Noise Impacts Technical Memorandum

I-25 Improvements Through the Colorado Springs Urbanized Area Project

CDOT Project No. IM 0252-316

Project Control No. 12210

Colorado Department of Transportation

February 2003
(Updated January 2004)

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1.0 Project Description (Proposed Action)

This report describes the results of a noise study conducted for the Interstate 25 Corridor Environmental Assessment (CDOT Project No: IM 0252-316 Sub No: 12210). The Interstate 25 (I-25) Improvements Project extends along approximately 29 miles of I-25 from State Highway (SH) 105 in Monument to SH 16 in Fountain (see Figure 1-1). The entire project is located in El Paso County, Colorado.

The proposed improvement strategy for I-25 is focused on multi-phase, multi-modal improvements. The strategy calls for the following three phases of capacity improvements, which will maintain flexibility to include future transportation options. The noise study was conducted assuming the implementation of all three phases.

- Phase 1: Widen I-25 to six lanes between South Circle Drive and Briargate Parkway
- Phase 2: Widen I-25 to six lanes from Briargate Parkway to Monument Interchange
- Phase 3: Add HOV lanes between U.S. 24 Bypass and Briargate Parkway, with one acceleration lane and one deceleration lane between U.S. 24 Bypass and Circle Drive, and widen I-25 to six lanes from U.S. 24 Bypass to South Academy Boulevard
- Park-and-Ride lots, freeway ramp metering, and provision for non-motorized modes are also included

The noise study was conducted according to Colorado Department of Transportation (CDOT) noise guidelines, which are set forth in the document entitled *CDOT Noise Analysis and Abatement Guidelines*, December 1, 2002. CDOT guidelines are consistent with those of the Federal Highway Administration (FHWA) (23 CFR 772) and have been approved by the FHWA for use on Federal-aid projects. Pursuant to these guidelines, the main purpose of this study was twofold. First, noise levels were predicted along the Corridor for both existing and design-year conditions, and these levels compared to CDOT's Noise Abatement Criteria and Increase Criterion. This is the process of determining impact. Second, the feasibility and reasonableness of providing noise mitigation was analyzed for areas where the criteria were exceeded.

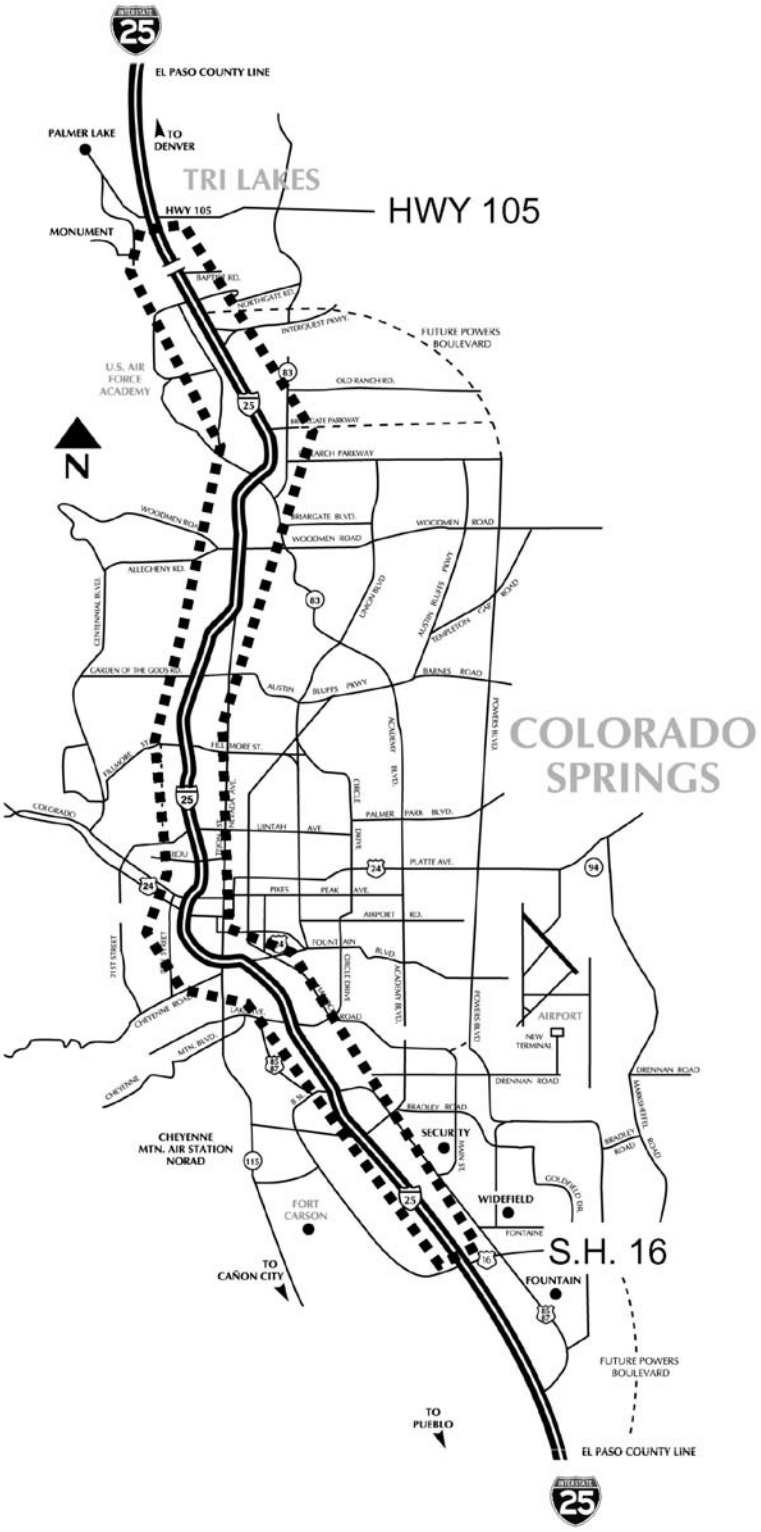

FIGURE 1-1: PROJECT LOCATION

2.0 Methodology

2.1 Noise Analysis Standards

This project, as it involves state and federal funds, is subject to CDOT noise guidelines, which are set forth in the document entitled *CDOT Noise Analysis and Abatement Guidelines*, December 1, 2002. The CDOT noise guidelines are consistent with those of the Federal Highway Administration (FHWA) (23 CFR 772) and have been approved by the FHWA for use on Federal-aid projects. CDOT's guidelines establish noise abatement criteria and design requirements for noise mitigation. The guidelines state that noise mitigation should be considered for any receptor or group of receptors where predicted traffic noise levels, using future traffic volumes and roadway conditions, equal or exceed CDOT's Noise Abatement Criteria (NAC), which are shown in Table 2-1. The guidelines also state that noise mitigation should be considered for any receptors where predicted noise levels for future conditions are greater than existing noise levels by 10 dB(A) or more. This standard is referred to hereafter as the Increase Criterion.

To be included in a project, a proposed noise mitigation measure must first be found to be feasible. A summary of the feasibility criteria is as follows (see Attachment A for more information):

- Most importantly, the proposed mitigation measure must be predicted to achieve at least 5 dB(A) of noise reduction at front row receptors.
- The proposed mitigation measure must not create any "fatal flaw" safety or maintenance issues such as reduced sight distances, shadowing of ice-prone areas, interference with snow/debris removal.
- If a barrier, it must be possible to construct it in a continuous manner, as gaps in noise barriers, e.g. for driveways, significantly degrade their performance.

If a mitigation measure is found to be feasible, it is then analyzed for its "reasonableness". A summary of the reasonableness criteria is as follows (see Attachment A for more information):

- The cost benefit index of the proposed measure should not exceed $4,000 per dB of reduction per benefited receptor.
- The predicted design year noise levels should equal or exceed the Noise Abatement Criteria shown in Table 2-1, below.
- At least 50% of the affected properties should approve of the proposed measure.
- Land use in the affected area should be at least 50% Category B (refer to Table 2-1).
- Design-year noise levels exceed existing levels by 5 dB(A) or more.

TABLE 2-1
CDOT Noise Abatement Criteria (based on FHWA Noise Abatement Criteria, 23 CFR 772)

Activity Category	L_{eq} [(1),(2)] (dB(A))	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.
E	51 (Interior)	Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals and auditoriums.

(1)Hourly A-weighted equivalent level for the noisiest hour of the day in the design year

(2)CDOT noise impact criteria are 1 dB(A) lower (more stringent) than FHWA values in 23 CFR 772, to identify noise levels that "approach" the FHWA criteria.

2.2 Noise Level Prediction Methodology and Input Data

To determine where noise levels exceed the Noise Abatement Criteria and the Increase Criterion, it was necessary to establish both existing and future noise levels adjacent to I-25 within the study area. Existing noise levels could, of course, be measured. They can also be predicted using a model of existing conditions. The latter method is preferred, because the model can be used to predict the desired loudest-hour condition anywhere along the Corridor. Measurements represent only the conditions present during the measurement itself, which may or may not be representative of loudest-hour conditions, and it is not practical to measure at every residence and business located along a corridor of this size. Therefore, the existing noise levels used in the impact analysis were predicted. However, existing noise levels were measured at select locations to determine the accuracy of the model, as described in Section 3.2.

The remainder of this section describes the noise model selection process conducted for this project, the input data used to predict noise levels, and the results of a validation procedure employed to ensure that the model is accurately predicting noise levels along I-25.

2.2.1 Noise Model Selection

Presently, both the STAMINA and TNM models are approved for use by FHWA. However, due to some functionality problems, TNM is, in effect, in a "test" mode in Colorado. STAMINA is presently the default model for CDOT projects. In an effort to determine which model better predicts noise levels along I-25, noise measurements from 75 locations along the Corridor were used. Traffic volumes, traffic speeds, and meteorological conditions were also measured. Then, using the traffic conditions measured on-site, both STAMINA and TNM were used to predict noise levels at each location. The models utilized accurate physical data

to represent the topographical aspects of each measurement location. The measured and predicted noise levels were then compared.

STAMINA v2.0 predicted noise levels between 5 dB(A) below and 8 dB(A) above measured levels. Averaging the results from all 75 measurements, STAMINA predicted 1 dB(A) above measured levels. STAMINA predicted within ±3 dB(A), a common measure of accuracy, at 55 of the 75 measurement locations (73%). TNM v1.1 predicted noise levels between 3 dB(A) below and 10 dB(A) above measured levels. Averaging the results from all 75 measurements, TNM predicted 4 dB(A) above measured levels, which is consistent with the findings of a recent FHWA study. TNM predicted within ±3 dB(A) at 27 of the 75 measurement locations (36%).

Overall, it was concluded that STAMINA v2.0 provides reasonably accurate and expected results for highway noise level predictions along the I-25 Colorado Springs Corridor. TNM provides less accurate results. Therefore, STAMINA was used for the I-25 Project. For more information regarding this analysis refer to Attachment B, *Noise Model Comparison Report – Interstate 25 Corridor Environmental Assessment Project*, Hankard Environmental Inc., February 2002.

2.2.2 STAMINA Noise Model Input Data

STAMINA calculates the hourly, A-weighted L_{eq} at a receptor location given the noise emission level of automobiles, medium, and heavy trucks, the volume and speed of each of these vehicle types on each roadway of interest, the relative location of all roadways, receptors, and terrain features (i.e., natural and man-made barriers), and the type of terrain between each receptor and each roadway. This section describes the STAMINA input data used to predict noise levels for both existing (1990) and design-year (2025) conditions on this project. The location of the 66 and 71 dB(A) noise level contours was predicted for design-year conditions, and the increase in highway noise levels between 1990 and 2025 was predicted at 40 representative locations throughout the Corridor. Many portions of I-25 underwent Safety Improvements in the early 1990s, so 1990 conditions were used as a representation of past I-25 traffic noise levels for comparison to future levels (the Proposed Action in 2025). Section 2.2.3 describes the validation of the model, which was accomplished by comparing measured and predicted noise levels. Refer to Attachment C for a description of relevant noise terminology including L_{eq}, dB(A) and a list of typical noise levels.

Vehicle Emission Levels

Vehicle emission levels refer to the noise level of vehicles measured at a reference distance and a reference speed. STAMINA requires separate emission levels for automobiles, medium trucks (generally trucks with two axles, six tires, and a gross vehicle weight greater than 9,900 lbs and less than 26,400 lbs), and heavy trucks (generally trucks with three or more axles and a gross vehicle weight greater than 26,400 lbs). The Colorado-specific Reference Energy Mean Emission Levels were used for all vehicle types in all of the predictions. These emission levels were developed by CDOT, approved by FHWA, and are published in the document entitled *Reference Energy Mean Emission Levels Used in STAMINA 2.0 for Highway Noise Prediction in the State of Colorado*, CDOT, February 1995.

Traffic Volumes and Speeds

Two conditions were modeled on this project: Existing (1990) (Pre-Safety Improvements), and Proposed Action (2025). The traffic volumes and speeds used to model these two conditions are shown in Attachment D. The No-Action (2025) conditions are discussed in Section 4.0. The 1990 traffic volumes were derived from Noise Analysis Technical Report I-25 Corridor, Harris Miller Miller & Hanson Inc. and Felsburg Holt and Ullevig, September 1992. The 2025 Proposed action traffic volumes were derived for this project by Wilson & Company. Traffic volumes for both scenarios are consistent with the applicable adopted Pikes Peak Area Council of Governments long range transportation plan traffic model, and the Pikes Peak Area Council of Governments was consulted in the development of these traffic numbers. In order to model loudest-hour conditions, all of the volumes represent Level-of-Service (LOS) C conditions or better. That is, where traffic projections indicated that the LOS would be A, B, or C, all of which represent free-flowing conditions, the projected volumes were used directly. When traffic projections indicated that the LOS would be D, E, or F, then the volumes were reduced to replicate LOS C conditions. Free-flow speeds were used in all of the predictions, which range from 55 to 75 mph throughout the Corridor.

Location of Roadways

For existing (1990) conditions, the location and elevation of I-25 (mainline and ramps) and major cross-streets were determined using CAD topographical maps. For the Proposed Action, this information was obtained from CAD design files provided by Wilson & Company. The effect of roadway slope was taken into account for all conditions.

Location of Receptors

Two types of predictions were made involving receptor locations: those used to locate the 66 and 71 dB(A) noise level contours, and those used to predict the increase in noise levels at representative locations. Locating noise contours theoretically requires noise levels to be predicted in a grid around the entire project. For example, to locate the contours with an accuracy of 25 feet, noise levels would need to be predicted in a line perpendicular to the highway every 25 feet out to the distance the furthest contour is expected to lie (typically 300 to 600 feet for the 66 dB(A) contour). These predictions would then need to be made at intervals of 25 feet along the entire length of the project, and on both sides of the highway. This would be a monumental task, given that all of the predictions need to take into account elevation, terrain barriers, buildings, etc. On this project, the location of the contours was estimated by predicting noise levels at 25-foot intervals along approximately 40 perpendicular lines. The lines were chosen to represent the different topographical features found along I-25. The points along these lines where 66 and 71 dB(A) were predicted is where these contours would pass in the vicinity of the line. The full contours were then developed using these 40 points as a guide.

To determine the magnitude of noise level increases along the Corridor, noise levels were predicted at 40 representative locations. The coordinates of these locations were determined from topographical plans. Elevation and topography were taken into account.

Location of Terrain Features and Structures

Existing terrain features such as embankments, the edge of the highway itself, and structures can act as barriers that reduce noise propagation. The effects of these features were modeled when it was determined that they break the line-of-sight between I-25 and receptors and were of substantial mass.

Terrain Type

STAMINA allows the user to select one of two types of ground for each receiver-roadway pair: hard or soft. This selection is made using the alpha factor input variable. An alpha factor of zero represents hard ground such as pavement and water, as well as the case where either the source or the receptor are significantly elevated above the ground. An alpha factor of 0.5 represents acoustically soft terrain, which is representative of vegetated ground with both source and receiver located close to the ground. An alpha factor of 0.5 was used in a majority of the predictions on this project. An alpha factor of 0 was used in a few areas where the line of sight between the highway and the adjacent receptors was significantly elevated above the ground.

2.2.3 Validation of Noise Prediction Procedures

To validate the above-described modeling procedures, noise levels were measured at 75 locations along the Corridor. Traffic volumes, traffic speeds, and meteorological conditions were also measured. Then, using the traffic conditions measured on-site, and accurate topographical data to model the physical aspects of each location, STAMINA 2.0 was used to predict noise levels at each measurement location. The measured and predicted noise levels were then compared. A summary of this analysis is provided below. For more detailed information, refer to the *Noise Model Validation Report – Interstate 25 Corridor Environmental Assessment Project*, Hankard Environmental, October 2002, in Attachment E.

Table 2-2 shows the average measured and predicted noise levels, and the differences between these levels on a per site basis. On average, STAMINA v2.0 predicted noise levels within 1 dB(A) of the measured levels. Reviewing the results of each individual measurement, STAMINA predicted within ±3 dB(A) at 55 of the 75 locations (73%). The maximum under-prediction was 5 dB(A) and the maximum over-prediction was 8 dB(A). Overall, these results are considered very good. Errors between measured and predicted levels can occur for a number of reasons, including wind conditions, the presence of noise from non-roadway sources such as a busy side road, lawn mower, or construction equipment, or the terrain between the roadway and the microphone was difficult to accurately model.

TABLE 2-2
Measured and Predicted Noise Levels (L_{eq} dB(A))

Site	Average Distance To I-25 (feet)	Number of Measurements	Average Measured Level (dB(A))	Average Predicted Level (dB(A))	Avg Predicted Minus Avg Measured (dB(A))
Pulpit Rock	638	4	60	62	2
Baptist Road	1,270	5	55	57	2
Garden of the Gods	360	5	63	61	-2
Circle Area	580	5	60	60	0
Circle-Lake	808	5	57	58	1
Old North End1	980	5	53	57	4
Old North End2	892	5	56	57	1
Stratmoor 1	504	5	58	60	2
Stratmoor 2	298	5	60	64	4
Bijou	150	2	66	65	-1
Nevada-Tejon	130	3	67	67	0
Woodmen	333	8	63	63	0
Mesa Springs	411	17	62	63	1
Park Pavilion	290	2	60	66	6

3.0 Existing Conditions

3.1 Background

This section summarizes the results of the noise level measurements that have been taken along the I-25 Corridor as part of the Safety Improvement Projects and other CDOT studies over the past 12 years. A list of the studies is shown below. Refer to the referenced reports for more detailed information, including maps showing the exact locations of the measurements.

- I-25 Corridor Improvements Feasibility Study, 1992
  Noise Analysis Technical Report I-25 Corridor, Harris Miller, Miller & Hanson Inc.
- Nevada-Tejon Categorical Exclusion, 1998
  Interstate 25/Nevada-Tejon Interchange Noise Report, Hankard Environmental Inc.
- North End Neighborhood Noise Study, 1999
  North End Neighborhood Noise Study, Hankard Environmental Inc.
- SH 105 Categorical Exclusion, 2000
  SH 105/Interstate 25 Interchange Noise Technical Report, Hankard Environmental Inc.
- Woodmen Road Categorical Exclusion, 2001
  Interstate 25/Woodmen Road Interchange Noise Technical Report, Hankard Environmental Inc.
- Bijou to Fillmore Noise Wall Study, 1998 to 2002
  Bijou to Fillmore Noise Wall Study, Final Report June 2002, Hankard Environmental Inc.

3.2 Existing Noise Levels

Table 3-1 lists the measured noise levels. Included in the table is the name of the study for which the measurements were conducted, the measurement number (as referenced in the original study), the month, year, and approximate time of each measurement, the approximate distance from the measurement to the center of I-25, and the measured noise level. Almost all of the measurements are one-hour, A-weighted L_{eq}'s. The average of all the measurements is 60 dB(A). The maximum measured level is 72 dB(A). This level was measured on the west side of I-25 on Spruce Street in 1990 (before construction of the wall), as well as on the west side of I-25 south of Bijou Street in 2000. In some of the measurement areas noise from other roads was also audible (i.e., Nevada Avenue and other major cross-streets).

TABLE 3-1

Measured Noise Levels

Study	Meas. No. (from referenced report)	Date	Approximate Time	Distance to Center of I-25 (feet)	One-Hour Noise Level (L_{eq}. dB(A))
I-25 Corridor Improvements Feasibility Study	M1	February 1991	11:00 a.m.	125	69
	M2	May 1991	4:30 p.m.	200	63
	M3	February 1991	2:00 p.m.	1300	48
	M4	February 1991	3:00 p.m.	300	59
	M5	May 1991	9:00 a.m.	175	64
	M6	May 1991	10:00 a.m.	300	69
	M7	May 1991	11:00 a.m.	200	56
	M8	May 1991	11:00 a.m.	900	49
	M9	May 1991	12:00 p.m.	100	72
	M10	May 1991	12:00 p.m.	200	61
	M11	May 1991	1:00 p.m.	200	62
	M12	May 1991	4:30 p.m.	200	66
Nevada Tejon Categorical Exclusion Noise Technical Report	M1	July 1998	N/A	225	71
	M2	July 1998	N/A	350	66
	M3	July 1998	N/A	750	64
North End Noise Study	Site 1	Jul – Sep 1999	7:00 a.m.	1300	58
	Site 2	Jul – Sep 1999	7:00 a.m.	1300	55
	Site 3	Jul – Sep 1999	12:00 p.m.	2200	54
	Site 4	Jul – Sep 1999	7:00 a.m.	800	62
	Site 5	Jul – Sep 1999	5:00 p.m.	4000	66
	Site 6	Jul – Sep 1999	7:00 a.m.	2600	52
SH 105 Categorical Exclusion Noise Technical Report	M1	August 2000	N/A	1700	55
	M2	August 2000	N/A	3200	56
	M3	August 2000	N/A	2800	53
Woodmen Road Categorical Exclusion Noise Technical Report	M1	January 2001	N/A	250	66
	M2	January 2001	N/A	280	64
	M3	January 2001	N/A	330	65
	M4	January 2001	N/A	160	68
	M5	January 2001	N/A	280	58
	M6	January 2001	N/A	420	62
	M7	January 2001	N/A	500	61
	M8	January 2001	N/A	600	61
Bijou to Fillmore Noise Wall Study (levels shown are after construction of noise wall, although Site 3 M1 and M2 not directly behind wall)	Site 1, M1	January 2002	N/A	300	60
	Site 2, M1	January 2002	N/A	240	61
	Site 2, M2	January 2002	N/A	420	56
	Site 3, M1	January 2002	N/A	240	68
	Site 3, M2	January 2002	N/A	340	63
	Site 4, M1	January 2002	N/A	240	60
	Site 4, M2	January 2002	N/A	420	59
	Site 5, M1	January 2002	N/A	250	58
	Site 5, M2	January 2002	N/A	620	56

TABLE 3-1

Measured Noise Levels

Study	Meas. No. (from referenced report)	Date	Approximate Time	Distance to Center of I-25 (feet)	One-Hour Noise Level (L_{eq}. dB(A))
	Site 6, M1	January 2002	N/A	475	60
	Site 6, M2	January 2002	N/A	725	56
	Site 7, M1	January 2002	N/A	260	47
	Site 7, M2	January 2002	N/A	480	55
	Site 8, M1	January 2002	N/A	420	60
	Site 8, M2	January 2002	N/A	840	55
	Site 9, M1	January 2002	N/A	415	60
	Site 9, M2	January 2002	N/A	400	60
	Site 10, M1	January 2002	N/A	290	60
	Site 10, M2	January 2002	N/A	310	58
I-25 Environmental Assessment Pulpit Rock Area	1	May 2001	2:00 p.m.	400	65
	2	May 2001	2:00 p.m.	700	58
	3	May 2001	2:00 p.m.	900	56
	4	May 2001	2:00 p.m.	550	63
I-25 Environmental Assessment Baptist Road Area	1	June 2001	11:00 a.m.	550	61
	2	June 2001	11:00 a.m.	1000	55
	3	June 2001	11:00 a.m.	1700	53
	4	June 2001	11:00 a.m.	1600	53
	5	June 2001	11:00 a.m.	1500	53
I-25 Environmental Assessment Garden of the Gods Area	1	June 2001	2:00 p.m.	200	69
	2	June 2001	2:00 p.m.	430	64
	3	June 2001	2:00 p.m.	400	65
	4	June 2001	2:00 p.m.	570	58
	5	June 2001	2:00 p.m.	200	58
I-25 Environmental Assessment Circle Area	1	June 2001	10:00 a.m.	300	65
	2	June 2001	10:00 a.m.	630	65
	3	June 2001	10:00 a.m.	450	64
	4	June 2001	10:00 a.m.	850	55
	5	June 2001	10:00 a.m.	670	52
I-25 Environmental Assessment Circle-Lake Area	1	June 2001	1:00 p.m.	660	55
	2	June 2001	1:00 p.m.	730	62
	3	June 2001	1:00 p.m.	950	71
	4	June 2001	1:00 p.m.	1000	59
	5	June 2001	1:00 p.m.	700	54
I-25 Environmental Assessment Old North End – North	1	June 2001	10:00 a.m.	600	54
	2	June 2001	10:00 a.m.	700	58
	3	June 2001	10:00 a.m.	1500	53
	4	June 2001	10:00 a.m.	1100	49
	5	June 2001	10:00 a.m.	1000	54
I-25 Environmental Assessment Old North End – South	1	June 2001	12:30 p.m.	640	58
	2	June 2001	12:30 p.m.	700	58
	3	June 2001	12:30 p.m.	770	57
	4	June 2001	12:30 p.m.	1050	54

TABLE 3-1

Measured Noise Levels

Study	Meas. No. (from referenced report)	Date	Approximate Time	Distance to Center of I-25 (feet)	One-Hour Noise Level (L_{eq}. dB(A))
	5	June 2001	12:30 p.m.	1300	56
I-25 Environmental Assessment Stratmoor Valley - North	1	June 2001	10:30 a.m.	230	65
	2	June 2001	10:30 a.m.	350	59
	3	June 2001	10:30 a.m.	530	56
	4	June 2001	10:30 a.m.	650	55
	5	June 2001	10:30 a.m.	760	56
I-25 Environmental Assessment Stratmoor Valley – South	1	June 2001	11:30 a.m.	250	65
	2	June 2001	11:30 a.m.	360	59
	3	June 2001	11:30 a.m.	200	57
	4	June 2001	11:30 a.m.	350	58
	5	June 2001	11:30 a.m.	330	61
I-25 Environmental Assessment Bijou Area	1	August 2000	3:30 p.m.	80	72
	2	August 2000	3:30 p.m.	220	61

4.0 Impacts of No-Action

Noise levels from I-25 will change between existing and 2025 No-Action conditions primarily due to changes in traffic volume and speed. Volume is projected to increase all along the Corridor as the result of growth in the area. However, with an increase in volume comes congestion and a corresponding decrease in speed. As a result, noise levels will either increase or decrease depending on location and time of day. Traffic noise is loudest when there is a significant amount of traffic traveling at relatively high speeds. This is referred to as Level-of-Service C (LOS C) conditions. When more traffic is added to the flow, noise levels will increase as long as there is no decrease in speed. At some point, the capacity of the highway will be exceeded, resulting in a decrease in speeds and noise levels. Therefore, the loudest hour occurs just before and just after periods of congestion.

