Noise Analysis Technical Memorandum
State Highway 7 Project, Phase 2

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and

Colorado Department of Transportation
Region 4
Greeley, Colorado

August 2007

NOISE ANALYSIS
TECHNICAL MEMORANDUM
STATE HIGHWAY 7 PROJECT, PHASE 2

C&B PROJECT NO.: 070702.401.1.0001

Prepared for:

MULLER ENGINEERING

and

COLORADO DEPARTMENT OF TRANSPORTATION
REGION 4
GREELEY, COLORADO

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FINAL REPORT

August 6, 2007

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1.0 Introduction

The Colorado Department of Transportation is currently considering improvements for State Highway 7 from Cherryvale Road to 75th Street. The study area is located within the Boulder County in Colorado, just east of the City of Boulder. A small portion of the western edge of the study area falls within the city limits of Boulder. A detailed traffic noise analysis was conducted to determine the potential impact to receptors along the roadway for the first phase of the project in November 2001.

This technical report adheres to both the Colorado Department of Transportation's (CDOT) and Federal Highway Administration (FHWA) policy. The use of CDOT and FHWA policy has been used in this analysis to determine noise impact on existing and future planned development for the second phase of the project.

The purpose of this report is to document this work effort, including results and mitigation recommendations. This document provides the following information:

- Study area definition
- Description of the proposed action
- Overview of noise standards and fundamentals,
- Description of the methodology employed for the analysis,
- Description of the traffic data utilized in the analysis,
- Summary of the results,
- Findings from the assessment of feasibility and reasonableness of mitigation, and
- Recommended mitigation measures and next steps.

All model input and output files have been included in the appendix.

