2016

Direction Photo Taken:

South

Description:

Map ID 138 HC Chandler and Son Inc.

Photo No. 46

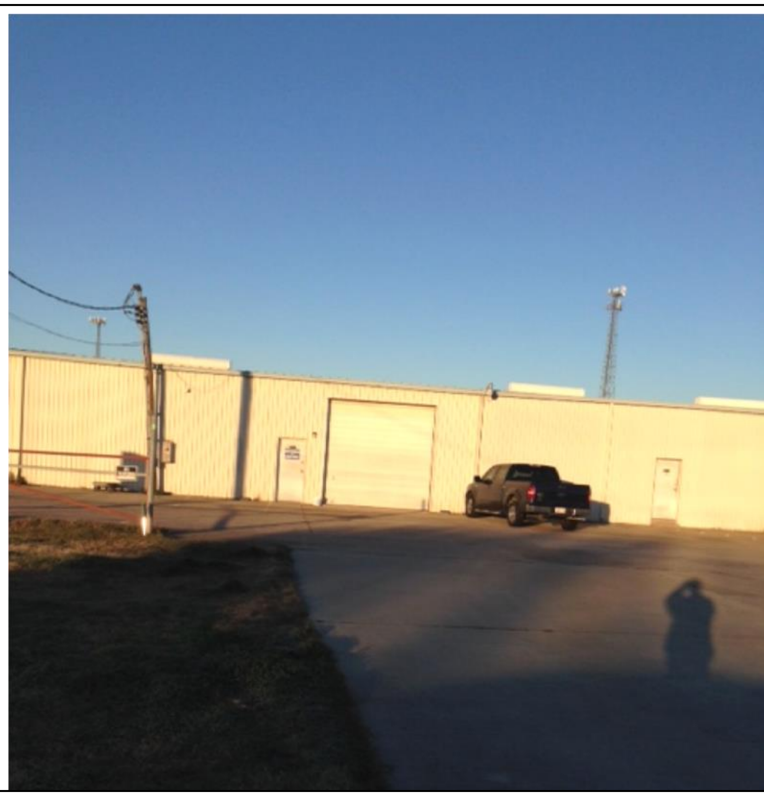
Date: January 28, 2016

Direction Photo Taken:

North

Description:

Map ID 144 APD Holdings III Cypress.



AECOM

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Texas Central Rail	Dallas, Ellis, Navarro, Limestone, Freestone, Leon, Grimes, Madison, Waller, and Harris Counties, Texas	60418787

Photo No.	Date:
47	January 28, 2016

Direction Photo Taken:

North

Description:

Map ID 145 Timewise Exxon 823.

Photo No.	Date:
48	January 28, 2016

Direction Photo Taken:

North

Description:

Map ID 146 Hewlett-Packard Company.

AECOM

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Texas Central Rail	Dallas, Ellis, Navarro, Limestone, Freestone, Leon, Grimes, Madison, Waller, and Harris Counties, Texas	60418787

Photo No. 49

Date: January 28, 2016

Direction Photo Taken:

East

Description:

Map ID 147 Plant 11.

Photo No. 50

Date: January 28, 2016

Direction Photo Taken:

West

Description:

Map ID 152 Wyman Gordon Forgings.

AECOM

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Texas Central Rail	Dallas, Ellis, Navarro, Limestone, Freestone, Leon, Grimes, Madison, Waller, and Harris Counties, Texas	60418787

Photo No.	Date:
51	January 28, 2016

Direction Photo Taken:

West

Description:

Map ID 158 SPX Flow Control Houston.

Photo No.	Date:
52	January 28, 2016

Direction Photo Taken:

East

Description:

Map ID 162 West End Lumber.

AECOM	PHOTOGRAPHIC LOG

Client Name: Texas Central Rail	**Site Location:** Dallas, Ellis, Navarro, Limestone, Freestone, Leon, Grimes, Madison, Waller, and Harris Counties, Texas	**Project No.** 60418787

Photo No. 53	**Date:** January 28, 2016

Direction Photo Taken:

East

Description:

Map ID 169 Varn Products now Akzonobel.