In the central portion of the study area, there is currently congestion during most of the rush-hour periods. Additional traffic, with no increase in capacity, will increase the amount of time each day when this occurs. During these times noise levels will decrease by as much as 5 to 10 dB compared to the noise level of free-flow traffic. The loudest-hour will shift in time, but will not get any louder. Noise levels will increase by 1 to 2 dB during the times of day when there is currently no congestion, as there will be an increase in volume with no decrease in speed.

In the very northern and southern portions of the study area there is currently little congestion. Additional traffic, with no increase in capacity, will increase the occurrence of congestion and a corresponding decrease in noise levels. The time of the loudest-hour will shift, and will increase slightly (1 to 2 dB). Noise levels will increase during all other times of the day, as there will be an increase in volume with no decrease in speed.

5.0 Direct Impacts of the Proposed Action

Direct noise impact from the Proposed action was assessed in two ways. First, 66 and 71 dB(A) noise level contours were produced and overlaid onto detailed maps of the Corridor to assess compliance with the Noise Abatement Criteria for Category B and C receptors, respectively (refer to Section 2.1 for more information). The resulting contours are shown in Figures 5-1 through 5-19. Table 5-1 lists approximately how far from the centerline of I-25 that the 66 and 71 dB(A) contours lie in general. The contours lie closer to the road than the distances shown in the table where barriers such as embankments and noise walls were modeled. All residences, parks, motels, schools, churches, libraries, and hospitals located between the highway and the 66 dB(A) contours are considered impacted. All commercial establishments located between the highway and the 71 dB(A) contours are considered impacted.

TABLE 5-1
Approximate Distance from Centerline of I-25 to Noise Contours

Section of I-25		Distance to 66 dB(A) (Feet)	Distance to 71 dB(A) (Feet)
From	**To**		
SH 16	So Academy	500	300
So Academy	Circle/Lake	375	200
Circle/Lake	MLK Bypass	425	175
MLK Bypass	Nevada Tejon	425	175
Nevada Tejon	Cimarron	425	200
Cimarron	Bijou	475	225
Bijou	Uintah	450	200
Uintah	Fontanero	450	200
Fontanero	Fillmore	550	275
Fillmore	Garden of Gods	400	225
Garden of Gods	Rockrimmon	425	200
Rockrimmon	North Nevada	425	200
North Nevada	Woodmen	425	200
Woodmen	N. Academy	425	175
N. Academy	Briargate	500	300
Briargate	Interquest	500	300
Interquest	Northgate	500	275
Northgate	Baptist	500	275
Baptist	Monument	500	275
Average		**450**	**225**

Secondly, the increase in noise levels between existing and future conditions was predicted at representative locations. All areas where a 10 dB(A) or greater increase was predicted would be considered impacted, however this was not predicted to be the case anywhere within the project study area. Noise mitigation was analyzed for each impacted area, as described in Section 6.0. The following sections describe the results of the impact assessment based on the contours and on increase, respectively.

5.1 Impact to Category B Receptors Based on 66 dB(A) Noise Level Contour

The locations of the 66 dB(A) noise level contours, shown in Figures 5-1 to 5-19, were predicted for design-year conditions (2025), assuming that the Proposed Action was implemented. That is, the predictions took into account the proposed highway location, elevation, and numbers of lanes, as well as the projected traffic volumes and speeds for 2025 assuming the expanded highway. The contours represent the hourly, A-weighted L_{eq} for the loudest hour of the day. Refer to Section 2.2 for more information on the modeling process. Table 5-2 lists each of the Category B receptors identified within the 66 dB(A) noise level contours. Noise mitigation strategies for each of these locations are discussed in Section 6.0.

TABLE 5-2
Impacted Category B Receptors

Land Use	Name (Number of Impacted Living Units)	Location
Residential	Stratmoor Valley (47)	East side of I-25, both sides of Academy Blvd.
	Stratton Meadows (29)	Along Arvada St. near Nevada-Tejon interchange
	Glen Avenue (8)	East side of I-25, south of Uintah St.
	San Miguel (3)	East side of I-25, north of Uintah St.
	Mesa Springs (15)	West side of I-25, south of Fillmore St.
	Holiday Village (19)	East side of I-25, north of Fillmore St.
	Park Terrace Apts. (5)	West side of I-25, north of Fillmore St.
	Holland Park (37)	West side of I-25, north of Fillmore St.
	Garden Terrace Apts. (7)	West side of I-25, north of Garden of Gods Road
	Pulpit Rock (20)	East side of I-25, north of N. Nevada Avenue
Parks	Dorchester Park	Near the Nevada-Tejon Interchange
	Confluence Park	Between Cimarron and Colorado
	Monument Valley Park	Between Bijou and Fontanero Interchanges
Hotels	Residence and Fairfield Inns	Circle-Lake interchange
	Sheraton and Quality Inns	Circle-Lake interchange
	Howard Johnson	Nevada-Tejon Interchange
	Red Lion Hotel	Bijou Interchange
	Ramada and Best Western	Fillmore interchange
	Motel 6 and Super 8	North of Fillmore interchange
	Budget Inn	North of Fillmore interchange
	AmeriSuites	Garden of Gods interchange
	Super 8 and Days Inn	Garden of Gods interchange
	Extended Stay America	Rockrimmon interchange
	Hampton Inn	Woodmen interchange
	Embassy Suites	Woodmen interchange

5.2 Impact to Category C Receptors Based on 71 dB(A) Noise Level Contour

The 71 dB(A) contours are also shown in Figures 5-1 through 5-19. These contours represent year 2025 conditions with the Proposed Action implemented. The contours lie approximately 225 feet from the centerline of I-25, on average. The 71 dB(A) contours delineate where noise mitigation needs to be considered for Category C receptors (i.e., commercial establishments). There are a number of office buildings, restaurants, and other commercial establishments that lie between I-25 and the 71 dB(A) contours. These areas are shaded in Figures 5-1 through 5-19, but are not listed individually herein. Mitigation considerations for these areas are discussed in Section 6.3.

5.3 Impact to All Receptors Based on 10 dB(A) Increase Criterion

The increase in highway noise levels between 1990 and 2025 was predicted at 40 representative locations throughout the Corridor. 1990 was used as the "existing" condition, as many portions of I-25 underwent safety improvements in the early 1990s. These levels were compared to foreseeable future conditions (the Proposed Action in 2025) to determine increase.

The conditions modeled for 1990 included I-25 as it existed before the Safety Improvement Projects, including traffic volumes and speeds occurring at that time. The conditions modeled for 2025 included the Proposed Action, including projected traffic volumes and speeds for the year 2025. The 40 representative locations are shown in Figures 5-1 through 5-19. They include most of the residential areas and parks adjacent to I-25. Table 5-3 shows the predicted noise levels at each location. The increases range from minus 2 (i.e., a 2 dB(A) decrease) to 7 dB(A). Decreases are the result of noise walls that were constructed after 1990. The average increase is 4 dB(A). None of the predicted increases in noise between 1990 and 2025 (i.e. the combined effects of the Safety Improvements and the Capacity Improvements) equal or exceed the 10 dB(A) increase standard. The increase in noise levels is due to a combination of the following:

- Speed: Speed on I-25 was modeled as 55 mph in 1990 and between 60 and 75 mph in 2025. Increasing speed from 55 to 60 mph results in a noise level increase of 0.7 dB. Increasing speed from 55 to 75 mph results in a noise level increase of 2.5 dB.
- Volume: The peak-hour volume of traffic on I-25 in 1990 was modeled as approximately 5,000 vehicles, and the volume in 2025 was modeled as approximately 9,500 vehicles. This results in an increase of 2.5 dB.
- Distance: The increase in noise levels as the result of the highway moving closer to receptors is dependent on the initial distance from the receptor to the highway. For example, if I-25 were expanded 24 feet in each direction, this would increase noise levels by approximately 0.5 dB at a point 200 feet from the centerline of the existing highway. The increase would only be 0.1 dB at a receptor 500 feet from the existing highway.
- Obstructions: Obstructions, such as large buildings and embankments, that are located between a receptor and the highway will reduce noise levels. There are some instances on this project where obstructions will be removed as part of the widening of the highway. In

other cases, the level of the highway may be raised and an obstruction that is currently providing reduction will no longer do so. Finally, the edge of pavement of the highway can act as a barrier when receptors are lower in elevation. That is, from a lower vantage point, one may not see the entire highway, only the closest lane or two. In general, a barrier that just breaks line of sight between the highway and a receptor provides 5 dB of noise reduction (assuming the receptor is within approximately 300 feet of the highway). All significant instances of these situations were modeled on this project.

- Ground Absorption: When both the highway and receptor are at ground level, the noise that reaches a receptor has traveled across the ground. When the ground is acoustically "soft," such as grass, there is some sound reduction that takes place. When the highway is raised significantly, this "ground effect" is lost and noise levels increase. The impact on noise levels of the loss of ground effect is difficult to predict. STAMINA allows the user to include or not include ground effect. Studies by Hankard Environmental have shown that not including the ground effect in the model greatly over-predicts noise levels. Therefore, ground effect was included in almost all cases. One situation where it was not was the Nevada-Tejon area. Here, portions of I-25 are as much as 25 feet above the surrounding terrain.

- Reflection: When a noise wall is constructed on one side of the highway it has the potential to reflect noise to the other side, thus increasing noise levels there. Theoretically, an infinitely tall, perfectly reflecting wall placed directly on the edge of the highway would increase noise levels on the opposite side of the road by 3 dB. On this project, reflections were modeled at the receptors located opposite of existing noise walls by adding 2 dB to the noise coming from the section of I-25 running in front of the wall. Two dB was used versus 3 dB, because the walls on this project are not infinitely tall, they have some absorption qualities due to the ribbed concrete used, they undulate slightly (i.e. they are not always parallel to the highway), and they are located between 10 and 30 feet from the edge of the travel way.

- Pavement: Different pavements, notably asphalt and concrete (as well as their different configurations), produce different noise levels given the same traffic flow. Pavement noise is represented in the STAMINA model in the noise emission factors (refer to Section 2.2.2). The noise emission factors used on this project were developed from measurements conducted along 19 different Colorado highways. The majority of the highways were open- or dense-graded asphaltic concrete (asphalt), and one was concrete. These pavements were of various ages, and were in various states of repair. Therefore, the predicted noise levels for the most part represent asphalt. Parts of I-25 were asphalt, and are now concrete or may be concrete in the future. The long-term effect that this change will have on noise levels is not clear, and this change was not accounted for in the predictions. In fact, it is currently against FHWA policy to account for changes in noise levels due to different pavements, because the long-term differences are not well understood.

TABLE 5-3
Predicted Noise Level Increases between 1990 and 2025

Point	Location	1990 dB(A)	2025 dB(A)	Increase dB(A)	Notes
1	Northeast quadrant of SH 16 interchange	56	63	6	
2	Stratmoor neighborhood	60	67	7	
3	Stratmoor neighborhood	54	59	5	
4	Stratmoor neighborhood	66	69	3	
5	Stratmoor Hills neighborhood	54	58	4	
6	Hotels near Circle-Lake interchange	65	68	3	
7	Res. Neighborhood north of Circle-Lake	54	58	4	
8	Res. Neighborhood south of MLK	54	59	5	
9	Res. Neighborhood north of MLK	57	61	4	
10	Stratton Meadows neighborhood	70	69	-1	Arvada no longer an on-ramp, and highway moves further away
11	East side of I-25 at Nevada-Tejon	59	63	4	
12	East side of I-25 at Nevada-Tejon	60	64	4	
13	Confluence Park	59	63	4	
14	Mixed-use area near Bijou	59	64	5	
15	Entrance to MVP near Bijou	59	64	5	
16	Monument Valley Park (MVP)	65	70	5	
17	East of Glen Ave. residences	56	62	6	
18	San Miguel neighborhood	62	66	4	
19	West Side neighborhood	60	60	0	Addition of Bijou-Fillmore Noise Wall
20	MVP	59	64	5	
21	MVP	58	63	5	
22	Old North End Neighborhood	50	55	5	
23	Old North End Neighborhood	53	59	6	
24	West Side neighborhood	61	59	-2	Addition of Bijou-Fillmore Noise Wall
25	Roswell neighborhood	57	63	6	
26	Mesa Springs neighborhood	62	68	6	
27	Holiday Village neighborhood	58	63	5	
28	Holland Park neighborhood	65	70	5	
29	Garden Terrace Apartments	69	74	5	
30	Residents on hill near Rusina Road	58	62	4	
31	Offices at Rockrimmon Drive	66	71	5	
32	Pulpit Rock neighborhood	66	70	4	1990 alignment was closer than 2025
33	Pine Creek Estates neighborhood	65	63	-2	Addition of Woodmen Noise Wall
34	Offices on east side of I-25 at Woodmen	54	59	5	
35	East side of I-25 north of Briargate	57	63	6	
36	Reynolds Ranch	54	61	7	
37	East side of I-25 south of Baptist	55	61	6	
38	East side of I-25 south of Baptist	55	61	6	
39	East side of I-25 south of Baptist	54	60	6	
40	East side of I-25 north of Baptist	56	62	6	
	Minimum	50	55	-2	Negative is due to the construction of noise walls after 1990
	Maximum	70	74	7	
	Average	59	63	4	

6.0 Mitigation

There are a number of measures available to mitigate highway noise, such as walls, earthen berms, and buffer zones. In Section 6.1, the technical and logistical aspects of all available measures are discussed regardless of their application to this project. This information is provided for general education purposes, as well as to reveal why some measures were not further considered for this Corridor. Per CDOT and FHWA noise guidelines, specific mitigation analyses were conducted for each of the receptors where their predicted 2025 noise levels equal or exceed the Noise Abatement Criteria. The results of the analyses for Category B and C receptors are discussed in Sections 6.2 and 6.3, respectively. There were no increases of 10 dB(A) or more found within the project area. A summary of the mitigation recommendations for this project is provided in Section 6.4.

6.1 Overview of Available Highway Noise Mitigation Measures

6.1.1 Noise Barriers

Noise barriers, either in the form of walls or earthen berms, are the most commonly employed highway noise mitigation measure. Noise walls are more common than berms, particularly in urban areas, because they require less space. That is, berms require approximately 6 feet of width for every one foot of height. Noise barriers can achieve between 5 and 15 dB of reduction, depending on height, topography (less reduction is achievable for receptors located above the highway), and proximity (barriers are most effective for receptors located within approximately 300 feet of the barrier). Both noise walls and berms were analyzed on this project, as discussed in Section 6.2.

6.1.2 Restricting Access to Heavy Trucks

Restricting heavy trucks from operating on I-25 would provide a significant reduction in traffic noise. However, this is not a feasible or legal action. It is not feasible because I-25 is a major truck route, and if prohibited, trucks would seek other nearby routes therefore only shifting impact. Moreover, CDOT cannot restrict trucks from I-25 as it is an interstate highway.

6.1.3 Acquisition of Property To Form Buffer Zone

Generally, this mitigation measure is a viable alternative only for undeveloped lands where noise impact prevention is the goal. The noise level contours produced for this project will be provided to local planning agencies in an effort to avoid future incompatible development adjacent to the highway.

6.1.4 Alteration of Horizontal Alignment

In order to provide significant noise reduction (at least 5 dB(A)) at a given receptor, the distance that currently exists between the receptor and the highway would need to be doubled. For example, if a residence were currently 250 feet from the highway, the highway would need to be shifted another 250 feet away. This is not a viable mitigation alternative on I-25 given the urban nature of most of the project. Also, in many cases this action would only

shift impact to receptors on the opposite side of the highway. Furthermore, this alternative would be extremely costly.

6.1.5 Alteration of Vertical Alignment

Changing the vertical alignment of I-25, that is depressing it into the ground, could provide a significant noise reduction at roadside receptors. This alternative is not feasible in many areas along the Corridor due to drainage, floodplain and constructability issues, and the need to maintain access, which would prohibit this construction.

6.1.6 Reducing Speed Limits

The reduction of speed limits is another option to control vehicle noise. On I-25, speeds range from approximately 55mph in the downtown area to 75mph near Fountain and Monument. Realistically, it would not be feasible to reduce speed by more than 10mph. If this were accomplished it would reduce noise levels by 1 to 1.5 dB. Speed reduction is, of course, dependent on enforcement.

6.1.7 Noise Insulation of Buildings

The insulation or soundproofing of buildings typically involves the installation of double-pane windows that are specially designed to provide a high degree of noise attenuation. CDOT guidelines state that noise insulation only be applied to public or non-profit buildings, such as schools and churches, unless there is a severe impact (absolute noise levels of 75 dB(A) or an increase of 30 dB(A) over existing levels) and other exterior noise mitigation measures are not as cost effective. There are no such situations on this project.

6.1.8 Pavement Type

As discussed in Section 5.3, different pavements do exhibit different levels of noise for a given traffic flow. FHWA "Highway Traffic Noise Analysis and Abatement Policy and Guidance" (June 1995) addresses pavement type relative to traffic noise as follows: "Pavement is sometimes mentioned as a factor in traffic noise. While it is true that noise levels do vary with changes in pavements and tires, it is not clear that these variations are substantial when compared to the noise from exhausts and engines, especially when there are a large number of trucks on the highway. Additional research is needed to determine to what extent different types of pavements and tires contribute to traffic noise. It is very difficult to forecast pavement surface condition into the future. Unless definite knowledge is available on the pavement type and condition and its noise generating characteristics, no adjustments should be made for pavement type in the prediction of highway traffic noise levels. Studies have shown open-graded asphalt pavement can initially produce a benefit of 2-4 dBA reduction in noise levels. However, within a short time period (approximately 6-12 months), any noise reduction benefit is lost when the voids fill up and the aggregate becomes polished. The use of specific pavement types or surface textures must not be considered as a noise abatement measure." Therefore, at this time, asphalt is not viewed as a noise mitigation measure in and of itself.

6.1.9 Active Noise Control

Active noise control is a method where noise from the source of interest is measured with a microphone, speakers then broadcast the measured noise after it has been processed to be 180 degrees out of phase with the incoming noise. The noise from the speakers then cancels out the incoming sound. This technology has been applied with some success to noise inside aircraft and to engines. However, the technology is no where near advanced enough to be applied to highways.

6.2 Mitigation Measures Analyzed For Category B Receptors

6.2.1 Residences

Noise mitigation was analyzed at each of the impacted residential areas listed in Table 5-2. Based on the information presented in Section 6.1, proposed mitigation in each case consists of a noise wall (although berms may be possible in some areas as noted below). The analyses consisted of first determining if a wall was feasible. This including determining if a wall:

1) could physically be constructed
2) could be constructed in a continuous manner (no gaps)
3) would achieve at least 5 dB of reduction at front row receptors
4) would not create any "fatal-flaw" maintenance or safety issues

If, and only if, a wall was determined to be feasible, an assessment of the reasonableness of the wall was assessed by examining the following:

1) Cost-benefit Index – The cost of each wall was estimated by multiplying its length by its height by a CDOT standard unit cost of $30 per square foot. This was divided by the predicted noise reduction of the wall, which was calculated using the 2025 STAMINA model of each site. The cost was also divided by the number of "benefited receivers", which was calculated as the number of living units predicted to receive at least 3 dB of noise reduction from the proposed wall. The resulting cost-benefit index was compared to the reasonableness criteria shown in Appendix A.
2) Design-Year Noise Levels – Deign year noise levels were predicted at each single-family house within residential neighborhoods, and at representative units in apartment complexes. The resulting levels were compared to the criteria shown in Appendix A.
3) Impacted Persons Desires – A number of public meetings were held throughout the course of this study. For example, in July 2001, nine noise-specific meetings were held along the Corridor. At these and other meetings the residents of the areas under study were very supportive of noise mitigation. This was assumed to constitute each wall as being extremely reasonable in terms of the CDOT criteria.
4) Development Type – The type of development surrounding each residential area was noted during a visit to the site, and compared to CDOT criteria.

5) Development Existence – Each of the residential areas under study for mitigation are greater than 15 years old. Therefore, each was given an "extremely reasonable" rating in terms of the CDOT criteria.

6) Build Versus Existing Noise Levels – Existing (1990) and build (Proposed Action - 2025) noise levels were predicted at 40 locations, as described in Section 5.3, above. One point was located in each residential area under study, and this was compared to CDOT reasonableness criteria.

Walls that were determined to be both feasible and reasonable are recommended for inclusion in the Proposed Action. The results of each analysis are described in the following paragraphs. The above discussion of proposed mitigation is based on studies completed to date, and not on final project design. A final decision on the installation of abatement measures will be made upon completion of project design and the public involvement process. During final design, CDOT will take into account the desires of the affected property owners and obtain their further input.

Stratmoor Valley (south of S. Academy Boulevard)

From Figures 5-2 and 5-3, it can be seen that only in the northern and southern ends of this neighborhood do noise levels exceed the Noise Abatement Criteria. Therefore, separate noise barriers were analyzed for each area. It may be prudent to combine these two barriers and provide noise reduction for the entire neighborhood. Also, it may be possible to construct a berm in this area, as there appears to be room. These possibilities should be considered during the next phase of the project.

For the southern area, it is possible to physically construct a continuous wall. The 19-foot tall, 1,540-foot long noise wall shown in Figure 6-1 was predicted to achieve an average of 6.3 dB of noise reduction at front row receptors. There do not appear to be any fatal-flaw maintenance or safety issues associated with the wall. Therefore, this wall is considered feasible.

The wall was predicted to achieve at least 3 dB of reduction at a total of 41 residences, with an average reduction at these residences of 4.4 dB. Therefore, the cost per receptor per dB of reduction is $4,866 (19x1540x30/41/4.4). However, there is the potential for a lower cost if a berm could be constructed, therefore the cost was considered marginally reasonable. Design-year noise levels at the front row of receptors range from 66 to 68 dB(A), which is considered reasonable. The area has greater than 75% residential development, which is considered extremely reasonable. The predicted increase in noise levels is 7 dB, which is considered reasonable. In consideration of all these factors, the wall is considered reasonable, and is recommended for inclusion in the Proposed Action.

For the northern area, it is possible to physically construct a continuous wall. The 12-foot tall, 790-foot long noise wall shown in Figure 6-1 was predicted to achieve an average of 6.0 dB of noise reduction at front row receptors. There do not appear to be any fatal-flaw maintenance or safety issues associated with the wall. Therefore, this wall is considered feasible.

The wall was predicted to achieve at least 3 dB of reduction at a total of 40 residences, with an average reduction at these residences of 4.8 dB. Therefore, the cost per receptor per dB of reduction is $1,481 (12x790x30/40/4.8), which is considered extremely reasonable. Design-

year noise levels at the front row of receptors range from 66 to 67 dB(A), which is considered reasonable. The area has greater than 75% residential development, which is considered extremely reasonable. The predicted increase in noise levels is 7 dB, which is considered reasonable. In consideration of all these factors, the wall is considered reasonable, and is recommended for inclusion in the Proposed Action.

Stratmoor Valley (north of S. Academy Boulevard)

It is possible to physically construct a continuous wall in this area. The 12-foot tall, 2,070-foot long noise wall shown in Figure 6-2 was predicted to achieve an average of 7.4 dB of noise reduction at front row receptors. There do not appear to be any fatal-flaw maintenance or safety issues associated with the wall. Therefore, this wall is considered feasible.

The wall was predicted to achieve at least 3 dB of reduction at a total of 62 residences, with an average reduction at these residences of 5.4 dB. Therefore, the cost per receptor per dB of reduction is $2,226 (12x2070x30/62/5.4), which is considered extremely reasonable. Design-year noise levels at the front row of receptors range from 70 to 71 dB(A), which is considered extremely reasonable. The area has greater than 75% residential development, which is considered extremely reasonable. The predicted increase in noise levels is 3 dB, which is considered marginally reasonable. In consideration of all these factors, the wall is considered reasonable, and is recommended for inclusion in the Proposed Action.

