3.6 NOISE AND VIBRATION

This section describes the analyses performed to assess existing and potential future impacts from noise and vibration from both traffic and rail transit to properties (i.e., "receivers") near the project corridors. The purpose of the analyses is to determine whether any receivers near the corridors would be impacted by either noise or vibration from the project alternatives according to CDOT, FHWA, or FTA guidelines. More details on the analyses can be found in the *Noise and Vibration Impact Assessments* (FHU, 2008a; Harris, Miller, Miller & Hanson [HMMH], 2008).

What's in Section 3.6?

The objectives of the noise and vibration analyses were to assess project-related noise and vibration at properties near any proposed improvements or substantive changes and to determine whether impacts are present or may be present in the future. The analyses were based on noise levels in A-weighted decibels (dBA) and on vibration levels in vibration decibels (VdB).

The main focus of the traffic noise and vibration analyses is I-25 because the alternatives being evaluated in this Draft EIS included substantive roadway changes only along I-25 between US 36 and SH 1. Other potential traffic noise sources relevant for each alternative were also considered as appropriate, such as commuter bus service and traffic accessing transit stations.

The focus of the rail transit noise and vibration analyses was the potential commuter rail corridor between Fort Collins and Thornton (**Section 2.2.2**).

3.6.1 Methodology

The traffic and rail analyses consisted of a combination of field measurements and calculations of future conditions. The analyses for traffic and rail were performed following different procedures (FHU, 2008a; HMMH, 2008), as summarized below.

Traffic noise and vibration analyses were performed according to CDOT procedures (CDOT, 2002). When applicable, FTA procedures (FTA, 2006) were followed to evaluate noise impacts from traffic to transit stations or maintenance facilities.

The main traffic noise sources analyzed were:

- roads that would be built or reconstructed under either of the alternatives
- roads where traffic volumes would be substantively changed by the alternatives
- other major roads adjoining the changed roads within the regional study area as needed for technical/modeling reasons

FHWA Traffic Noise Model Version 2.5 software (FHWA, 1998) was used to model traffic noise levels at more than 500 points that represented noise-sensitive properties within approximately 500 feet of project roads.

Impacts from traffic noise were assessed either by comparing the measured and modeled traffic noise levels to CDOT's Noise Abatement Criteria (NAC) or through FTA procedures, as appropriate. CDOT's NACs (**Table 3.6-1**) are based on the one-hour average sound level (L_{eq}). Land Use Categories A and E are either not present or not analyzed within the project area and were not considered further. Under CDOT guidelines, traffic noise levels equaling or exceeding the NAC are viewed as noise impacts, which trigger an evaluation of traffic noise mitigation measures. A "substantial" traffic noise increase (when the future noise level is expected to increase by 10 dBA or more over existing levels) is also considered a noise impact, also leading to evaluation of noise mitigation actions. Assessment of impacts from traffic vibration is described in **Section 3.6.2.5**.

Table 3.6-1 CDOT Noise Abatement Criteria (NAC)

Land Use Category	CDOT NAC (L_{eq})	Description
A	56 dBA (Exterior)	Tracts of land in which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is to continue to serve its intended purpose. Such areas could include amphitheaters, particular parks, or open spaces that are recognized by appropriate local officials for activities requiring special qualities of serenity and quiet.
B	66 dBA (Exterior)	Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals, picnic areas, playgrounds, active sports areas, and parks.
C	71 dBA (Exterior)	Developed lands, properties, or activities not included in categories A and B above.
D	None	Undeveloped lands.
E	51 dBA (Interior)	Residences, motels, public meeting rooms, schools, churches, libraries, hospitals, and auditoriums.

Source: CDOT, 2002.

The rail transit noise and vibration analyses were carried out in conformance with procedures prescribed by FTA (FTA, 2006). The highest level of analysis under the FTA process (i.e., "detailed" analysis) was followed. FTA noise criteria use either one-hour averaged noise levels (abbreviated L_{eq} or L_{eq}(h)) or 24-hour averaged noise levels (L_{dn}). The L_{dn} is defined to include a 10 dBA penalty for noise between 10 PM and 7 AM. FTA groups noise-sensitive land uses into the following three categories:

- **Category 1:** 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, concert pavilions, National Historic Landmarks with significant outdoor use, recording studios, and concert halls.
- **Category 2:** Residences and buildings where people normally sleep. This category includes homes, hospitals, and hotels where a nighttime sensitivity to noise is assumed to be of utmost importance.
- **Category 3:** Institutional land uses with primarily daytime and evening use. This category includes schools, libraries, theaters, and churches where it is important to avoid interference with such activities as speech, meditation, and concentration on reading material. Places for meditation or study associated with cemeteries, monuments, museums, campgrounds, and recreational facilities can also be considered to be in this category. Certain historical sites and parks are also included.

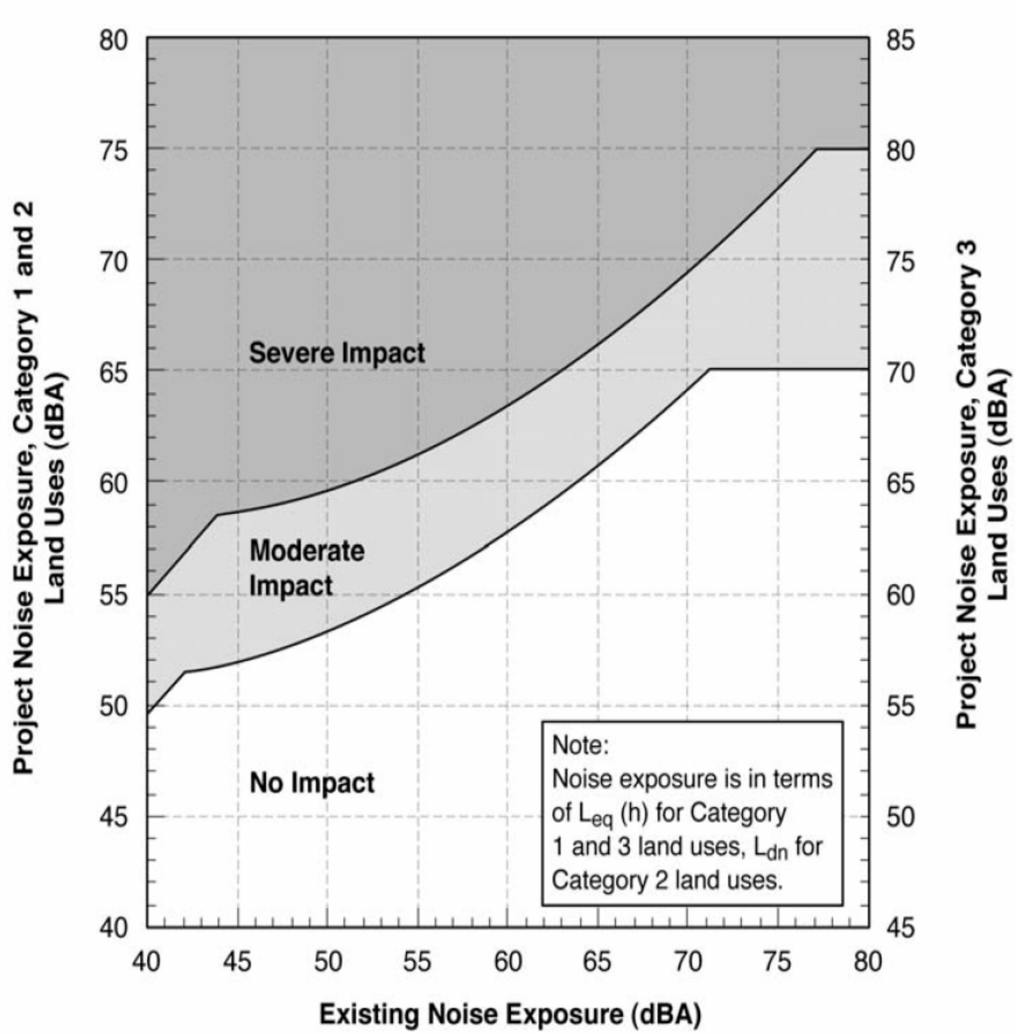
The noise level thresholds used to determine transit noise impacts are variable, depending on existing noise exposure, as illustrated in **Figure 3.6-1**. There are two levels of impact associated with the FTA noise criteria:

- **Moderate Impact:** In this range of noise impact, the change in the cumulative noise level is 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. These factors include the existing noise level, the predicted increase over existing noise levels, the types and numbers of noise-sensitive land uses affected, the noise sensitivity of the affected properties, the effectiveness of possible mitigation measures, community views, and the cost of mitigating the noise.
- **Severe Impact:** Project-generated noise in the severe impact range can be expected to cause a significant percentage of people to be highly annoyed by the new noise and represents the most compelling need for mitigation. Noise mitigation would normally be specified for severe impact areas unless there are truly extenuating circumstances which prevent it.

There are also separate FTA criteria for ground-borne noise, i.e., the "rumble" that can be radiated from room surfaces in buildings due to ground-borne vibration. Because airborne noise often masks ground-borne noise for above ground (i.e., at-grade or elevated) rail systems, ground-borne noise criteria are primarily important with subway operations where airborne noise is not a factor, which is not the case with this project.

Finally, the FTA vibration impact criteria are based on land use and train frequency (FTA, 2006). The vibration criteria are rather technical and are therefore discussed in detail in *Rail Noise and Vibration Impact Assessment* (HMMH, 2008). Briefly stated, FTA has established a criterion for detailed vibration analyses of residential buildings with nighttime occupancy at 72 VdB, measured in one-third octave bands over the frequency range from 8 Hertz (Hz) to 80 Hz.

Figure 3.6-1 Transit Noise Impact Criteria



Source: FTA, 2006.

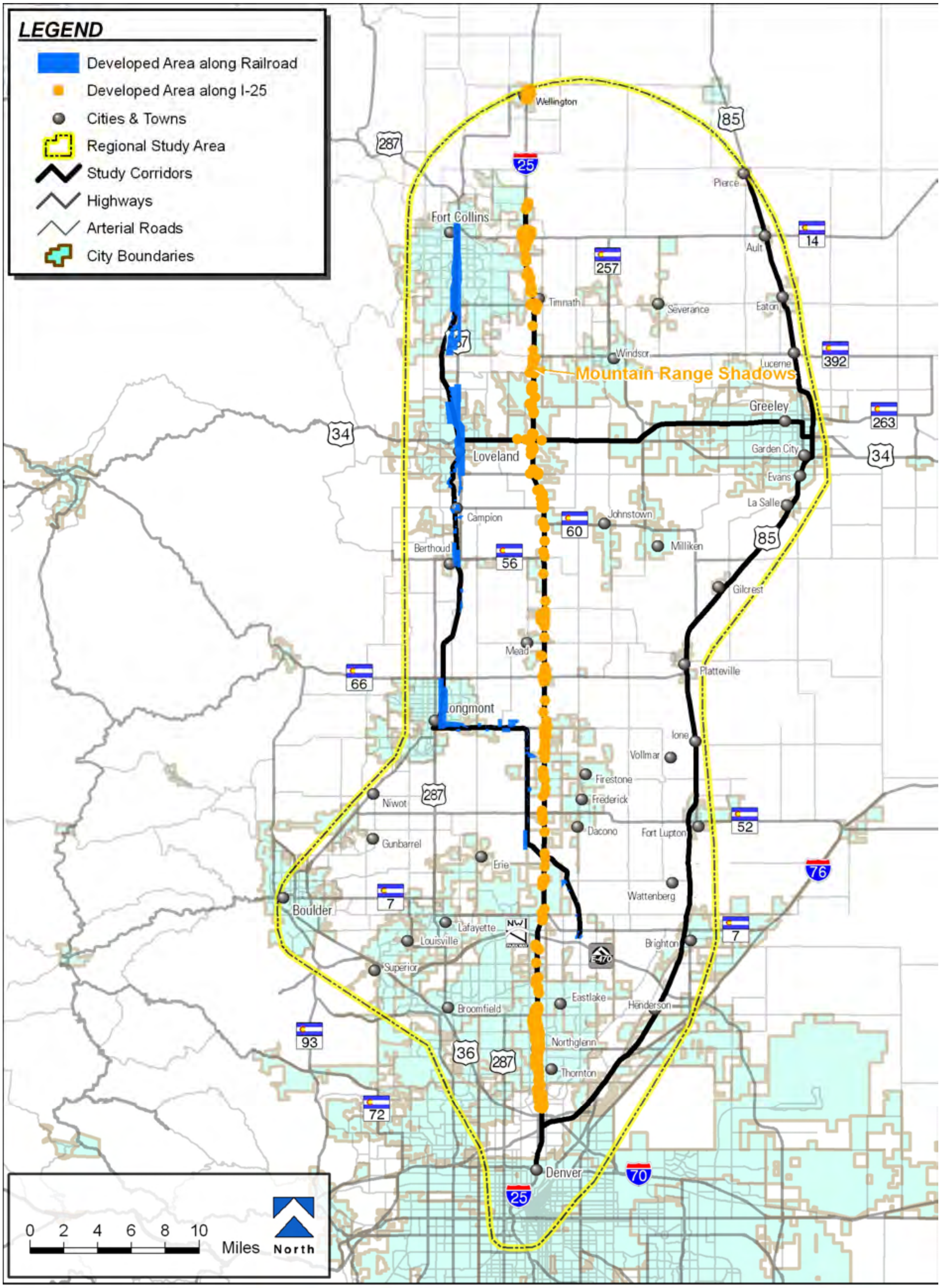
3.6.2 Affected Environment

There are a number of receivers along both the road and rail corridors (**Figure 3.6-2**) of the EIS alternatives that could be impacted by noise or vibration. Potential impacts from noise or vibration were evaluated according to the methods described in **Section 3.6.1**.

Along I-25 between SH 1 and 136th Avenue, there are dispersed residential and business properties with some clusters of developed properties. The Mountain Range Shadows residential development located south of SH 392 is one of the larger neighborhoods near I-25, while the majority of other developed properties are scattered throughout the northern project area. At the south end of the project area between 136th Avenue and US 36, there are numerous densely populated residential and business areas along both the east and west sides of I-25.