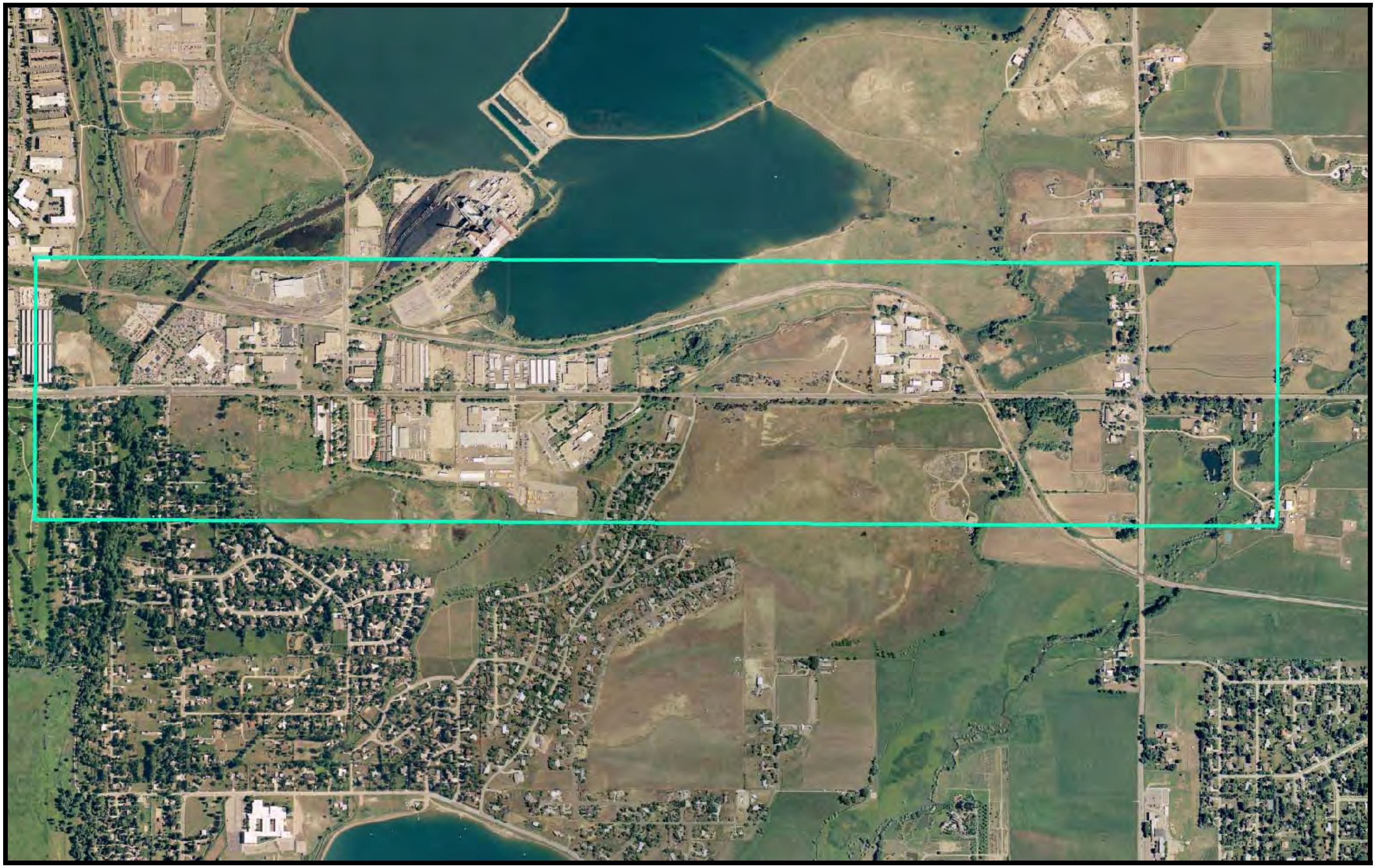
2.0 Study Area

Figure 1 graphically defines the study area that was evaluated for this noise analysis. From the Cherryvale Road/SH7 intersection, the study area extends approximately 3.0 kilometers (1.9 miles) east along SH7 to the SH7/75th Street intersection. Both intersections were included in the analysis.

The major roadway within the study area is SH7, a continuous two-lane roadway with an east-west alignment. At Cherryvale Lane, SH7 widens to four lanes as it heads west into Boulder.

Existing land uses within the study area primarily include residential and commercial developments with some light industrial. Commercial developments within the study area include office, business, restaurant, school, and motel, all generally one or two stories tall. Residential uses primarily consist of single-family dwelling units. The study area also includes a church, which is located at the northwest corner of the SH7/75th Street intersection. The Boulder Technical Education Center and the Arapahoe Ridge High School are located to the south of SH7 along a 0.5-kilometer (1/3-mile) stretch of the roadway. These land uses are defined as "noise-sensitive" activity categories in Section 7.1. The adjacent land uses to the study area are generally at the same elevation as SH7.

Figure 1: Project Study Area



3.0 Proposed Action

The proposed transportation improvements evaluated consist of two alternatives, named the Two-Lane Alternative and the Four-Lane Option. The Two-Lane Alternative has two thru lanes in each direction from Cherryvale Road to the Boulder Valley School District entrance. In the westbound direction, there is a continuous right turn acceleration/deceleration lane that also functions as a bus bypass lane from east of 63rd to Cherryvale Road. In the eastbound direction, there is a continuous right turn acceleration/deceleration lane between the business access west of the Boulder Valley School District to east of the BVSD signal. From the BVSD signal to Westview Drive there is one thru lane westbound and two thru lanes eastbound. The second eastbound thru lane is dropped as a right turn lane at Westview Drive. There is a right turn lane in the westbound direction at Valtec lane. The two-lane section (one lane in each direction) continues past the Burlington Northern Railroad Crossing. After the railroad crossing, the roadway section widens to two lanes in each direction to the 75th Street improvements. The Four-Lane Option is identical to the Two-Lane Alternative between Cherryvale Road and the Boulder Valley School District entrance. The Four-Lane Option retains two lanes in each direction to 75th Street with deceleration lanes at Westview Drive and Valtec lanes.

For both alternatives, the roadway is an urban section with curb and gutter between Cherryvale Road and Westview Drive. Between Westview Drive and the Burlington Northern Railroad crossing, The Two-Lane Alternative is a rural section with 10-foot shoulders. Between the railroad crossing and 75th Street, SH7 is an urban section with curb and gutter; and between Cherryvale and 63rd, there is a raised median with left turn lanes. East of 63rd to the 75th Street improvements is a continuous 16-foot left turn lane.

Both alternatives require the existing hill east of Westview Drive to be lowered approximately thirteen feet. Retaining walls have been incorporated adjacent to the Burlington Northern Railroad crossing and as required to minimize impacts to private parking or private access roads.

4.0 NOISE STANDARDS & FUNDAMENTALS

There are three primary regulations that assist in the determination of noise impacts and when it is applicable to provide mitigation for impacted receivers:

- *Federal Highway Administration's (FHWA) Procedures for Abatement of Highway Traffic Noise and Construction Noise (23 CFR Part 772)*
- *Federal Highway Administration, Highway Traffic Noise Analysis and Abatement, Policy and Guidance, June 1995*
- *Colorado Department of Transportation, Noise Analysis and Abatement Guidelines, December 2002*

These documents collectively establish noise thresholds based on land use. Land uses are categorized and hourly noise level maximums have been established. A complete list of Noise Abatement Criteria (NAC) and each land use threshold has been included in **Table 1**.