Stratton Meadows (at Nevada-Tejon)

To achieve significant noise reduction, continuous walls would need to be constructed both along mainline I-25 and along the southbound on-ramp, as shown in Figure 6-3. This is physically possible. The total length of the walls is 3,830 feet, and their height is 20 feet. The walls are predicted to achieve an average of 4.8 dB of noise reduction at front row receptors (essentially 5 dB, given the margin of error in these calculations). There do not appear to be any fatal-flaw maintenance or safety issues associated with the wall. Therefore, this wall is considered feasible.

The wall was predicted to achieve at least 3 dB of reduction at approximately 80 living units (many of the residences in the area are apartments), with an average reduction at these units of 4.3 dB. Therefore, the cost per receptor per dB of reduction is $6,680 (20x3830x30/80/4.3), which is considered unreasonable. It should be noted that many of the apartments are shielded by each other and by other buildings. Therefore, actual noise reduction is likely to be less than that predicted here. On the other hand, I-25 is elevated as much as 25 feet in this area, so the number of living units at or below the level of the highway could be greater than 80. Given both of these variables, it is difficult to accurately predict the cost benefit of this wall.

Design-year noise levels at the front row of receptors range from 67 to 71 dB(A), which is considered extremely reasonable. The area has approximately 25 to 50% residential development, which is considered marginally reasonable. Noise levels are predicted to decrease in the future at some locations due to the interstate moving farther away from the receivers and the ramp traffic being removed from Arvada Street (Arvada Street directly abuts the residences), which is considered unreasonable. In consideration of all these factors, the wall is considered unreasonable, and not recommended for inclusion in the Proposed Action.

Glen Avenue (south of Uintah Street)

There are two reasons for considering a wall in this area a) protecting the residences along Glen Avenue just south of Uintah Street, and b) protecting the duck pond area in Monument Valley Park. This section describes the feasibility and reasonableness of protecting just the residences. The park aspect of this wall is discussed in Section 6.2.2, below.

Two different noise wall alignments were analyzed. As shown in Figure 6-4, the first (D1) is located on the I-25 right of way and has a break for ramp access, and the second (D2) is located to the east of the railroad tracks. The modeling results show that D1 could not provide the minimum reduction of 5 dB, and it was therefore considered infeasible. D2 (20 feet tall, 1,080 feet long) was predicted to achieve an average of 5.5 dB of noise reduction at front row receptors. There do not appear to be any fatal-flaw maintenance or safety issues associated with the wall. Therefore, this wall is considered feasible.

There are a total of eight living units in this area (Receptor #3 in Figure 6-4 represents five living units). The wall was predicted to achieve at least 3 dB of reduction at all eight units, with an average reduction of 5.5 dB. Therefore, the cost per receptor per dB of reduction is $8,181 (20x600x30/8/5.5), which is considered unreasonable (note that only 600 feet of the wall is designed to protect the residences). Design-year noise levels at the front row of receptors range from 66 to 67 dB(A), which is considered reasonable. The area has approximately 50 to 75% Category B development, which is considered reasonable. The predicted increase in noise levels is 6 dB, which is considered reasonable. In consideration of all these factors, the wall is considered unreasonable, and is not recommended for inclusion in the Proposed Action on the basis of only protecting the residences. It is recommended to protect the residences and the park, as discussed in Section 6.2.2, below.

San Miguel

It is possible to physically construct a continuous wall in this area. A wall could be constructed either along the I-25 shoulder, or east of the railroad tracks. The advantage of the latter is that it mitigates freight train noise as well, which is substantial (approximately 40 trains per day). The disadvantage is that it would reflect noise from traffic on Recreation Way, which carries a relatively significant amount of car and truck traffic due to the adjacent City facilities. It was determined that a wall located east of the tracks would be most appropriate, as shown in Figure 6-4. It should be noted that a wall at this location would need to be constructed on private property, as there is likely not enough room on railroad property due to horizontal track clearance requirements. The 21-foot tall, 740-foot long noise wall was predicted to achieve an average of 4.6 dB of noise reduction at front row receptors. It achieves the 5 dB minimum reduction at two residences. There do not appear to be any fatal-flaw maintenance or safety issues associated with the wall. Therefore, this wall is considered feasible.

The wall was predicted to achieve at least 3 dB of reduction at a total of 9 of the 18 residences, with an average reduction at these residences of 4.5 dB. Therefore, the cost per receptor per dB of reduction is $11,511 (21x740x30/9/4.5), which is considered unreasonable. Design-year noise levels at the front row of receptors range from 65 to 66 dB(A), which is considered marginally reasonable. The residences are bordered by commercial uses along Uintah and the City's Park and Recreation Offices to the north. Further north on Recreation Way lie maintenance facilities for the Parks Department and Colorado Springs Utilities. The railroad is

located to the west. Overall, the area is 25 to 50% residential, which is considered marginally reasonable. The predicted increase in noise levels is 4 dB, which is considered marginally reasonable. In consideration of all these factors, the wall is considered unreasonable, and is not recommended for inclusion in the Proposed Action.

Mesa Springs (south of Fillmore Street)

As shown in Figure 6-5, these homes are on the west side of I-25 south of Fillmore Street. Five of these homes will be acquired as part of the Proposed Action. The remaining homes are on the west side of Chestnut Street. There are no homes on the east side of Chestnut Street, only an undeveloped parcel between Chestnut Street and the interstate right-of-way. The interstate is lower than the homes at this location. A wall could be constructed either along the I-25 right of way line, along the east side of Chestnut Street, or along the west side of Chestnut Street. A wall was modeled along the right of way, but due to the relatively significant amount of traffic on Chestnut Street, 5 dB of noise reduction could not be achieved at the front row of receptors. Thus, a wall along the east side of Chestnut (i.e., closer to the residences) would also not achieve 5 dB(A) of noise reduction. A continuous wall cannot be constructed along the west side of Chestnut Street, due to the driveways at each house. These houses do have alley access, but restricting them to that is considered infeasible as the garages are only accessible from Chestnut Street. Building the wall with gaps for the driveways would reduce its effectiveness and could create sight distance problems for residences backing out of their driveways onto Chestnut Street. Therefore, a wall in this area is considered infeasible.

Holiday Village

The residences on the east side of I-25 at Holiday Village are lower in elevation than I-25. There is a retaining wall along the west side of the neighborhood, on top of which sits a six-foot privacy fence. As shown in Figure 6-5, the logical solution here is to replace the privacy fence with a noise wall. This can physically be achieved, and it does not present any fatal-flaw maintenance or safety issues. The analysis indicates that an 860-foot long, 8-foot tall wall would provide 5.4 dB of noise reduction at the front row of receptors. Therefore, it is considered feasible.

A total of 13 noise receptors were predicted to receive at least 3 dB of noise reduction, with an average reduction of 4.6 dB. This results in a cost per receptor per dB of reduction of $3,451 (860x8x30/13x4.6). Noise levels at the Holiday Village residences, an area of 75% residential development older than 15 years, were predicted to increase by 5 decibels in the future resulting in noise levels ranging from 67 to 72 dB(A). In accordance with the evaluation criteria established in CDOT guidelines, mitigation for Holiday Village has been determined to be within the extremely reasonable to reasonable range, and is recommended for inclusion in the Proposed Action.

Park Terrace Apartments (north of Fillmore Street)

As shown in Figure 6-5, the Park Terrace Apartments lie on the west side of Chestnut Street. A wall is the only potentially feasible mitigation solution at this site. It could be built either on the east or west side of Chestnut Street. The advantage of the west side wall is that it also mitigates Chestnut Street traffic noise. Its disadvantages are that it would require right of way acquisition, would require breaks in the wall for the driveways (which would degrade the performance of the wall), and would create a safety hazard for people trying to pull out of the

apartment complex onto Chestnut Street. For these reasons, the west side wall was deemed infeasible.

A wall on the east side avoids the right of way and safety issues, but would reflect Chestnut Street traffic noise. There are separate buildings in the apartment complex that surround common use areas. Two of these buildings face onto Chestnut Street and I-25. The parking areas for each set of buildings have direct access onto Chestnut Street. The interstate right-of-way abuts the east side of Chestnut Street, and the interstate is lower in elevation by approximately 5 feet. There are seven ground floor units and seven second-floor units in each building that face the highway. There is minimal evidence of frequent outdoor use on the highway side of these units. However, each unit has a back door that opens to a quadrangle. One quadrangle has a pool and the other an open area. Clearly, these are the center of outdoor activities for most residents.

The effect of a 540 foot long 20 foot tall wall placed along the east side of Chestnut Street was predicted at the locations shown in Figure 6-5. This wall is predicted to achieve 5.2 dB of reduction at the ground floor apartments facing I-25. Given this, and the fact that there do not appear to be any fatal-flaw maintenance or safety issues, the wall is considered feasible.

Each of the 14 ground floor units was predicted to receive at least 3 dB of reduction, with an average of 5.2 dB of reduction. This results in a cost per receptor per dB of $4,450 (540x20x30/14x5.2), which is considered unreasonable. The design year noise levels range from 65 to 71 dB(A), which is considered reasonable. The area is approximately 50% commercial, including gas stations and motels to the south and restaurants and miniature golf to the north, which is considered marginally reasonable to reasonable. The predicted increase in noise levels is 5 dB, which is considered marginally reasonable to reasonable. In consideration of all these factors, particularly the lack of outdoor use that would directly benefit, the wall is considered unreasonable and is not recommended for inclusion in the Proposed Action.

Holland Park Neighborhood (north of Fillmore Street)

It is possible to physically construct a continuous wall in this area, on the east side of the alley. The 16-foot tall, 2,820-foot long noise wall shown in Figure 6-6 was predicted to achieve an average of 6.5 dB of noise reduction at front row receptors. There do not appear to be any fatal-flaw maintenance or safety issues associated with the wall. Therefore, this wall is considered feasible.

The wall was predicted to achieve at least 3 dB of reduction at a total of 70 residences, with an average reduction at these residences of 5.7 dB. Therefore, the cost per receptor per dB of reduction is $3,392 (16x2820x30/70/5.7), which is considered reasonable. Design-year noise levels at the front row of receptors range from 69 to 71 dB(A), which is considered extremely reasonable. The area has greater than 75% residential development, which is considered extremely reasonable. The predicted increase in noise levels is 5 dB, which is considered marginally reasonable to reasonable. In consideration of all these factors, the wall is considered reasonable, and is recommended for inclusion in the Proposed Action.

Note: There are four multi-unit residential buildings north of the single-family homes, and the Foxfire Apartment complex north of these. It was determined through a field inspection that the southern two multi-unit buildings have some areas of frequent human outdoor use that

would benefit from reduced noise levels. Therefore the wall should be designed to protect these residences. The northern two multi-unit buildings and the Foxfire buildings all have no outdoor use facing I-25 that would benefit from the wall. Therefore, the wall need not be designed to explicitly protect these residences, however, they will receive some latent benefit.

Garden Terrace Apartments (north of Garden of the Gods Road)

As shown in Figure 6-7, the Garden Terrace Apartments lie on the west side of Rusina Road. A wall is the only potentially feasible mitigation solution at this site. It could be built either on the east or west side of Rusina Road. The advantage of the west side wall is that it also mitigates Rusina traffic noise. Its disadvantages are that it would require right of way acquisition, would require breaks in the wall for the driveways (which would degrade the performance of the wall), and would create a safety hazard for people trying to pull out of the apartment complex onto Rusina Road. For these reasons, the west side wall was deemed infeasible.

A wall on the east side avoids the right of way and safety issues, but would reflect Rusina Road traffic noise. The interstate right-of-way abuts the east side of Rusina Road. There are seven ground floor units facing I-25 within the complex. There is minimal evidence of frequent outdoor use on the highway side of these units. The effect of a 1,010 foot long 20 foot tall wall placed along the east side of Rusina Road was predicted at the locations shown in Figure 6-7. This wall is predicted to achieve 5.4 dB of reduction at the ground floor apartments facing I-25. Given this, and the fact that there do not appear to be any fatal-flaw maintenance or safety issues, the wall is considered feasible.

At least 3 dB of noise reduction was predicted at a total of 18 living units, with an average reduction of 4.1 dB. This reduction is from interstate noise only, and the reduction in overall noise levels would be less due to the reflection of Rusina Road traffic. This results in a cost per receptor per dB of $8,211 (1010x20x30/18x4.1), which is considered unreasonable. The design year noise levels range from 69 to 70 dB(A), which is considered reasonable. The area is approximately 50% commercial, with gas stations and motels to the south and restaurants and commercial office buildings to the north. This is considered marginally reasonable to reasonable. The predicted increase in noise levels is 5 dB, which is considered marginally reasonable to reasonable. In consideration of all these factors, particularly the lack of outdoor use that would directly benefit, the wall is considered unreasonable and is not recommended for inclusion in the Proposed Action.

Pulpit Rock Neighborhood (north of N. Nevada Avenue)

It is possible to physically construct a continuous wall in this area. The 15-foot tall, 1,885-foot long noise wall shown in Figure 6-8 was predicted to achieve an average of 6.0 dB of noise reduction at front row receptors. There do not appear to be any fatal-flaw maintenance or safety issues associated with the wall. Therefore, this wall is considered feasible.

The wall was predicted to achieve at least 3 dB of reduction at a total of 38 residences, with an average reduction at these residences of 5.6 dB. Therefore, the cost per receptor per dB of reduction is $3,986 (15x1885x30/38/5.6), which is considered reasonable. Design-year noise levels at the front row of receptors range from 65 to 70 dB(A), which is considered reasonable. The area has greater than 75% residential development, which is considered extremely reasonable. The predicted increase in noise levels is 4 dB, which is considered marginally

reasonable. In consideration of all these factors, the wall is considered reasonable, and is recommended for inclusion in the Proposed Action.

6.2.2 Parks

From Table 5-2, three parks are considered impacted by noise: Dorchester Park, Confluence Park and Monument Valley Park. The decision of whether or not to provide mitigation for parks is based in part on how the park facilities are used and on the desires of the park's owners. All three parks are owned by the City of Colorado Springs, and managed by the City's Parks, Recreation and Cultural Services department. In cases where mitigation for parks was determined to be feasible, consultation was conducted to obtain the City's input.

Dorchester Park

In the case of Dorchester Park, mitigation was found to be infeasible because 5 dB(A) of noise reduction could not be achieved due to the contribution of noise from Nevada Avenue and Tejon Street, which are arterial streets that border the park on its east and west sides. Also, I-25 is relatively distant from Dorchester Park, as it is located on the other side of Monument Creek.

Confluence Park

The City was not in favor of a noise barrier along I-25 at Confluence Park (under construction, not yet open for use) because it wants the park to be visible from the interstate. However, the City urged the use of solid guardrail barriers along the park instead of the standard open guardrail. This type of barrier is available as a design treatment, but would not be considered noise mitigation.

Monument Valley Park

In the case of Monument Valley Park, CDOT presented a number of mitigation alternatives to the City staff, and these were subsequently considered by the Colorado Springs Parks and Recreation Advisory Board.

Monument Valley Park (MVP) extends from Bijou Street to Fillmore Street on the east side of I-25. The layout and use of the Park changes from south to north. Between Bijou Street and Uintah Street the Park is fairly close to I-25 (300 to 500 feet), and the Park consists of ballfields, trails, a swimming pool and tennis courts, and a picnic pavilion. Between approximately Uintah and Fontanero Streets, the Park is anywhere from 600 to over 1,000 feet from the center of I-25. In this area the Park consists of hiking trails and a more natural setting. North of Fontanero Street the Park veers to the east and becomes shielded from the highway by a number of large commercial warehouse-type buildings owned and used by the City's utilities company. The Park use and setting remain natural and become more wooded.

Unlike residential properties, CDOT and FHWA do not define strict rules for determining where noise mitigation must be implemented in park areas. Where to analyze mitigation within MVP was first determined by CDOT. Mitigation was focused on those areas where there is active outdoor use and where noise reduction would provide a clear benefit to users. Based on this, mitigation was considered and analyzed for the following five areas: the ball fields to the south, the Demonstration Gardens, the ponds south of Uintah Street (across from the Glen Avenue residences), and the trails on the west side of Monument Creek north of

Uintah Street. The results of these analyses were provided to the City of Colorado Springs Parks Department staff and board. This information was also presented to and discussed with the Friends of Monument Valley Park. At their December 2002 meeting, the Parks Board voted to adopt some of CDOT's proposals, but not others. A letter summarizing their opinions was provided to CDOT, and is included in this report as Attachment F. The analyses conducted for each of these areas and the City's responses to them are discussed separately in the following paragraphs. A summary of which mitigation measures were proposed by CDOT and accepted by the City's Parks Board is provided in Section 6.4.

Berm near Ball Fields

Noise mitigation for the ball fields was considered. As shown in Figure 6-9, CDOT owns a triangular piece of land north of Bijou Street. The effect of placing a berm on that property was analyzed and found to be a relatively cost-effective solution for the benefit derived. It was determined that an 890 foot long, 5 to 20 foot tall berm could be constructed. This berm would provide an average noise reduction of 2 dB at the ball fields, and at least 5 dB of reduction along the trail on the west side of the ball fields. The City supports this proposal. Although, at this point neither the City nor CDOT has the funds for annual maintenance of landscaping.

Vegetation South of Existing Noise Wall

CDOT has proposed planting additional trees south of the existing noise wall, as shown in Figure 6-9. The main purpose of this is to provide added visual screening. There would be very little measurable decrease in noise levels as a result of this. However, there could be some perceived noise reduction. The City supports this proposal.

Wall Near Demonstration Gardens

Three noise wall alignments were analyzed for this area, as shown in Figure 6-9. The first (C1) wraps around the garden itself, the second (C2) is located east of the railroad tracks and the third (C3) is located on the I-25 right of way line. The results show that C1 (370 feet long, 12 feet tall), C2 (470 feet long, 20 feet tall), and C3 (625 feet long, 20 feet tall) would each provide approximately 5 to 6 dB(A) of noise reduction in the gardens. C1 requires the least structure, followed by C2, and C3 requires the most structure. C1 provides noise reduction from both trains and traffic on Glen Avenue. C2 would mitigate train noise, but reflect Glen Avenue noise. It might also eliminate critical parking spaces. C3 would reflect both train and Glen Avenue noise. The City's prefers C3. It would support C2 if the parking could be maintained. C1 is not supported due to safety and visual concerns.

Wall Near Ponds

The two walls under consideration for the duck pond area of MVP are shown in Figure 6-4, and described in Section 6.2.1, under the Glen Avenue Residences. As shown in Figure 6-4, the first (D1) is located on the I-25 right of way and has a break for ramp access, and the second (D2) is located to the east of the railroad tracks. The results show that D1 (1060 feet long, 20 feet tall) and D2 (1080 feet long, 20 feet tall) would provide about 4 dB(A) and 5 dB(A) of noise reduction, respectively. The D2 alignment also provides protection from passing trains. The City supports either option. One concern they have with D2 is that it may have a "crowding" effect on the Park

Noise Wall or Berm Between Uintah Street and Fontanero Street

Between Uintah and Fontanero Streets, the park is east of Monument Creek and includes a playground, soccer field (in a former reservoir) and a running track, and recreational trails.

On the extreme western edge of the park next to Recreation Way is a recreational trail. Only this short trail section is exposed to noise levels that equal or exceed the Category B Noise Abatement Criterion.

CDOT proposed two noise mitigation strategies to protect this very small section of the trail. In this area, the trail abuts Monument Creek with the useable portion of the park located on the opposite bank. Mitigation strategies for the trail were presented to the City Parks, Recreation and Cultural Services staff, the Recreation staff, and the City's Parks and Recreation Advisory Board, as well as to the Friends of Monument Valley Park.

The first strategy, the construction of a noise wall, approximately 1,500 feet long and 15 to 20 feet tall, was found to reduce noise for this small trail segment by three to four decibels, at a cost of $1,125,000. Construction of a noise wall to protect this small trail segment was considered cost prohibitive for the small benefit achieved. Construction of this noise wall was not supported by the City Parks, Recreation and Cultural Services or the Park and Recreation Advisory Board. The second strategy, the construction of a noise berm, required the closure of Recreation Way. This strategy was not supported by the City's Parks, Recreation and Cultural Services staff, the Park and Recreation Advisory Board, or the Colorado Springs Utility Department because it would close Recreation Way, an important roadway for Park and Utility operations. A combination of berm and wall was rejected since it would also require the closure of Recreation Way.

Trails

There are a number of walking and biking trails that either intersect or run along I-25. Some portions of these trails have noise levels in excess of 66 dB(A), other portions of these trails are not impacted due to their great distance from the highway. Due to the linear nature of these trails, the construction of walls would be very expensive for the benefit derived, and would have other impacts such as the loss of view, drainage, and safety of the trail user.

6.2.3 Hotels/Motels

As shown in Figures 5-1 through 5-19, 17 hotels were identified within the 66 dB(A) contours. Each was visited to determine if the facility had any outdoor uses facing the highway, such as pools, patios, and ground-floor balconies. A number of the hotels did have some form of outdoor use facing I-25. However, in each case it was found that mitigation was either not feasible or reasonable.

6.3 Mitigation Measures Analyzed For Category C Receptors

A thorough inspection of the commercial areas inside the 71 dB(A) noise level contours concluded that there are no areas of frequent human use where reduced noise level would be of benefit. That is, patrons and employees of these facilities generally park their cars and walk inside. There are no significant outdoor seating areas or other outdoor uses that would benefit significantly from noise mitigation. CDOT and FHWA noise policies are geared toward providing mitigation only in areas where there will be a significant benefit to regularly used, outdoor areas. Therefore, no noise mitigation was analyzed or is proposed for commercial areas on this project.

6.4 Summary of Noise Mitigation

Table 6-1 in Attachment H summarizes the results of the mitigation analyses conducted for this project. The CDOT Noise Abatement Determination forms are included as Attachment I. Per CDOT policy, mitigation must be found to be both feasible and reasonable in order to be included in the project. Noise mitigation, in the form of noise walls and earthen berms, was found to be both feasible and reasonable at the following residential neighborhoods:

- Stratmoor Valley neighborhood
- Holiday Village neighborhood
- Holland Park neighborhood
- Pulpit Rock neighborhood

At the other residential areas, mitigation was found to be either infeasible because the minimum noise reduction of 5 dB could not be achieved or the barrier created safety problems, or unreasonable because cost effective noise mitigation could not be achieved.

Various noise mitigation strategies are being recommended for Monument Valley Park. These include a berm near the Bijou interchange, a wall near the Demonstration Gardens, and a wall near the Duck Ponds. Mitigation recommendations for the Park were determined through consultation with the City of Colorado Springs.

A field inspection of the hotels and commercial facilities impacted by noise concluded that either there was no active outdoor use facing the highway, or mitigation would be infeasible or unreasonable.

7.0 Construction Noise

Construction of the project will generate noise from diesel-powered earth moving equipment such as dump trucks and bulldozers, back-up alarms on certain equipment, compressors, and pile drivers (near bridge abutments and retaining walls, if necessary). Construction noise at off-site receptor locations will usually be dependent on the loudest one or two pieces of equipment operating at the moment. Noise levels from diesel-powered equipment range from 80 to 95 dB(A) at a distance of 50 feet. Impact equipment such as rock drills and pile drivers can generate louder noise levels. Construction noise impacts, while temporary, can be mitigated by limiting work to daylight hours and requiring the contractor to use well-maintained equipment (particularly with respect to mufflers).

8.0 Indirect Impacts of Proposed action

The primary indirect noise impact of expanding I-25 is the effect that this action will have on local streets. In some cases, particularly along main access routes, noise levels could increase due to increased traffic volume. In other cases, where traffic volumes decrease due to more people opting to use I-25, noise levels could decrease.

9.0 Cumulative Impacts of Proposed Action

For noise, cumulative impact is the result of the noise level increases of the project at hand added to the increases that occurred as the result of previous projects in the Corridor. STAMINA 2.0 was used to predict noise levels using 1990 traffic conditions and roadway alignment.

As described in more detail in Section 5.3, the increase in highway noise levels between 1990 and 2025 was predicted at 40 representative locations throughout the Corridor. They include most of the residential areas and parks adjacent to I-25. Increases are due to a combination of traffic volume and speed increases, changes in the distance to the highway, the addition or removal of obstructions (buildings, noise walls, embankments, etc), changes in acoustical ground absorption, and the addition of sound reflections due to noise walls. The predictions do not take into account changes in the pavement type, as the long-term noise level effects of this are not well understood and it is against current FHWA policy.

The predicted changes in noise levels range from a decrease of 2 dB(A) to an increase of 7 dB(A). Decreases are the result of noise walls constructed after 1990. The average increase is 4 dB(A). None of the 40 representative locations showed an increase of 10 dB(A) or greater, thus no locations along this Corridor are considered to be impacted per the 10 dB(A) increase criterion.

ATTACHMENT A – I25 EA NOISE TECHNICAL REPORT

CDOT Noise Guidelines Excerpts

5.4 Feasibility

Feasibility deals with physical considerations and concerns with the construction of an acoustically effective noise barrier at a particular site and project.

5.4.1 Noise Reduction

The major feasibility criterion that is to be considered is to whether or not a substantial noise reduction can be obtained based on constraints that are inherent to the individual project. If a substantial reduction cannot be provided a noise barrier is not feasible and will not be recommended for inclusion in the project.