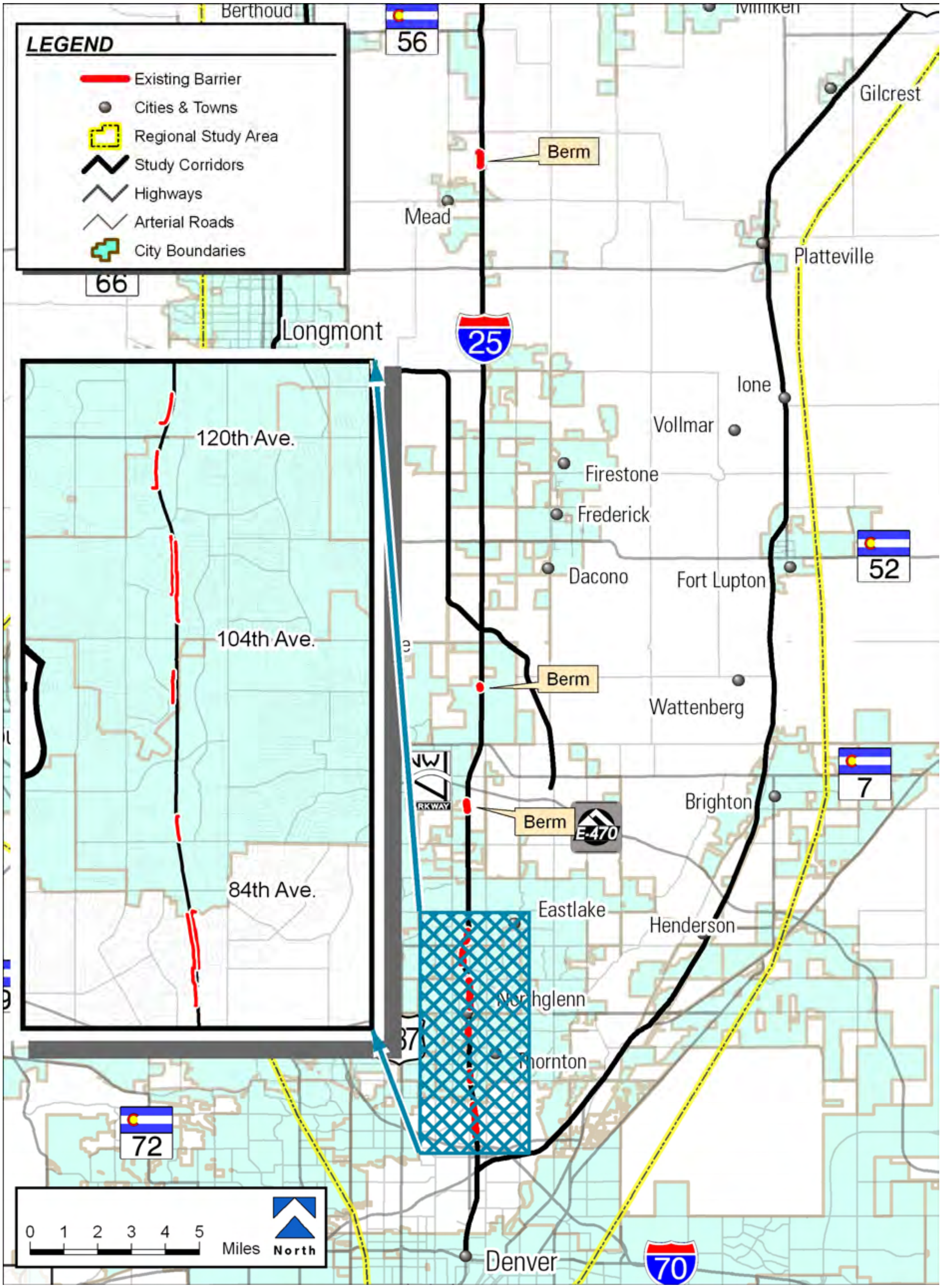
A number of traffic noise barriers (**Figure 3.6-3**) have been built in the project area along I-25. There are several constructed walls in the southern region of the project between US 36 and 120th Avenue. In addition, there are three earth berms along the I-25 corridor, as shown on **Figure 3.6-3**.

Figure 3.6-2 Noise Sensitive Areas along Project Corridors



Source: FHU project data, 2007.

1 **Figure 3.6-3 Existing Noise Barriers along Project Corridor**



2 *Source: FHU project data, 2007.*

Along the proposed rail corridor, there is a range of adjoining property uses. Much of the corridor abuts undeveloped or agricultural land with dispersed residential properties and neighborhoods in some areas (**Figure 3.6-2** or **Figure 3.1-2**). Some of this area is developing quickly, however, into primarily commercial properties. The rail corridor intersects substantial portions of highly developed areas in several cities and towns, including Fort Collins, Loveland, Campion, Berthoud, and Longmont. In many of these areas, residences are very near the project rail corridor and at-grade rail crossings.

The affected environment for traffic and rail noise and vibration in the project area has been characterized through a combination of measurements and modeling, as described in the following sections.

3.6.2.1 Traffic Noise Measurements

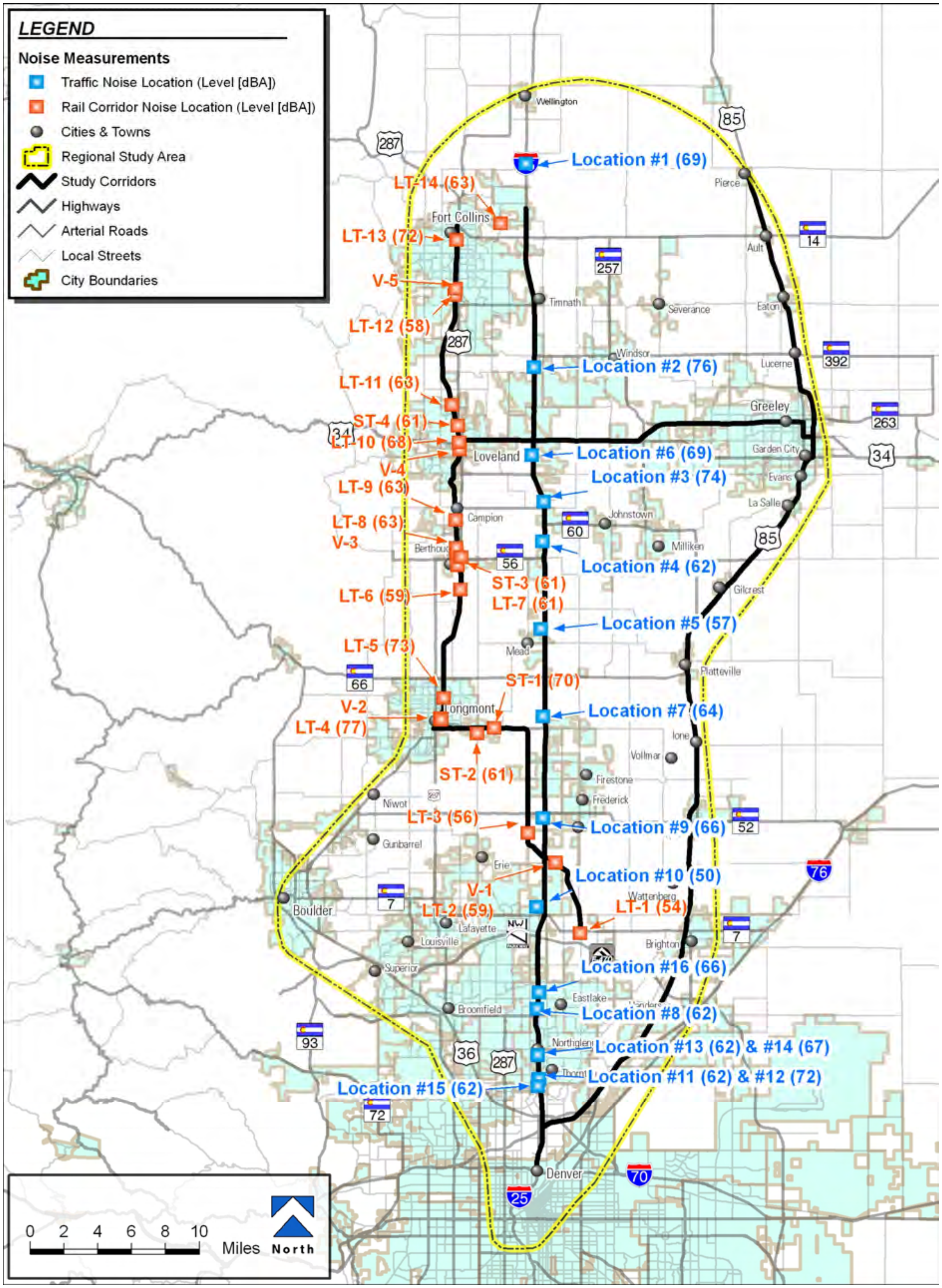
Measurements of existing traffic noise levels (**Table 3.6-2**) were performed at 16 locations in the project area in 2005 or 2006. The measurements consisted of 10-minute measurements at 13 locations and 24-hour measurements at the three remaining locations. The measurements were spread over a variety of locations in the project area adjacent to I-25 (**Figure 3.6-4**). Measured noise levels at six of the monitoring locations equaled or exceeded the applicable CDOT NAC, which indicated that these areas are currently impacted by traffic noise (**Table 3.6-2**). The measured noise levels for these locations are denoted in bold in the table.

Table 3.6-2 Existing Traffic Noise Measurement Results

Location Number	Location Description	Land Use Category*	CDOT NAC (dBA)*	Measured L_{eq} (dBA)
1	Fort Collins soccer fields	B	66	**69**
2	Mountain Range Shadows neighborhood	B	66	**76**
3	Johnson's Corner Campground	B	66	**74**
4	Home along Weld County Road 46	B	66	62
5	Coyote Run neighborhood	B	66	57
6	Big Thompson Ponds State Wildlife Area	B	66	**69**
7	St. Vrain State Park	B	66	66
8	Willowbrook Park	B	66	62
9	Businesses near SH 52	C	71	66
10	Near SH 7 interchange	D	None	50
11	Summit View Apartments (behind wall)	B	66	62
12	Summit View Apartments (beside wall)	B	66	**72**
13	Near former University of Phoenix (behind wall)	C	71	62
14	Near former University of Phoenix (beside wall)	C	71	67
15	Near Wagon Wheel park-n-Ride	D	None	62
16	13000-block Grand Circle neighborhood	B	66	**66**

Source: FHU field data, 2005–2006.
** See Table 3.6-1.*

Figure 3.6-4 Noise and Vibration Measurement Locations



Source: FHU and HMMH field data, 2007.

3.6.2.2 RAIL NOISE MEASUREMENTS

Fourteen sites, designated as LT-1 through LT-14, were selected for long-term (24-hour) monitoring and four sites, designated as ST-1 through ST-4, were selected for short-term (one-hour) monitoring (**Figure 3.6-4**). Results of these 2006 measurements are summarized in **Table 3.6-3**.

Based on the average measured train noise levels, the noise exposure in L_{dn} from current freight train operations at a distance of 100 feet from the track was estimated to be approximately 60 dBA in areas where train horns are not sounded and approximately 72 dBA in areas near grade crossings where horns are sounded for trains in both travel directions. Where train horns are sounded in only one direction of train travel, the L_{dn} at 100 feet was estimated to be 65 dBA, assuming that the horn is not sounded for the single nighttime train. This provides a conservatively low estimate of the existing noise for purposes of the noise impact assessment (**Figure 3.6-1**).

The total existing noise environment along the rail corridor was established by combining train noise (adjusted for distance) with background ambient noise from other sources (e.g., road traffic, aircraft, general neighborhood activities). The results of the noise-monitoring program indicated that the background L_{dn} (i.e., without trains) generally ranged between 50 dBA and 60 dBA, depending on the location along the corridor.

3.6.2.3 EXISTING TRAFFIC NOISE

Existing traffic noise was calculated based on traffic models which include existing roadways, interchanges, and frontage roads near noise receivers and existing (2005) traffic volumes. These calculations have also been compared to the actual noise measurement data to make sure there is an accurate reflection of the existing noise.

More than 500 total (residential and commercial) points were used in the noise models (FHU, 2008a). In some cases, a single point in the model represented several nearby and similar receivers/properties where distance from the roads and geography were similar. Modeling results are presented in **Appendix C**. From the modeled points, 473 receivers are calculated to have existing traffic noise levels above the respective NAC during the afternoon peak hour. Of the 473 impacted receivers, 374 are Category B properties (residential) and 99 are Category C properties (commercial). The impacted areas are shown in **Figure 3.6-5** and summarized in **Table 3.6-4**.

It should be noted that noise levels at 30 Category B modeled locations without existing barriers currently are at or above 75 dBA (FHU, 2008a), which is a severe impact (CDOT, 2002). In general, these locations are homes within about 150 feet of I-25 without any intervening barriers and are spread throughout the corridor.

3.6.2.4 EXISTING TRAFFIC VIBRATION

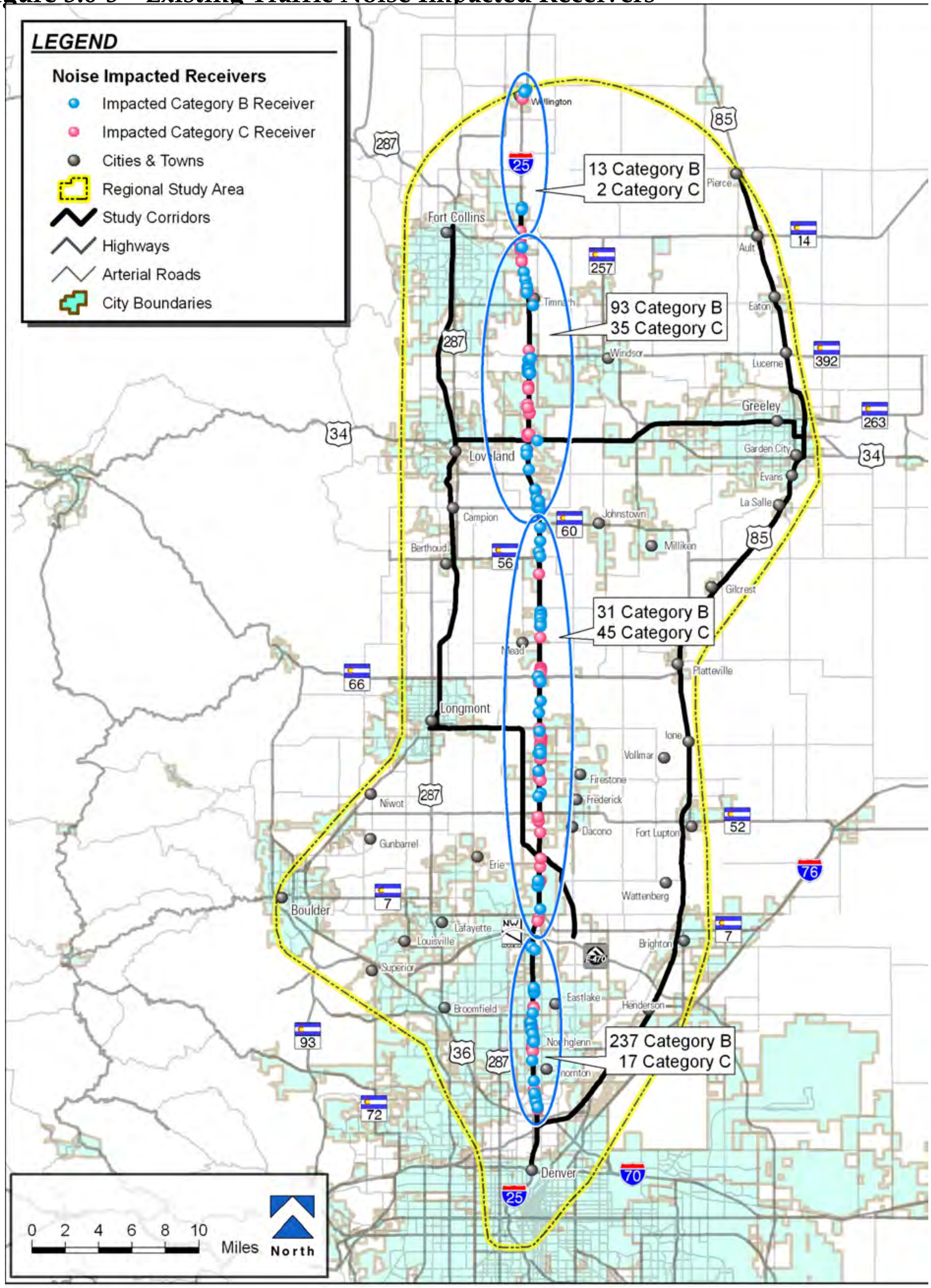
There are no FHWA or CDOT requirements regarding traffic-induced vibration. Studies assessing the impact of operational traffic-induced vibrations have shown that both measured and predicted vibration levels from traffic were less than any known criteria for structural damage to buildings (FHWA, 1995). Often, normal indoor activities, such as closing doors, have been shown to create greater levels of vibration than highway traffic. As such, vibration from highway traffic was not a major concern for this EIS and was not examined in this analysis.