Table 1: Noise Abatement Criteria (NAC)
Hourly A-Weighted Sound Level (dBA)

Activity Category	CDOT Leq (h) (hourly)	Description of Activity Category
A	56 (exterior)	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.
B	66 (exterior)	Picnic areas, recreation areas, playgrounds, active sports areas, parks, residences, motels, hotels, schools, churches, libraries, and hospitals.
C	71 (exterior)	Developed lands, properties or activities not included in Categories A or B above.
D	--	Undeveloped lands.

Source: Colorado Department of Transportation, *Noise Analysis and Abatement Guidelines, December 2002.*

The following terms are used to quantify impacts and define sound levels. The following is a brief summary of key terminology:

Decibel — A decibel is a unit of measure for sound. Decibels are presented with the units dB(A).

dB(A) — dB(A) represents the noise levels in decibels measured with an A-weighted frequency. The A- weighting corresponds to the A-scale on a standard sound level instrument that closely approximates frequencies that the human ear can detect.

Leq(h) — Leq(h) is defined as the sound level for a specified time period. For normal human hearing, the actual sound level measurement is modified by applying A weighting. The A-weighted sound level is the most widely used measure of environmental noise.

Noise impacts occur when existing or future predicted noise levels exceed the levels shown in **Table 1**. Impact also occurs when future noise levels “substantially” exceed existing noise levels by 10 decibels.

Table 2 provides a list of common outdoor noise levels. These noise levels can be used as a point of reference for those presented in **Table 1**.

Table 2: Common Outdoor Noise Levels

Common Outdoor Noise Levels	Noise Level (dBA)
Diesel Truck at 15 meters	90
Noisy Urban Daytime	80
Commercial Area	65
Quiet Urban Daytime	50
Quiet Urban Nighttime	40
Quiet Suburban Nighttime	35
Source: "*Guide on Evaluation and Abatement of Traffic Noise*" (American Association of State Highway and Transportation Officials, 1993).	

5.0 Methodology

The major work elements associated with this traffic noise analysis included the following items:

1. Inventory of land uses (identify "noise-sensitive" developments).
2. Collect field noise measurements, traffic counts and speeds.
3. Validate the noise model.
4. Existing conditions model runs using STAMINA. Peak hour conditions used to represent worst-case noise scenario.
5. Future year model runs using STAMINA.
6. Determination of noise impacts.
7. Consideration of feasible and reasonable noise abatement measures.

The methodology employed for this analysis is consistent with both FHWA and CDOT guidelines for analyzing traffic noise. FHWA's noise prediction model (STAMINA 2.0) was utilized for this analysis, using Colorado 1995 vehicle noise emission factors. The basic inputs to noise modeling include roadway network layout, site characteristics, traffic volume projections, fleet mix, and vehicular operating speeds. Roadway and residential receiver geometry was included based on a preliminary civil design CAD file and aerial photography.

6.0 Traffic Data

Traffic counts of existing conditions and traffic volumes from the 2030 traffic model of the Denver Regional Council of Governments (DRCOG) were used to derive peak hour volumes in the noise models for this study. The existing (year 2004) average daily traffic (ADT) is approximately 18,600 total vehicles. Future (year 2030) ADT is projected to be approximately 25,600 total vehicles. A vehicle mix of 97% automobile, 2% buses and medium trucks, and 1% heavy trucks was used in the analysis. The morning and evening split of traffic in the eastbound direction and westbound direction was determined by modeled traffic patterns. The detailed traffic data used in the analysis is included in the Appendix A.

7.0 Noise Analysis

7.1. Land Use Inventory

Several areas of noise-sensitive land uses exist along the project corridor. A mobile home park, a church, and single-family residential units are all present along the corridor. A total of 9 locations were field monitored for noise while 39 receivers were modeled in order to represent the Category B and C receivers along the corridor.

Two residences located south of SH7 and between Cherryvale and 63rd Streets are located on parcels that are slated to become the site of Cherryvale Commons, a future commercial development. These sites are represented in the models as Receptor SW10. Receptor SW9 in the same area, has been torn down since field measurements were taken at the start of the project. Residences located north of SH7 in the 6300 block are vacant and the buildings are in conditions that render them uninhabitable at this time. They are represented in the models as Receptors NW3 and NW4.