CDOT defines a substantial reduction goal as a barrier that is predicted to reduce noise levels to at least one adjacent front row receiver by at least 10 dBA. The initial barrier evaluation shall be performed to determine what will be required to achieve a 10 dBA reduction. If the barrier's height that is required for this reduction is found to be 25 feet or greater, then it can be considered not feasible and the barrier evaluation will take place at a lower height. Each barrier that is evaluated shall also be evaluated under the reasonableness criteria.

It is desired that barriers be optimized in terms of overall reduction (height) and cost-benefit, which is one of the factors for reasonableness. In this case, it is desired that a point be identified where a potential noise barrier provides the best balance between cost and benefit. This is not a trivial task, as the benefit versus cost relationship is not linear and a point of diminishing returns will be reached. An iterative process, however, can result in a barrier that will be optimal within the scope of the reduction goal (10 dBA or greater), and the minimum reduction required (5 dBA). **In any case, no barrier shall be deemed feasible if an absolute minimum reduction of 5 dBA cannot be achieved for at least one front-row receiver.**

A benefited receiver is one, impacted or not, which receives at least 3 dBA of noise reduction, corresponding to at least a perceptible benefit. This is reduction that is based on the addition of the noise barrier only, which is only considered after any shielding affects, such as for rows of buildings, are taken into account.

The overall noise environment should also be considered in whether or not a noise barrier will be feasible. If the area in question is one where aircraft or rail activity exists, a barrier that only mitigates highway noise might not be enough to reduce the overall background levels appreciably. In those cases, it would not normally be feasible to construct a highway traffic noise barrier. Other considerations that need to be taken into account are situations where a barrier will shield a main highway, but not a frontage road. In these cases, the overall noise environment shall be the basis for the determination if a substantial noise reduction is possible, not just the reduction to the mitigated source.

5.4.2 Safety and Maintenance Considerations

As is the case with any structure, there are obvious engineering, safety and maintenance issues that must be considered to determine its constructability, and thus, be a feasible proposition. If any of these issues are significant enough to cause a fatal flaw condition, then the barrier can be deemed not feasible. Examples of situations which can be considered fatal flaws include, but are not limited to, the following:

- Excessive reduction of sight distance.
- Creation of a continuous shadowing condition that may cause excessive icing of driving lanes through the winter months.
- Inability to provide for adequate snow/debris removal.

5.4.3 Constructability

If reliable and common engineering practices could be employed to construct a noise barrier, then that barrier is considered to be a feasible proposition. Other factors that are sometimes considered concurrently, such as costs, are to be evaluated separately under the reasonableness criteria described in section 5.5.

If it is obvious that the constructability of a noise barrier due to site limitations or engineering considerations is not possible without major modifications to the site or technological efforts, the barrier can be considered not to be feasible and no further analysis is required, however, this should only be used for situations that are very clear. If it may be possible that a barrier(s) can be constructed, the evaluation with the computer model will take place in order to determine if a substantial reduction can take place. Decisions such as these shall be thoroughly documented and justified in the noise study report.

A very common issue to consider in this case is the ability to construct a continuous barrier for the entire length of the impacted area. An effective noise barrier cannot be built if breaks for driveways, sidewalks, streets, utilities, drainage facilities or streams are needed, as these breaks drastically reduce the barrier's performance. One possible solution in a case such as this is to consider overlapping the barriers.

5.4.4 Berms

Most of the above feasibility discussions have focused on the construction of noise barrier walls. Berms, however, can be considered as an alternative to walls where possible, as they are generally more aesthetically pleasing and have a more natural appearance. Limitations with berms do need to be considered in the feasibility evaluation, as they do require a much larger footprint. Ideally, this will be enough of a footprint to provide no steeper than a 3:1 slope.

5.4.5 Considerations for Parallel Barriers

Due to multiple sound reflections, performance degradation of parallel barriers needs to be investigated if the width-to-height ratio is less than 10:1 (distance between the barriers is less than 10 times the height of the barriers) or if the barriers are closer together than 200 feet. In these cases, if it is found that the overall noise reduction has decreased, steps need to be taken to reduce this degradation. Possible solutions include raising the height of the barriers to overcome the degradation or investigating the use of absorptive treatments on either or both barriers to reduce the reflections. In these cases, retaining walls, if they are present, should be treated as barriers in the analysis.

If all noise barriers that have been evaluated for a particular project are deemed not to be feasible (i.e. no barrier can be constructed that will result in a 5 dBA reduction to at least one receiver), the reasonableness criteria are not assessed and the noise analysis is considered complete. This decision is to be discussed and documented in the noise study report.

5.5 Reasonableness

The reasonableness determination is a more subjective process than what is done to determine feasibility. It implies that common sense and good judgment have been used in the consideration of noise abatement. The process for evaluating the reasonableness of abatement is meant to be flexible enough to meet individual situations but able to be applied in as consistent and uniform a manner as possible on a statewide basis. The main consideration in this evaluation is whether or not the barrier is a practical solution for a certain situation.

The FHWA regulations are meant to give the states flexibility in complying with the requirements of 23CFR772, and many of the criteria that are to be considered are based on a range of possible solutions, many of which are to be determined by the individual states. While the determination of impacts is fairly standard and must be done by all states, the evaluation of any potential mitigation does not contain any mandates as to when mitigation is to be provided, other than after a determination of feasibility and reasonableness. In this determination, there is only one "absolute" criterion that is considered by CDOT in these guidelines: Even if a barrier meets all feasibility requirements and is deemed to be reasonable, it will not be built if the majority of the affected property owners do not want it to be built. A property is considered to be "affected" if it is predicted to receive at least a 3 dBA benefit from the barrier (i.e. is considered to be a "benefited" receiver).

The final determination of reasonableness of noise mitigation will be made only after a careful and thorough consideration of a wide range of criteria. The following are the criteria that will be considered by CDOT in its noise abatement evaluation. **None of the following reasonableness factors by itself shall be sole grounds for acceptance or rejection of mitigation**.

Each reasonableness factor discussed below will have one of four possible values:

- EXTREMELY REASONABLE – The proposed mitigation can be accomplished through minimal financial or social costs, or reflects a situation that warrants high consideration for mitigation.
- REASONABLE – The proposed mitigation can be accomplished through acceptable financial or social costs, or reflects a situation which warrants greater consideration for mitigation.
- MARGINALLY REASONABLE – The proposed mitigation can be ac-accomplished through moderate financial or social costs, or reflects a situation that is moderately warranted for mitigation consideration.
- UNREASONABLE – The proposed mitigation cannot be accomplished without excessive financial or social costs, or reflects a situation in which mitigation consideration should be minimal at best.

5.5.1 Cost Benefit Index

In consideration of the cost of each potential noise barrier segment, the barrier benefit index shall be evaluated based on an estimate of cost per receiver per decibel of reduction. This will determine the "cost-reasonableness" of the abatement.

The cost benefit index, calculated as a ratio, is not intended to function as an accurate itemization of all of the different costs that are prevalent in the construction of a noise barrier, but rather to determine a consistent level of consideration that will be used for all CDOT noise abatement evaluations under these guidelines.

EXTREMELY REASONABLE: Less than $3000/receiver/decibel
REASONABLE: $3000-$3750/receiver/decibel
MARGINALLY REASONABLE: $3750-$4000/receiver/decibel
UNREASONABLE: More than $4000/receiver/decibel

This value will be determined by dividing the approximate cost of the barrier (length * height * unit cost) by the total decibel reduction that is predicted to occur. For evaluation purposes, the unit cost that will be used for this cost calculation will be a typical cost of $30 per exposed square foot, which will approximate all costs in construction of a standard concrete/masonry barrier that does not require special site considerations. If berms are possible and are potentially feasible, use the unit cost of $10 per square yard of earth for the berm portion of the calculation.

The total decibel reduction is the cumulative sum of all of the decibel reductions projected for each receiver that receives at least a 3 dBA benefit directly due to the noise barrier (all benefited or affected receivers).

For example, consider a barrier 10 feet high and 1000 feet long to protect a development of 16 homes. If 6 receivers are predicted to receive a 5 dBA benefit

and 10 are predicted to receive a 7 dBA benefit, the cost benefit index value will be calculated as follows:

Cost = (10 ft. ht.) * (1000 ft. l.) * ($30/sq. ft) = $300000;
Benefit = (6 rec. * 5 dBA) + (10 rec. * 7 dBA) = 100 total dBA reduction;
Cost-Reasonableness Value = $300000/100 dBA = $3000/receiver/decibel.
This barrier would be considered REASONABLE.

As mentioned earlier, receiver points that were used in the modeling usually represent several actual receivers. It is very important to properly quantify these receivers to obtain an accurate count of the benefits achieved to be used for the calculation. For the calculation, each benefited individual residence, business, etc. is to be counted as one receiver. For multi-family residences, each unit adjacent to the highway should count as one receiver. If the multi-family structure is predicted to receive an overall benefit of 8 dBA, for example, but there are 4 separate units, then an overall benefit of 32 dBA (4*8) must be used in the calculation.

In many cases, the number of receivers and their locations are not easily defined. The noise analyst in this case must use good judgment in determining these values, with the overall social benefit being the primary consideration in this evaluation. Special use facilities, such as parks and churches, should be handled with the same consideration and judgment on a case-by-case basis.

5.5.2 Build Noise Level

The future projected noise levels with the completion of the project should, on average, be at least 66 dBA for consideration of noise mitigation for the front row receivers.

EXTREMELY REASONABLE: Design-year noise levels 70 dBA or more
REASONABLE: Noise levels of 66-70 dBA
MARGINALLY REASONABLE: Noise levels 63-66 dBA
UNREASONABLE: Levels less than 63 dBA

This criterion gives greater consideration to areas, which are or will be subjected to a higher absolute level of noise.

5.5.3 Impacted Persons' Desires

The opinions and desires of the impacted community should be of primary importance in the evaluation of reasonableness of a noise barrier. At least 50% of the affected property owners should want the noise barrier.

EXTREMELY REASONABLE: More than 75% in support
REASONABLE: 50-75% supportive
MARGINALLY REASONABLE: 25-50% supportive

UNREASONABLE: Less than 25% supportive

These values are normally based on residential areas, as normally mitigation for commercial and special-use areas by themselves are not reasonable. The percentages are to be based on the properties that benefit from the noise barrier (i.e. receive at least a 3 dBA benefit). In all cases, each individual property owner or their official designee or representative shall be the party to be consulted in this manner.

5.5.4 Development Type

The mixture of development types plays a major role in determining the reasonableness of mitigation. To be considered, the amount of residential CDOT Noise Analysis and Abatement Guidelines 22
development should be at least 75% of the overall development in the area around the project.

EXTREMELY REASONABLE: Greater than 75% residential
REASONABLE: 50-75% residential
MARGINALLY REASONABLE: 25-50% residential
UNREASONABLE: Less than 25% residential

In general, the term "residential" as described above also includes other category "B" type development, such as parks, churches, hospitals, hotels, etc.

5.5.5 Development Existence

To be fully considered for a reasonable project, the majority of the development in the area of a highway improvement should have been in existence for at least 15 years before the consideration of the project.

EXTREMELY REASONABLE: Greater than 75% of properties at least 15 years old
REASONABLE: 50-75% at least 15 years old
MARGINALLY REASONABLE: 25-50% at least 15 years old
UNREASONABLE: Less than 25% at least 15 years old

The spirit of this criterion is to give greater consideration to long-term residents.

5.5.6 Build Noise Level vs. Existing Noise Level

The future build noise levels over the existing levels will be more of an issue if there is to be a readily perceptible increase with the completion of the project.

EXTREMELY REASONABLE: Greater than a 10 dBA increase
REASONABLE: 5-10 dBA increase
MARGINALLY REASONABLE: 0-5 dBA increase

UNREASONABLE: A project that will result in a decrease in projected noise levels.

This criterion allows greater consideration for projects that receive a perceptible increase in noise levels. In any case, this criterion is to still give consideration and not dismiss a potential barrier just because the project is not contributing any additional noise, especially if the overall noise levels are projected to be very high (70 dBA or greater).

Upon review of these criteria, the decision that is made should be well documented in the noise study report. To aid in this documentation, completion of CDOT form 1209 is required and is to be included within the noise study report (see Appendix C for a copy of the form). This form is to be filled out for each barrier segment or each distinct area of the project that were evaluated in the analysis.

5.6 Special Considerations for Severe Impacts

If a private-use residential property is determined to be severely impacted by noise (75 dBA exterior levels or a 30 dBA or more increase in noise levels), then extra-ordinary abatement measures may be considered if no other possible abatement is determined to be feasible and reasonable. One such method that can be used in these cases is noise insulation of the structure, which can include such measures as sealing windows and doors, filling voids in the structure, installation of an air-conditioning system, or other use of noise-absorbing material.

The consideration of extraordinary abatement measures in the case of severe highway traffic noise impacts can be made on a case-by-case basis and is not a mandatory requirement at this time.

5.7 Special Considerations for Non-Profits

Public use or nonprofit institutional structures, such as churches and schools, may be considered for noise insulation in accordance with 23CFR772.13.c(6). This evaluation is strictly voluntary and can be made on a case-by-case basis. Care must be taken in this evaluation as to the condition of the structure, its current amenities, and overall use characteristics to be sure that any proposals consider fully the implications of providing the abatement. One such case is for a facility which is not subjected to high interior noise levels unless the windows are open, but must remain open for the purposes of ventilation, and thus, provide proper use and enjoyment of the facility. Any decisions in this regard must be thoroughly and completely documented in the text of the noise report.

ATTACHMENT B – I25 EA NOISE TECHNICAL REPORT

Noise Model Comparison Report

Noise Model Comparison Report

Interstate 25 Through Colorado Springs Environmental Assessment

El Paso County, Colorado

Report No.: HEI 4-9-1

February 2002

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1.0 Summary

This report describes the results of a study that was conducted to determine which noise model, STAMINA v2.0 or Traffic Noise Model (TNM) v1.1, better predicts measured noise levels along Interstate 25 (I-25) though Colorado Springs, Colorado. The study was conducted as part of the I-25 Corridor Environmental Assessment (EA).

Presently, both STAMINA and TNM are approved for use by the Federal Highway Administration (FHWA). However, due to some functionality problems, TNM is, in effect, in a "test" mode. STAMINA is the default model for Colorado Department of Transportation (CDOT) projects.

Noise levels were measured at 75 locations along the Corridor (Figure 1 shows the study area). Traffic volumes, traffic speeds, and meteorological conditions were also measured. Then, using the traffic conditions measured on-site, both STAMINA and TNM were used to predict noise levels at each location. The models utilized accurate topographical data to model the physical aspects of each measurement location. The measured and predicted noise levels were then compared.

STAMINA v2.0 predicted noise levels between 5 dB(A) below and 8 dB(A) above measured levels. Averaging the results from all 75 measurements, STAMINA predicted 1 dB(A) above measured levels. STAMINA predicted within ±3 dB(A), a common measure of accuracy, at 55 of the 75 measurement locations (73%). TNM v1.1 predicted noise levels between 3 dB(A) below and 10 dB(A) above measured levels. Averaging the results from all 75 measurements, TNM predicted 4 dB(A) above measured levels. TNM predicted within ±3 dB(A) at 27 of the 75 measurement locations (36%).

In trying to rectify differences between measured and predicted noise levels and differences between the modeling results, a number of investigations were conducted into how specific data inputs (speed for example) affect each model. From these investigations it was found that STAMINA generally provides the expected result. With TNM, however, unexpected results were obtained for tests involving ground type, noise level decay versus distance, roadway grade, roadway separation, and barrier insertion loss.

Overall, this study concludes that STAMINA v2.0 provides reasonably accurate and expected results for highway noise level predictions along the I-25 Colorado Springs Corridor. TNM provides less accurate results. Also, TNM provides results in simple tests that do not agree with the expected result.

2.0 Introduction

This report describes the results of a study that was conducted to determine which noise model, STAMINA v2.0 or Traffic Noise Model (TNM) v1.1, better predicts measured noise levels along Interstate 25 (I-25) though Colorado Springs, Colorado. The study was conducted as part of the I-25 Corridor Environmental Assessment (EA).

Noise levels were measured at 75 locations along the Corridor (Figure 1 shows the study area). Traffic volumes, traffic speeds, and meteorological conditions were also measured. Then, using the traffic conditions measured on-site, both STAMINA and TNM were used to predict noise levels at each location. The models utilized accurate topographical data to model the physical aspects of each measurement location. The measured and predicted noise levels were then compared.

This report is organized as follows. Section 3 describes the noise level measurements. Section 4 describes the modeling procedures. Section 5 describes the results of comparisons of measured and predicted noise levels. Section 6 discusses various modeling issues with STAMINA and TNM. Other technical details relating to the noise measurements and noise modeling are provided in Appendix A and B, respectively.

FIGURE 1: PROJECT AREA

3.0 Noise Level Measurements

This section describes the noise level measurements that were conducted. This includes a description of the noise level measurement procedures and results, and a general description of the measurement locations. This is followed by a more detailed discussion of each measurement site.

Referring to Figure 2, noise level measurements were taken at 20 "sites", e.g. the Pulpit Rock neighborhood, the area around the Bijou Street interchange, etc. Measurements were taken at anywhere from two to 17 locations at each site, for a total of 75 measurements. Forty-four of the measurements were taken between May and June 2001. The others were conducted as part of previous CDOT projects located in the Corridor. During each measurement, traffic volumes (including truck percentages) and traffic speeds were recorded for each direction of I-25 as well as any significant nearby side-roads. Meteorological conditions were recorded as well. Noise levels at each location were recorded for approximately one hour (some cases 30 minutes), using ANSI Type 1 sound level meters (SLM). Each SLM was field calibrated prior to each measurement and re-checked after each measurement. The microphones were all located 5 feet above ground level. Meteorological conditions were measured using an automated system mounted 10 feet above the ground. Traffic speeds were recorded using a radar gun.

Table 1 lists the measured noise levels along with other relevant information for each site. Additional technical details regarding these measurements including specific measurement locations, traffic data and meteorological data can be found in Appendix A.

TABLE 1
MEASURED NOISE LEVELS

Site *(---)*	**Measurement** *(---)*	**Date** *(---)*	**Time** *(---)*	**Noise Level** *(Leq - dB(A))*	**Distance to Highway** *(feet)*
Pulpit Rock	M1	5/30/01	13:30 to 13:45, 14:15 to 14:30, 14:45 to 15:15	65	400
	M2			58	700
	M3			56	900
	M4			63	550
Baptist Road	M1	6/5/01	10:00 to 11:00	61	550
	M2			55	1000
	M3			53	1700
	M4			53	1600
	M5			53	1500
Garden of the Gods	M1	6/5/01	13:45 to 14:45	69	200
	M2			64	430
	M3			65	400
	M4			58	570
	M5			58	200

TABLE 1
MEASURED NOISE LEVELS (CONTINUED)

Circle Area	M1	6/6/01	09:45 to 10:45	65	300
	M2			65	630
	M3			64	450
	M4			55	850
	M5			52	670
Circle-Lake	M1	6/6/01	12:30 to 13:30	55	660
	M2			62	730
	M3			71	950
	M4			59	1000
	M5			54	700
Old North End1	M1 (1)	6/12/01	09:30 to 09:45, 10:00 to 10:45	54	600
	M2 (1)			58	700
	M3			53	1500
	M4			49	1100
	M5			54	1000
Old North End2	M1 (1)	6/12/01	12:15 to 13:15	58	640
	M2			58	700
	M3			57	770
	M4 (1)			54	1050
	M5			56	1300
Stratmoor Valley1	M1	6/14/01	10:00 to 11:00	65	230
	M2			59	350
	M3			56	530
	M4			55	650
	M5			56	760
Stratmoor Valley2	M1	6/14/01	11:15 to 12:15	65	250
	M2			59	360
	M3			57	200
	M4			58	350
	M5			61	330
Bijou	M1	8/1/00	11:00 to 11:30	72	220
	M2			61	80
Nevada-Tejon	M1	8/31/98	10:30 to 11:00	71	70
	M2			66	100
	M3			64	220

TABLE 1
MEASURED NOISE LEVELS (CONTINUED)

Woodmen	M1	1/24/01	11:37 to 12:37	66	210
	M2			64	240
	M3		12:57 to 13:57	65	290
	M4			68	150
	M5			58	270
	M6		14:10 to 14:40	62	400
	M7			61	500
	M8			61	600
Mesa Springs[2]	M1-1	1/18/98	14:30 to 16:50	64	280
	M2-1	1/19/98	10:32 to 12:06	66	240
	M2-2			58	420
	M4-1	1/20/98	15:24 to 16:45	64	240
	M4-2			63	340
	M5-1	1/21/98	8:50 to 10:40	64	250
	M5-2			56	600
	M6-1		13:51 to 16:10	65	470
	M6-2			60	720
	M7-1	1/22/98	9:02 to 10:42	63	260
	M7-2			59	480
	M8-1		13:26 to 15:30	62	420
	M8-2			57	840
	M9-1	1/23/98	13:24 to 14:34	63	420
	M9-2			62	400
	M10-1		9:15 to 10:15	64	300
	M10-2			64	300
Park Pavilion[3]	M3-1	1/19/98	11:15 to 12:15	62	240
	M3-1			58	340

(1) Measurements conducted in Monument Valley Park
(2) The measurements taken prior to the construction of the Bijou to Fillmore noise wall on the west side of I-25
(3) The measurements taken prior to the construction of the Park Pavilion noise wall on the east side of I-25

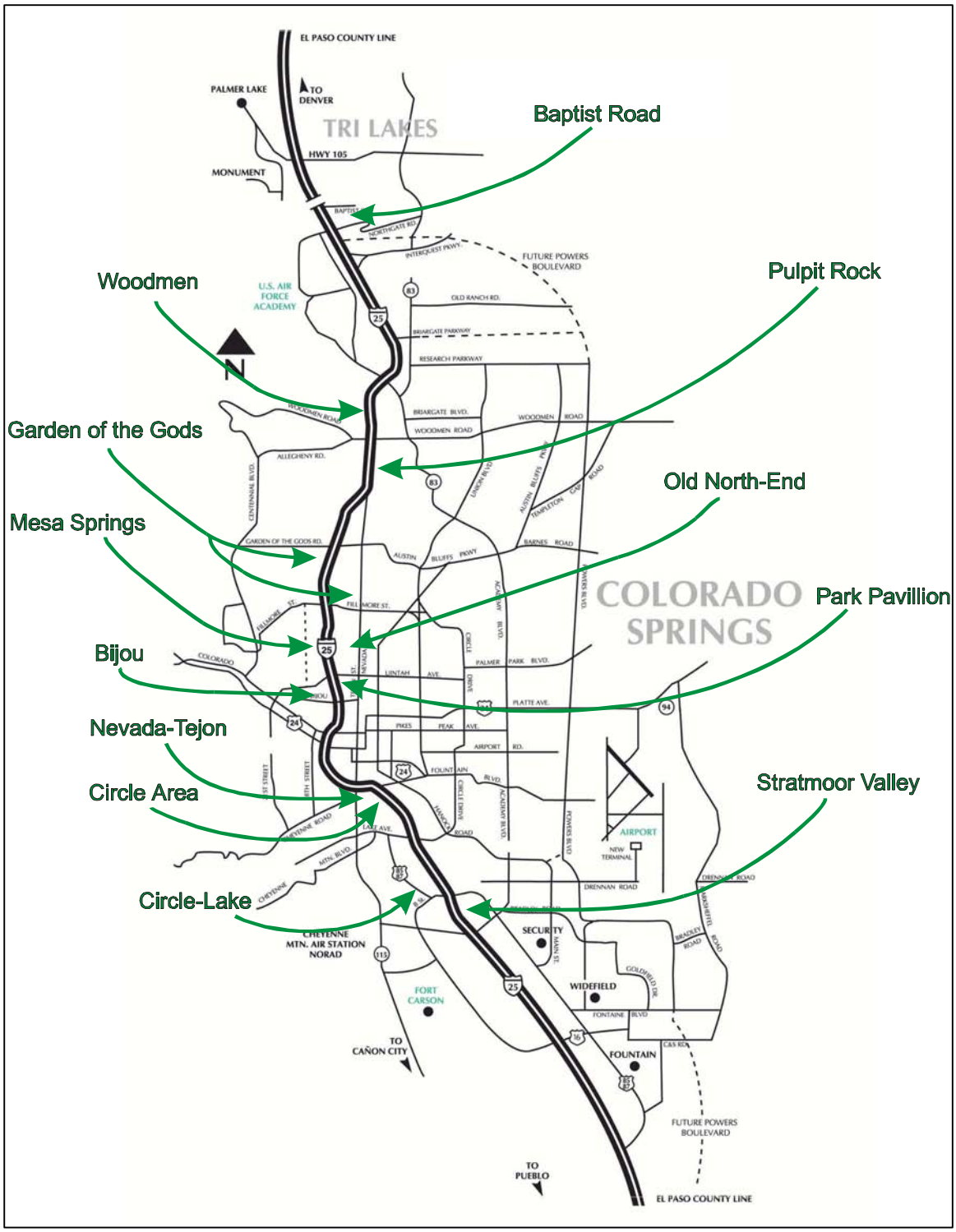

FIGURE 2: NOISE MEASUREMENT SITES

The following paragraphs describe the measurement locations.

Pulpit Rock – This site is located on the northern end of Colorado Springs near Pulpit Rock Drive, on the east side of I-25. The neighborhood is elevated 25 to 30 feet above I-25. A row of house partially blocked the view of I-25 to the north for M1 – M3, and completely blocked the view of I-25 from M4. Wind direction was observed to have significant effect on the perceived direction of the noise source and level. Average wind speed and temperature were 8 mph and 69°F, respectively.