Table 3.6-3 Rail Noise Measurement Results

Location (North to south)	Location Description	Distance from Rails (feet)	Measurement Duration (hours)	Noise Level		
				L_{dn} (dBA)		L_{eq}(dBA)
				With Trains	Without Trains	
LT-14	401 N. Timberline Road, Unit #178 – Fort Collins (near potential maintenance facility site)	N/A	24	--	63	--
LT-13	635 Mason Street – Fort Collins (track in median of street)	80	24	72	60	
LT-12	328 Albion Way – Fort Collins	150	24	58	56	--
LT-11	4355 Filbert Drive – Loveland	120	24	63	51	--
LT-10	1246 N. Arthur Avenue – Loveland (track in cut)	50	24	68	58	--
LT-9	5105 S. Iowa Avenue – Campion	120	24	63	53	--
LT-8	1220 N. 4th Street – Berthoud (near potential maintenance facility site)	180	24	63	50	--
LT-7	208 3rd Street – Berthoud	80	24	61	50	--
LT-6	1375 S. Larimer County Road 15 – Berthoud (120 feet from road; track in cut)	90	24	59	52	--
LT-5	1556 Centennial Drive – Longmont	50	24	73	51	--
LT-4	514 Atwood Street – Longmont (track in median of street)	80	24	77	55	--
LT-3	4871 Weld County Road 7 – Erie (100 feet from road)	N/A	24	--	56	--
LT-2	4647 Chia Court – Dacono (near unused track)	N/A	24	--	59	--
LT-1	15930 Jackson Street – Brighton (near unused track)	N/A	24	--	54	--
ST-4	2639 Cedar Drive at N. Garfield Avenue – Loveland (near potential station site)	N/A	1	--	59*	61
ST-3	Peakview Meadows (SH 287 at Turner Avenue) – Berthoud (near potential station site)	N/A	1	--	59*	61
ST-2	Weld County Road 1 at Great Western Drive – Longmont (near potential station site)	N/A	1	--	59*	61
ST-1	SH 119 at Fairview Street – Longmont (170 feet from highway)	N/A	1	--	68*	70

Source: HMMH field data, 2006.
-- Not measured
* Estimated level
N/A – Not applicable

1 **Figure 3.6-5 Existing Traffic Noise Impacted Receivers**



Map Document: (3N_I-25_Noise_Impacted_Receivers_8x11.mxd)
1/24/2007 -- 9:41:40 AM

2 *Source: FHU project data, 2007.*

Table 3.6-4 Number of Properties Currently Impacted by Traffic Noise

Road Component	Number of Impacted Category B Receivers	Number of Impacted Category C Receivers
Between SH 1 and SH 14	13	2
Between SH 14 and SH 60	93	35
Between SH 60 and E-470	31	45
Between E-470 and US 36	237	17
Total Impacted Properties	**374**	**99**

Source: FHU project data, 2007.

3.6.2.5 EXISTING RAIL NOISE

The FTA noise evaluation protocol is based on comparison of existing noise levels to projected noise levels from the proposed project (FTA, 2006). Under the protocol, a rail transit noise impact occurs when the predicted project-generated noise level increase relative to the existing noise level is too large (**Figure 3.6-1**). There are not specific noise levels used by FTA to define noise impacts universally, as there are with the CDOT/FHWA protocol (**Table 3.6-1**). Because the determination of impacts depends on the change in noise levels, it is not possible or appropriate to assess “existing” noise impacts from rail transit using FTA procedures.

However, the existing noise exposure at the residential areas along the rail corridor between Fort Collins and Longmont is relatively high, dominated by BNSF freight train noise. In this area, the existing Ldn typically ranges from 65 dBA to 75 dBA at homes close to the tracks. The highest noise levels occur at locations near grade crossings where the train horns are routinely sounded.

3.6.2.6 EXISTING RAIL VIBRATION

To characterize the existing baseline vibration conditions at sensitive receivers along the rail corridor, a field measurement program was performed in 2006. The measurement program consisted of ground vibration propagation tests as well as vibration measurements during train operations in representative areas along the proposed rail transit alignment. Five sites, designated as V-1 through V-5, were selected to represent the range of soil conditions in areas along the proposed transit corridor (**Figure 3.6-4)**.

Ground vibration measurements were made at various distances from the BNSF tracks during train operations at V-2 through V-5 to document existing train vibration levels along the corridor. The results are summarized in **Table 3.6-5.** Overall, the measurements suggest that existing ground-borne vibration levels from trains operating along the BNSF track between Longmont and Fort Collins are likely to be perceptible at buildings located as far away as 100 to 150 feet from the track.

Table 3.6-5 Vibration Measurement Data for Freight Trains

Site (North to South)	Description	Number of Locomotives	Number of Rail Cars	Train Speed (MPH)	Train Travel Direction	Maximum Vibration Velocity Level (VdB) at Distance				
						45-65 feet	70-90 feet	95-115 feet	120-140 feet	145-165 feet
V-5	S. of Horsetooth Rd. – Fort Collins	3	66	36	North	82	74	71	68	66
V-4	Railroad Ave. and E. 8th St. – Loveland	3	86	18	South	76	72	69	69	62
V-3	Third St. and Capitol Ave. – Berthoud	2	2	22	South	78	73	70	72	67
V-2	Atwood St. and 6th Ave. – Longmont	3	45	11	North	70	64	59	59	58

Source: HMMH field data, 2006.
Note: Site V-1 is not near freight rails.

3.6.3 Environmental Consequences

Three alternatives are being evaluated for this Draft EIS: the No-Action Alternative, Package A, and Package B. Each alternative was evaluated for noise and vibration impacts (FHU, 2008a; HMMH, 2008). Depending on the alternative, some project area roads may be widened or realigned resulting in traffic closer to adjoining properties. Increased traffic volumes, increased traffic speeds, or different road alignments may lead to impacts from traffic. Rail transit would be added with Package A, which may cause impacts from rail along the existing corridors or may introduce impacts from rail into new corridors.

The important new noise and vibration sources or changed conditions that were the focus of the noise and vibration analysis included:

- Road design changes in the I-25 corridor (Packages A and B)
- Traffic volumes on I-25 (all alternatives)
- Rail transit equipment and operations with the freight rail operations (Package A only)
- Traffic volumes on roads connecting to I-25 from commuter buses, feeder buses, etc. (Packages A and B)
- New transit and maintenance facilities, parking lots, and access roads (Packages A and B)

Some other sources were considered but found not to be important. For example, CDOT requires analysis of noise impacts if a project would make major physical changes to a road (CDOT, 2002). Small changes, such as addition of traffic control devices, do not require noise analysis. Packages A and B both would make major changes by widening roads in the I-25 corridor.

Outside the I-25 corridor, minor proposed changes to the project area roads that may affect noise or vibration conditions would be installation of queue jumps for buses at select intersections and addition of commuter/feeder bus traffic on the existing roads. The queue jumps would be small changes within the existing road right-of-way and would not cause a substantive change in traffic noise, so the queue jumps are inconsequential for noise impacts. The loudest noise scenario for additional bus traffic on any project area road would be six buses per hour (three buses in each direction), which is a trivial amount of traffic relative to the volumes that already would be on these roads. The additional bus traffic would not have a material effect on traffic noise levels, so bus traffic noise was eliminated from detailed examination as well.

Therefore, project area roads outside the I-25 corridor, such as US 85, US 287, and SH 119, were not subjected to detailed traffic noise analysis because the proposed alternatives would not materially change noise conditions on these roads. However, new transit facilities (bus or rail) and new access roads to these facilities that were part of the alternatives were examined for noise impacts regardless of location within the regional study area because these facilities could be substantial changes at the local level.

For the detailed analyses, future noise and vibration levels were evaluated for areas near the road and rail corridors in the project area for each alternative. The analyses for the alternatives assessed whether future levels near the project corridors would exceed the relevant CDOT, FHWA, or FTA criteria (**Section 3.6.1**). If future noise or vibration impacts were identified, mitigation measures were considered and evaluated following the relevant CDOT, FHWA, or FTA guidelines.

As previously described, many sensitive areas exist along the corridors in the project area (**Figure 3.6-1**). Noise and vibration results for these areas are presented below and impacts are summarized in **Section 3.6.6**. Detailed modeling results are presented in **Appendix C**.

3.6.3.1 NO-ACTION ALTERNATIVE

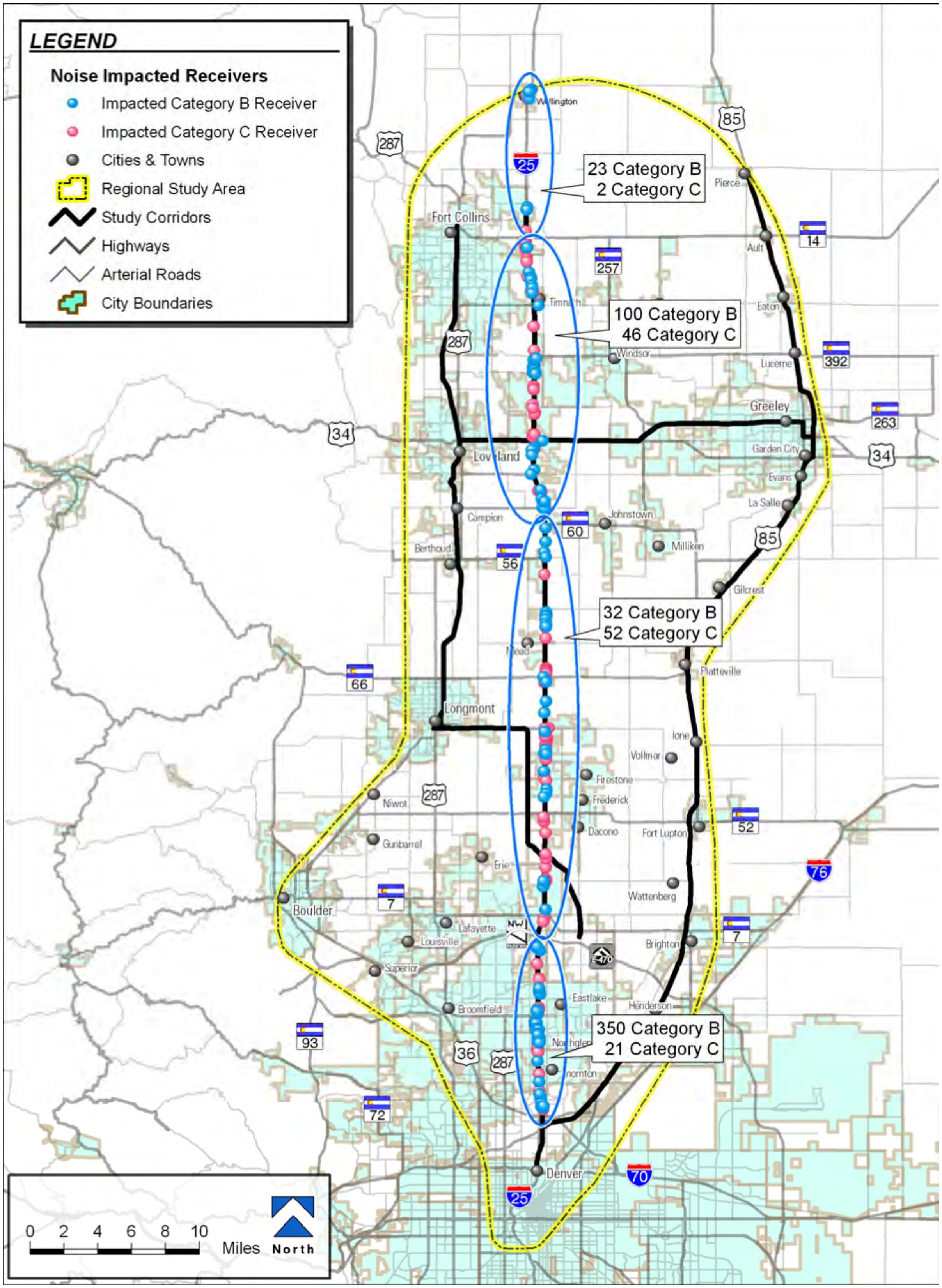
Only potential impacts from road traffic are relevant for the No-Action Alternative; no changes to rail facilities would be made. As described in **Section 3.6.2.4**, traffic vibration would not be a major concern. Therefore, only potential road traffic noise impacts (**Appendix C**) are relevant for the No-Action Alternative and are discussed below.

Results for this alternative for year 2030 (**Figure 3.6-6**) would be similar to existing conditions results. Traffic noise patterns would be similar to existing conditions with noise levels pushed out a bit farther from the roads due to increased traffic volumes, so that impacted areas would be slightly larger overall. Areas impacted under existing conditions also would be impacted under this alternative. For the No-Action Alternative, it is calculated that 505 Category B receivers and 121 Category C receivers in the project area would be impacted by traffic noise (**Table 3.6-6**).

The residential areas calculated to be impacted are:

- Wellington East (Wellington) – 16 receivers
- Mountain Range Shadows (Larimer County) – 69 receivers
- Isolated/scattered homes along I-25 in Larimer and Weld counties – 70 receivers
- Numerous neighborhoods abutting I-25 in Broomfield, Northglenn, Thornton, and Westminster, and in Adams County – 350 receivers

1 **Figure 3.6-6 Noise-Impacted Areas for the No-Action Alternative (Year 2030)**



2 *Source: FHU project data, 2007.*

In addition, portions of Big Thompson Ponds State Wildlife Area, St. Vrain State Park, Willowbrook Park, Niver Creek Open Space, Civic Center Park, and Thorncreek Golf Course are calculated to have traffic noise levels at or above the CDOT NAC for Category B. No receivers would be expected to experience a 10-dBA increase; the largest calculated increase would be 6 dBA.

The farthest distance from a modeled road to a receiver impacted by traffic noise in year 2030 would be approximately 400 feet from I-25.

Table 3.6-6 Summary of Traffic Noise Impacts

Highway Component	Number of Noise-Impacted Receivers (Category B / Category C)			
	Existing (2005)	No-Action (2030)	Package A (2030)	Package B (2030)
Component A-H1: SH 1 to SH 14	13 / 2	23 / 2	23 / 2	23 / 2
Component A-H2: SH 14 to SH 60	93 / 35	100 / 46	93 / 47	93 / 42
Component A-H3: SH 60 to E-470	31 / 45	32 / 52	37 / 50	38 / 50
Component A-H4: E-470 to US 36	237 / 17	350 / 21	350 / 21	469 / 39
Total	**374 / 99**	**505 / 121**	**503 / 120**	**623 / 133**

Source: FHU project data, 2007.

3.6.3.2 PACKAGE A

Both road and rail noise and vibration are relevant for Package A. Each of these two travel modes are discussed separately below. As described in **Section 3.6.2.4**, traffic vibration is not a major concern and is not discussed further.