7.2. Existing Noise Levels—Noise Measurements

Noise measurements were taken at nine different sites (see **Figure 2**) to determine the existing noise conditions. The on-site measurements ranged from 60.6 to 69.9 dB(A). All on-site noise measurements were taken during the PM (4:00 PM – 6:00 PM) peak periods. Field measurements at the monitoring locations were generally taken at the closest point of the structure or closest outdoor use area to the roadway. **Table 3** summarizes the results of the on-site measurements. Locations for existing monitoring locations are included on **Figure 3**. The existing noise levels do not approach or exceed the NAC, as defined in **Table 1**, at any of the monitoring locations.

Table 3: Existing Noise Levels

Site	Category	Location	Monitored Noise (dBA)	Modeled Noise (dBA)
1	B	Church at northwest corner of SH7/75th St.	65.3	63.8
2	C	Restaurant at southwest corner of SH7/75th St.	63.5	62.8
3	B	Church at southwest corner of SH7/Westview Dr.	60.9	59.5
4	B	Trailers at BVSD site	62.8	60.2
5	B	Tech school at 6500 Arapahoe Rd. (SH7)	61.8	60.4
6	B	Abandoned residence at 6437-6439 Arapahoe Rd. (SH7)	61.1	62.2
7	B	Trailer park southwest of SH7/63rd St.	60.6	64.9
8	C	Commercial site at 6123 Arapahoe Rd. (SH7)	67.5	65.6
9	C	Historic structure at northeast corner of SH7/63rd St.	69.9	70.7