Baptist Road – This site is located just south of Baptist Road on the east side of I-25. There is a grass field located between the measurement locations and I-25. This area is somewhat rural in that there are a lot of open fields. This area is relatively flat with some gradual elevation increases to the east. Just south of the neighborhood is a winding berm that was modeled as a barrier; and is roughly 5 feet above the surrounding area. This is a textbook case of simple hemispherical propagation in which the model is expected to have good accuracy. Noise measurements were taken at distances and locations representative of the nearest residences. Average wind speed, temperature and relative humidity were 13 mph, 51°F, and 90%, respectively.

Garden of the Gods– This site is located between Garden of the Gods Road and Fillmore Street. Measurements were taken on both the east (M1-M3) and west side (M4-M5) of I-25. M1 was taken near the Foxfire West Apartments, M2 was taken near the Salem Church, M3 was taken on the corner of Dunston and Chestnut, M4 and M5 were taken in the Holliday Village Trailer Park near the pool and residence close to I-25, respectively. The elevations of M1 – M3 were about 25 feet above I-25. M1 was located nearest to I-25, while M2 and M3 were behind one row of houses. Locations M4 and M5 were below I-25 and had some shielding of noise from the existing businesses and fence. Average wind speed and temperature were 11 mph and 74°F respectively.

Circle Area – This site is located between US 24 Bypass and Circle-Lake (off Cheyenne Rd.) on the west side of I-25. M1 was located near the Southgate Church. M2 and M3 were located on the west side of Cheyenne Rd. M4 was located along Aspen Road, one block to the west of Cheyenne Rd. M5 was located along Sheridan Rd., two blocks to the west of Cheyenne Rd. This site is a dense neighborhood with the first row of houses set back 550 feet from I-25 with businesses in-between. A 3 dB shielding factor was applied to M4 since it was behind one row of homes and 5 dB of shielding was used for M5 five since it was behind two rows of homes. Average wind speed and temperature were 4 mph and 72°F, respectively.

Circle Lake – This site is located to the West of US85 and is between Circle-Lake and B St. This site is distant and elevated from I-25 with the nearest homes at a distance of 700 feet horizontal and roughly 60 feet above I-25. M1 – M3 were located along Kearney Avenue. M1 was located in some open space between a few homes. M2 was located in the front yard of a residence and had a direct line of sight to I-25. M3 was located near a water tower behind on row of homes. M4 was located down Chamberlin Place and M5 was located along Westmark Avenue. M3 data was corrupted due to a loud car stereo nearby and was eliminated from the analysis. All sites except M3 provided a decent line-of-sight to I-25. The primary barrier for these sites was the hill leading up to the sites, which was modeled. Average wind speed and temperature were 11 mph and 88°F, respectively.

North End 1– This site is located between Uintah and Fillmore Streets on the east side of I-25. In general, this neighborhood is located above I-25. Monument Creek is located between I-25 and this site, forming a valley. M1 was located down in Monument Valley Park near the walking path, with M2 located above M1 adjacent to Culebra Avenue. Both M1 and M2 are in the same line as West Caramillo Street. M3 was located next to Culebra Avenue near Fontanero Street, with M4 located below it in the

Park. M5 was located at the intersection of Wood Terrace Drive and Culebra Avenue. All sites provided a direct line of sight to I-25. Average wind speed and temperature were <1 mph and 84°F, respectively.

North End 2 – This site is located near the intersection of Culebra Avenue and Del Norte Street. The measurements were located in a straight line starting at the walking path in the Park and ending at Culebra Place. M1 was located next to the walking path. M2 was partially up the slope to the east of the path. M3 was on top the slope near Culebra Avenue. M4 was located about 70 feet down Del Norte Street, and M5 was at the intersection of Del Norte Street and Culebra Place. The intent of this measurement was to try and determine how I-25 traffic noise propagates through the Park to the neighborhood. The measured data shows that the noise level drops and then actually increases at the farthest distance from I-25. This is due to noise in the neighborhood from sources other than I-25, which were adding to the noise generated by I-25. Average wind speed and temperature were 1 mph and 95°F, respectively.

Stratmoor Valley 1 – This site is located towards the southern end of Colorado Springs, just to the north of the South Academy Blvd and I-25 Interchange. Measurements were taken on the east side of I-25 along Glenwood Drive. M1 was nearest to I-25 and was in-line with the homes along Cambridge Avenue. M2 was in-line with Cambridge Avenue. M3 and M4 were on opposite sides of Livingston Avenue and M5 was at the intersection of Hartford Avenue and Glenwood Drive. There was a significant berm in-between the measurement locations and I-25 that blocked line-of-sight. Average wind speed and temperature were 3 mph and 84°F, respectively.

Stratmoor Valley 2 – This is the same site as Stratmoor Valley 1, except that three of the measurement locations were moved. M1 and M2 remained in the same location. M3 and M4 were located further south. Average wind speed and temperature were 3 mph and 84°F, respectively.

Bijou – This site is located at the I-25 Bijou Street interchange. M1 is located adjacent to the I-25 southbound on-ramp. M2 is located behind the noise at the east end of Platte Avenue.

Nevada–Tejon – This site is located at the I-25 and Nevada-Tejon interchange. M1 is located adjacent to the southbound I-25 at the end of Arvada Avenue. M2 is located along Arvada between Nevada and Tejon. M3 is located along Nevada Avenue, north of I-25 adjacent to the City Park.

Woodman – This site is located on the west side of I-25, north of Woodmen Road, in the Pine Creek Estates neighborhood. There were eight measurements taken in this area, with six located primarily off Gillen Road and two located on USAF property to the north. M1 – M3 were considered to be the front row locations closest to I-25. M4 and M5 were located on USAF property. M6 – M8 were located in a line along Gillen Road further away from I-25 than M1 – M3. There is a significant berm to the North of M3 that breaks line-of-sight to this portion of I-25. Average wind speed and temperature were 3 mph and 33°F, respectively.

Mesa Springs – This one site includes a total of nine separate sites. Measurements were conducted in January 1998, prior to the installation of the Bijou to Fillmore noise wall or other I-25 alignment changes. A description of each site is as follows.

Site 1 is located at the east end of Monument Street. Receptor 1 is in an open field on the south side of Monument Street at the end of the cul-de-sac, and represents residences located directly behind the wall. This site is directly opposite the location of the Monument Valley Park noise wall. Receptor 1 is 300 feet from and relatively level in elevation with the center of I-25. With the exception of a house to the south, the view to the highway is unobstructed in all directions.

Site 2 is located at the east end of Nichols Court. Receptor 1 is in front of the house on the north side of Nichols Court at the end of the cul-de-sac, and is representative of residences located directly behind the wall. Receptor 2 is in the backyard of a residence on the north side of Nichols Court, three residences west of the wall. It is representative of residences three rows back from the wall. Receptor 1 is 240 feet from and relatively level in elevation with the center of I-25. The view of I-25 is unobstructed in all directions. Receptor 2 is 420 feet from the center of I-25, and approximately 10 feet above the highway. The view of the highway is obstructed by residences in all directions.

Site 4 is located at the east end of Yampa Street. Receptor 1 is in an open area at the end of the cul-de-sac, and is representative of the residences directly behind the wall. Receptor 2 is in the side-yard of the residence on the southeast corner of Yampa Street and Raymond Place. It is representative of residences three rows of houses back from the wall. Receptor 1 is 240 feet from and relatively level with the center of I-25. The view of I-25 is unobstructed in all directions. Receptor 2 is 420 feet from the center of I-25, and approximately 10 feet above the highway. The view of the highway is obstructed by residences in all directions.

Site 5 is located at the east end of San Rafael Street. Receptor 1 is in front of the last residence on the south side of the cul-de-sac, and is representative of the residences directly behind the wall. Receptor 2 is in the front yard of the residence located approximately 175 feet west of Walnut Street. It is representative of residences five rows of houses back from the wall. Receptor 1 is 250 feet from I-25. To the north I-25 is higher than Receptor 1 as it comes down from the Uintah Street overpass. The view of I-25 is partially blocked to the south by a residence. Receptor 2 is 620 feet from the center of I-25, and approximately 20 feet above the highway. The view of the highway is obstructed by residences in all directions except straight down San Rafael Street.

Site 6 is located at the intersection of San Miguel Street and Walnut Street. Receptor 1 is in front of the residence on the northwest corner of this intersection. Receptor 2 is in the front yard of the residence four houses west of Receptor 1. Receptor 1 is 475 feet from and approximately 10 feet above I-25. The view of I-25 is unobstructed in all directions, and the berm which was built as part of the noise wall project almost breaks line of sight to the highway. Receptor 2 is 725 feet from the center of I-25, and approximately 20 feet above the highway. The view of the highway is obstructed by residences in all directions except straight down San Miguel Street.

Site 7 is located at the intersection of Caramillo Street and Cooper Avenue. Receptor 1 is in the side yard of the residence on the southeast corner of this intersection, and is representative of residences directly behind the wall. Receptor 2 is in the side yard of the residence on the southwest corner of this intersection, and is representative of residences one row back from the wall. Receptor 1 is 260 feet from, and level with, I-25. The view of I-25 is unobstructed in all directions. Receptor 2 is 480 feet from the center of I-25, and approximately 10 feet above the highway. The view of the highway is obstructed by residences to the south.

Site 8 is located near the Fontanero interchange. Receptor 1 is in an open field, 130 feet west of the southbound on-ramp from Fontanero Street, and 420 feet from I-25. It is representative of residences directly behind the wall. Receptor 2 is in the side yard of a residence on the west side of Chestnut Avenue, approximately 840 feet from I-25. It is representative of residences many rows back from the wall, and significantly elevated above the base of the wall. I-25 is elevated above Receptor 1, particularly to the north as it passes over Fontanero Street. The view of I-25 from Receptor 1 is unobstructed. Receptor 2 is elevated approximately 30 feet above I-25, and the view of the highway is blocked by residences in most directions.

Site 9 is located on Cooper Avenue between Washington and Jefferson Streets. Receptor 1 is in the front yard of the residence on the southwest corner of Cooper and Jefferson, and representative of residences directly behind the wall. Receptor 2 is in an open field in front of the southbound off-ramp onto Fontanero Street (via Cooper Avenue). Receptor 1 is 415 feet from and level with I-25. The view of I-25 is unobstructed in all directions except to the north where a pile of dirt created as part of the noise wall project breaks line of sight. Receptor 2 is 400 feet from the center of I-25, and also level with the highway. The view of the highway is unobstructed in all directions.

Site 10 is located at the north end of the noise wall on Green Ridge Drive. Receptor 1 is in the front yard of the residence on the north side of Green Ridge Drive where the road turns west. Receptor 2 is in the front yard of the residence on the northwest corner of the intersection of Green Ridge Drive and Cooper Avenue. Both of these receptors are representative of residences located directly behind the wall. The reference location is approximately 50 feet north of the end of the wall. Receptor 1 is 290 feet from and approximately 10 feet above I-25. The view of I-25 is obstructed to the north by area topography. Receptor 2 is 310 feet from the center of I-25, and level with the highway. The view of the highway is unobstructed in all directions

Park Pavilion – This site is located in Monument Valley Park on the east side of I-25. M1 is to the west of the tennis courts and sidewalk, and M2 is just south of the tennis courts. Both of these receptor locations are representative of the active use areas within the park. M1 and M2 are 240 feet and 340 feet from the center of I-25, respectively. Both locations are about 5 feet below the level of I-25, and line of sight to the highway is just broken by the railroad tracks. Measurements for these sites were done in January 1998, prior to the installation of the Bijou to Fillmore noise wall or other I-25 alignment changes.

4.0 Noise Modeling Procedures

The purpose of validating a noise model, either STAMINA or TNM, is to ensure that the noise model is accurately predicting noise levels for a particular site. Accuracy is dependent on the capabilities of the model, the complexity of the site, and the accuracy of the input data used. STAMINA is generally expected to predict noise levels within ±3 dB(A). TNM has no stated accuracy, but certainly should be expected to perform as well if not better than STAMINA. The complexities of the measurement sites on this project range from simple to complex. Very accurate input data was used on this project, including electronic topographic maps with two-foot elevation contours, and traffic volumes and speeds measured on site.

The process of validating the model consists of the following steps:

- Measuring noise levels, and concurrent traffic conditions
- Constructing a model of the site
- Comparing the predicted and measured results

The following sections provide an overview of the STAMINA and TNM models, and describe how each of the model validation steps was conducted on this project.

4.1 Overview of STAMINA

STAMINA is an acronym for "Standard Method in Noise Analysis". It is a software program that implements the equations and algorithms contained in FHWA's "Highway Traffic noise Prediction Model" (FHWA-RD-77-108, December 1978). STAMINA v2.0 was released in April 1982. STAMINA calculates the hourly, A-weighted L_{eq} at a receptor location when provided the following data:

- The noise emission level of automobiles, medium, and heavy trucks
- The volume and speed of each of these vehicle types on each roadway of interest
- The relative location and elevation of all roadways and receptors
- The relative location and elevation of terrain features (i.e. natural and man-made barriers)
- The type of terrain between each receptor and each roadway.

STAMINA has built-in noise emission factors, which are based on a four-state study conducted as part of the development of the model. CDOT developed its own emission factors in 1993, and these were used in this study. These emission levels are adjusted to account for distance using line source equations. The model propagates sound at a decay rate of between 3 and 4.5 dB per doubling of distance (dB/dd), depending on the user selected alpha factor. An alpha factor of 0, which results in a propagation decay rate of 3 dB/dd, represents hard ground such as pavement and water, as well as the case where either the source or the receptor is significantly elevated above the ground. An alpha factor of 0.5, which results in a propagation decay rate of 4.5 dB/dd, represents acoustically soft terrain (vegetated ground with both source and receiver located close to the ground). The emission factors are also adjusted to account for traffic volume, mix, and speed. STAMINA uses Fresnel diffraction for barriers, and user input correction factors to account for rows of houses. The user is required to input the locations and elevations of these entities.

4.2 Overview of TNM

TNM was also developed by FHWA. The most current version of TNM is 1.1. TNM offers a better graphical user interface along with many more input options including pavement type, ground type, temperature, humidity, multiple barrier analysis, contour lines, and building rows. TNM has different emission factors and acoustic propagation algorithms than STAMINA. Another major difference is that TNM does not use alpha factors, but rather it allows the user to select various ground types. Also, terrain lines can be added to tell the model where the ground is.

4.3 Modeling Procedures Utilized on This Project

This section describes the input data and procedures used to predict noise levels on this project. The main factors that affect the predicted noise levels are traffic volume, a receptor's distance from the roadway, the presence of any barriers between the roadway and the receptor, and ground type. The following paragraphs describe, in general, the input data used in the modeling. See Appendix B for more specific information.

Location of Roadways
The locations and elevation of all roadways the roadways were determined using Colorado Springs FIMS mapping with 2-foot elevation contours.

Location of Noise Measurements
The locations of the measurements were noted in the field and transferred to the CAD mapping.

Location of Terrain Features
Based on field observations, all existing terrain features such as embankments and structures that blocked line of sight from the receptor to the highway were modeled as barriers (or in the case of building rows, these were modeled using shielding factors in STAMINA).

Terrain Type
Based on field observations, the terrain type was modeled in STAMINA using the aforementioned alpha factors. In TNM, "lawn" was used as the default terrain type, however "field grass" was used in a few cases where appropriate.

Pavement Type
In TNM, the "average" pavement type was used in all of the predictions. There are no pavement options in STAMINA.

Traffic Conditions
Traffic volumes on I-25 were monitored using a video camera, which was synchronized to the measurement times. The traffic videotapes were then reviewed and the number of automobiles, medium trucks, and heavy trucks traveling in each direction on I-25 (and any other significant roads) were tabulated. Traffic speeds were monitored periodically during the measurements using a radar gun. Both noise models use separate emission levels for automobiles, medium trucks (trucks with two axles, six tires, and a gross vehicle weight greater than 4500 kg and less than 12,000 kg), and heavy trucks (trucks with three or more axles and a gross vehicle weight greater than 12,000 kg). For STAMINA, the Colorado-specific Reference Energy Mean Emission Levels were used for all vehicle types in all of the predictions. These emission levels were developed by CDOT, and are published in the document entitled

Reference Energy Mean Emission Levels Used in STAMINA 2.0 for Highway Noise Prediction in the State of Colorado, CDOT, and February 1995. For TNM, the built-in emission levels were used.

5.0 Noise Model Validation Results

Table 2 shows the average measured noise level at each site, the average predicted noise level at each site using both models, and the differences between these levels. STAMINA v2.0 predicted noise levels between 5 dB(A) below and 8 dB(A) above measured levels. Averaging the results from all 75 measurements, STAMINA predicted 1 dB(A) above measured levels. STAMINA predicted within ±3 dB(A), a common measure of accuracy, at 55 of the 75 measurement locations (73%). TNM v1.1 predicted noise levels between 3 dB(A) below and 10 dB(A) above measured levels. Averaging the results from all 75 measurements, TNM predicted 4 dB(A) above measured levels. TNM predicted within ±3 dB(A) at 27 of the 75 measurement locations (36%).

TABLE 2
MEASURED AND PREDICTED NOISE LEVELS
(L_{eq} dB(A))

Site	Number of Meas.	Measured	STAMINA	TNM	STA-meas	TNM-meas
Pulpit Rock	4	60	62	67	2	7
Baptist Road	5	55	57	60	2	5
Garden of the Gods	5	63	61	63	-2	0
Circle Area	5	60	60	64	0	4
Circle-Lake	5	57	58	63	1	6
Old North End1	5	53	57	59	4	6
Old North End2	5	56	57	58	1	2
Stratmoor 1	5	58	60	63	2	5
Stratmoor 2	5	60	64	66	4	6
Bijou	2	66	65	64	-1	-2
Nevada-Tejon	3	67	67	68	0	1
Woodmen	8	63	63	68	0	5
Mesa Springs	17	62	63	66	1	4
Park Pavilion	2	60	66	68	6	8
Range	**---**	**49 to 72**	**53 to 72**	**55 to 73**	**-5 to +8**	**-3 to +10**
Average (all 75 measurements)	**---**	**60**	**61**	**64**	**1**	**4**

6.0 Noise Modeling Investigations

In trying to rectify differences between measured and predicted noise levels and differences between the modeling results, a number of investigations were conducted into how specific data inputs (speed for example) affect each model. Section 6.1 describes the results of these investigations. Section 6.2 describes the results of two case studies where TNM inputs were changed to try to improve results. Section 6.3 summarizes the results of a STAMINA-TNM comparison study conducted in Kansas.

6.1 Non-Project Specific Investigations

Various non-project specific investigations were conducted to compare STAMINA v2.0 (using Colorado emission factors) to TNM v1.1, as well as investigate the sensitivity and results of the numerous input variables. These comparisons involve parameters such as: roadway width, ground type, distance, roadway grade, separation distance of parallel roadways, speed, barrier heights, and noise contour development. All of these analyses use receptor locations at 5 feet above ground level, lawn or 0.5 alpha for terrain type, speeds of 55 mph, 1000 automobiles, 30 medium trucks, and 90 heavy trucks for traffic unless otherwise noted.

Road Width

As the width of the roadway (pavement) is increased, assuming nearby terrain is grass or a similarly absorptive ground type, the predicted noise level at a receptor should slightly increase or remain the same depending on the distance from the roadway. This is because roadway pavement is typically more sound reflective, whereas grass and other similar ground types are more sound absorptive. Noise predictions were conducted using TNM for road widths ranging from 12 to 60 feet, with noise receptors at various distances from the road. Figure 3 shows the results of this analysis. It is shown that as the pavement width is increased, the noise levels are increased. At closer receptor locations, the increase is more evident, which is expected. STAMINA does not allow for adjustment of pavement widths.

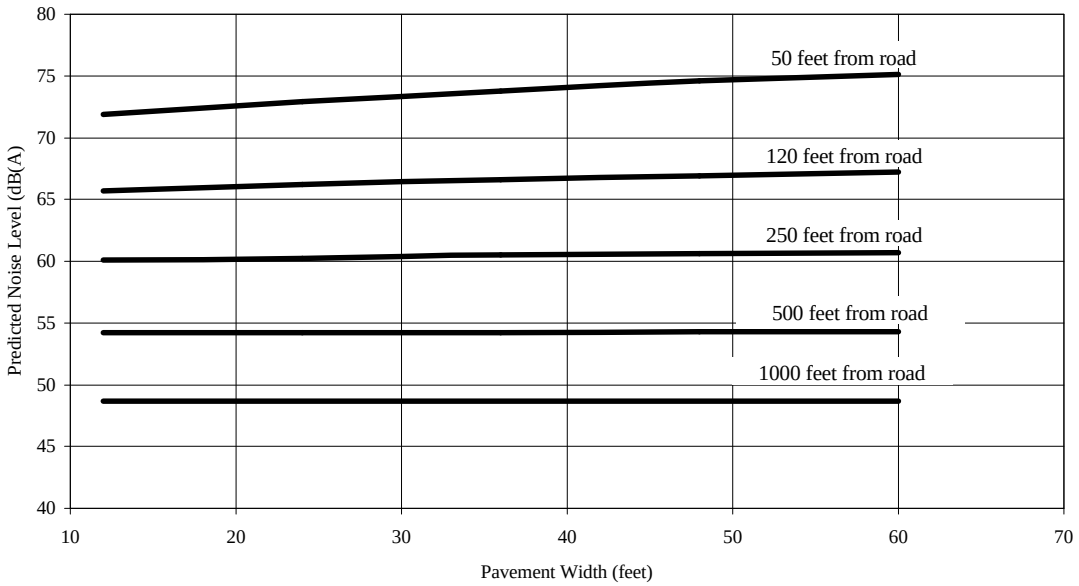

FIGURE 3: AFFECT OF ROADWAY WIDTH ON PREDICTED NOISE LEVELS USING TNM

Ground Type

Ground type is a TNM input that defines the amount of sound absorption (flow resistivity) the ground has. STAMINA uses alpha factors for defining the amount of sound absorption. In STAMINA, an alpha factor of 0.5 is used for acoustically soft or absorptive areas such as grass or lawn, and 0.0 alpha factor represents sound reflective surfaces with little sound absorption such as pavement or open air. A comparison using TNM's 'lawn' and 'pavement' ground types and STAMINA's alpha factors of 0.5 and 0.0 was done, respectively. Additionally, the same analysis was done using TNM's 'field grass', though STAMINA has no direct comparison. The results are shown in Figure 4. The trends of this comparison are relatively similar within 200 feet. Beyond 200 feet, the TNM model using pavement ground type is about 5 dB(A) greater than the STAMINA model using alpha of 0.0. Conversely, the TNM model using a lawn ground type remains within 1 or 2 dB(A) of the STAMINA model using a 0.5 alpha factor. TNM's field grass ground type has a lower flow resistivity (more absorption) than the lawn type, yet at distances between 100 and 200 feet it displays higher noise levels. It is unclear as to why this would be the case.

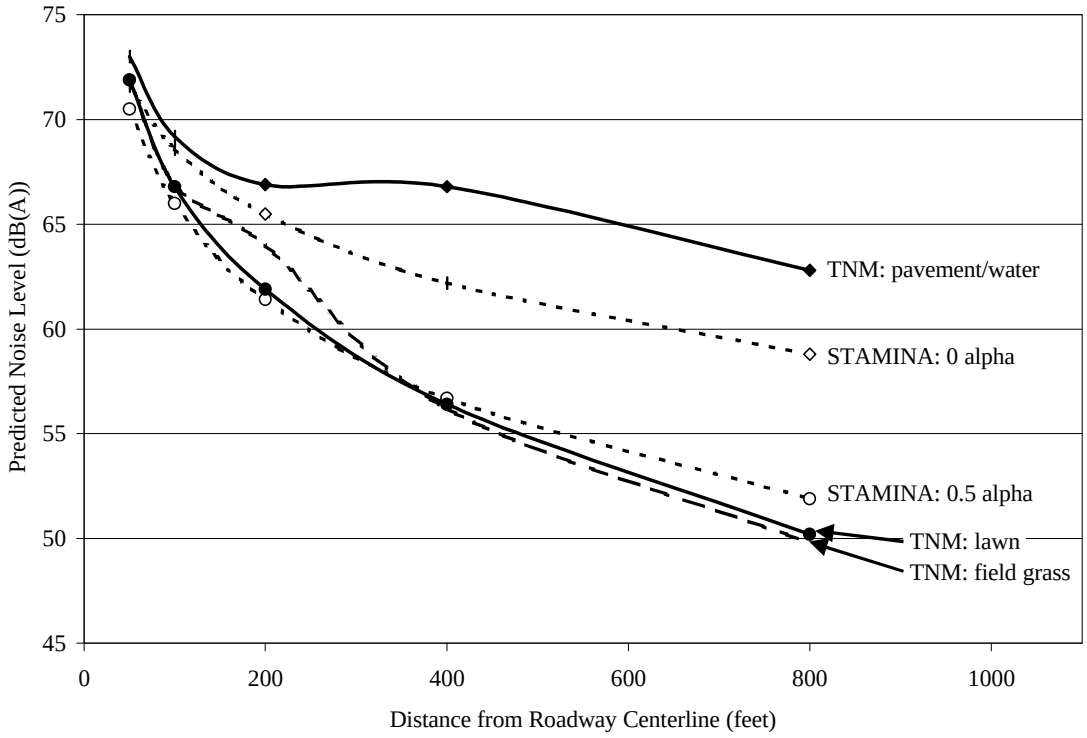

FIGURE 4: AFFECT OF GROUND TYPE ON PREDICTED NOISE LEVELS

Distance

Using a STAMINA alpha factor of 0.5 and the "lawn" terrain type in TNM, a noise level reduction of approximately 4.5 dB per doubling of distance (dB/dd) is expected for a line noise source such as highway traffic. Two comparisons were conducted using flat terrain with noise receptors located twice as far as the previous receptor to predict the amount of reduction per doubling of distance. Figure 5 shows results of the analysis. It can be seen that TNM predicts about 0.5 to 1.0 dB more noise reduction per doubling of distance for simple flat terrain within about 500 feet. This is reasonably close, but one would expect an even closer relationship with such a simple model.