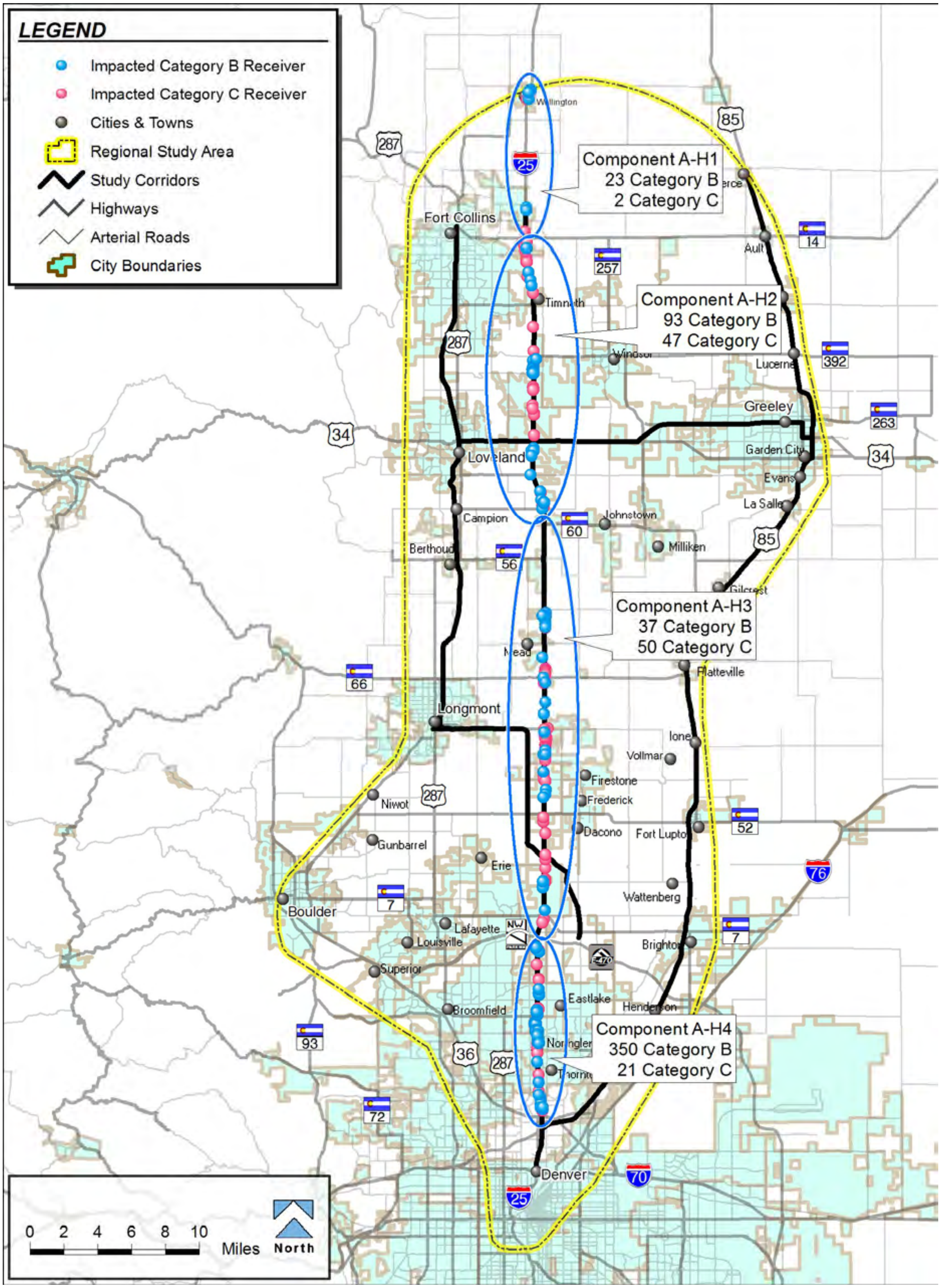
Traffic Noise

For convenience, this discussion is divided into highway traffic noise based on the FHWA process and bus transit noise based on the FTA process.

Highway Noise. Detailed modeling results are presented in **Appendix C**. For Package A, 503 Category B receivers and 120 Category C receivers in the project area would be impacted by traffic noise (**Figure 3.6-7**), which represents three fewer receivers than for the No-Action Alternative (**Table 3.6-6**). Traffic noise impacts are summarized by project component in **Table 3.6-6**.The greatest number of impacted receivers is in the southern end of the corridor, which is also where the greatest number of existing impacted receivers are located. All of the impacted receivers would equal or exceed the NAC; no impacts would result from a 10 dBA increase.

Package A would impact the fewest traffic noise receivers of the alternatives partly because some homes would need to be removed. Results for Package A are similar to the No-Action Alternative results for 2030. Even with the proposed roadway changes, many of the same receivers would be impacted. However, Package A is calculated to impact some different receivers due to wider roads and greater traffic volumes. A few receivers impacted under the No-Action Alternative would be removed under Package A, thereby reducing the number of impacted receivers in a few areas.

Figure 3.6-7 Noise-Impacted Areas for Package A (Year 2030)



Source: FHU project data, 2007.

Residential areas that would be impacted are:

- Wellington East (Wellington) – 16 receivers (same as No-Action Alternative)
- Mountain Range Shadows (Larimer County) – 69 receivers (same as No-Action Alternative)
- Margil Farms (Mead) – 7 receivers (more than No-Action Alternative)
- Singletree Estates (Mead) – 2 receivers (more than No-Action Alternative)
- Isolated/scattered homes along I-25 in Larimer and Weld Counties – 59 receivers (fewer than No-Action Alternative)
- Numerous neighborhoods and isolated receivers abutting I-25 in Broomfield, Thornton, Northglenn, and Westminster, and in Adams County – 350 receivers (same as No-Action Alternative)

In addition, portions of Big Thompson Ponds State Wildlife Area, St. Vrain State Park, Willowbrook Park, Niver Creek Open Space, Civic Center Park, and Thorncreek Golf Course would have traffic noise levels above the CDOT NAC for Category B.

The farthest distance from a modeled road to an impacted receiver in year 2030 would be approximately 500 feet.

Commuter Bus Transit Noise (Components A-T3/A-T4). A total of five new commuter bus parking lots (**Figure 3.6-8**), two potential maintenance facilities and associated access roads were evaluated for noise impacts following FTA procedures (FTA, 2006). The FTA screening process was the first step in the evaluations. Results from the screening showed no potential noise impacts would occur from any of the commuter bus parking lots or maintenance facilities or four of the associated access roads. However, the screening showed that an access road to the proposed 42nd Street lot (**Figure 3.6-8**) needed to be reviewed using the more detailed FTA General Assessment procedures. Results from the general assessment indicated there would be no noise impacts to nearby homes. Therefore, Component A-T3 would not cause traffic noise impacts, and no noise mitigation considerations are necessary.

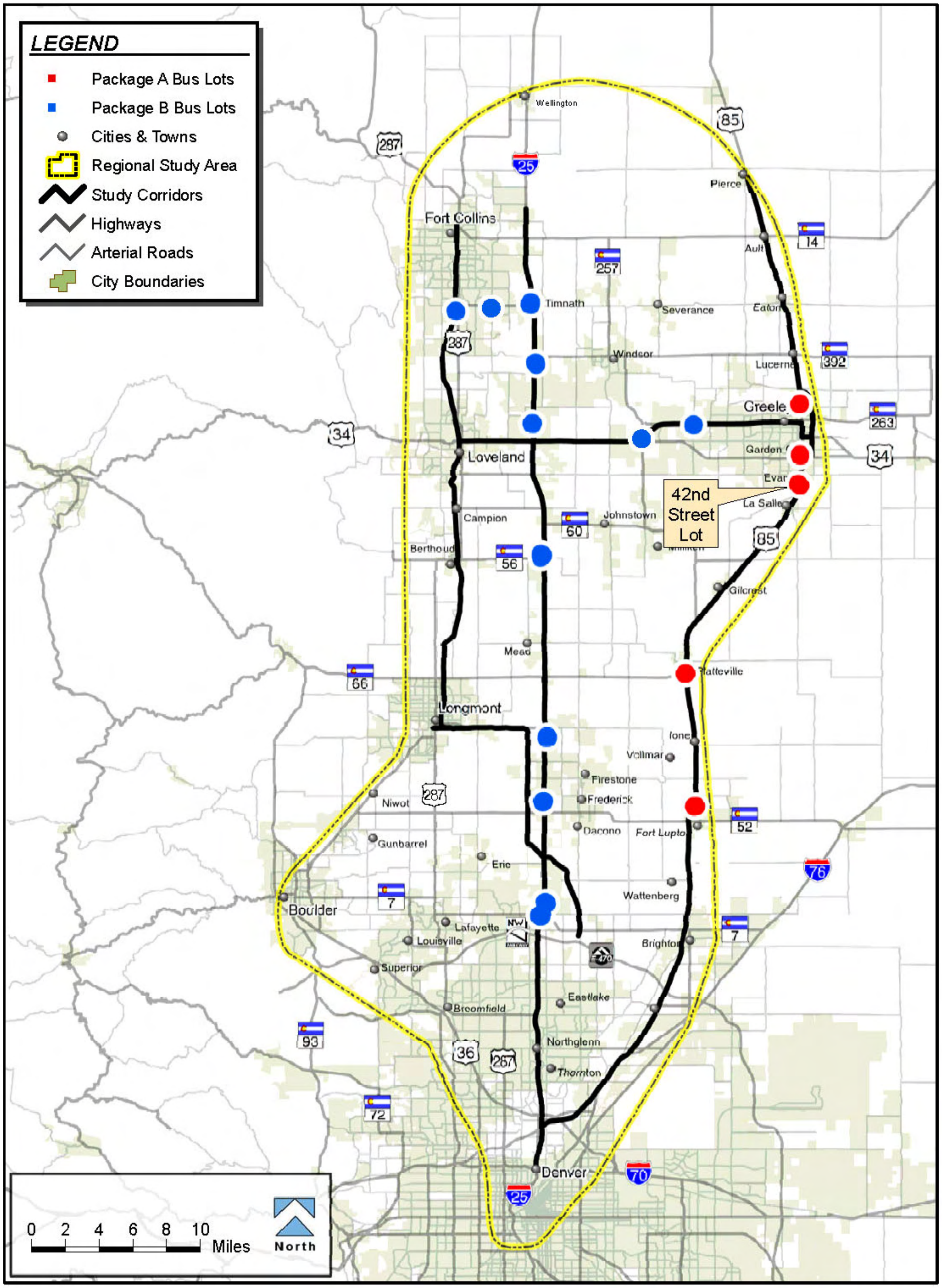
Rail Transit Noise and Vibration

For convenience, this discussion has been divided into rail noise and rail vibration. Both are based on the FTA process.

Rail Transit Noise. The assessment of noise impacts from commuter rail operations is based on a comparison of existing noise conditions with projected future noise conditions following the FTA land use categories. Projected noise exposures in L_{dn} at locations without obstructions near commuter rail operations as a function of distance are illustrated in **Figure 3.6-9**. This figure shows 75 MPH train speeds, which is a worst case situation for the corridor, to ensure that potential rail noise impacts are not underestimated.

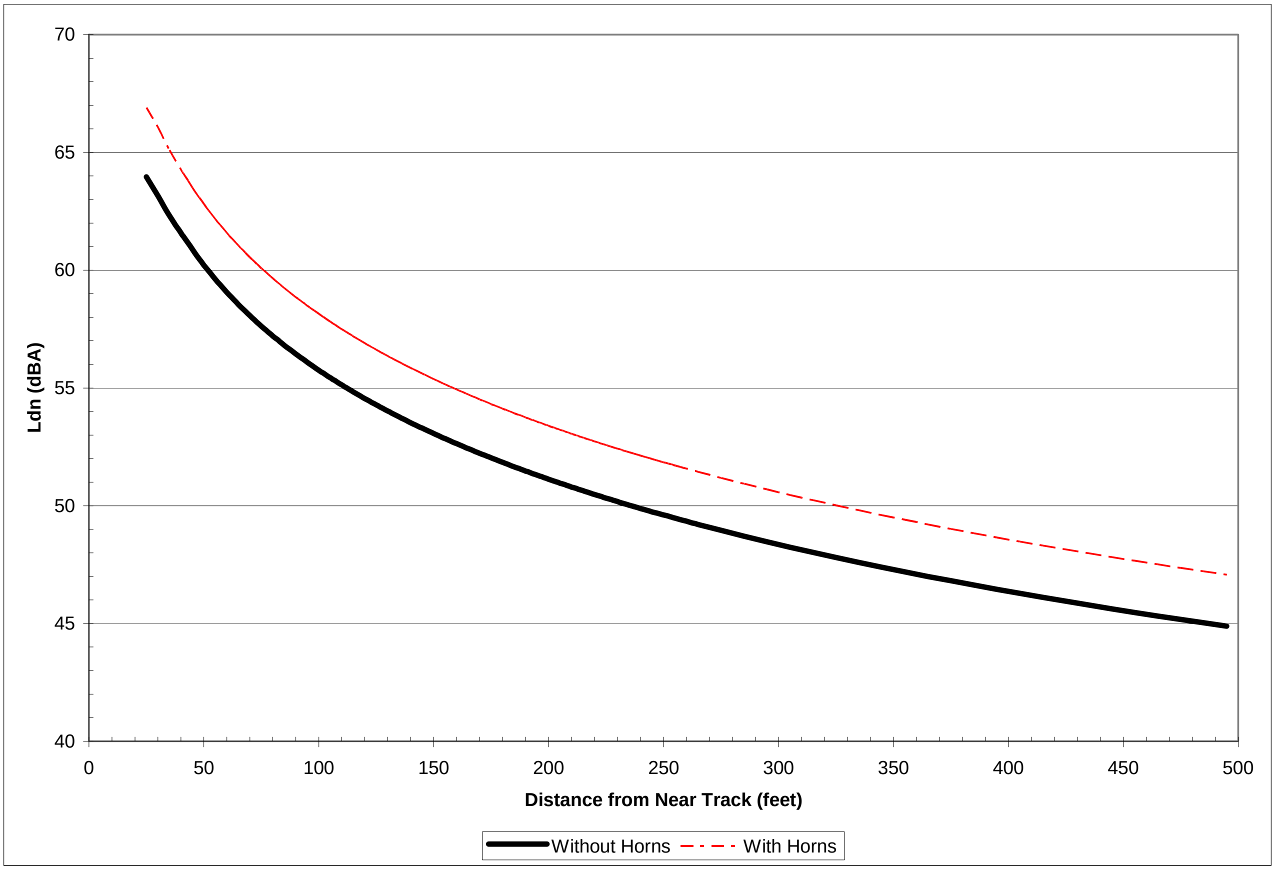
Comparisons of existing and future noise levels are presented in **Table 3.6-7** for residential locations along the rail alignment. Based on a comparison of the calculated project noise level with the impact criteria, **Table 3.6-7** includes an inventory of the number of residences that would be impacted for each area along the corridor. The results indicate that moderate noise impact is predicted at a total of 167 residences along the project rail corridor, due primarily to train horn noise (The train horn noise level assumed for this analysis is 90 decibels). No severe noise impacts are predicted for the corridor.

Figure 3.6-8 Proposed Bus Transit Parking Lots for Packages A and B



Source: FHU project data, 2007.

Figure 3.6-9 Projected Commuter Rail Noise Exposure at 75 MPH Train Speed



Source: HMMH project data, 2007.

Table 3.6-7 Summary of Residential Noise Impacts from Commuter Rail

Location	Side of Track	Distance to Nearest Track (feet)	Train Speed (MPH)		L_{dn} Noise Level (dBA)			Number of Moderate Impacts
			Northbound	Southbound	Existing	Alternative A Total Noise	Increase due to Alternative A	
Commuter Rail Component From Fort Collins To Longmont (Component A-T1)								
Loveland:								
Mountain Ash Place	East	40	37	29	68	70	2	2
E. 23rd Street	East	40	62	43	68	70	2	5
W. 1st Street	West	45	35	35	77	78	1	3
Campion: 35th St. SW	East	40	75	61	63	65	2	1
Longmont:								
21st Ave. – 23rd Ave.	West	55	40	40	69	70	1	9
19th Ave. – 21st Ave.	East	40	40	40	68	70	2	31
17th Ave. – 19th Ave.	East	40	40	40	68	69	1	16
17th Ave. – 19th Ave.	West	55	40	40	69	70	1	14
17th Avenue	East	30	40	40	76	77	1	3
15th Ave. – 17th Ave.	East	50	40	40	74	75	1	2
15th Avenue	East	50	40	40	67	69	2	1
Mtn. View Ave. – 15th Ave.	East	50	40	40	67	68	1	8
11th Ave – Mtn. View Ave.	East	70	40	40	66	67	1	15
9th Ave. – 10th Ave.	East	50	35	35	67	68	1	7
8th Ave. – 9th Ave.	East	50	35	35	74	75	1	2
8th Ave. – 9th Ave.	West	45	35	35	77	78	1	3
Atwood St./3rd – 8th Ave.	East	50	35	35	74	75	1	29
Total for Component:								151
Commuter Rail Component From Longmont To Thornton (Component A-T2)								
Erie: CR 7	East	120	75	75	56	60	4	1
Erie: CR 7	West	135	75	75	56	59	3	1
Dacono: CR 8	East	80	60	60	59	62	3	14
Total for Component:								16

Source: HMMH project data, 2007.