Figure 2: Noise Modeling Sites

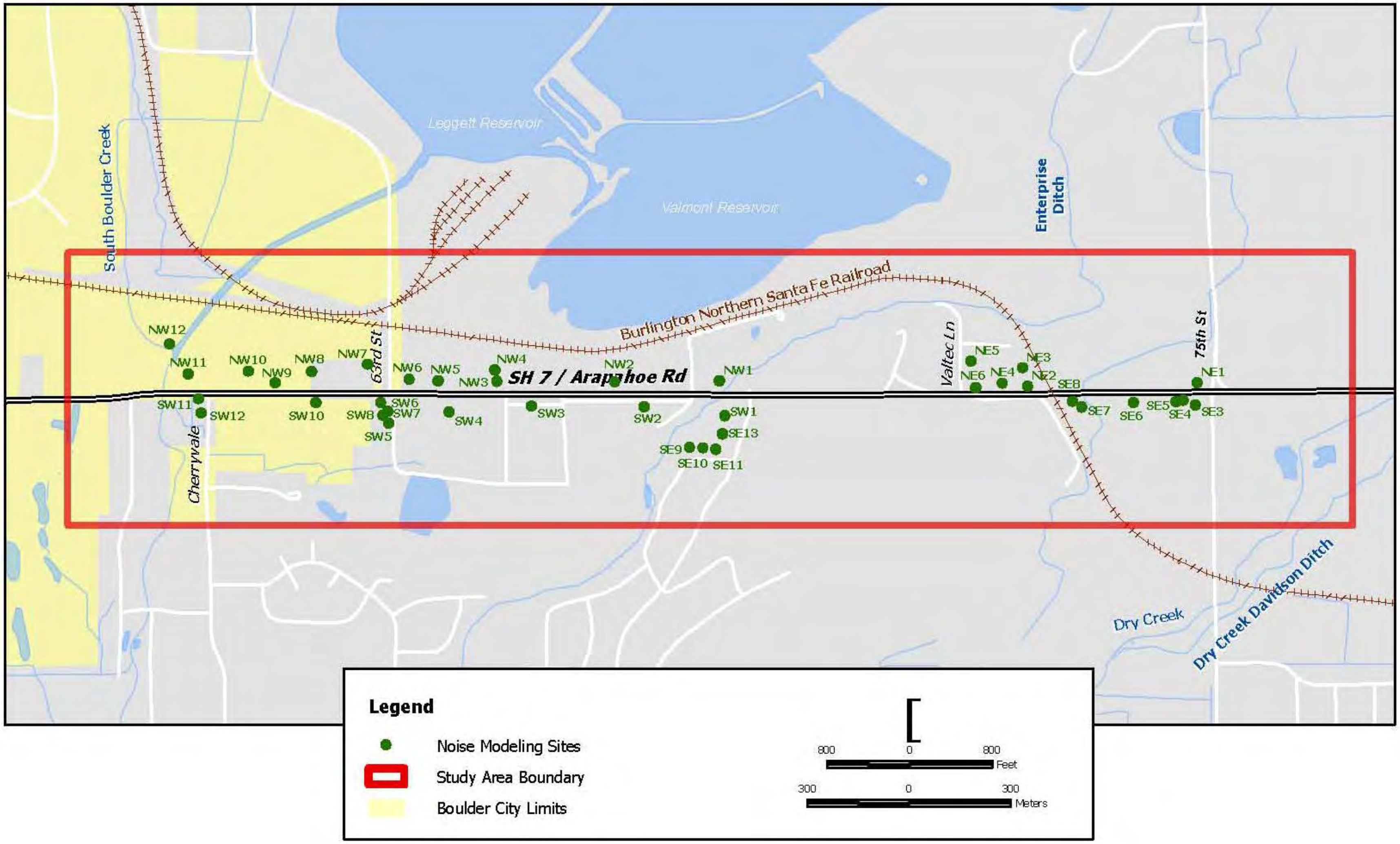


Figure 3: Noise Monitoring Locations

7.3. NOISE MODEL VALIDATION

FHWA's noise prediction model (STAMINA 2.0) was utilized to model existing and future noise conditions. The model calculates existing and future noise levels during the peak traffic period based on such variables as traffic volume, traffic speed, vehicle mix, and receptor distance from the roadway. Because the project was initiated prior to release of the FHWA approved TNM noise evaluation model, STAMINA 2.0 will be utilized for all analyses.

In order to accurately model future noise conditions, the STAMINA noise model must be validated to emulate the existing field conditions. The model run for existing conditions resulted in noise levels that were within 3 dB(A) as required by CDOT guidelines, except at one location. At location 7, the field measurements were approximately four decibels lower than the noise level predicted by the model. This difference is probably due to the storage units on either side of this location blocking some of the sound waves from actually reaching the receptor. Although the model tended to over-predict noise levels at this location, overall the noise model was found to perform acceptably for this project.

7.4. EXISTING CONDITIONS NOISE MODEL RUNS

Noise levels were modeled at 39 locations along SH7 to represent the receptors along the project corridor. These locations are listed in **Table 4**. According to the model, there are two residential and one commercial noise level above the NAC in the existing conditions model.

7.5. PREDICTION OF FUTURE NOISE LEVELS

Future conditions for the 2030 were modeled at the same 39 locations along SH7 as in the existing conditions model. The roadway alignments of both alternatives being evaluated were modeled. Morning and evening peak hour traffic volumes represent the predicted 2030 vehicle numbers. The No Action Alternative carries the same traffic volumes as the Two-Lane Alternative. Roadway differences between the two conditions include widening of shoulders and addition of auxiliary and turn lanes, which did not contribute significant changes to the noise regime for this area. The lowering of the road profile (elevation), widening and extensive road cuts at the hill by the BNRR railroad crossing increases local noise readings in the Four-Lane Option. Noise modeling results have been summarized in **Table 4**.

7.6. IMPACT ASSESSMENT

Two-Lane Preferred Alternative. According to the model, the Two-Lane Preferred Alternative would cause four of the modeled locations to have noise levels above the NAC in 2030. These 4 receptors approach or exceed the NAC with predicted future noise levels increasing between 3 and 5 dB(A). One of the sites, Receptor SW10 representing two residences, would experience noise levels above the impact NAC for Category B if either build alternative was constructed. Mitigation should be considered for this location. Receptors NE2, NE6 and SW7 would be acquired and removed, and therefore no mitigation needs to be considered for these locations. Therefore, mitigation does not need to be considered for this location. If, however, the condition of the structure should be improved and become habitable prior to construction of either build alternative, the location should be analyzed at that time for possible mitigation.

All remaining receivers falling below the NAC have modeled noise levels ranging from 53.8 to 67.2 dB(A) for Category B receivers and from 56.0 to 71.3 dB(A) for Category C receivers. Of these receivers, the greatest projected increase over existing noise levels is 3.4 dB(A).