Photo No. 54	**Date:** January 28, 2016

Direction Photo Taken:

West

Description:

Map ID 174 Eldridge Fast Stop Shell and now Lone Star Chevrolet.

AECOM	PHOTOGRAPHIC LOG

Client Name: Texas Central Rail	**Site Location:** Dallas, Ellis, Navarro, Limestone, Freestone, Leon, Grimes, Madison, Waller, and Harris Counties, Texas	**Project No.** 60418787

Photo No. **55**	**Date:** January 28, 2016	
Direction Photo Taken: North		
Description: Map ID 176 Fabmark now Sparkle Sign.		

Photo No. **56**	**Date:** January 28, 2016	
Direction Photo Taken: North		
Description: Map ID 178 Jones Road Exxon 69395.		

AECOM

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Texas Central Rail	Dallas, Ellis, Navarro, Limestone, Freestone, Leon, Grimes, Madison, Waller, and Harris Counties, Texas	60418787

Photo No.	Date:
57	January 28, 2016

Direction Photo Taken:

South

Description:

Map ID 181 Concrete Batch Plant Houston 539 and United Rentals.

Photo No.	Date:
58	January 28, 2016

Direction Photo Taken:

East

Description:

Map ID 184 Guardsman and Cytex Industries now CSE W-Industries.

AECOM

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Texas Central Rail	Dallas, Ellis, Navarro, Limestone, Freestone, Leon, Grimes, Madison, Waller, and Harris Counties, Texas	60418787

Photo No.	Date:
59	January 28, 2016

Direction Photo Taken:

North

Description:

Map ID 191 Elg Ireland Alloys, Inc. now Versa Tech.

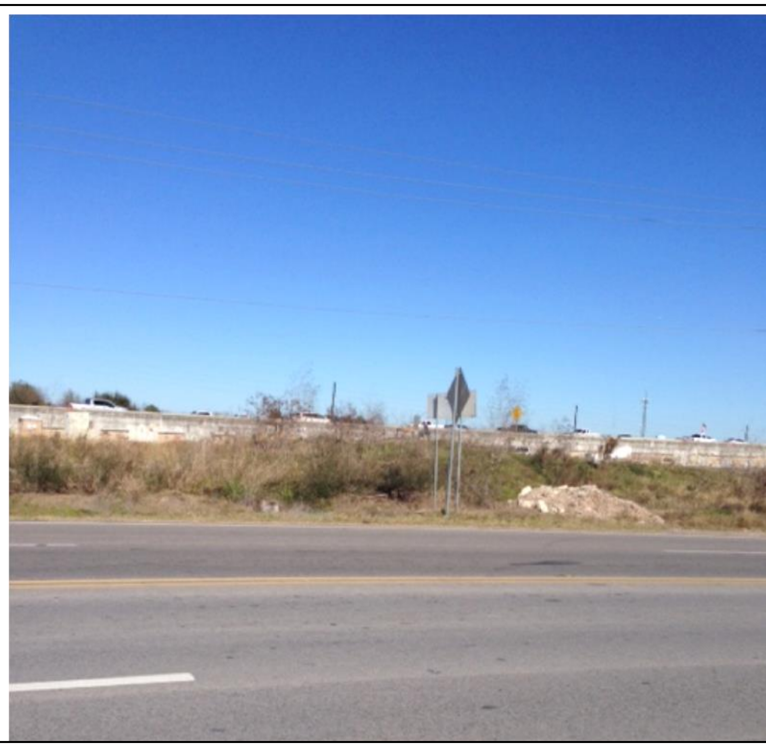
Photo No.	Date:
60	January 28, 2016

Direction Photo Taken:

West

Description:

Map ID 199 Texaco Service Station/Star Enterprise.