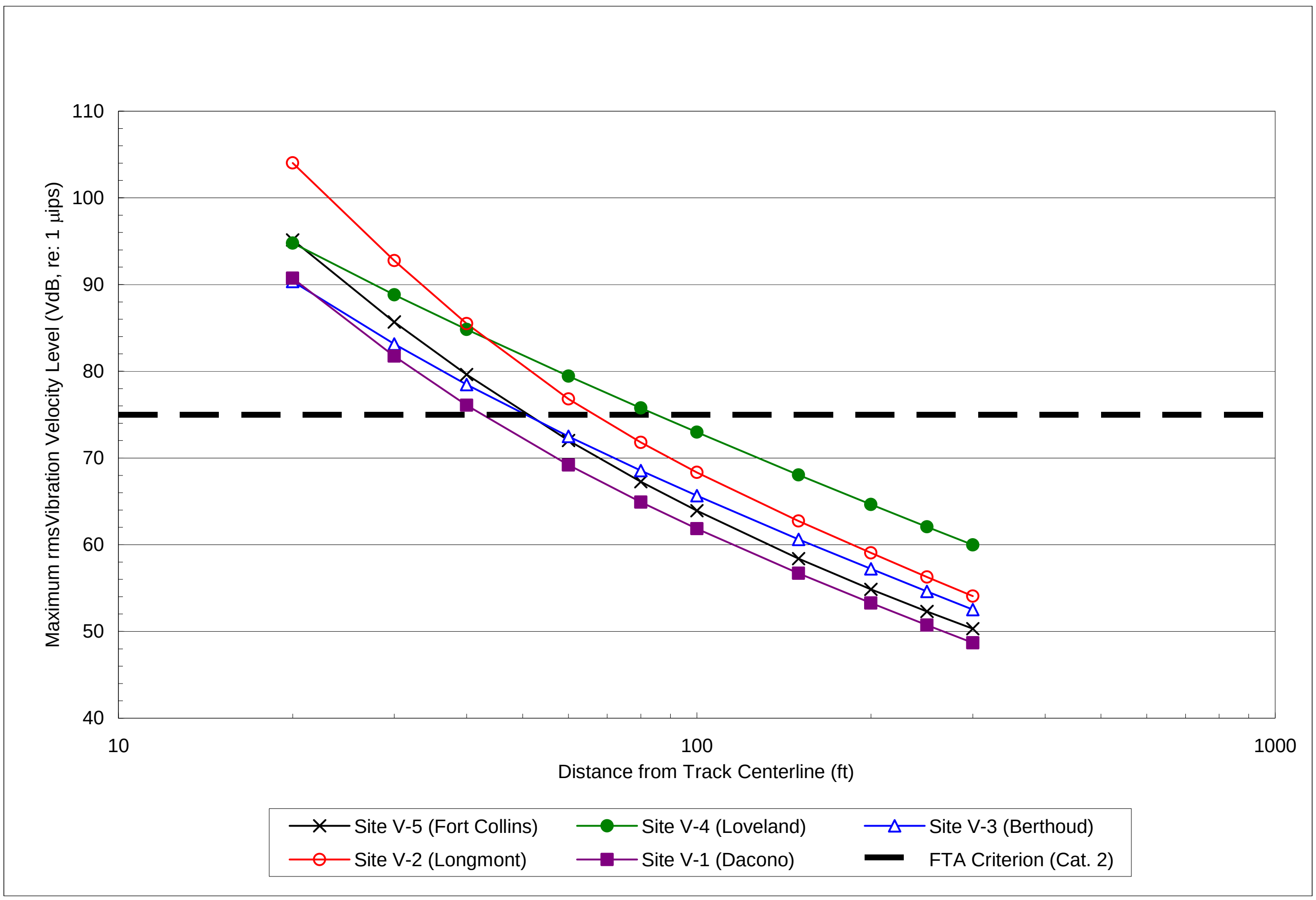
For the rail component from Fort Collins to Longmont (Component A-T1), noise impacts are predicted at 151 residences located within 70 feet of the nearest track; 140 of these are in Longmont. For the rail component from Longmont to Thornton (Component A-T2), noise impacts are predicted for 16 residences within 135 feet of the nearest track; 14 of these are in Dacono.

Rail Vibration. The approach used for assessing vibration impact generally follows the approach used for assessing noise impact, except that existing vibration levels are not considered when evaluating impact (FTA, 2006). For residential buildings with nighttime occupancy, the criterion for the detailed FTA analysis is a maximum vibration velocity level of 72 VdB, measured in one-third octave bands over the frequency range from 8 Hz to 80 Hz. The same receivers used for the rail noise analysis were evaluated for the vibration impact assessment.

The projected maximum overall ground vibration levels from commuter rail operations in various parts of the corridor are shown in **Figure 3.6-10** as a function of distance for the maximum train speed of 75 MPH. This train speed is consistent with the rail noise analysis and ensures that potential impacts are not underestimated. The residential criterion for an FTA general assessment (75 VdB) is also shown. These results indicate that for maximum train speed operation, ground-borne vibration impact would typically be expected to occur at residential buildings located within 40 feet to 80 feet from the track, depending on location in the corridor.

Detailed projections of future vibration levels are presented in **Table 3.6-8** for residential locations along the rail alignment where impacts are anticipated. Based on a comparison of the predicted project vibration level with the FTA impact criterion, results also indicate the number of residences where vibration impact is predicted for each residential area along the corridor. Results indicate that vibration impact is projected for a total of 87 residences within 65 feet of the nearest track, consisting of 37 residences in Loveland and 50 residences in Longmont. Vibration impacts affect 60 residences that would also have rail noise impacts and 27 residences that would not.

Figure 3.6-10 Projected Commuter Rail Ground Vibration Levels at 75 MPH



Source: HMMH project data, 2007.

Table 3.6-8 Summary of Residential Vibration Impact Without Mitigation

Location along Rail Alignment	Side of Track	Distance to Nearest Track (feet)	Train Speed (MPH)		Maximum Vibration Level (VdB re 1 µin./sec)		Total Number of Vibration Impacts
			NB	SB	Alt. A	FTA Criterion	
Commuter Rail Component From Fort Collins To Longmont (Component A-T1)							
Loveland:							
Mountain Ash Place	East	40	37	29	75	72	2
E. 23rd Street	East	40	62	43	79	72	5
W. 10th St – W. 13th St	West	65	54	70	72	72	13
Jackson Avenue	East	40	63	62	79	72	3
E. 12th St – Eisenhower Blvd	East	60	58	67	72	72	6
E. 11th S – E. 12th St	East	50	54	70	74	72	2
E. 10th St – E. 11th S	East	40	53	70	77	72	3
W. 1st Street	West	45	35	35	73	72	3
Longmont:							
E. 17th Av – E. 21st Av	East	40	40	40	75	72	47
E. 15th Av – E. 17th Av	East	30	40	40	84	72	3
Total for Component:							**87**
Commuter Rail Component From Longmont To Thornton (Component A-T2)							
None							0
Total for Component:							**0**

Source: HMMH project data, 2007.

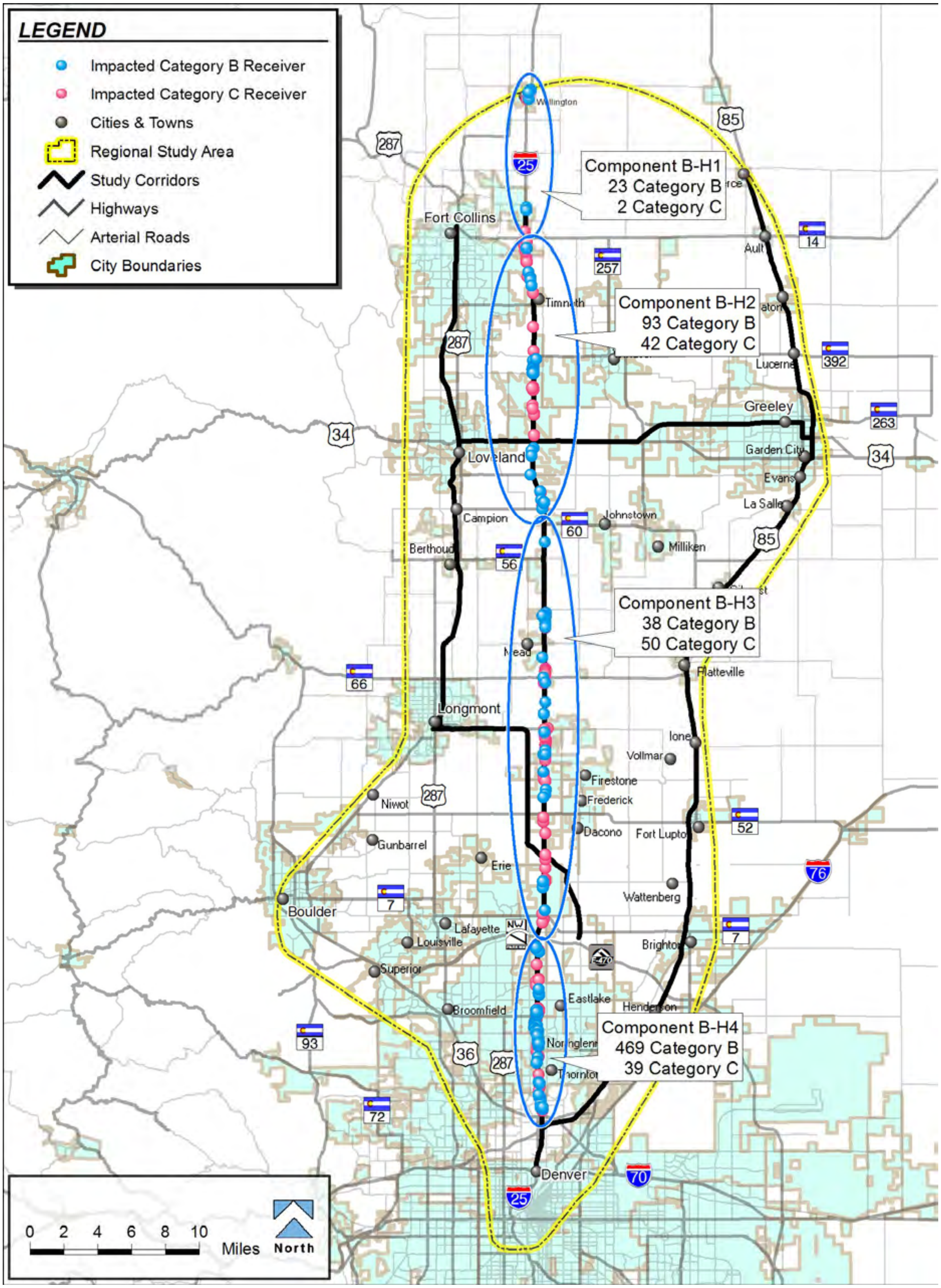
3.6.3.3 PACKAGE B

Only potential impacts from road traffic are relevant for Package B; no rail facilities are included. As described in **Section 3.6.2.4**, traffic vibration would not be a major concern. Therefore, only potential road traffic noise impacts are relevant for Package B and are discussed below. For convenience, this discussion has been divided into highway traffic noise based on the FHWA process and bus transit noise based on the FTA process.

Highway Noise. Detailed modeling results are presented in **Appendix C**. For Package B, 623 Category B receivers and 133 Category C receivers in the project area would be impacted by traffic noise (**Figure 3.6-11**), which represents 130 more receivers than the No-Action Alternative (**Table 3.6-6**). Of these 756 impacts, 755 would result from reaching the NAC and one Category C receiver would increase by 10 dBA over existing conditions. Traffic noise impacts are summarized by project component in **Table 3.6-6**. As with Package A, the majority of these impacts would occur in the southern end of the corridor.

Results for Package B are similar to the No-Action Alternative results for 2030. Even with the proposed roadway changes, many of the same receivers would be impacted. This is largely because both alternatives focus on the I-25 corridor. However, Package B is calculated to impact more receivers due to wider roads and greater traffic volumes. More receivers along I-25 would be impacted primarily because of additional travel lanes. A few of the receivers impacted under the No-Action Alternative would be removed under Package B, thereby reducing the number of impacted receivers in a few areas.

Figure 3.6-11 Noise-Impacted Areas for Package B (Year 2030)



Source: FHU project data, 2007.

The residential areas that would be impacted are:

- Wellington East (Wellington) – 16 receivers (same as No-Action Alternative)
- Mountain Range Shadows (Larimer County) – 69 receivers (same as No-Action Alternative)
- Margil Farms (Mead) – 7 receivers (more than No-Action Alternative)
- Singletree Estates (Mead) – 2 receivers (more than No-Action Alternative)
- Isolated/scattered homes along I-25 in Larimer and Weld Counties – 60 receivers (fewer than No-Action Alternative)
- Numerous neighborhoods and isolated receivers abutting I-25 in Broomfield, Thornton, Westminster, Northglenn and Adams County – 469 receivers (more than No-Action Alternative)

In addition, parts of the Big Thompson Ponds State Wildlife Area, St. Vrain State Park, Willowbrook Park, Niver Creek Open Space, Civic Center Park and Thorncreek Golf Course would have traffic noise levels above the CDOT NAC for Category B.

The farthest distance from a modeled road to a receiver impacted by traffic noise in year 2030 would be approximately 525 feet from I-25.

Package B would impact the most receivers from traffic noise of all the alternatives. This is primarily because it would result in the most vehicles traveling on the widest I-25 profile at the highest speeds, thus producing more traffic noise.

Bus Rapid Transit Noise (Components B-T1/B-T2). For Package B, a total of 12 bus rapid transit parking lot locations (**Figure 3.6-8**), two potential maintenance facilities and the associated access roads were evaluated for noise impacts following the FTA procedures (FTA, 2006). The FTA screening process was the first step in the evaluations and the results from the screening indicated no potential noise impacts would occur from any of the bus rapid transit elements. For all the parking lot locations, maintenance facilities and the associated access roads, adjacent buildings were found to be beyond the perimeter distance where noise impacts would occur. Therefore, it has been concluded that Package B bus rapid transit elements would not cause traffic noise impacts, and noise mitigation considerations are not necessary.

3.6.4 Mitigation Measures

The results from noise measurements and modeling for the Draft EIS indicate that many receivers would be impacted by noise or vibration from each of the alternatives. Therefore, noise reduction actions for the impacted areas were investigated (CDOT, 2002; FHWA, 1995; FTA, 2006). It is important to note that impacted areas are not guaranteed mitigation measures under either the CDOT or FTA guidelines, but mitigation measures for the areas must be evaluated.

Noise and vibration impacts from the alternatives affected multiple geographic areas and multiple land uses. Several types of mitigation were considered. Noise barriers are a common mitigation action and were evaluated. There currently are several noise mitigation barriers (installed by other projects) within the I-25 corridor. Other kinds of mitigation also were considered. The overall feasibility and reasonableness of noise reduction actions that provide a minimum acceptable mitigation benefit for the impacted receivers were evaluated and these actions were then either recommended or not. For convenience, the mitigation discussion is divided between road actions and rail actions.

3.6.4.1 Existing Noise Barriers

There currently are several traffic noise barriers in the project area (**Figure 3.6-3**) primarily south of E-470. These barriers are comprised of both berms and walls. The walls consist of both older "first generation" CDOT wooden walls and newer masonry walls. The barriers were included in the traffic noise modeling for the Draft EIS and the model results showed that the existing barriers are effective at reducing traffic noise to the homes behind the barriers.

There are two important considerations within the Draft EIS regarding the existing barriers: new construction from the project that would require removal of an existing barrier, and the fate of deteriorating existing walls not touched by new construction. First, if any of the existing barriers must be removed for construction, the removed barrier would be replaced with an equivalent or better barrier as part of Package A or Package B. Second, the wooden CDOT barriers along I-25 are deteriorating and their long-term effectiveness is in doubt. Therefore, any of the CDOT wooden barriers remaining in the project corridor at the time of construction of this project would be replaced, but only if Package B is the selected alternative. (Package B is the only alternative including improvements near the wooden barriers.)

The details of a replacement barrier would be determined during final design of the construction element relevant to the barrier. It is important to understand that these barrier replacements would not be new noise mitigation actions because the old barriers are products of previous projects. Barrier replacement is considered to be the restoration of infrastructure disturbed by construction. Therefore, the feasibility and reasonableness of replacement barriers was not evaluated for this project.