Table 4: Noise Model Results (Peak Hour 2004 and 2030)

Site ID	Activity Category (#)*	AM 2004 Modeled Noise Level (dBA)	PM 2004 Modeled Noise Level (dBA)	AM 2030 No Action and 2-Lane Alternatives Modeled Noise Level (dBA)	PM 2030 No Action and 2-Lane Alternatives Modeled Noise Level (dBA)	AM 2030 Four Lane Option Modeled Noise Level (dBA)	PM 2030 Four-Lane Option Modeled Noise Level (dBA)	Preferred Alternative Impact
NE1	B(1)	62.3	61.5	62.6	63.2	**66.0**	64.8	No
NE2	C(1)	**71.8**	**71.0**	Acquired	Acquired	Acquired	Acquired	No
NE3	B(1)	58.9	59.0	60.5	60.4	61.5	61.0	No
NE4	C(1)	66.9	66.5	68.0	68.4	66.7	65.7	No
NE5	C(1)	56.6	56.8	58.2	58.0	65.6	64.8	No
NE6	C(1)	70.7	69.9	Acquired	Acquired	Acquired	Acquired	No
SE3	C(1)	56.8	58.4	59.5	57.8	63.8	65.0	No
SE4	C(1)	59.2	61.4	62.6	60.3	66.7	68.5	No
SE5	B(2)	58.0	60.2	61.4	59.1	65.6	64.8	No
SE6	B(1)	60.3	60.6	62.0	61.7	65.0	**66.4**	No
SE7	B(1)	59.8	60.5	61.9	61.2	61.6	61.6	No
SE8	B(1)	62.4	63.3	64.7	63.8	65.0	**66.4**	No
SE9	B(1)	52.6	53.3	54.2	54.1	-	-	No
SE10	B(1)	52.5	53.2	54.2	54.0	-	-	No
SE11	B(1)	52.4	53.1	54.1	53.8	-	-	No
SE13	B(1)	54.6	55.3	56.3	56.1	-	-	No
NW1	B(1)	62.7	63.0	63.8	64.1	65.1	64.1	No
NW2	C(1)	64.2	64.5	65.3	65.6	65.2	64.2	No
NW3	B(1)	63.5	64.0	65.4	65.3	**66.4**	**66.1**	No
NW4	B(1)	58.7	59.3	60.8	60.5	63.3	62.2	No
NW5	C(1)	61.8	62.3	63.8	63.6	64.4	64.2	No
NW6	C(2)	61.3	61.8	63.1	63.0	69.9	69.1	No

Table 4: Noise Model Results (Peak Hour 2004 and 2030)

Site ID	Activity Category (#)*	AM 2004 Modeled Noise Level (dBA)	PM 2004 Modeled Noise Level (dBA)	AM 2030 No Action and 2-Lane Alternatives Modeled Noise Level (dBA)	PM 2030 No Action and 2-Lane Alternatives Modeled Noise Level (dBA)	AM 2030 Four Lane Option Modeled Noise Level (dBA)	PM 2030 Four-Lane Option Modeled Noise Level (dBA)	Preferred Alternative Impact
NW7	C(1)	57.7	58.3	59.4	59.0	59.2	59.3	No
NW8	C(1)	54.8	55.6	56.6	56.1	61.4	61.4	No
NW9	C(1)	67.8	67.6	68.6	68.9	67.6	67.0	No
NW10	C(1)	61.1	61.4	62.4	62.3	61.3	61.2	No
NW11	C(1)	53.5	54.1	55.2	54.7	62.0	61.6	No
NW12	C(1)	67.6	67.6	68.7	69.0	50.4	50.6	No
SW1	B(1)	58.7	59.6	60.5	60.2	60.9	61.9	No
SW2	B(1)	61.7	62.7	63.6	63.3	61.3	62.1	No
SW3	C(1)	61.6	62.7	64.1	63.6	65.8	66.9	No
SW4	C(1)	60.5	61.5	62.9	62.4	62.8	63.6	No
SW5	B(2)	62.2	63.2	64.4	63.6	64.0	65.0	No
SW6	B(2)	58.3	59.2	60.4	59.8	64.2	65.2	No
SW7	B(1)	**68.1**	**69.7**	Acquired	Acquired	Acquired	Acquired	No
SW8	B(2)	60.7	61.7	62.8	62.1	64.6	65.7	No
SW10	B(2)	65.9	**67.4**	**68.4**	**67.2**	**67.6**	**69.1**	**Yes**
SW11	B(1)	57.9	58.8	59.8	59.1	**68.7**	**70.7**	No
SW12	B(1)	55.4	56.4	57.5	56.6	60.7	61.7	No

*Number of individual dwelling units or businesses represented by the modeling site.

Four-Lane Option. According to the model, the Four-Lane Option would cause nine of the modeled locations to have noise levels above the NAC in 2030. These areas approach or exceed the NAC with predicted future noise levels increasing between 2 and 5 dB(A) over existing noise levels.

- Receptors NE2, NE6 and SW7 would be acquired and removed, and therefore no mitigation needs to be considered for these locations.