AECOM	PHOTOGRAPHIC LOG	
Client Name: Texas Central Rail	**Site Location:** Dallas, Ellis, Navarro, Limestone, Freestone, Leon, Grimes, Madison, Waller, and Harris Counties, Texas	**Project No.** 60418787

Photo No. **61**	**Date:** January 28, 2016
Direction Photo Taken: South	
Description: Map ID 202 former Shell station.	

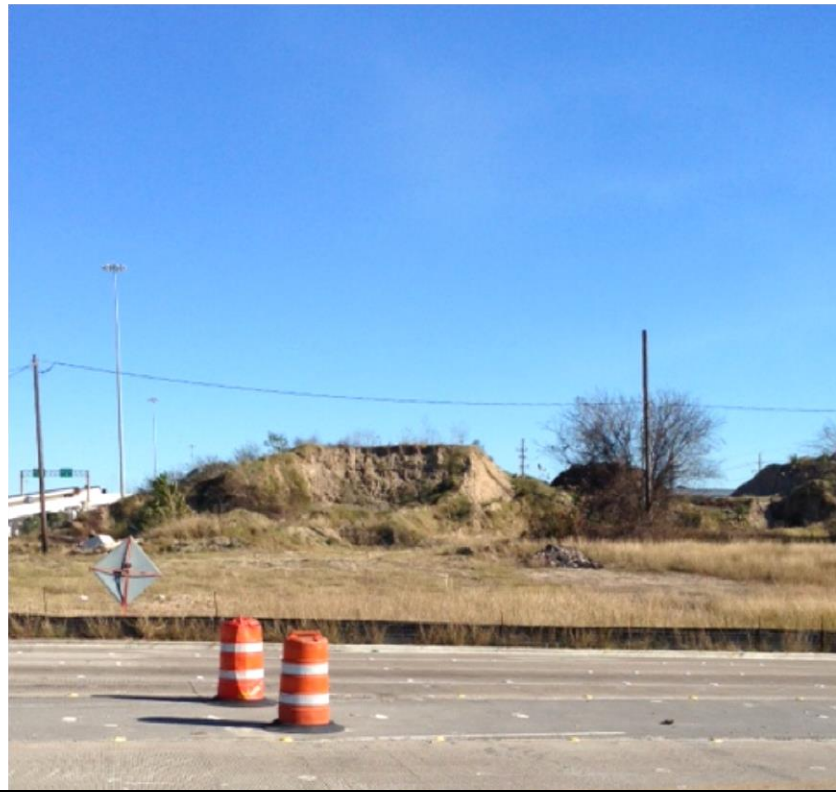


Photo No. **62**	**Date:** January 28, 2016
Direction Photo Taken: West	
Description: Map Id 204 former SPM Houston Mfg.	

AECOM

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Texas Central Rail	Dallas, Ellis, Navarro, Limestone, Freestone, Leon, Grimes, Madison, Waller, and Harris Counties, Texas	60418787

Photo No.	Date:
63	January 28, 2016

Direction Photo Taken:

West

Description:

Map ID 205 Houston 2 US Army Reserve Center.

Photo No.	Date:
64	January 28, 2016

Direction Photo Taken:

East

Description:

Map ID 210 AMSA 4.

AECOM

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Texas Central Rail	Dallas, Ellis, Navarro, Limestone, Freestone, Leon, Grimes, Madison, Waller, and Harris Counties, Texas	60418787

Photo No.	Date:
66	January 28, 2016

Direction Photo Taken:

North

Description:

Map ID 215 Gavlon Industries.

PHOTOGRAPHIC LOG

Client Name:	**Site Location:**	**Project No.**
Texas Central Rail	Dallas, Ellis, Navarro, Limestone, Freestone, Leon, Grimes, Madison, Waller, and Harris Counties, Texas	60418787

Photo No.	**Date:**
67	January 28, 2016

Direction Photo Taken:

West

Description:

Map ID 216 Sunbelt Steel Texas.

Photo No.	**Date:**
68	January 28, 2016

Direction Photo Taken:

East

Description:

Map ID 218 Living Earth Technologies.