3.6.4.2 Non-Barrier Traffic Noise Mitigation Evaluations

CDOT guidelines require the evaluation of several mitigation options other than noise barriers. For reasons described below, barriers appear to be the only viable mitigation action and were the only mitigation evaluated through modeling.

Traffic management measures, such as lane closures or reduced speeds, could reduce noise but do not appear to be reasonable for the roads of primary interest to the project. One of the reasons for the road improvements in the regional study area is to enhance intra-regional and inter-regional traffic flow. I-25 is a major regional and national highway and closing lanes would conflict with its function. While reducing vehicle speeds could reduce traffic noise, it would not be consistent with the function of an interstate highway.

Changes in horizontal alignments of the roads near the impacted receivers could reduce noise but have limited possibilities. This action would require snaking I-25 around current developed areas; however, removing unnecessary curves that reduce the safety of a high-speed interstate highway is one of the project goals for I-25. Also, many of the impacted Category B receivers are in areas that are developed on both sides of I-25, limiting possible horizontal realignments. Moving I-25 horizontally away from some impacted receivers could reduce traffic noise in those areas but could transfer the impacts to other neighboring areas or require disruptions of adjoining property uses. Wholesale relocation of I-25 from its current corridor would have profound cost, environmental, and functional ramifications, so horizontal relocation of I-25 for noise reduction is neither feasible nor reasonable.

Changes in vertical alignments could reduce noise. Changes in vertical alignments were included for some parts of some alternatives in the project area. For example, the current elevation profiles would be reversed at the SH 56 and SH 402 interchanges with I-25. However, wholesale changes in corridor road elevations could have secondary impacts on connecting or adjoining roads that would not be reasonable or desirable. In summary, vertical elevation changes were evaluated, but vertical realignments just to reduce traffic noise are not practical.

Noise buffer zones could reduce noise. Many of the newer developments along I-25 include these, but many of the older residential areas do not. Often, past development has occurred purposely near the roads for access, which left little or no space for a buffer. In many places, there generally is little available undeveloped land along the project roads that could be used for a noise buffer zone or a vegetative planting area that would provide substantial noise benefit.

Pavement types and surfaces can affect traffic noise. Research efforts to learn more about the long-term noise benefits of different pavement types and surface treatments are ongoing. Quieter pavement types could be preferred for the project if and when the requirements for safety, durability, and other considerations are met. However, they cannot be used as a mitigation action under the noise reduction evaluation because they are not a “permanent” solution to tire noise.

3.6.4.3 Traffic Noise Barrier Evaluations

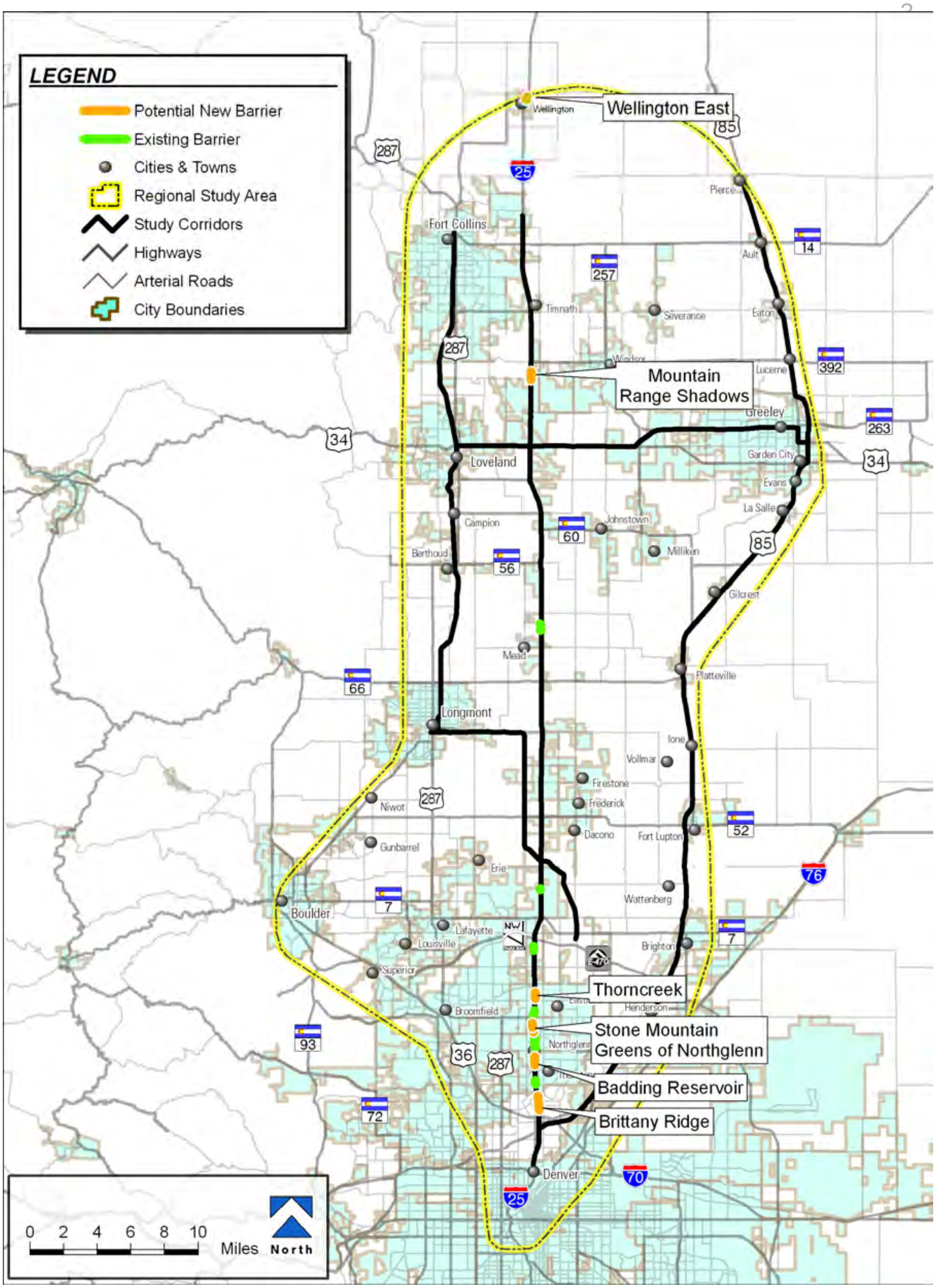
In addition to the existing barriers, noise barriers in some new areas could be appropriate for an alternative. To permit the evaluation of potential noise barriers, computer models of barriers protecting the impacted areas were developed and the models were re-run to assess barrier effectiveness (FHU, 2008a). Each potential barrier was assessed for effectiveness and feasibility. CDOT’s goal for noise barrier benefits is a reduction of 10 dBA with a minimum reduction of 5 dBA. If the minimum parameters for an effective barrier were met and the barrier was feasible, the barrier was evaluated through a reasonability assessment according to CDOT guidance (CDOT, 2002). The feasibility and reasonableness of each barrier determined whether the barrier has been recommended for the project.

The locations evaluated for new noise barriers are shown in **Figure 3.6-12**. Typical barrier locations would be on road right-of-way, but off right-of-way locations (farther away from I-25 and on someone else’s property) were also evaluated where physical conditions warranted additional investigation (FHU, 2008a). In instances where only part of a neighborhood would be impacted by noise, barriers benefiting the entire neighborhood were evaluated for thoroughness.

It is important to note that the noise barriers could be either earth berms or constructed walls because either material could be effective. Berms can be very effective but occupy considerably more space than comparable walls. Throughout the project area, the impacted receivers tend to be rather close to the project roads. This usually makes earth berms impractical or impossible choices for the noise barriers. Barriers more than 25 feet tall were not considered due to the impractical structural requirements.

The topography of the corridor plays a very important role in the overall noise environment and in noise mitigation results. Physical placement of a barrier is a consideration. The preferred barrier location is on CDOT right-of-way for several reasons. In some places in the project area, the land adjoining CDOT right-of-way may be generally incompatible to convert to noise mitigation uses, such as a park or wildlife area. Also, there would be long-term ownership, access, maintenance, and cost concerns for CDOT if a barrier is placed on someone else’s property or if more property

Figure 3.6-12 Locations of Traffic Noise Barriers Evaluated



Source: FHU project data, 2007.

needs to be acquired just for a barrier. Nevertheless, placement of traffic noise barriers off CDOT right-of-way may be possible in select situations (FHU, 2008a).

CDOT guidelines state that a traffic noise mitigation action is unreasonable if the cost-benefit is more than $4,000/receiver/decibel of noise reduction (CDOT, 2002). This is based on an assumed cost of $30/square foot of barrier. However, cost-benefit is not the only consideration for reasonableness (CDOT, 2002).

Isolated receivers (e.g., dispersed homes) are a special case worth noting. For a barrier protecting a single receiver to be reasonable, the barrier size could be no more than about 670 square feet if it reduces noise by 5 dBA or no more than about 1,300 square feet if it reduces noise by 10 dBA. It is a rare situation where barriers of such small sizes provide that much noise reduction. Therefore, it is usually not reasonable to construct barriers for isolated receivers. There would be approximately 60 isolated Category B receivers, primarily north of SH 7, in the project area and barriers for two example locations were evaluated to represent the entire group (**Table 3.6-9**).

Results of the feasibility and reasonableness evaluation are shown in **Table 3.6-9**. The noise barriers summarized below were located on CDOT property, generally at the edge of the road right-of-way.

Some but not all of the barriers evaluated are recommended for construction for some of the alternatives at this point in time (**Table 3.6-9**). Traffic noise barriers were assessed to be feasible and reasonable for the following locations and are therefore recommended for construction (**Table 3.6-9**):

- Wellington East – Packages A and B
- Mountain Range Shadows – Packages A and B
- Thorncreek Village – Package B only
- Stone Mountain Apartments – Package B only
- Greens of Northglenn – Package B only
- Badding Reservoir extension – Package B only
- Brittany Ridge extension – Package B only

The locations for these recommended noise barriers are illustrated in **Figure 3.6-13** through **Figure 3.6-18**, respectively. The design requirements for noise barriers in a given location may vary by alternative because of differences in road designs.

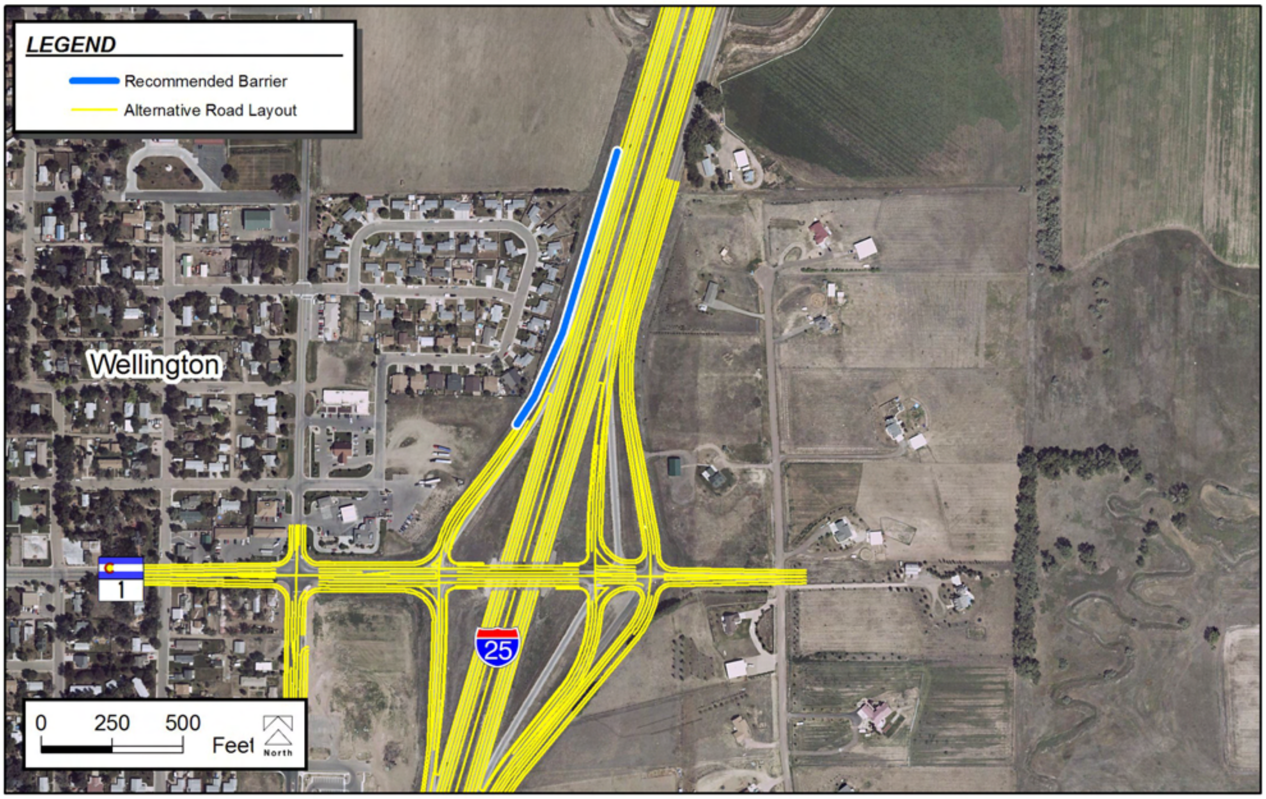
These recommendations are based on the current project road designs. The recommendations are all for barriers within road rights-of-way. If the final designs in the future differ from that assumed in these evaluations, corresponding adjustments to the mitigation evaluations may be required. More details on the noise barriers can be found in *Traffic Noise and Vibration Impact Assessment* (FHU, 2008a).

Table 3.6-9 Traffic Noise Mitigation Barrier Summary

Noise Impacted Category B Area	Barrier Height (feet)	Barrier Length (feet)	Cost Analysis ($/receiver/dB)*	Reduction (dBA)	Feasible?	Reasonable?	Recommended?	Comment
Wellington East	10-12	1,000	1,900	3-12	Yes	Yes	Yes	Recommended for Packages A and B.
Mountain Range Shadows	12	2,500	2,400	3-7	Yes	Yes	Yes	Recommended for Packages A and B.
Near LCR 20E	14	470	18,000	0-11	Yes	No	No	Cost-benefit was calculated to be prohibitive.
Johnsons Corner Campground	10	675	11,200	3-9	Yes	No	No	Cost-benefit was calculated to be prohibitive.
Margil Farms	16	2,200	7,000	3-6	Yes	No	No	Cost-benefit was calculated to be prohibitive.
Singletree Estates	16	3,200	41,000	3-5	Yes	No	No	Cost-benefit was calculated to be prohibitive.
St.Vrain State Park	14	2,700	75,000	5	Yes	No	No	Cost-benefit was calculated to be prohibitive.
Near WCR 22	12	550	16,500	6	Yes	No	No	Cost-benefit was calculated to be prohibitive.
Near WCR 2050	16	675	27,000	6	Yes	No	No	Cost-benefit was calculated to be prohibitive.
Thorncreek Village	14	1,850	3,800	3-7	Yes	Yes	Yes	Recommended for Package B only.
Stone Mountain Apartments	14	1,300	1,300	3-10	Yes	Yes	Yes	Recommended for Package B only.
Greens of Northglenn	10-12	600	1,100	3-8	Yes	Yes	Yes	Recommended for Package B only.
Badding Reservoir extension	12	900	4,100	3-8	Yes	Yes	Yes	Recommended for Package B only.
Brittany Ridge extension	12	1,300	3,000	3-7	Yes	Yes	Yes	Recommended for Package B only.
Isolated receiver #1 (Wellington)	10	720	31,000	7	Yes	No	No	An example of an isolated receiver. Cost-benefit was calculated to be prohibitive.
Isolated receiver #2 (SH 7)	8-12	550	24,000	7	Yes	No	No	An example of an isolated receiver. Cost-benefit was calculated to be prohibitive.