- Receptor NE1, the City on the Hill Church, would experience noise levels at the 66 decibel NAC during peak afternoon travel periods in 2030. Because of the location at the corner of SH 7 and 75th Street, noise walls located within right-of-way would not be feasible for intersection line of sight safety and driveway accessibility reasons. Visibility of the church from the roadways is considered important. Therefore no further consideration of noise abatement mitigation was considered. If noise levels reach a greater level, such that indoor use of the church becomes impaired, then a noise reassessment at this location should be undertaken in the future.

- Receptor SE6 would experience noise levels above the 66 decibel NAC during peak afternoon travel periods in 2030. This receiver is located along the south side of Arapahoe Road east of the Burlington Northern Railroad freight line. Mitigation should be considered for this location. It is included in the mitigation analyses.

- Receptor SE8 would experience noise levels above the 66 decibel NAC during peak afternoon travel periods in 2030. This receiver is located 8 feet above SH 7 on a hillside, adjacent to the Burlington Northern Railroad freight line. The roadway in this area will be lowered approximately 13 feet. A slope cut will be required between the residence and SH 7 to accommodate the new roadway height and width. The right-of-way does not reach the top of the slope; therefore, a noise wall located within right-of-way would by necessity have to be constructed along the outside shoulder of the eastbound roadway. The required noise wall height to achieve a minimum 5 decibel noise reduction would exceed a height of 25 feet, and resultant shading issues with icing along the shadow zone of the downhill eastbound highway lanes would present a safety issue. Therefore no further consideration of noise abatement mitigation was considered.

- Noise levels at Receptor NW3 would be above the NAC for Category B in 2030. Two of the three residential structures represented by Receptors NW3 and NW4 have been abandoned for that use, and in their current condition are uninhabitable. However, because these structures have not yet been removed and re-occupancy is possible, mitigation should be considered.

- Receptor SW10 representing two residences, would experience noise levels above the impact NAC for Category B if the build alternative is constructed. Mitigation should be considered for this location.

- Receptor SW11, a private residence, would experience noise levels above the 66 decibel NAC during both morning and afternoon peak travel periods in 2030. Because of the location at the intersection of SH 7 and Cherryvale Road, noise walls located on right-of-way of SH 7 and Cherryvale Road capable of reducing noise levels the required minimum 5 decibels would not be feasible for line of sight and safety reasons. Therefore no further consideration of noise abatement mitigation was considered.

All remaining receivers falling below the NAC have modeled noise levels ranging from 60.6 to 65.1 dB(A) for all Category B receivers and from 56.4 to 69.9 dB(A) for Category C receivers. Of these receivers, the greatest projected increase over existing noise levels is 8.5 dB(A).

7.7. Mitigation Analysis—Reasonableness and Feasibility

Once a noise impact is determined to result from the proposed improvements, a Reasonableness and Feasibility analysis must be conducted to determine if mitigation is warranted at these locations. Mitigation should consider all possible noise abatement measures for reasonableness and feasibility. These include noise barriers or walls, earthen berms, creating buffer zones of undeveloped land, planting vegetation, traffic management, installing noise insulation on buildings and relocating the highway.

According to FHWA and CDOT guidelines, the “feasibility and reasonableness” of mitigation needs to be considered for all locations that are projected to experience noise impacts. The feasibility analysis of mitigation considers such factors as the effectiveness of a barrier to achieve a 5-dBA reduction in predicted future noise levels, construction, engineering, maintenance or other design issues. Mitigation measures are considered feasible if they can achieve a noise reduction of 5-dBA for at least one receiver. They should not create any safety or unacceptable maintenance problems. Noise mitigation is considered reasonable if it meets certain criteria, such as the cost per receiver per decibel of noise reduction and type of land use protected. For example, business districts typically do not receive noise mitigation, as noise barriers would block the view of businesses from motorists.

Relocating the highway, creating buffer zones, constructing earth berms and planting vegetation are not feasible in this situation because these abatement measures require large amounts of land to achieve the necessary noise reductions. The surrounding land use in the project area prohibits acquiring the space needed for these abatement measures. Traffic management, such as limiting truck traffic on the highway, is not feasible because of the status of SH 7 as a major highway and the commercial and light industrial uses along the highway. Because of the high cost, installing noise insulation on buildings is usually reserved for public buildings such as schools or hospitals. For these reasons, noise barriers seem to be the most appropriate noise abatement measure for this project. Noise mitigation models were run to test the reasonableness and feasibility of noise walls. Note that a unit noise wall cost of $30 per square foot was used in all of the calculations, according to current CDOT guidelines. Noise abatement structures were analyzed for one impacted area according to CDOT guidelines.