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Texas Central Rail	Dallas, Ellis, Navarro, Limestone, Freestone, Leon, Grimes, Madison, Waller, and Harris Counties, Texas	60418787

Photo No. 69

Date: January 28, 2016

Direction Photo Taken:

North

Description:

Map ID 224 BJ Stringer.

Photo No. 70

Date: January 28, 2016

Direction Photo Taken:

West

Description:

Map ID 235 City of Houston Transfer Station Facility.

AECOM

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Texas Central Rail	Dallas, Ellis, Navarro, Limestone, Freestone, Leon, Grimes, Madison, Waller, and Harris Counties, Texas	60418787

Photo No. 71

Date: January 28, 2016

Direction Photo Taken:

North

Description:

Map ID 236 Matthew-Price Industries.

Photo No. 72

Date: January 28, 2016

Direction Photo Taken:

East

Description:

Map ID 241 CY Fair Tire.

AECOM		**PHOTOGRAPHIC LOG**
Client Name: Texas Central Rail	**Site Location:** Dallas, Ellis, Navarro, Limestone, Freestone, Leon, Grimes, Madison, Waller, and Harris Counties, Texas	**Project No.** 60418787

Photo No. **73**

Date: January 28, 2016

Direction Photo Taken:

East

Description:

Map ID 246 Teague Water Maintenance.

Photo No. **74**

Date: January 28, 2016

Direction Photo Taken:

North

Description:

Map ID 258 Midwest Paint and Body now Coastal Metal Recycling.

AECOM

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Texas Central Rail	Dallas, Ellis, Navarro, Limestone, Freestone, Leon, Grimes, Madison, Waller, and Harris Counties, Texas	60418787

Photo No. 75

Date: January 28, 2016

Direction Photo Taken:

South

Description:

Map ID 263 Los Gas and Diesel LPST 112333 now vacant lot.

Photo No. 76

Date: January 28, 2016

Direction Photo Taken:

East

Description:

Map ID 283 Bio Energy Landscape Maintenance.

AECOM	PHOTOGRAPHIC LOG	
Client Name: Texas Central Rail	**Site Location:** Dallas, Ellis, Navarro, Limestone, Freestone, Leon, Grimes, Madison, Waller, and Harris Counties, Texas	**Project No.** 60418787

Photo No. 77	**Date:** January 28, 2016
Direction Photo Taken: North	
Description: Map ID 297 Sandvik Rock Tools Facility.	

Photo No. 78	**Date:** January 28, 2016
Direction Photo Taken: West	
Description: Map ID 299 Chamdal Food Mart.	

AECOM

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Texas Central Rail	Dallas, Ellis, Navarro, Limestone, Freestone, Leon, Grimes, Madison, Waller, and Harris Counties, Texas	60418787

Photo No.	Date:
79	January 28, 2016

Direction Photo Taken:

East

Description:

Map ID 319 Rectorseal.

Photo No.	Date:
80	January 28, 2016

Direction Photo Taken:

North

Description:

Map ID 332 American Door Products.

AECOM

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Texas Central Rail	Dallas, Ellis, Navarro, Limestone, Freestone, Leon, Grimes, Madison, Waller, and Harris Counties, Texas	60418787

Photo No. 81

Date: January 28, 2016

Direction Photo Taken:

West

Description:

Map ID 337 Penske Truck Leasing.

Photo No. 82

Date: January 28, 2016

Direction Photo Taken:

East

Description:

Map ID 391 Southern Pacific Transport.

AECOM

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Texas Central Rail	Dallas, Ellis, Navarro, Limestone, Freestone, Leon, Grimes, Madison, Waller, and Harris Counties, Texas	60418787

Photo No. **83**

Date: January 28, 2016

Direction Photo Taken:

North

Description:

Map ID 400 Firestone Master Care Center now Northwest Mall.

Photo No. **84**

Date: January 28, 2016

Direction Photo Taken:

North

Description:

Map ID 401 Electro Welding.