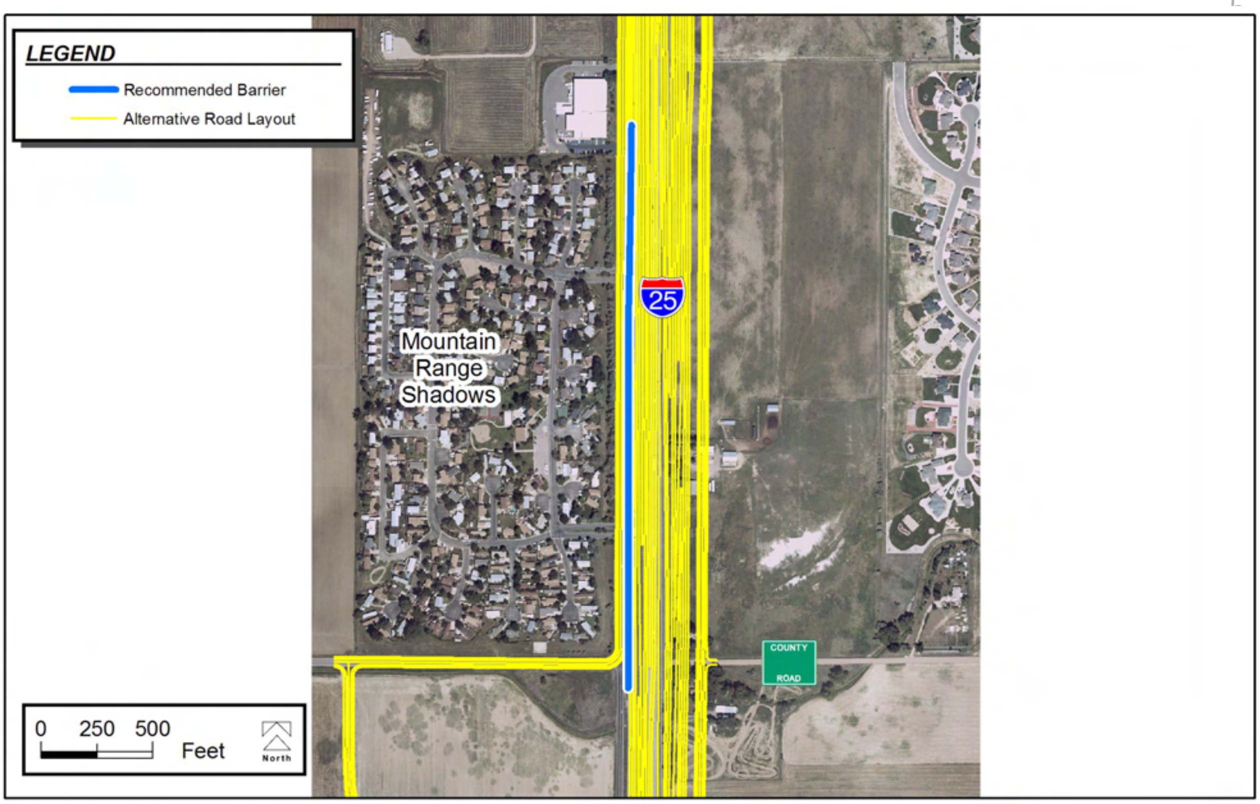
Source: FHU project data, 2007.
* Assumes cost of $30/square foot of barrier surface.

Figure 3.6-13 Recommended Noise Barrier near Wellington



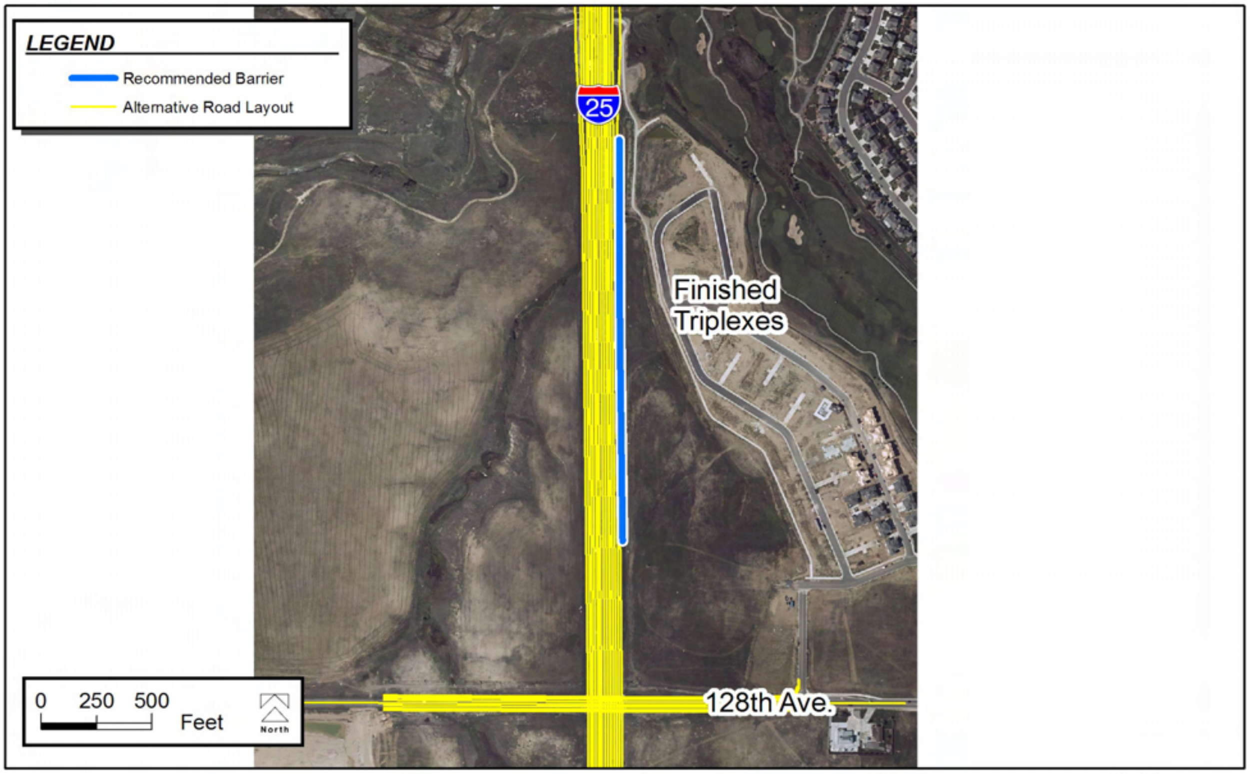
Source: FHU project data, 2007.

Figure 3.6-14 Recommended Noise Barrier near Mountain Range Shadows



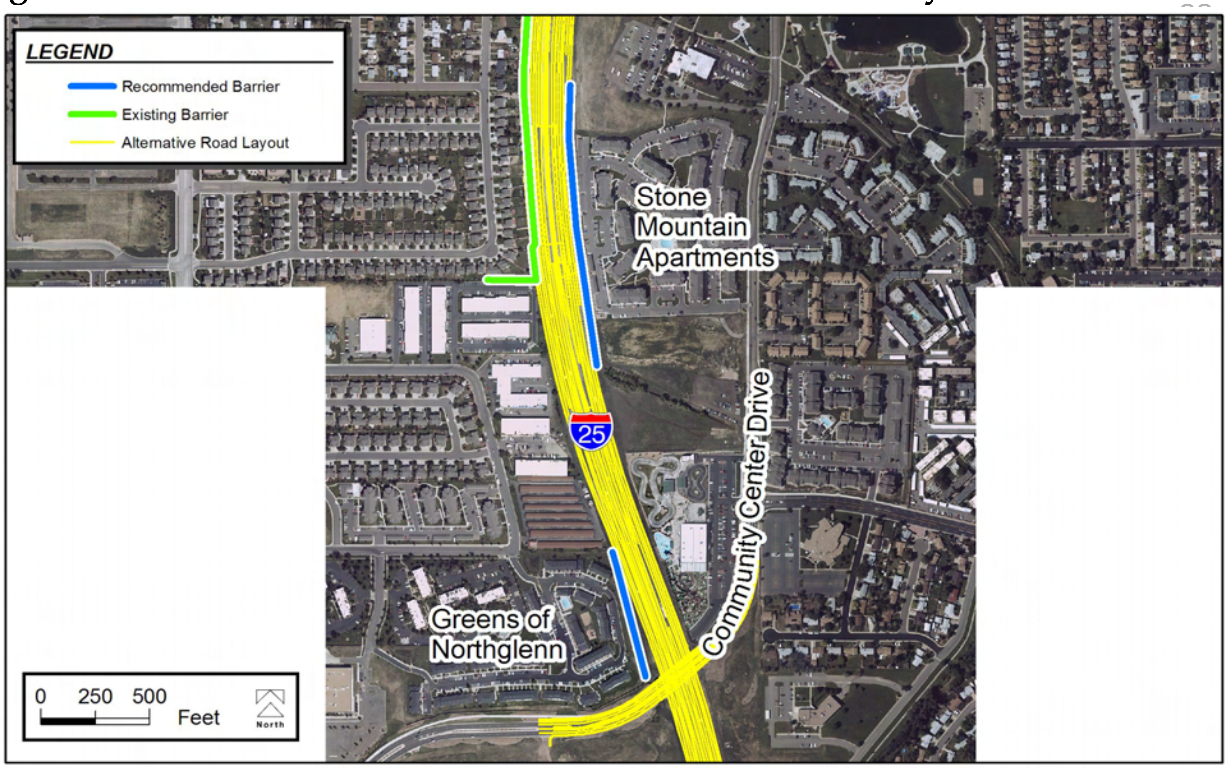
Source: FHU project data, 2007.

Figure 3.6-15 Recommended Noise Barrier near Thorncreek Village



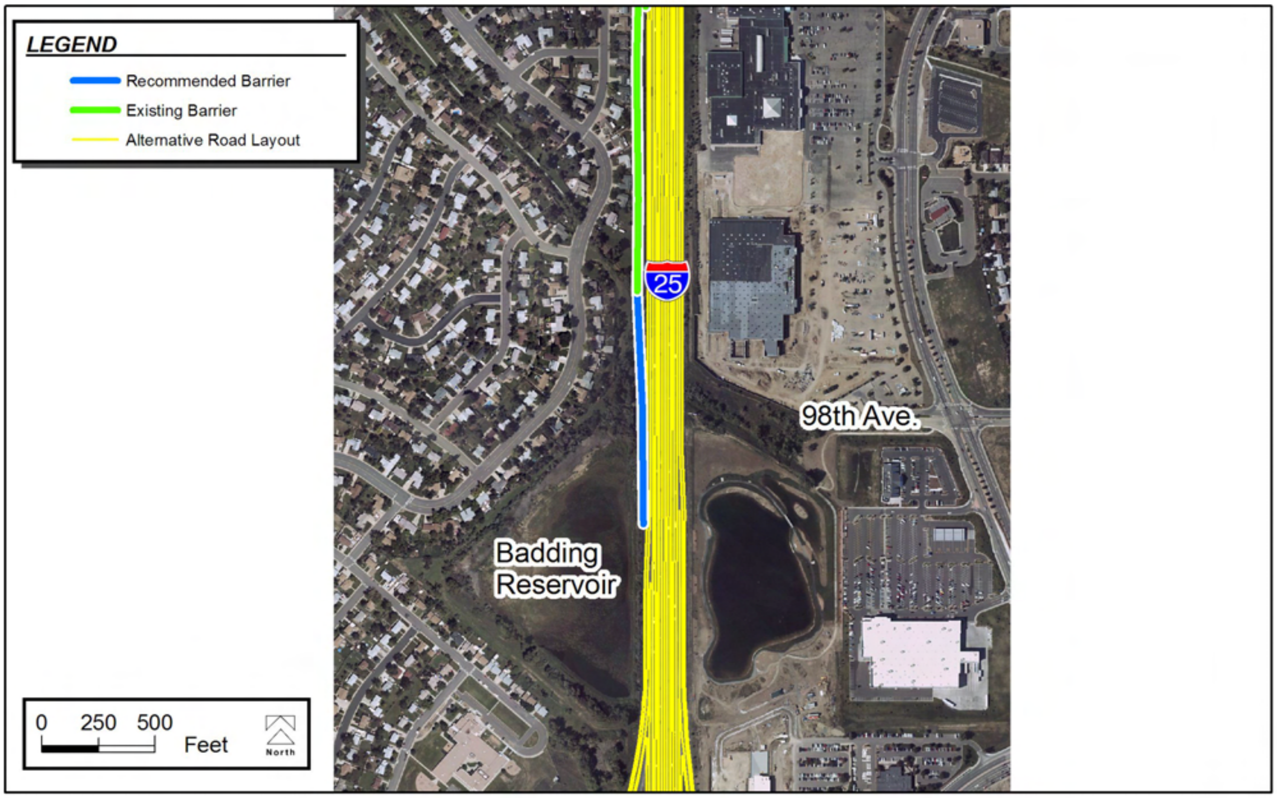
Source: FHU project data, 2007.

Figure 3.6-16 Recommended Noise Barriers near Community Center Drive



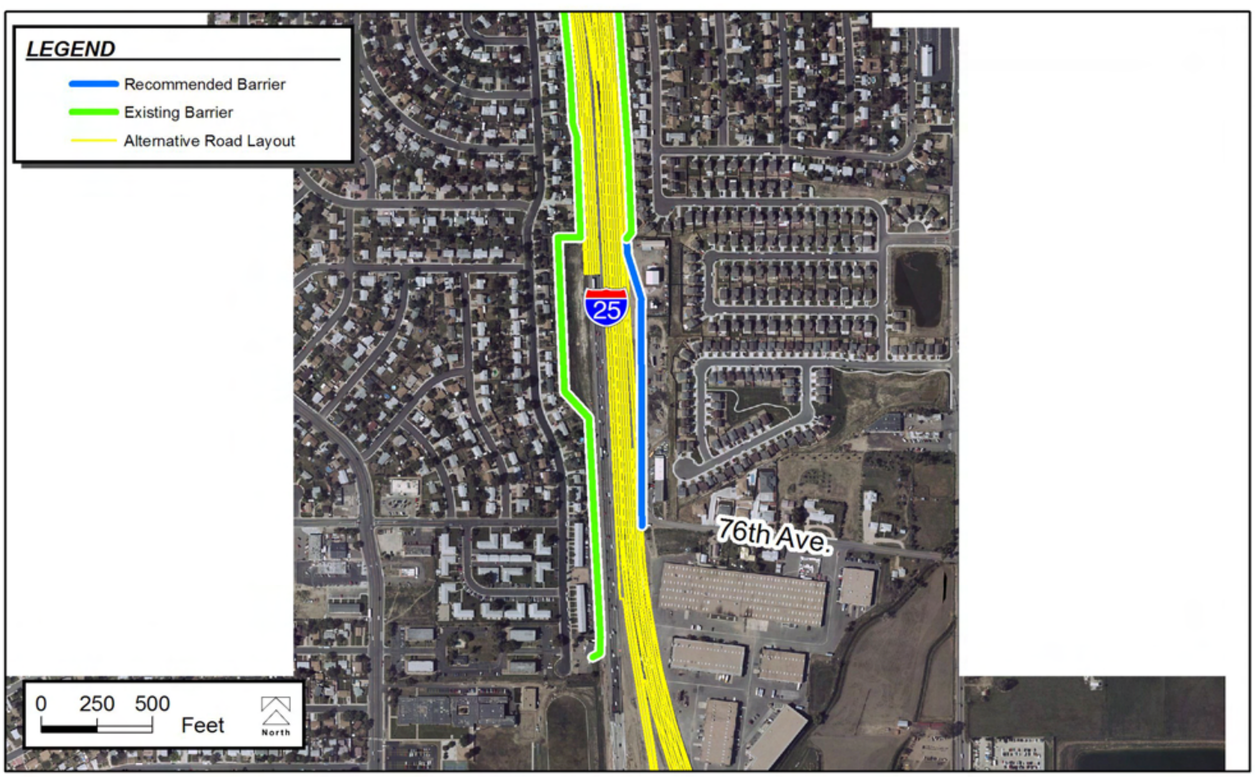
Source: FHU project data, 2007.