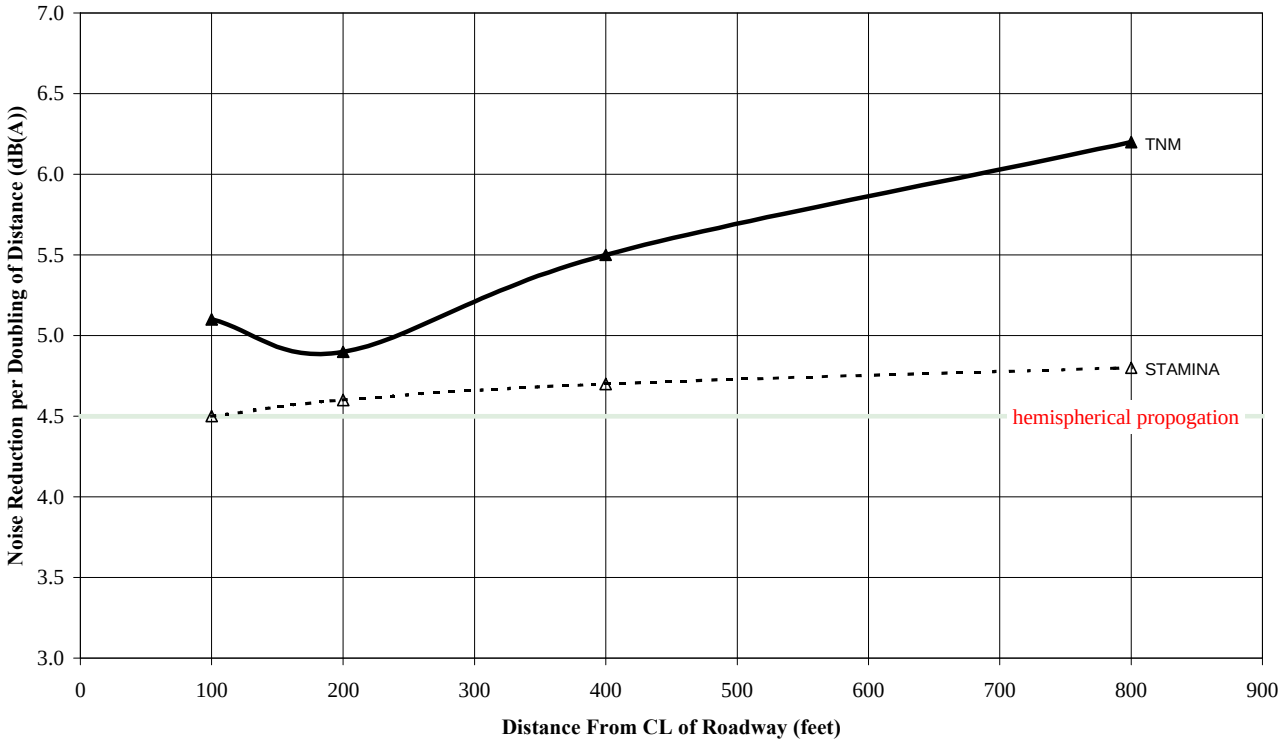

FIGURE 5: PREDICTED NOISE REDUCTION DUE TO DOUBLING OF DISTANCE

Roadway Grade

The grade of a roadway relates to up slope (positive grade) or down slope (negative grade) directions. Typically one would expect a positive roadway grade to increase noise levels and a negative grade roadway to have no affect or be slightly lower than a flat roadway. An analysis was done using a typical separated two lane roadway, with a noise receptor 350 feet away. Figure 6 shows how STAMINA and TNM are affected by positive roadway grade input. It can be seen that STAMINA is not affected by roadway grade through 7%, and only slightly at 8%. Conversely, TNM is affected by roadway slope, but not at any constant trend. The results from TNM show that a 1% grade would increase the noise levels the most. As the roadway grade increases from 1% to 4%, the noise level actually decreases and then levels out beyond 4%. One would expect a gradual increase in the noise level as the roadway slope increases, rather than the changes seen by both the TNM and STAMINA models.

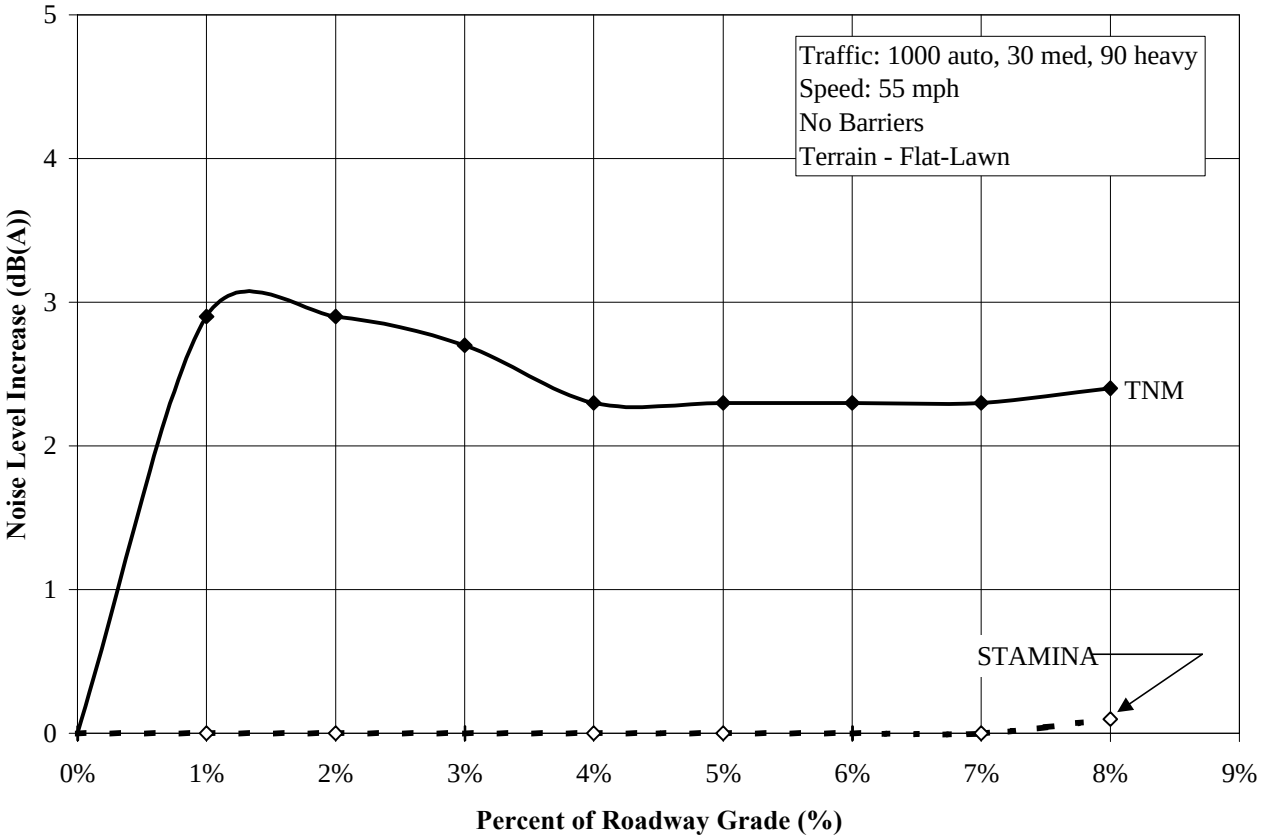

FIGURE 6: AFFECT OF ROADWAY GRADE ON PREDICTED NOISE LEVELS

Roadway Separation

In most cases, highways consist of two divided parallel roadways for vehicles traveling in opposite directions. An investigation was done to analyze how both STAMINA and TNM handle roadway separation distances. For this analysis, roadway separation (centerline to centerline) was increased from 30 feet to 60 feet. The results shown in Figure 7 indicate that noise receptors within 100 feet are affected in both STAMINA and TNM models. Additionally, TNM has affected receptors at distances greater than about 700 feet. STAMINA performs as expected, that is the effect of roadway separation decreases with increasing receptor distance. It is unclear as to why the TNM model has lower noise levels for noise receptor beyond 100 feet and then increased noise levels for noise receptors beyond about 500 feet.

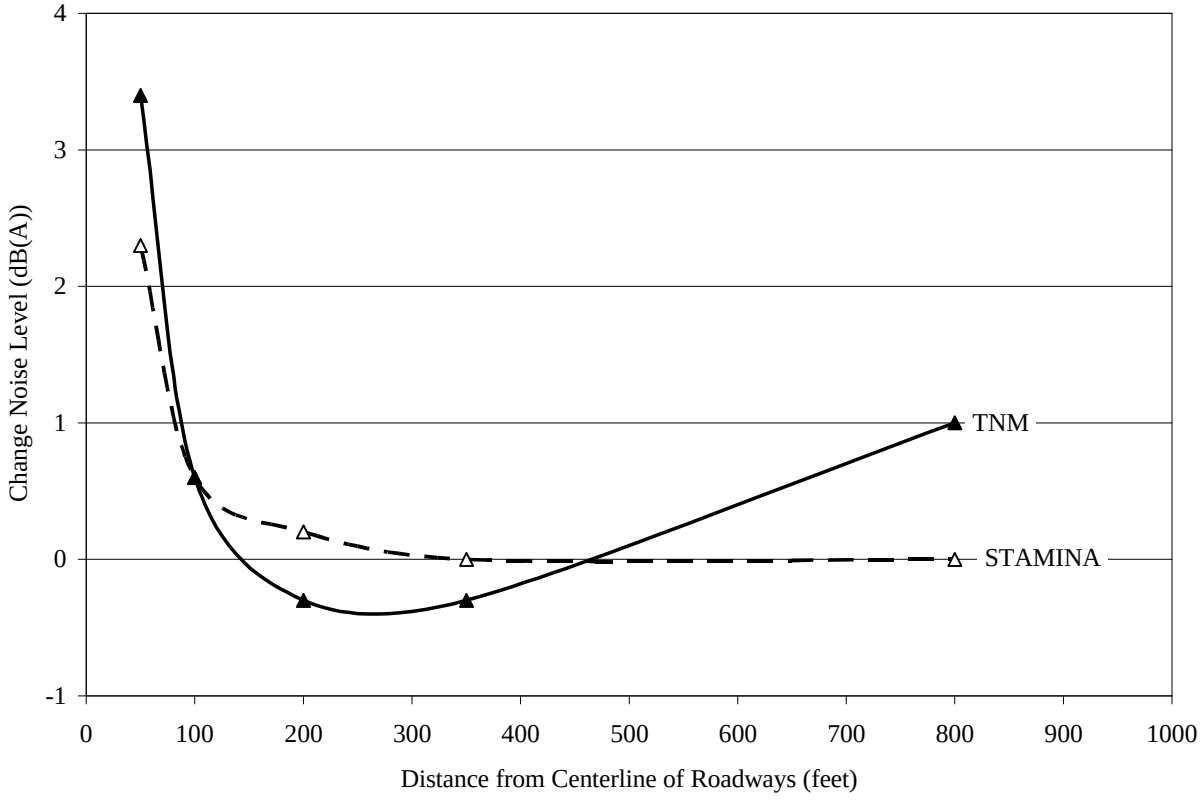

FIGURE 7: AFFECT OF INCREASING ROADWAY SEPARATION ON PREDICTED NOISE LEVELS

Traffic Speeds

An analysis of how sensitive each model is to traffic speed was conducted. A separated two-lane roadway was modeled using the standard traffic volumes previously described. Three traffic speeds were analyzed with both models. The results of this analysis are shown in Figure 8. It is shown that TNM is more linear with the change in speed and STAMINA has a slight bow to its trend. Differences between the overall predicted noise levels ranged from 0.3 to 1.1 dB(A).

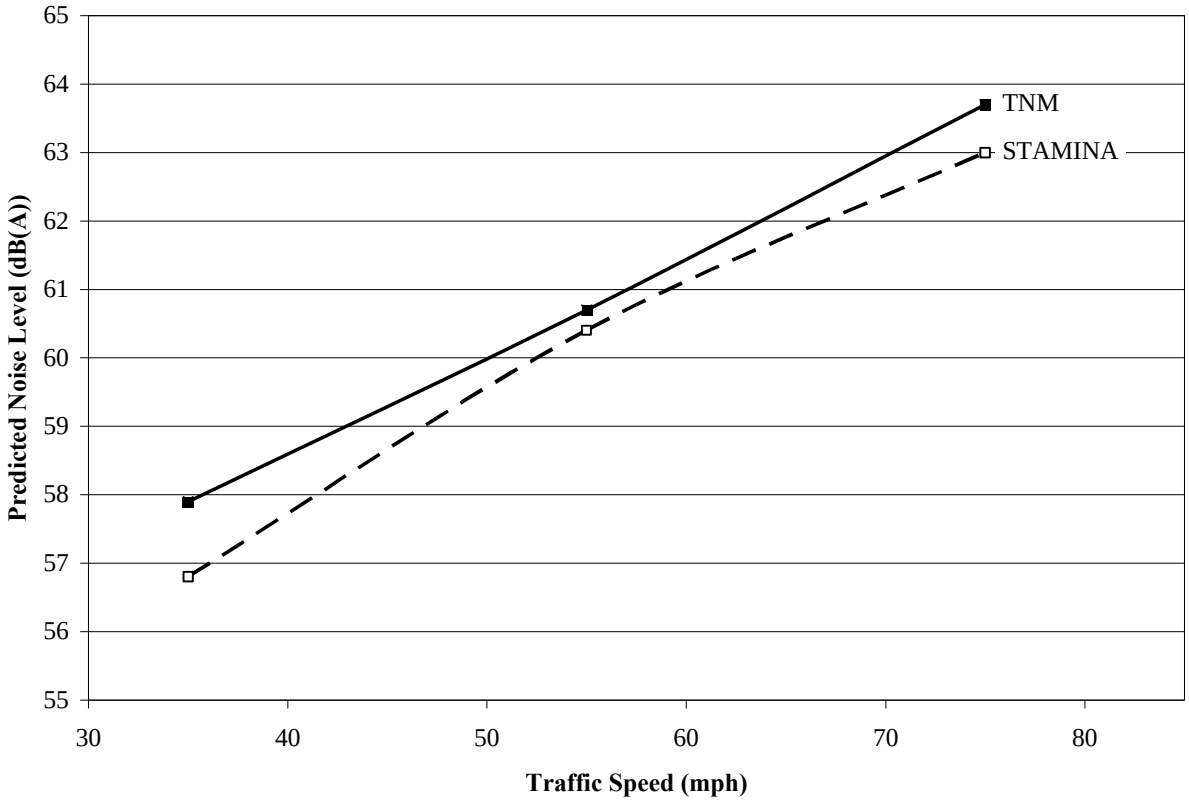

FIGURE 8: AFFECT OF TRAFFIC SPEED ON PREDICTED RECEPTOR NOISE LEVELS

Barriers

A comparison of how the use of a barrier affects the noise level predicted by each model was done. A 12 foot barrier was modeled at 65 feet from the centerline of a single roadway. It is expected that noise receptors closer to the barrier would result in higher noise reduction than those further away. Figure 9 provides a plot of these results. The results show that the STAMINA model displays this trend. The TMN model initially shows the same trend up to about 700 feet and then the amount of predicted insertion loss actually increases. It is unknown why the TNM model displays this increased insertion loss at such a large distance from the barrier.

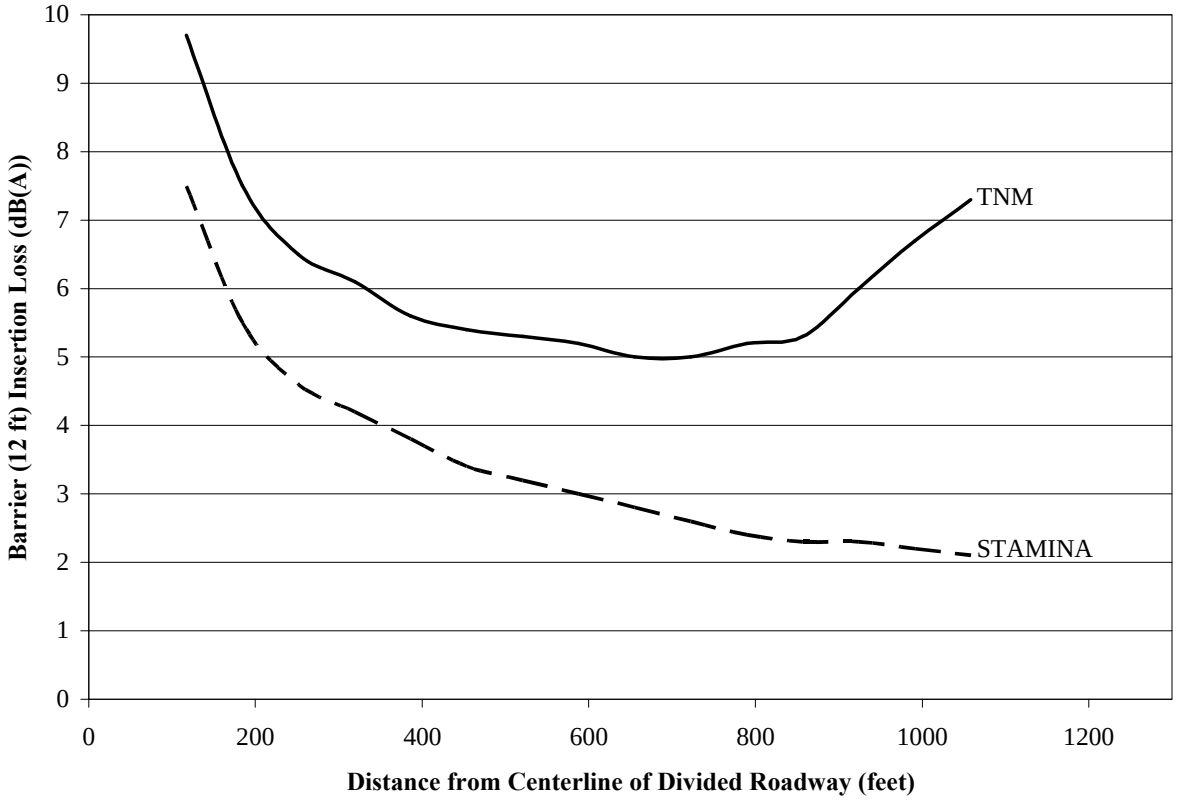

FIGURE 9: PREDICTED INSERTION LOSS FOR A 12-FOOT NOISE BARRIER

Noise Contours

Noise contours are a useful tool in locating a particular noise level within a project area. Typically, noise contour lines relate to a state or federal standard that allows planners and other designers to know at what distance a particular noise level is achieved. STAMINA does not automatically generate these noise contour lines, and the user is required to manually locate points to develop these lines. TNM has the option to generate the noise contours automatically, but this option does not appear to work in v1.1 at the time of this study.

6.3 Project Specific Investigations

At two selected sites, TNM was successively modified in an attempt to determine the effect of changing certain inputs. The selected sites are Baptist Road (because it is relatively straightforward) and the North End measurements (because it is complex).

Case 1: Baptist Road
This site has simple terrain with few barriers and many open fields. Additional description of this site is provided in Section 3.0. Primary inputs used for both models includes the existing alignment generated from CAD, measurement locations, monitored traffic volumes and speeds and a barrier where the terrain is elevated to the south. Additional input details are provided in Appendix A.

Table 3 shows the STAMINA results, as well as various TNM modeling results. The following describe the changes made for each successive TNM run:

- Run#1: Direct import from STAMINA
- Run#2: Run 1 plus barrier imported from STAMINA converted to a terrain barrier
- Run#3: Run2 plus default temperature and humidity (68ºF, 50%) set to measured (52ºF, 90%)
- Run#4: Run 3 plus default ground type from 'lawn' (300 cgs Rayls) to 'field grass' (150 cgs Rayls), which more closely represents what is there
- Run#5: Run 5 plus increased the roadway width from the default 12 feet to 24 feet per direction

TABLE 3
RESULTS OF CASE 1
(L_{eq} dB(A))

Meas #	Meas	STAMINA	*TNM*				
			Run 1	***Run 2***	***Run 3***	***Run 4***	***Run 5***
M1	61	63	65	65	65	65	66
M2	55	58	58	58	59	59	60
M3	53	54	55	55	55	55	57
M4	53	55	54	54	55	55	57
M5	53	55	54	54	55	55	58
Avg Difference	---	+2	+2	+2	+3	+3	+5

It is shown that STAMINA predicted an average of 2 dB(A) over the measured noise levels, as did the TNM model generated by directly inputting the STAMINA file. As each TNM input was changed to more accurately reflect the topography of the site, the difference in the predicted and measured noise levels increased as opposed to decreased. Changing the wall barrier to a terrain barrier showed no change in the results. Adjusting the default temperature and humidity resulted in an average increase of about 1 dB(A). Changing the default ground type slightly reduced the predicted noise levels, but this improvement had no effect on the overall error. Adjusting the pavement width to represent the accurate lane width increased the noise levels by an average of 3 dB(A), which again further increased the overall error. The best correlation between TNM and the measured noise levels occurred when using the direct import from the STAMINA model and the default TNM settings. The result of increasing the site details in the TNM model produced greater inaccuracies in the predictions.

Case 2: North End

The North End site has more complex topography than Baptist Road. There is a river valley separating it from I-25. Additionally, the residences in the area are elevated in relation to I-25, there is an existing noise barrier on the west side of I-25, and a Type-7 jersey barrier separating the northbound and southbound lanes of I-25. Additional description of this site is provided in Section 3.0.

Table 4 shows the STAMINA results, as well as various TNM modeling results. The following describe the changes made for each successive TNM run. From Table 4 it can be seen that the additional changes within the TNM model to more accurately define the site did not improve the predictions.

- Run#1: Direct import from STAMINA
- Run#2: Run 1 plus roadway width changed to 24 feet
- Run#3: Run2 plus added building rows to model houses along Glen Avenue/Recreation Way
- Run#4: Run 3 plus converted barrier representing the riverbank to a terrain line

TABLE 4
RESULTS OF CASE 2
(L_{eq} dB(A))

Meas#	**Meas**	**STAMINA**	**TNM**			
			Run#1	***Run#2***	***Run#3***	***Run#4***
M1	58	61	61	62	62	62
M2	57	60	61	62	62	62
M3	57	59	57	57	57	57
M4	54	57	58	59	59	59
M5	55	56	58	58	58	58
Avg Difference	---	+2	+3	+3	+3	+3

The measurements at the North End 2 site were taken in a line perpendicular to the highway. This was done to measure the decrease in highway noise levels with distance through Monument Valley Park and up into the North End neighborhood. Figure 10 shows the results of the measurements. The measured levels decay with distance as expected, with the exception of the furthest measurement. This is due to the presence of noise from trash trucks and other neighborhood activities.

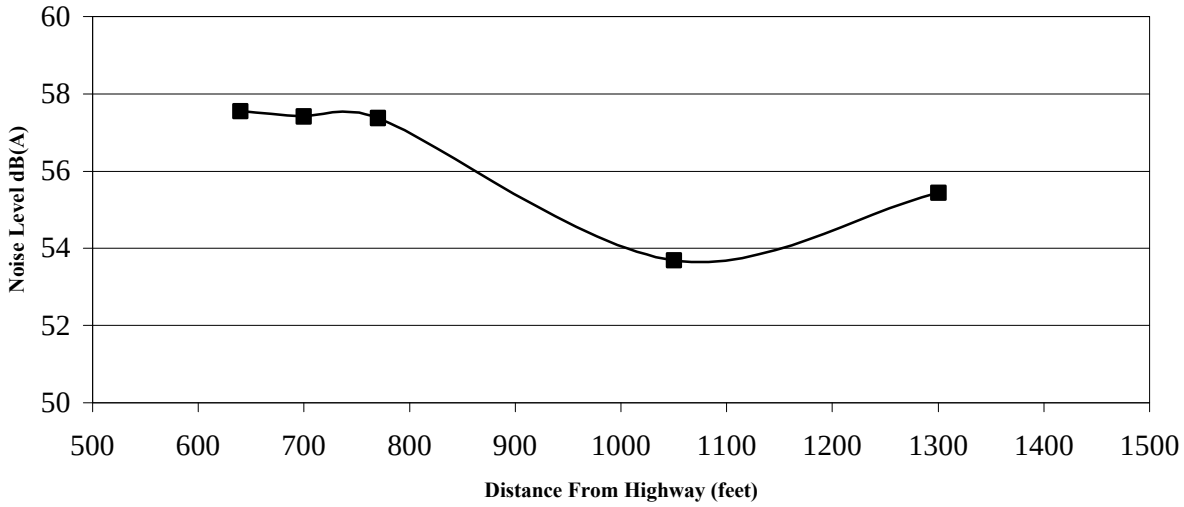

FIGURE 10: MEASURED NOISE LEVELS VERSUS DISTANCE AT NORTH END 2 SITE

6.3 Review of "TNM vs. STAMINA in Kansas"

A case study was conducted by Dr. Louis Cohn of the University of Louisville entitled, *"Case Study: TNM vs. STAMINA in Kansas"*. A review of this study, and a comparison of the results between it and the EA study is provided below. One item of note, the Kansas study utilized TNM v1.0b, while the I-25 EA study utilized v1.1. However, the changes between these versions of TNM primarily include graphical and functionality improvements and not changes to the acoustic algorithms.