PHOTOGRAPHIC LOG

Client Name: Texas Central Rail	Site Location: Dallas, Ellis, Navarro, Limestone, Freestone, Leon, Grimes, Madison, Waller, and Harris Counties, Texas	Project No. 60418787

Photo No. 85 | **Date:** January 28, 2016

Direction Photo Taken:

South

Description:

Map ID 403 Lunsford Estate Property/V&G.

Photo No. 86 | **Date:** January 28, 2016

Direction Photo Taken:

North

Description:

Map ID 405 Tex-Tube.

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Texas Central Rail	Dallas, Ellis, Navarro, Limestone, Freestone, Leon, Grimes, Madison, Waller, and Harris Counties, Texas	60418787

Photo No. 87

Date: January 28, 2016

Direction Photo Taken:

West

Description:

Map ID 406 Wheel World.

Photo No. 88

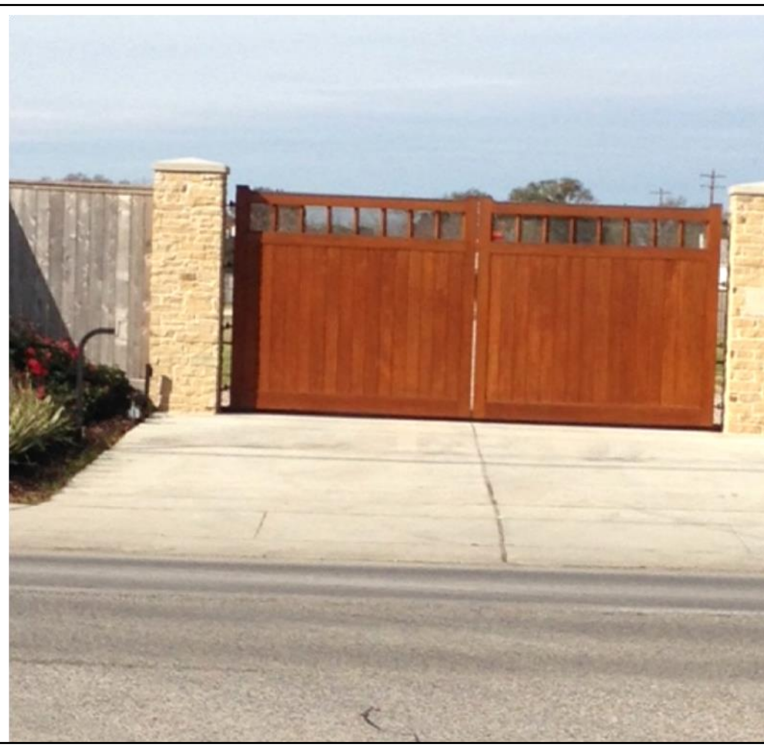
Date: January 28, 2016

Direction Photo Taken:

West

Description:

Map ID 407 South Texas Equipment.



AECOM

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Texas Central Rail	Dallas, Ellis, Navarro, Limestone, Freestone, Leon, Grimes, Madison, Waller, and Harris Counties, Texas	60418787

Photo No. 89

Date: January 28, 2016

Direction Photo Taken:

North

Description:

Map ID 408 Bergen Brunswig Drug now Prologis.

Photo No. 90

Date: January 28, 2016

Direction Photo Taken:

East

Description:

Map ID 410 Celotex The Houston Plant.

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Texas Central Rail	Dallas, Ellis, Navarro, Limestone, Freestone, Leon, Grimes, Madison, Waller, and Harris Counties, Texas	60418787

Photo No. 91 | **Date:** January 28, 2016

Direction Photo Taken:

North

Description:

Map ID 412, 413, and 415 Fant Children's Trust Property now New Process Steel.

Photo No. 92 | **Date:** January 28, 2016

Direction Photo Taken:

South

Description:

Map ID 414 Amber Booth.

AECOM

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Texas Central Rail	Dallas, Ellis, Navarro, Limestone, Freestone, Leon, Grimes, Madison, Waller, and Harris Counties, Texas	60418787

Photo No. 93

Date: January 28, 2016

Direction Photo Taken:

South

Description:

Map ID 419 and 440 McKinley Paper and Patrick Media Group of Houston.