Figure 3.6-17 Recommended Noise Barrier near Badding Reservoir



Source: FHU project data, 2007.

Figure 3.6-18 Recommended Noise Barrier near Brittany Ridge



Source: FHU project data, 2007.

3.6.4.4 RAIL NOISE AND VIBRATION MITIGATION EVALUATIONS

Potential mitigation measures for reducing commuter rail noise and vibration impacts are described below.

Rail Noise

Possible rail noise mitigation actions include the following:

- **Limiting Use of Train Horns**. The Federal Railroad Administration (FRA) has issued new regulations (FRA, 2006) regarding safety at railroad crossings, which would apply to the portion of the North I-25 alignment shared with BNSF freight operations. These regulations may affect noise impacts to sensitive receptors near grade crossings. An option for reducing such impacts under the FRA regulation would be to establish "quiet zones" at grade crossings. In a quiet zone, train operators would sound warning devices (e.g., horns) only in emergency situations rather than as a standard operational procedure because of safety improvements at the at-grade crossings. Establishing a quiet zone requires cooperative action among the municipalities, CDOT, and FRA. The municipalities are key participants as they must initiate the request to establish the quiet zone through application to FRA. To meet safety criteria, major improvements are typically required at grade crossings. These may include modifications to the streets, raised medians, warning lights, four-quadrant gates, and other devices. The current assumptions for Package A are that these safety devices would be included to allow local municipalities to apply for a quiet zone if they desire. The FRA regulation also authorizes the use of automated wayside horns at crossings with flashing lights and gates as a substitute for the train horn. While activated by the approach of trains, these devices are stationary at the grade crossings, thereby limiting the horn noise exposure area to the immediate vicinity of the grade crossing. In the event that it is not possible to eliminate the train horns, reduced sound emission horns can be considered. Although the establishment of quiet zones or the use of wayside horns would be very effective noise mitigation measures, considerable design analysis and coordination efforts with the BNSF Railroad and local communities along the corridor would be required.

- **Noise Barriers**. This is a common approach to reducing noise impacts from surface transportation sources. The primary requirements for an effective noise barrier are that: (1) the barrier must be high enough and long enough to break the line-of-sight between the sound source and the receiver, (2) the barrier must be of an impervious material with a minimum surface density of 4 lb/sq. ft., and (3) the barrier must not have any gaps or holes between the panels or at the bottom. Many materials meet the requirements, so the barrier type is usually dictated by aesthetics, durability, cost, and maintenance. Noise barriers for commuter rail systems typically range in height from 8 to 12 feet.

- **Building Insulation**. Sound insulation of residences and institutional buildings has been widely applied around airports but has seen limited application for transit projects. Although this approach has no effect on exterior noise, it may be a choice for sites where noise barriers are not feasible or desirable, and for buildings where indoor sensitivity is of most concern. Substantial improvements in building sound levels (e.g., 5 to 10 dBA) can often be achieved by adding an extra layer of glazing to the windows, sealing any holes in exterior surfaces that act as sound leaks, and providing forced ventilation and air-conditioning so that windows do not need to be opened.

- **Special Trackwork at Crossovers and Turnouts.** Because the impacts of rail wheels over rail gaps at track-turnout locations increases airborne noise by about 6 dBA, turnouts can be a major source of noise impact. If turnouts cannot be located away from sensitive areas, special rail treatments, such as spring-rail, flange-bearing, or moveable-point frogs may be used in place of standard rigid frogs. These devices allow the flangeway gap to remain closed in the main traffic direction and reduce rail wheel noise.

FTA guidelines state that in implementing noise impact criteria, severe impacts should be mitigated if at all practical (FTA, 2006). At the moderate impact level, more discretion can be used and other project-specific factors should be included in considering mitigation. These factors can include the predicted increase over existing noise levels, the types and number of noise-sensitive land uses affected, existing outdoor-to-indoor sound insulation and the cost-effectiveness of mitigating the noise. However, FTA also states that there is a stronger need for mitigation if a project is proposed in an area currently experiencing high noise levels (e.g. with L_{dn} above 65 dBA) from surface transportation sources. Areas along the project corridor from Fort Collins to Longmont meet this condition. In these areas, the existing noise exposure is dominated by existing freight train and horn noise, with L_{dn} levels typically ranging from 65 dBA to 75 dBA. In such cases, FTA indicates that impacts predicted in the moderate range should be treated as if they were severe in terms of mitigation.

In view of the above considerations, most, if not all, of the predicted rail noise impacts should be mitigated. The results of the noise analysis suggest that the most effective mitigation measure would be to eliminate all train horn noise near residential areas by establishing quiet zones. It is estimated that this mitigation measure could eliminate noise impacts at all but one residence along the project corridor, so quiet zones are the preferred mitigation for train noise. Package A includes enhancing each at-grade crossing such that an application for a quiet zone could be made by the local government.

A less effective approach is the use of wayside horns or reducing train horn sound levels. If reducing horn noise by any of these methods is not feasible and reasonable, noise barriers to shield residences may be considered. As shown in **Table 3.6-10**, it is estimated that a total of 15,100 lineal feet (i.e. about three miles) of noise walls could potentially reduce or eliminate noise impacts at all but eight residences along the project corridor. Potential noise mitigation measures will need to be further evaluated during later project design to determine approaches that are both feasible and reasonable.

Vibration

Beyond ensuring that the vehicle wheels and track are well maintained, there are several approaches that can be considered to reduce ground-borne vibration from commuter rail operation, as described below:

- **Ballast Mats**. A ballast mat consists of a pad made of rubber or rubber-like material placed on an asphalt or concrete base with the normal ballast, ties and rail on top. The reduction in ground-borne vibration provided by a ballast mat is strongly dependent on the frequency content of the vibration and design and support of the mat.

- **Tire Derived Aggregate (TDA)**. Also known as shredded tires, a typical TDA installation consists of an underlayment of tire shreds or chips wrapped with filter fabric, covered with ballast. Tests suggest that the vibration attenuation properties of this treatment are midway between that of ballast mats and floating slab track. While this is a low-cost option, it has only recently been installed on two U.S. light rail transit systems (San Jose and Denver's Southeast Corridor) and its long-term performance is unknown.

Table 3.6-10 Potential Rail Noise Barrier Mitigation Locations

Location along Alignment	Side of Track	Barrier Length (ft)	Number of Residences Protected
E. 23rd St – Mountain Ash Pl (Loveland)	East	1400	7
35th Street SW (Campion)	East	400	1
21st Avenue – 23rd Avenue (Longmont)	West	900	9
17th Avenue – 19th Avenue (Longmont)	West	1300	14
17th Avenue – 21st Avenue (Longmont)	East	2500	47
15th Avenue – 17th Avenue (Longmont)	East	700	5
Mountain View Av – 15th Av (Longmont)	East	1300	9
11th Av – Mountain View Av (Longmont)	East	1500	15
9th Avenue – 10th Avenue (Longmont)	East	600	7
8th Avenue – 9th Avenue (Longmont)	East	600	2
7th Avenue – 8th Avenue (Longmont)	East	500	8
5th Avenue – 6th Avenue (Longmont)	East	500	8
4th Avenue – 5th Avenue (Longmont)	East	500	7
3rd Avenue – 4th Avenue (Longmont)	East	500	6
CR 8 (Dacono)	East	1500	14
TOTAL:		**15,100**	**159**

Source: HMMH project data, 2007.

- **Under-Tie Pads**. This treatment consists of resilient rubber pads placed underneath the ties. Although tests using the Amtrak Acela high-speed train indicated that such pads under the concrete ties provided significant vibration attenuation over a wide frequency range, experience with this treatment is limited.

- **Floating Slabs**. Floating slabs consist of thick concrete slabs supported by resilient pads on a concrete foundation; the tracks are mounted on top of the floating slab. Most successful floating slab installations are in subways, and their use for at-grade track is rare. Although floating slabs are designed to provide vibration reduction at lower frequencies than ballast mats, they are extremely expensive.

- **Special Trackwork at Crossovers and Turnouts**. Vehicle wheels hitting rail gaps at track turnout locations increases ground-borne vibration by about 10 VdB, so they are a major source of vibration impact when located in sensitive areas. If turnouts cannot be located away from sensitive areas, an alternative is to use special rail treatments, such as spring-rail, flange-bearing, or moveable-point frogs in place of standard rigid frogs at turnouts. These devices allow the flangeway gap to remain closed in the main traffic direction and reduce vibration.

- **Property Acquisitions or Easements**. Additional options for avoiding vibration impacts (and noise impacts) are to purchase residences likely to be impacted by train operations or to acquire easements for such residences by paying the homeowners to accept the future train vibration conditions. These approaches are usually taken only in isolated cases where other mitigation options are infeasible, impractical, or too costly.

Vibration impacts that exceed FTA criteria are considered to be significant and to warrant mitigation, if mitigation is reasonable and feasible. To evaluate the effectiveness of mitigation for the project, typical vibration reductions for the potential mitigation measures were applied, on a one-third octave frequency basis, to the projected ground vibration spectra at locations where vibration impact is anticipated. The results indicate that the installation of 7,700 lineal feet of TDA (shredded tires) beneath each of the tracks at the locations listed in **Table 3.6-11** could eliminate all of the projected vibration impacts, so this is the preferred mitigation action. It is also estimated that under-tie pads could eliminate all but 13 of the vibration impacts. These measures will need to be further investigated during project design to evaluate their true feasibility.

Table 3.6-11 Potential Ground–Borne Vibration Mitigation Locations

Location along Alignment	Survey Station Location	Length (feet)
Mountain Ash Pl (Loveland)	1926 – 1930	400
E. 23rd Street (Loveland)	1916 – 1922	600
Jackson Avenue (Loveland)	1888 – 1892	500
10th St – Eisenhower Blvd (Loveland)	1865 – 1885	2000
W. 1st Street (Loveland)	1830 – 1836	600
E. 15th Avenue (Longmont)	1043 – 1046	300
E. 15th Ave – E. 21st Ave (Longmont)	1053 – 1086	3300
TOTAL:		**7,700**

Source: HMMH project data, 2007.

3.6.4.5 Impacted Receivers After Recommended Mitigations

For a noise or vibration mitigation action to be recommended, it must be both feasible and reasonable according to the evaluation guidelines. In many of the areas with traffic noise impacts, effective noise barriers were not feasible or the cost-benefit value for an effective barrier was prohibitive (**Table 3.6-9**). Therefore, not all impacted areas have been recommended for noise mitigation.

The recommended mitigation actions would serve to reduce noise and vibration impacts for each of the EIS build alternatives (**Section 3.6.3**). The results differ between the alternatives for a number of reasons, including:

- Different road designs within the same alignment
- Different traffic volumes and speeds
- Different vertical road profiles
- Inclusion of transit rail impacts

The recommended mitigation actions would not eliminate all of the calculated noise impacts; some noise impacts would remain. These remnant noise impacts are described below for each of the Draft EIS alternatives.

No-Action Alternative

The No-Action Alternative does not include any new noise mitigation actions, so there would be no change in the traffic noise impacts (**Section 3.6.3.1**). The same 505 Category B receivers and 121 Category C receivers would still be impacted by traffic noise. It should be noted that noise levels at 85 unmitigated Category B modeled locations would be at or above the severe impact level of 75 dBA (CDOT, 2002).

Package A Alternative

Several highway traffic noise mitigation actions are recommended for Package A along I-25 north of SH 7 (**Section 3.6.4.2**). The recommended mitigation measures would remove the traffic noise impact from these receivers:

- Wellington East – 16 Category B receivers
- Mountain Range Shadows – 37 Category B receivers

An estimated 450 Category B receivers and 120 Category C receivers would still be impacted by traffic noise. It should be noted that noise levels at 18 unmitigated Category B modeled locations would be at or above 75 dBA, 67 fewer locations than the No-Action Alternative.

Package A also includes transit rail noise and vibration impacts. The preferred mitigation actions of quiet zones and TDA (**Section 3.6.4.3**) would remove rail noise and vibration impacts from:

- Noise – 166 receivers
- Vibration – 87 receivers

An estimated one receiver would still be impacted by rail noise and no receivers would be impacted by rail vibration.

Package B Alternative

Several noise mitigation actions are recommended for Package B (**Section 3.6.4.2**). The recommended mitigation measures would remove the traffic noise impact from these receivers:

- Wellington East – 16 Category B receivers
- Mountain Range Shadows – 37 Category B receivers
- Thorncreek Village – 5 Category B receivers
- Stone Mountain Apartments – 32 Category B receivers
- Greens of Northglenn – 16 Category B receivers
- Badding Reservoir extension – 9 Category B receivers
- Brittany Ridge extension – 17 Category B receivers

An estimated 491 Category B receivers and 133 Category C receivers would still be impacted by traffic noise. It should be noted that noise levels at 17 unmitigated Category B modeled locations would be at or above 75 dBA, 68 fewer locations than the No-Action Alternative.

3.6.5 Construction Noise

Adjoining properties in the project area could be exposed to noise from construction activities from the build packages. Construction noise differs from traffic and rail noise in several ways:

- Construction noise lasts only for the duration of the construction event, with most construction activities in noise-sensitive areas being conducted during hours that are least disturbing to adjacent and nearby residents.
- Construction activities generally are of a short-term nature and, depending on the nature of the construction operations, could last from seconds (e.g., a truck passing a receiver) to months (e.g., constructing a bridge).
- Construction noise is intermittent and depends on the type of operation, location, and function of the equipment, and the equipment usage cycle.

Construction noise is not assessed in the same way as operational traffic noise; there are no CDOT NACs for construction noise. Construction noise would be subject to relevant local regulations and ordinances, and any construction activities would be expected to comply with them.

Construction noise impacts would be somewhat limited because the majority of the corridors do not abut residential areas. To address the temporary elevated noise levels that may be experienced during construction, standard mitigation measures would be incorporated into construction contracts, where it is feasible to do so. These would include:

- Exhaust systems on equipment would be in good working order. Equipment would be maintained on a regular basis, and equipment may be subject to inspection by the project manager to ensure maintenance.
- Properly designed engine enclosures and intake silencers would be used where appropriate.
- New equipment would be subject to new product noise emission standards.
- Stationary equipment would be located as far from sensitive receivers as possible.
- Most construction activities in noise-sensitive areas would be conducted during hours that are least disturbing to adjacent and nearby residents.

3.6.6 Summary

A number of noise and vibration impacts were calculated for the alternatives (**Section 3.6.3**). Potential mitigation actions for Package A and B impacts were evaluated (**Table 3.6-9, Section 3.6.4,** and **Table 3.6-11**).

From the feasibility and reasonableness evaluations for the barriers, traffic noise barriers are recommended for the following locations:

- Wellington East – Packages A and B
- Mountain Range Shadows – Packages A and B
- Thorncreek Village – Package B only
- Stone Mountain Apartments – Package B only
- Greens of Northglenn – Package B only
- Badding Reservoir extension – Package B only
- Brittany Ridge extension – Package B only

The preferred mitigation measures for Package A transit rail impacts are quiet zones at the rail crossings and 8,400 lineal feet of TDA.

These results are preliminary and based on specific project designs and assumptions. If the designs in the future differ from those used in these evaluations, corresponding adjustments to the mitigation evaluations may be required. The analysis and recommendations will be reviewed following identification and refinement of a preferred alternative for the project. Consideration of the placements of noise barriers will continue through the final design of the selected alternative. Mitigation actions for transit rail will also require further consideration if Package A is selected because the preferred mitigation actions will require the involvement of several local governments.

These recommended mitigation actions would not eliminate all the predicted impacts, therefore, some residual noise impacts would remain (**Section 3.6.4.5**). This is due primarily to the closeness of many receivers to I-25 and to the presence of many isolated receivers for which mitigation is not feasible and reasonable.

Somewhat similar traffic noise results were produced by the alternatives because the road alignments share several existing roadways; however, only Package A has rail impacts. In the order of increasing noise and vibration impacts, the ranking of the alternatives (without mitigation) are: No-Action Alternative, Package B, and Package A.