The Kansas study first compares measured data with predicted data using both STAMINA (with Kansas emission factors) and TNM. Six locations ranging from 100 ft to 1,215 ft from the roadway centerline were investigated along a relatively flat project area. This compared the effects of using a number of TNM's features including terrain lines, pavement width, fixed and adjustable barrier height function, ground zone type and tree zone type. Using STAMINA, the predicted values were within 1 dB of the measured existing noise levels for all but one location (100 ft location was predicted at 2.1 dB below). When comparing the measurements to TNM using the terrain line feature, the differences ranged from 2.4 dB below to 3.8 dB above the measured results, with only the 200 ft location within 1 dB. When comparing the measurements to TNM without using the terrain feature, the differences ranged from 1.4 to 5.4 dB above the measured results. These results compare favorably with the I-25 EA study, in that both show STAMINA better predicts measured levels.

Next, analyses were conducted with TNM to determine how it various inputs correspond to conventional acoustical knowledge. One such analysis was conducted by changing TNM's pavement width feature. This showed that an increase in pavement width by 150% resulted in decreased sound levels ranging from 0.5 dB to 1.6 dB. Conversely, when the pavement width was reduced by 50%, the noise levels increased from 0.6 dB to 2.0 dB. The expected result is a slight increase when the pavement is widened and a slight decrease when the pavement width is reduced. The I-25 EA study found TNM to predict as expected. Without analysis of the respective input files it is unknown why the Kansas study and the I-25 EA study came up with different results.

One feature of TNM is that the user can input a barrier as being adjustable. By making a barrier adjustable, a user can quickly investigate the impact of various heights. When using this feature, but reducing the barrier height to 0 ft, the Kansas study found that the predicted noise levels were 0.7 dB to 2.6 dB louder than an identical model without a barrier using TNM. When comparing a fixed 12 ft barrier to an adjustable 12 ft barrier, the results were identical. This finding would suggest that adjustable barrier models not be used for predicting no barrier results. No similar analysis was conducted as part of the I-25 EA.

Both the Kansas and I-25 studies found that TNM predicted increased insertion losses as the prediction point was moved further from a barrier. Typically, the highest levels of insertion loss are found closer to the barrier.

An analysis was conducted to determine the effects of the TNM ground type input feature. This feature allows the user to input various ground types such as lawn, field grass, pavement, water, hard soil, snow, etc. Both studies show that using field grass results in higher levels than when using lawn. This is the opposite of what is expected.

The Kansas study found that TNM predicted that field grass is more reflective than pavement and water, hard soil is more reflective than pavement and water, loose soil is more reflective than hard soil and snow is the most reflective ground type option. Typically, one would expect water, pavement and hard packed snow to be the most reflective ground types with hard soil, loose soil and grasses increasingly more absorptive. These additional findings are not what one would expect. The I-25 EA analyses found the ground types to agree with what is expected, aside from the lawn-field grass issue discussed in Section 6, above.

The Kansas study also investigated the tree zone feature of TNM. This feature allows a user to input an area of trees and vegetation that will help absorb noise, depending on the size of the zone. Using 12 ft tall trees, TNM predicted a 1.2 dB decrease in noise levels for a 100 ft wide tree zone, a 2.5 dB decrease in noise levels for 200 ft wide tree zone and a 0.6 dB increase in noise levels for a 300 ft wide tree zone. Typically, one would expect a continued increase in noise reduction as the tree zone is increased, but beyond 200 ft, TNM began to actually predict an increase when compared to no tree zone.

Overall, the Kansas study showed that STAMINA was more accurate in predicting existing noise levels, and that caution is needed when using TNM.

Appendix A

Measurement Details

The following provides measurement details for each site including weather conditions, monitored traffic volumes and speeds, and locations.

WEATHER

Table A1 provides the measured weather data for each noise measurement period measurement as available.

TABLE A1
MEASURED WEATHER DATA DURING NOISE MEASUREMENTS

Site *(---)*	**Date** *(---)*	**Time** *(---)*	**Temperature** *(°F)*	**Average Wind Speed** *(mph)*	**Average Wind Direction** *(---)*
Pulpit Rock	5/30/01	13:30 to 13:45, 14:15 to 14:30, 14:45 to 15:15	69	8	n/a
Baptist Road	6/5/01	10:00 to 11:00	51	13	0
Garden of the Gods	6/5/01	13:45 to 14:45	74	11	358
Circle Area	6/6/01	09:45 to 10:45	72	4	359
Circle-Lake	6/6/01	12:30 to 13:30	88	11	0
Old North End1	6/12/01	09:30 to 09:45, 10:00 to 10:45	84	1	3

TABLE A1 (CONTINUED)

Old North End2	6/12/01	12:15 to 13:15	95	1	0
Stratmoor Valley1	6/14/01	10:00 to 11:00	84	3	2
Stratmoor Valley2	6/14/01	11:15 to 12:15	84	3	2
Bijou	See Individual Technical Noise Reports				
Nevada-Tejon					
Woodmen					
Mesa Springs					
Park Pavilion					

TRAFFIC

Table A2 provides the hourly measured traffic volumes and speeds during each noise measurement period. Some measurement periods were shorter or longer in duration than one-hour. For these locations, the representative hourly traffic volumes are provided. Hourly traffic volumes are used in both STAMINA and TNM.

TABLE A2
MEASURED TRAFFIC VOLUMES AND SPEEDS DURING NOISE MEASUREMENTS

	Measurement	Veh	I25 NB	I25 SB	Speed (mph)
Pulpit Rock	all	cars	3634	3870	60
		med	127	110	60
		hvy	184	189	60

	Measurement	Veh	I25 NB	I25 SB	Speed (mph)
Baptist Road	all	cars	1593	1964	75
		med	105	101	75
		hvy	147	140	75

	Measurement	Veh	I25 NB	I25 SB	Chestnut	Speed (mph)
GoG	all	cars	3040	2560	372	60
		med	170	88	4	60
		hvy	119	196	0	60

	Measurement	Veh	I25 NB	I25 SB	Cheyenne	Speed (mph)
Circle Area	all	cars	1580	1624	180	55
		med	54	112	36	55
		hvy	212	248	20	55

	Measurement	Veh	I25 NB	I25 SB	HWY 85-87	Speed (mph)
Circle-Lake	all	cars	1440	1380	882	65
		med	58	118	6	65
		hvy	208	180	0	65

	Measurement	Veh	I25 NB	I25 SB	Speed (mph)
Old North End 1	all	cars	2704	2893	55
		med	80	145	55
		hvy	179	211	55

TABLE A2 (CONTINUED)

	Measurement	Veh	I25 NB	I25 SB	Speed (mph)
Old North End 2	all	cars	3090	2780	55
		med	122	119	55
		hvy	186	201	55

	Measurement	Veh	I25 NB	I25 SB	Speed (mph)
Stratmoor Valley 1	all	cars	1485	1500	65
		med	84	70	65
		hvy	161	230	65

	Measurement	Veh	I25 NB	I25 SB	Speed (mph)
Stratmoor Valley 2	all	cars	1752	1442	65
		med	74	85	65
		hvy	171	180	65

	Measurement	Veh	I25 NB	I25 SB	Speed (mph)
Bijou	all	cars	1646	2932	55
		med	102	74	55
		hvy	160	158	55

	Measurement	Veh	I25 NB	I25 SB - NPL to SB off	I25 SB - SB on to SPL	ramp mainline to Arvada on-ramp	Arvada on-ramp to SB off 24	Arvada	Speed (mph)
Nevada Tejon	all	cars	2540	2164	1652	512	914	402	55
		med	144	108	92	16	24	8	55
		hvy	158	156	126	30	36	6	55

	Measurement	Veh	I25 NB	I25 SB	Speed (mph)
Woodmen	M1 - 2	cars	2226	2124	60
		med	107	79	60
		hvy	158	170	60
	M3 - 5	cars	2168	2250	60
		med	94	87	60
		hvy	129	179	60
	M6 - 8	cars	2486	2786	60
		med	98	114	60
		hvy	108	152	60

TABLE A2 (CONTINUED)

	Measurement	Veh	I25 NB	I25 SB	Speed (mph)
Mesa Springs	M1	cars	2604	2114	55
		med	30	25	55
		hvy	30	52	55
	M2	cars	2329	2433	55
		med	73	79	55
		hvy	174	216	55
	M4	cars	3644	3480	55
		med	71	65	55
		hvy	120	145	55
	M5	cars	2275	2473	55
		med	80	112	55
		hvy	171	179	55
	M6	cars	2709	3129	55
		med	91	88	55
		hvy	151	173	55
	M7	cars	2284	2571	55
		med	85	95	55
		hvy	186	168	55
	M8	cars	2990	2842	55
		med	114	105	55
		hvy	157	164	55
	M9	cars	3048	2914	55
		med	100	109	55
		hvy	133	152	55
	M10	cars	2396	2528	55
		med	89	107	55
		hvy	164	169	55

TABLE A2 (CONTINUED)

	Measurement	***Veh***	***I25 NB***	***I25 SB***	***Speed (mph)***
Park Pavilion	all	cars	2632	2818	55
		med	101	111	55
		hvy	174	188	55

MEASUREMENT LOCATIONS

Figures A1 through A15 provide the locations of each particular measurement location for each site. Only locations which were measured specifically for the I-25 EA are included here. Figures for other measurement locations can be found in their respective noise technical report.