Photo No. 94

Date: January 28, 2016

Direction Photo Taken:

West

Description:

Map ID 423 Zenneca and Former Stauffer Management.

AECOM	PHOTOGRAPHIC LOG

Client Name: Texas Central Rail	**Site Location:** Dallas, Ellis, Navarro, Limestone, Freestone, Leon, Grimes, Madison, Waller, and Harris Counties, Texas	**Project No.** 60418787

Photo No. 95	**Date:** January 28, 2016
Direction Photo Taken: North	
Description: Map ID 428 Hughes MPD.	

Photo No. 96	**Date:** January 28, 2016
Direction Photo Taken: North	
Description: Map ID 430 Southline Metal Products.	

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Texas Central Rail	Dallas, Ellis, Navarro, Limestone, Freestone, Leon, Grimes, Madison, Waller, and Harris Counties, Texas	60418787

Photo No. 97

Date: January 29, 2016

Direction Photo Taken:

East

Description:

Map ID 431 Kennametal Firth Sterling.

Photo No. 98

Date: January 29, 2016

Direction Photo Taken:

North

Description:

Map ID 432 Kvaener Oilfield Products-Western Plume now North Post Oak Lofts.

AECOM	**PHOTOGRAPHIC LOG**

Client Name:	**Site Location:**	**Project No.**
Texas Central Rail	Dallas, Ellis, Navarro, Limestone, Freestone, Leon, Grimes, Madison, Waller, and Harris Counties, Texas	60418787

Photo No. **99**

Date: January 29, 2016

Direction Photo Taken:

North

Description:

Map ID 434 West Loop 6 & 7 now Strip Center.

Photo No. **100**

Date: January 29, 2016

Direction Photo Taken:

North

Description:

Map ID 439 Malibu Grand Prix.

AECOM

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Texas Central Rail	Dallas, Ellis, Navarro, Limestone, Freestone, Leon, Grimes, Madison, Waller, and Harris Counties, Texas	60418787

Photo No. **101**

Date: January 29, 2016

Direction Photo Taken:

East

Description:

Map ID 438 Graebel Houston Movers.

Photo No. **102**

Date: January 29, 2016

Direction Photo Taken:

North

Description:

Map ID 437 A Division of Cummins Southern Plains no is feeder road construction with parking lot.

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Texas Central Rail	Dallas, Ellis, Navarro, Limestone, Freestone, Leon, Grimes, Madison, Waller, and Harris Counties, Texas	60418787

Photo No. 103

Date: January 29, 2016

Direction Photo Taken:

West

Description:

Map ID 441 Post Oak Memorial Office Park.

Photo No. 104

Date: January 29, 2016

Direction Photo Taken:

North

Description:

Map ID 444 MTSO now Pitney Bowes Management Services.

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Texas Central Rail	Dallas, Ellis, Navarro, Limestone, Freestone, Leon, Grimes, Madison, Waller, and Harris Counties, Texas	60418787

Photo No.	Date:
105	January 29, 2016

Direction Photo Taken:

South

Description:

Map ID 443 Malibu Grand Prix now TxDOT concrete batch plant.

Photo No.	Date:
106	January 29, 2016

Direction Photo Taken:

North

Description:

Map ID 447 and 449 Duratherm Inc. /Bird Environmental and Business Park.

AECOM	PHOTOGRAPHIC LOG

Client Name: Texas Central Rail	**Site Location:** Dallas, Ellis, Navarro, Limestone, Freestone, Leon, Grimes, Madison, Waller, and Harris Counties, Texas	**Project No.** 60418787

Photo No. 107	**Date:** January 29, 2016
Direction Photo Taken: North	
Description: Map ID 450 Laroche Industries.	

<u>Note:</u>
Photos #24, #26 and #65, that correspond to Map IDs 94, 96 and 214 were removed from the hazardous materials sites list based on revisions to the LOD.