Mitigation Barrier—All Build Alternatives

Mitigation Barrier at SW10

A noise barrier was analyzed for Site SW10, which consists of two residences located at 6160 and 6180 Arapahoe Road. Noise mitigation at this site is not recommended because the resultant cost-benefit was unreasonable according to CDOT and FHWA guidelines. The feasible and reasonable analyses are detailed in Appendix B of this report.

An effective noise reduction of 5.7 decibels could be achieved at this location by constructing a continuous six-foot noise wall that is 310 feet long. The noise wall would require relocation of the two residential driveway accesses. Any gaps in the wall would decrease the effectiveness of the noise abatement, making the wall infeasible. The wall is shown in **Figure 4**, illustrating the gaps created by intervening driveway access points. Construction of a continuous wall should not create safety hazards for vehicles or pedestrians along SH 7. The cost of a continuous wall of these dimensions would be approximately $55,800. Using the CDOT criterion for cost benefit in determining the reasonableness of noise abatement discussed in the paragraphs above, the cost benefit of this noise wall would be approximately $4,895 per receiver per decibel noise reduction. CDOT considers any amount over $4,000 not reasonable. Noise mitigation at this location is not recommended because, although relocating the two accesses would make this wall feasible, the extraordinary cost/benefit ratio would make the wall unreasonable.

Mitigation Barrier—Four- Lane Option Only

Mitigation Barrier at SE6

A noise barrier was analyzed for Receptor SE6 a residence located along the south side of SH 7. Noise mitigation at this site is not recommended because the resultant cost-benefit was unreasonable according to CDOT and FHWA guidelines. The feasible and reasonable analyses are detailed in Appendix B of this report.

An effective noise reduction of 5.2 decibels could be achieved at this location by constructing a 18-foot noise wall of 180 foot length. The wall is shown in **Figure 5.** Construction of a continuous wall would likely cause icing safety hazards for vehicles along the eastbound lanes of SH 7 making this noise mitigation not feasible. The cost of a continuous wall of these dimensions would be approximately $97,200. Using the CDOT criterion for cost benefit in determining the reasonableness of noise abatement discussed in the paragraphs above, the cost benefit of this noise wall would be approximately $18,690 per receiver per decibel noise reduction. CDOT considers any amount over $4,000 not reasonable. Noise mitigation at this location is not recommended.

Mitigation Barrier at NW3

A noise barrier was analyzed for Sites NW3 and NW4, which consists of two currently abandoned residences located along the north side of Arapahoe Road and 1 residence located behind NW3 as a second row receiver. Noise mitigation at this site is not recommended because the resultant cost-benefit was unreasonable according to CDOT and FHWA guidelines. The feasible and reasonable analyses are detailed in Appendix B of this report.

An effective noise reduction of 6.5 decibels could be achieved at this location by constructing a 10-foot noise wall of 220 foot length. The noise wall would require relocation of one residential driveway access. Any gaps in the wall would decrease the effectiveness of the noise abatement, making the wall infeasible. The wall is shown in **Figure 6**, and illustrates the gap created by the intervening driveway. Construction of a continuous wall should not create safety hazards for vehicles or pedestrians along SH 7. The cost of a continuous wall of these dimensions would be approximately $66,000. Using the CDOT criterion for cost benefit in determining the reasonableness of noise abatement discussed in the paragraphs above, the cost benefit of this noise wall would be approximately $5,077 per receiver per decibel noise reduction. CDOT considers any amount over $4,000 not reasonable. Noise mitigation at this location is not recommended because, although relocating the access would make this wall feasible, the excessive cost/benefit ratio would make the wall unreasonable.

Figure 4: Preliminary Noise Barrier

Figure 5: Preliminary Noise Barrier

Figure 6: Preliminary Noise Barrier

8.0 Recommendation

No noise mitigation is recommended for either alternative. If the structures at 6160 and 6180 Arapahoe Road still exist and development of the commercial center in this area is not scheduled to proceed in the foreseeable future, and there are changes to the final design of the project, a noise barrier should be reconsidered for these residences prior to final design of the selected alternative.

APPENDIX A:
2004 AND 2030 TRAFFIC DATA
(INCLUDED IN FULL TECHNICAL REPORT)

APPENDIX B:
CDOT FORM 1209
(INCLUDED IN FULL TECHNICAL REPORT)

APPENDIX C:
STAMINA 2.0 INPUT AND OUTPUT FILES
(INCLUDED IN FULL TECHNICAL REPORT)