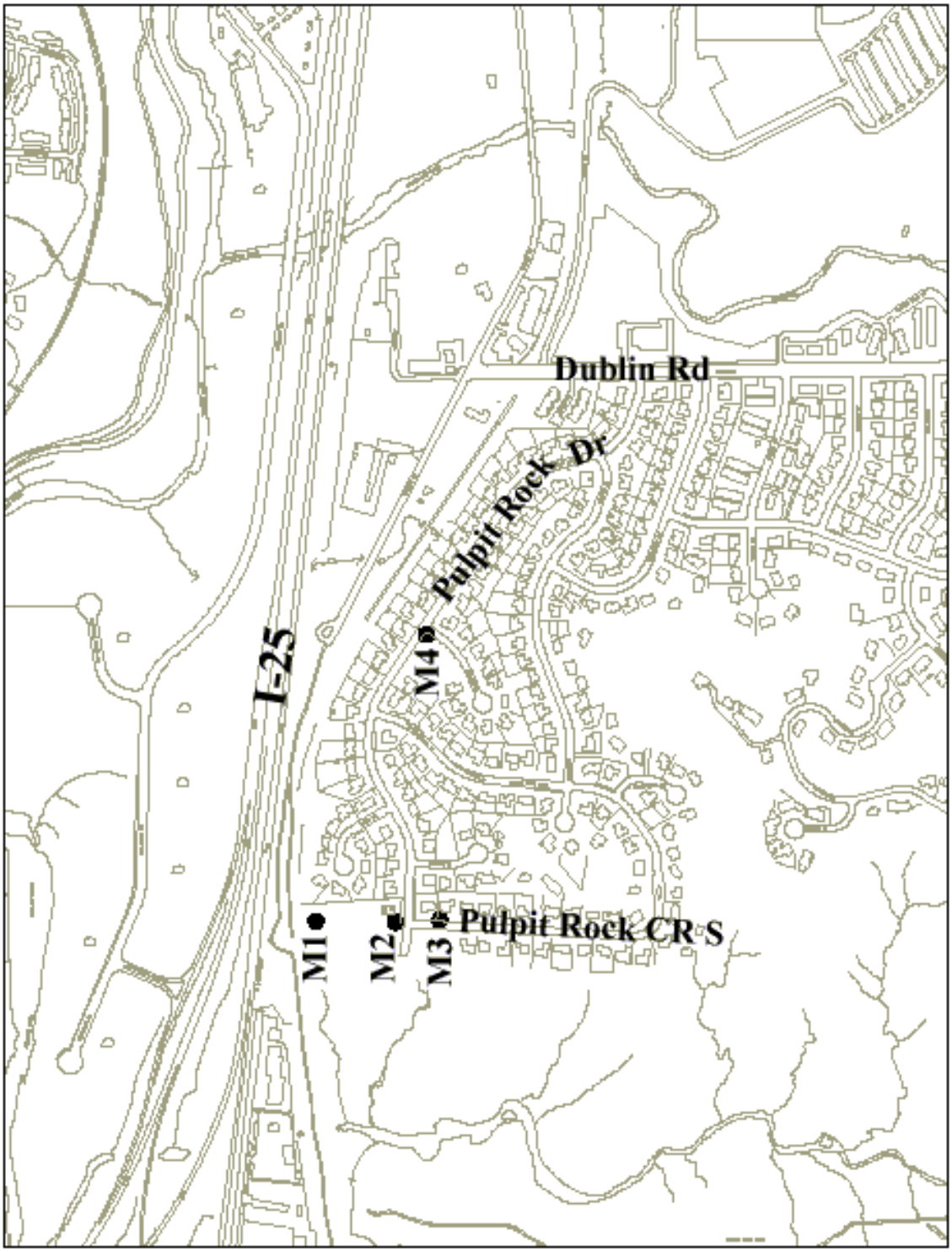

FIGURE A1: PULPIT ROCK NOISE MEASUREMENT LOCATIONS

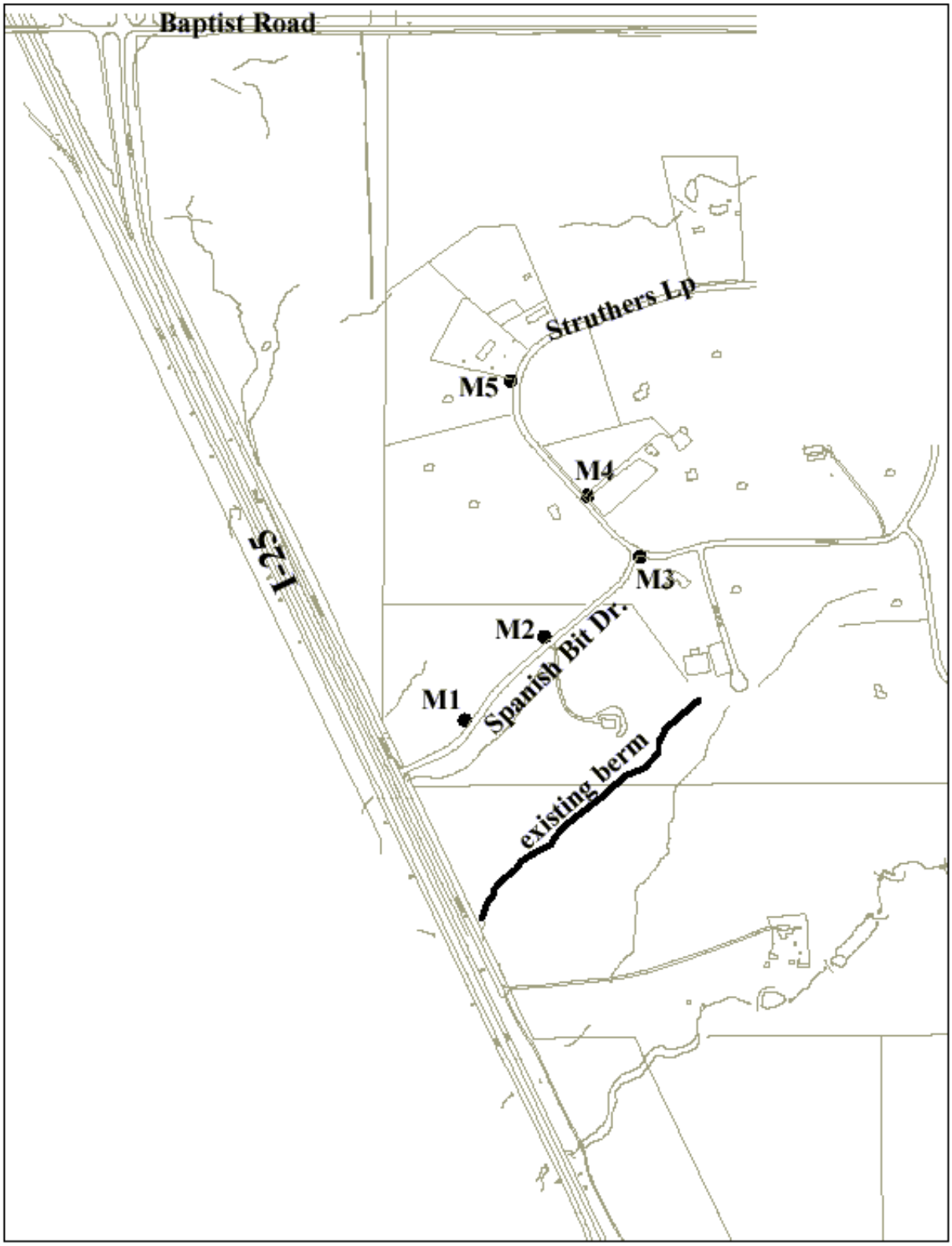

FIGURE A2: BAPTIST ROAD NOISE MEASUREMENT LOCATIONS

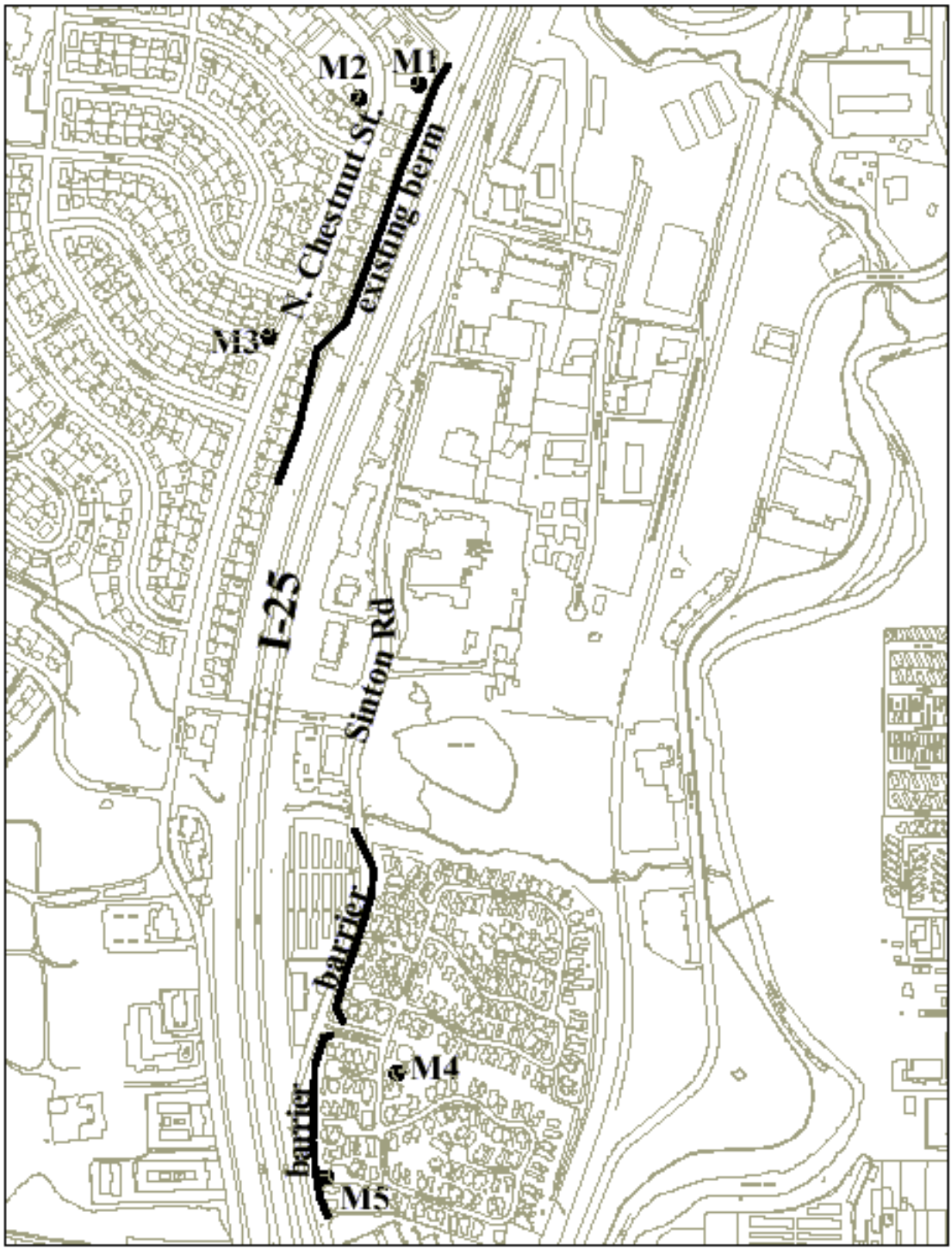

FIGURE A3: GARDEN OF THE GODS NOISE MEASUREMENT LOCATIONS

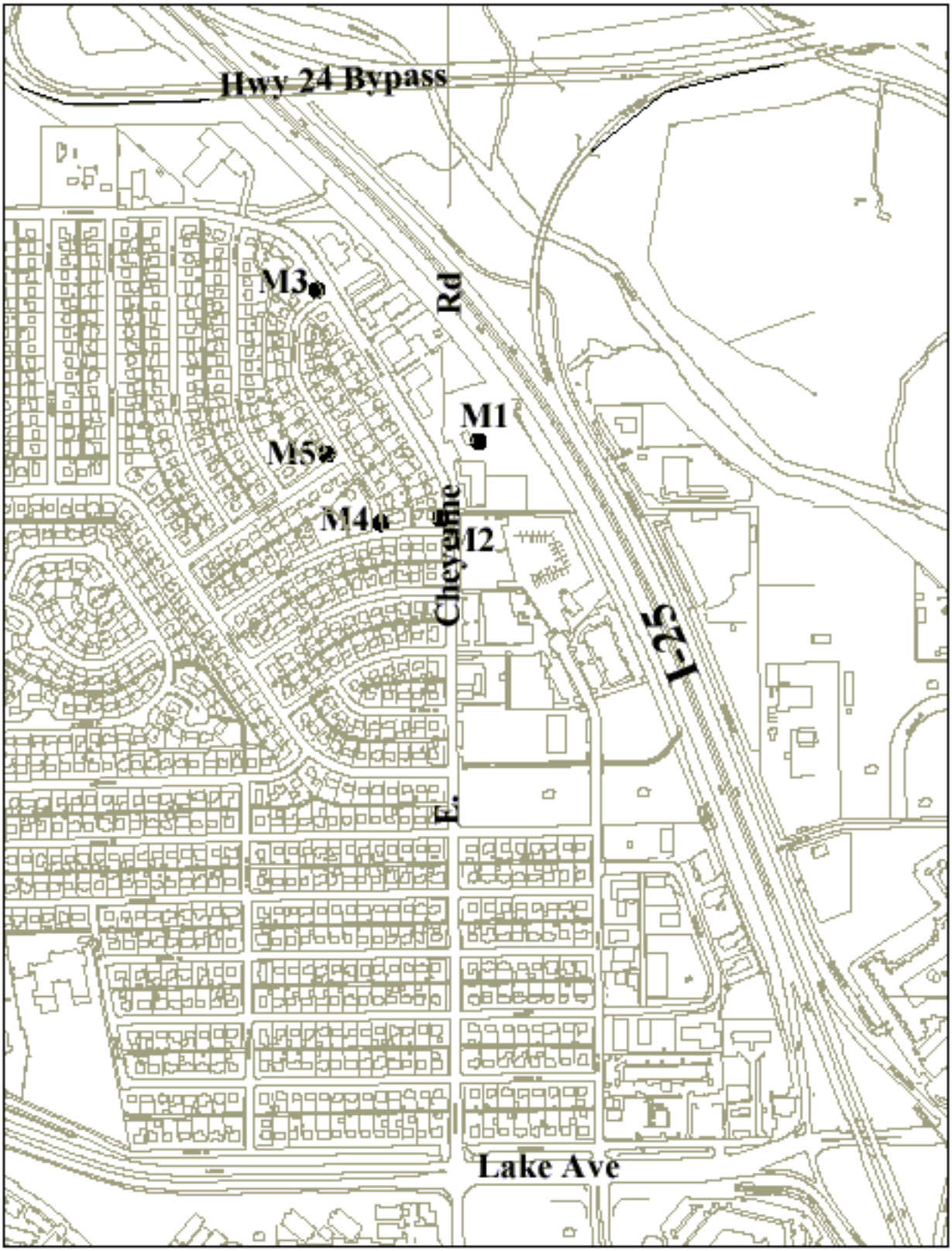

FIGURE A4: CIRCLE AREA NOISE MEASUREMENT LOCATIONS

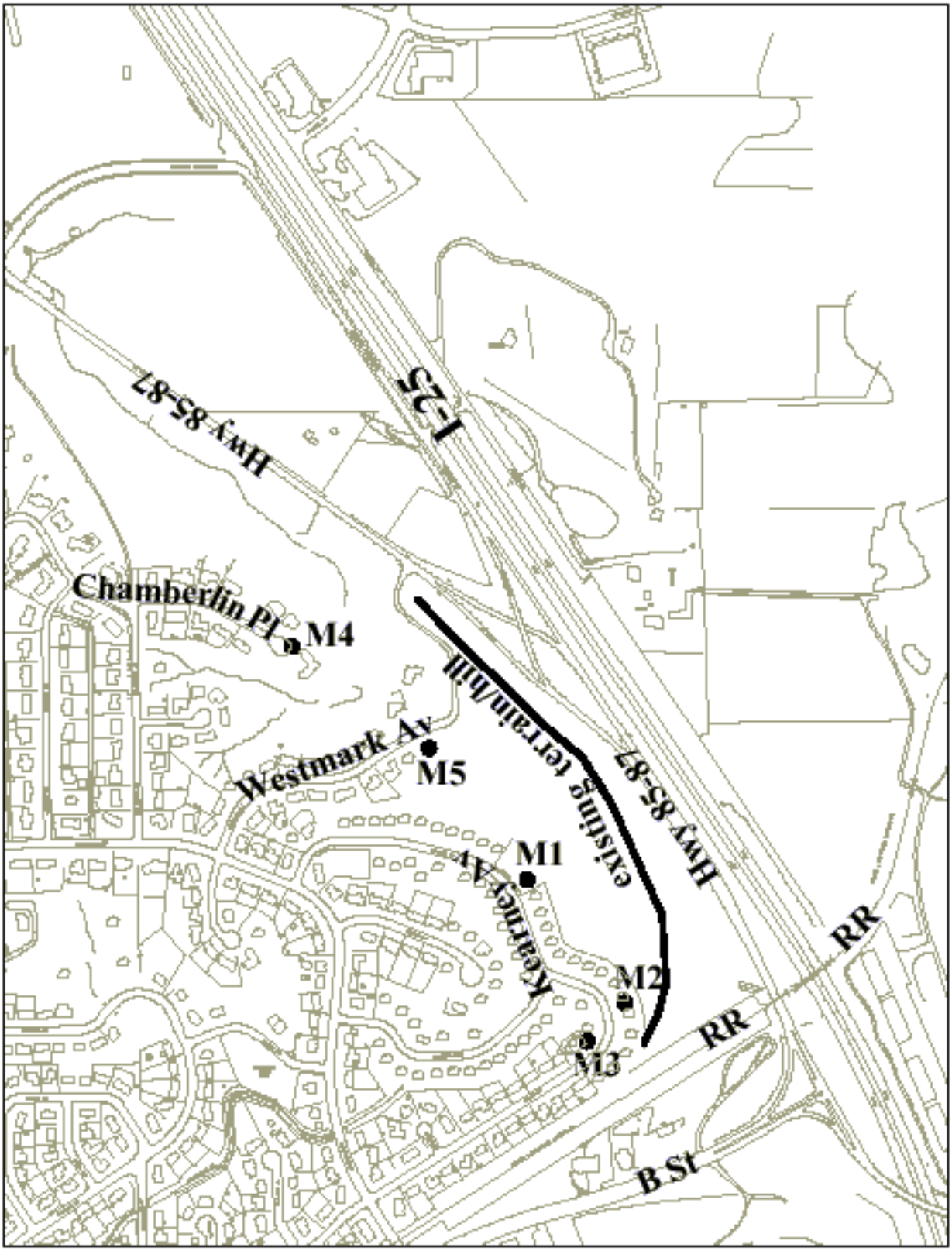

FIGURE A5: CIRCLE-LAKE NOISE MEASUREMENT LOCATIONS

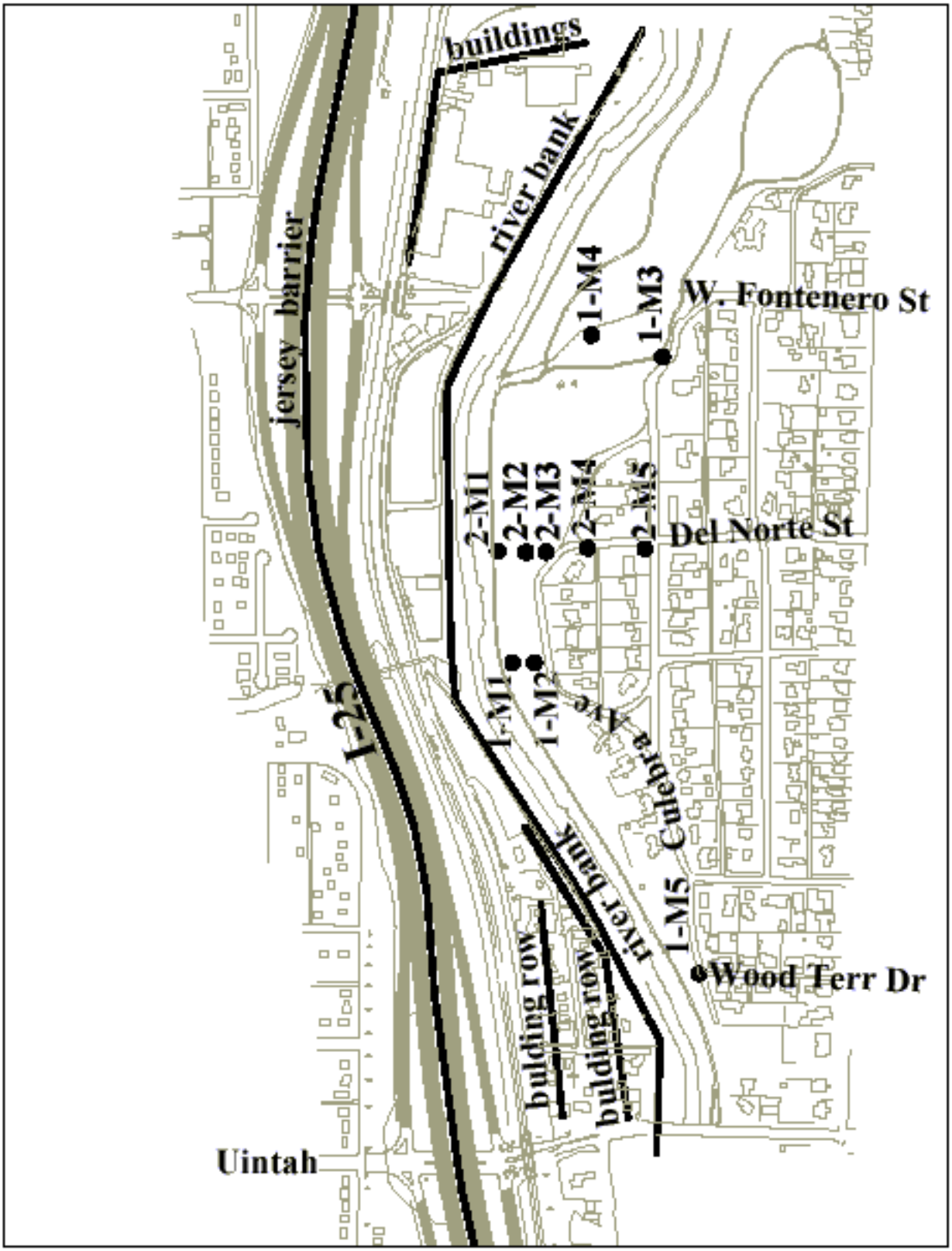

FIGURE A6: OLD NORTH END (1 & 2) NOISE MEASUREMENT LOCATIONS

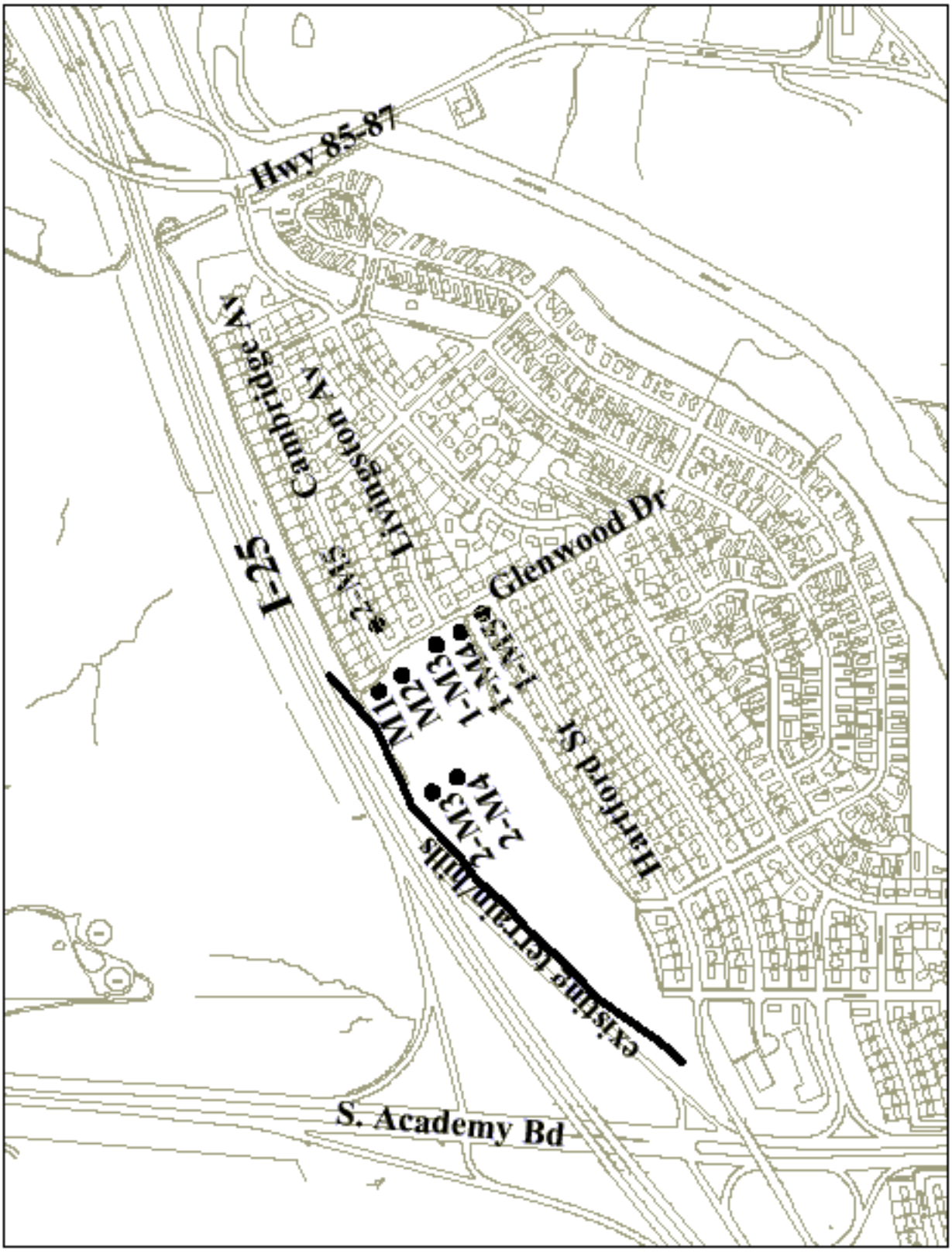

FIGURE A7: STRATMOOR VALLEY (1 &2) NOISE MEASUREMENT LOCATIONS

Appendix B

Noise Modeling Data

General inputs guidelines used for the STAMINA and TNM models is provided below. All traffic data including speeds was monitored during the measurements. This information was tabulated and input into the models. This information is also provided in Appendix A.

STAMINA

Emission Factors: The CDOT approved Colorado specific vehicle emission factors were used in each model.

Roadways, Noise Receptors/Measurement Locations and Barriers: This information was located using aerials and existing topography CAD which included elevation contours. This data was directly exported from CAD into the model. Barriers included natural terrain barriers, building rows, noise walls, and other structures that blocked noise propagation. Noise receptor elevation was increased by 5 feet to account for the typical person's ear height.

Alpha Factors: For "open air" situations where the noise receptor is at a different elevation such that the noise from the roadway is not affected by the ground type, a 0.0 alpha factor is used. Additionally, a 0.0 alpha factor is used for any hard surfaces such as a paved parking lot or large area of water (lake, pond, etc). For most other situations, an alpha factor of 0.5 is used which corresponds to grassy ground types such as a lawn or grassy field.

TNM

Emission Factors: Each model used the TNM specific emission factors. TNM is not authorized to use the Colorado specific emission factors.

Roadways, Noise Receptors/Measurement Locations and Barriers: This information was imported from each respective STAMINA model. With regard to TNM importing elevation of the noise receptor/measurement locations, the program subtracts the 5 feet from its elevation, but then adds this back through a default receptor height option, which is set to 5 feet. Barriers primarily included only noise walls or individual large structures.

Ground Type: The default ground type for these models was 'lawn'. This was changed for areas in which "field grass" or "pavement". The other ground type options (hard soil, loose soil, powder snow, etc) did not apply to these locations.

Terrain Lines: Terrain lines were used for natural berms, hills, etc. to simulate significant elevation changes in the terrain that would affect noise propagation.

Building Rows and Tree Zones: These inputs were used where they were significant enough to affect noise propagation from the roadway. Building rows represented a row of houses or similar structures and tree zones represent thick dense trees and vegetation and not simply a row of trees.

TABLE B1
ALPHA AND SHIELDING FACTORS USED IN STAMINA MODELING

Site	M#	Alpha	Shielding	Barriers (other than building rows)
Pulpit Rock	M1	0.5	0	NB I-25 EOP
	M2	0.5	1.5	NB I-25 EOP
	M3 - M4	0.5	3	NB I-25 EOP
Baptist Road	M1 - M5	0.5	0	natural berm to south
Garden of the Gods	M1	0	0	none
	M2 - M3	0.5	3	natural berm to east
	M4	0.5	5	fence
	M5	0	0	fence
Circle Area	M1 - M3	0.5	0	none
	M4 - M5	0.5	5	none
Circle-Lake	M1 - M2	0.5	0	natural berm to east
	M3	0.5	3	natural berm to east
	M4 - M5	0.5	0	natural berm to east
Old North End1	M1 - M4	0.5	0	jersey between I-25 lanes
	M5	0.5	3	jersey between I-25 lanes
Old North End2	M1 - M4	0.5	0	jersey between I-25 lanes
	M5	0.5	3	jersey between I-25 lanes
Stratmoor Valley1	M1	0.5	0	terrain line
	M2	0.5	1.5	terrain line
	M3 - M5	0.5	2.5	terrain line
Stratmoor Valley2	M1	0.5	0	terrain line
	M2	0.5	1.5	terrain line
	M3 - M4	0.5	0	terrain line
	M5	0.5	3	terrain line
Bijou	M1	0	0	jersey between I-25 lanes
	M2	0.5	0	noise wall and building
Nevada-Tejon	M1 - M2	0	0	SB EOP, jersey barrier, and buildings
	M3	0.5	0	NB EOP and jersey barrier
Woodmen	M1 - M8	0.5	0	natural berm to north
Mesa Springs	M1-1 - M10-2	0.5	0	houses modeled as barriers
Park Pavilion	M3-1 - M3-2	0.5	0	houses modeled as barriers

ATTACHMENT C – I25 EA NOISE TECHNICAL REPORT

Relevant Noise Terminology

Noise, often defined as unwanted sound, is the result of pressure fluctuations in the air. The range of sound pressures which the human ear is capable of detecting is very large (0.00002 to 200 Pa). To facilitate easier discussion, sound pressures are described on a decibel (dB) scale. Sound pressure level in dB is equal to $10Log_{10}(p^2/p_o^2)$ where p is the instantaneous sound pressure and p_o is the reference sound pressure of 0.00002 Pa. This results in a scale of 0 dB (threshold of audibility) to 120 dB (threshold of pain).

In addition to level or loudness, sound has both frequency and time components. The human ear is, in general, capable of detecting frequencies between 20 to 20,000 Hertz. The human ear is more sensitive to high frequency sounds than to low frequency sounds. Because of this, the A-weighting network was developed and is applied to either measured or predicted noise levels to mimic the ear's varying sensitivity to frequency. Resulting noise levels are expressed in dB(A). Table C1 shows the A-weighted noise levels of some common noise sources.

Different methods have been developed to quantify the time-varying nature of environmental noise levels (environmental noise levels are those found outdoors as the result of sources such as traffic, industry, and wind). The method used to describe noise levels along highways is the equivalent level (L_{eq}). The L_{eq} is essentially the average noise level over a given time period. Technically, it is called the energy-average noise level because of the fact that noise levels are expressed in decibels, which must be converted to absolute values of pressure before being averaged. The L_{eq} is a single level that has the same sound energy as the time-varying sound level over the stated time period. The time period used for highway noise analysis is one hour. All noise levels described in this report are hourly, A-weighted L_{eq}'s.

Locations at which noise is analyzed are typically known as noise receptors. Noise receptors are defined as areas in which people are typically located, which include places such as residences, hotels, commercial buildings, parks, etc. Usually, one noise receptor location is used to analyze an area unless the area is quite large and covers various distances from the roadway. The noise receptor is typically located on the façade of a structure that faces the noise source or roadway.

<u>Human Perception of Changes in Noise Levels</u>
Increases in noise levels of less than 3 dBA are generally considered imperceptible to humans. Increases of 3 to 5 dBA are considered noticeable, and increases of 10 dBA are perceived as a doubling of loudness.

TABLE C1
Typical Noise Levels

Noise Source	Noise Level (dB(A))
Amplified rock band	115 – 120
Commercial jet takeoff at 200 feet	105 – 115
Community warning siren at 100 feet	95 – 105
Busy urban street	85 – 95
Construction equipment at 50 feet	75 – 85
Freeway traffic at 50 feet	65 – 75
Normal conversation at 6 feet	55 – 65
Typical office interior	45 – 55
Soft radio music	35 – 45
Typical residential interior	25 – 35
Typical whisper at 6 feet	15 – 25
Human breathing	5 – 15
Threshold of hearing	0 – 5

ATTACHMENT D – I25 EA NOISE TECHNICAL REPORT

Traffic Volumes, Speeds, and Truck Percentages

1990 Mainline Truck Percentages and Traffic Speeds

I-25 Mainline Section		Medium Truck %	Heavy Truck %	Speed (mph)
From	To			
SH 16	SH 105 Monument	3.5%	4.0%	55

1990 Mainline Traffic Volumes – Northbound

I-25 Mainline Section		Total Peak Hour	Autos	Medium Trucks	Heavy Trucks
From	To				
SH 16	SH 105 Monument	2530	2340	89	101

1990 Mainline Traffic Volumes – Southbound

I-25 Mainline Section		Total Peak Hour	Autos	Medium Trucks	Heavy Trucks
From	To				
SH 16	SH 105 Monument	2530	2340	89	101

2025 Mainline Truck Percentages and Traffic Speeds

I-25 Mainline Section		Medium Truck %	Heavy Truck %	Speed (mph)
From	To			
South Academy	SH 16	3.8%	8.5%	75
Circle Drive	South Academy	4.5%	8.0%	60
US 24 Bypass	Circle Drive	3.7%	7.9%	60
Nevada Avenue	US 24 Bypass	2.8%	6.0%	60
Cimarron Street	Nevada Avenue	3.0%	5.6%	60
Bijou Street	Cimarron Street	3.9%	5.3%	60
Uintah Street	Bijou Street	4.1%	4.8%	60
Fontanero Street	Uintah Street	4.1%	4.6%	60
Fillmore Street	Fontanero Street	4.1%	4.6%	60
Garden of the Gods Road	Fillmore Street	3.4%	3.6%	60
Rockrimmon Drive	Garden of the Gods Road	4.7%	4.9%	60
North Nevada Avenue	Rockrimmon Drive	4.7%	4.9%	60
Woodmen Road	North Nevada Avenue	4.0%	4.1%	60
North Academy	Woodmen Road	3.7%	4.9%	60
Briargate	North Academy	5.4%	6.2%	65
Interquest	Briargate	5.4%	6.7%	75
Northgate	North Powers	5.4%	6.7%	75
Baptist Road	Northgate	5.4%	7.1%	75
SH 105 Monument	Baptist Road	5.4%	7.9%	75

2025 Mainline Traffic Volumes – Northbound

I-25 Mainline Section		Total Peak Hour	Autos	Medium Trucks	Heavy Trucks
From	To				
South Academy	SH 16	1772	1304	67	151
Circle Drive	South Academy	2156	1713	97	172
US 24 Bypass	Circle Drive	2870	2391	106	227
Nevada Avenue	US 24 Bypass	3820	3350	107	229
Cimarron Street	Nevada Avenue	4292	3422	129	240
Bijou Street	Cimarron Street	4626	2897	180	245
Uintah Street	Bijou Street	4526	2737	186	217
Fontanero Street	Uintah Street	4484	2616	184	206
Fillmore Street	Fontanero Street	4472	2612	183	206
Garden of the Gods Road	Fillmore Street	4059	2373	138	146
Rockrimmon Drive	Garden of the Gods Road	3994	1688	188	196
North Nevada Avenue	Rockrimmon Drive	3994	2920	188	196
Woodmen Road	North Nevada Avenue	3286	3092	131	135
North Academy	Woodmen Road	3528	3010	131	173
Briargate	North Academy	3451	2194	186	214
Interquest	Briargate	3593	2129	194	241
Northgate	North Powers	3469	1973	187	232
Baptist Road	Northgate	3546	2062	191	252
SH 105 Monument	Baptist Road	3121	1940	169	247

2025 Mainline Traffic Volumes – Southbound

I-25 Mainline Section		Total Peak Hour	Autos	Medium Trucks	Heavy Trucks
From	To				
South Academy	SH 16	1735	1522	66	147
Circle Drive	South Academy	2266	1983	102	181
US 24 Bypass	Circle Drive	3081	2724	114	243
Nevada Avenue	US 24 Bypass	4042	3686	113	243
Cimarron Street	Nevada Avenue	4148	3791	124	232
Bijou Street	Cimarron Street	3659	3322	143	194
Uintah Street	Bijou Street	3447	3140	141	165
Fontanero Street	Uintah Street	3293	3007	135	151
Fillmore Street	Fontanero Street	3287	3001	135	151
Garden of the Gods Road	Fillmore Street	2857	2657	97	103
Rockrimmon Drive	Garden of the Gods Road	2291	2071	108	112
North Nevada Avenue	Rockrimmon Drive	3654	3303	172	179
Woodmen Road	North Nevada Avenue	3654	3358	146	150
North Academy	Woodmen Road	3625	3313	134	178
Briargate	North Academy	2935	2595	158	182
Interquest	Briargate	2917	2564	158	195
Northgate	North Powers	2722	2393	147	182
Baptist Road	Northgate	2863	2505	155	203
SH 105 Monument	Baptist Road	2716	2355	147	215

ATTACHMENT E – I25 EA NOISE TECHNICAL REPORT

Noise Model Validation Report

Noise Model Validation Report

Interstate 25 Through Colorado Springs Environmental Assessment

El Paso County, Colorado

Report No.: HEI 4-9-2

March 2002

Prepared for:
Colorado Department of Transportation – Region 2

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1.0 Summary

This report describes the results of a study that was conducted to determine the accuracy of the STAMINA v2.0 traffic noise model along Interstate 25 (I-25) though Colorado Springs, Colorado. The study was conducted as part of the I-25 Corridor Environmental Assessment (EA).

Noise levels were measured at 75 locations along the Corridor. Traffic volumes, traffic speeds, and meteorological conditions were also monitored. Using the traffic conditions measured on-site, and accurate topographical data to model the physical aspects of each location, STAMINA was used to predict noise levels at each measurement location. The measured and predicted noise levels were then compared.

STAMINA v2.0 predicted noise levels between 5 dB(A) below and 8 dB(A) above measured levels. Averaging the results from all 75 measurements, STAMINA predicted 1 dB(A) above measured levels. STAMINA predicted within ±3 dB(A), a common measure of accuracy, at 55 of the 75 measurement locations (73%).

Overall, this study concludes that STAMINA v2.0 provides reasonably accurate and expected results for highway noise level predictions along the I-25 Colorado Springs Corridor.

2.0 Introduction

This report describes the results of a study that was conducted to validate the accuracy of the STAMINA v2.0 traffic noise model along Interstate 25 (I-25) though Colorado Springs, Colorado. The study was conducted as part of the I-25 Corridor Environmental Assessment (EA).

Noise levels were measured at 75 locations along the Corridor (Figure 1 shows the study area). Traffic volumes, traffic speeds, and meteorological conditions were also monitored. Using the traffic conditions measured on-site, and accurate topographical data to model the physical aspects of each location, STAMINA was used to predict noise levels at each measurement location. The measured and predicted noise levels were then compared.

This report is organized as follows. Section 3 describes the noise level measurements. Section 4 describes the modeling procedures. Section 5 describes the results of comparisons of measured and predicted noise levels. Technical details relating to the noise measurements are provided in Appendix A.

FIGURE 1: PROJECT AREA

3.0 Noise Level Measurements

This section describes the noise level measurements that were conducted. This includes a description of the noise level measurement procedures and results, and a general description of the measurement locations. This is followed by a more detailed discussion of each measurement site.

Referring to Figure 2, noise level measurements were taken at 20 "sites", e.g. the Pulpit Rock neighborhood, the area around the Bijou Street interchange, etc. Measurements were taken at anywhere from two to 17 locations at each site, for a total of 75 measurements. Forty-four of the measurements were taken between May and June 2001. The others were conducted as part of previous CDOT projects located in the Corridor. During each measurement, traffic volumes (including truck percentages) and traffic speeds were recorded for each direction of I-25 as well as any significant nearby side-roads. Meteorological conditions were recorded as well. Noise levels at each location were recorded for approximately one hour (some cases 30 minutes), using ANSI Type 1 sound level meters (SLM). Each SLM was field calibrated prior to each measurement and re-checked after each measurement. The microphones were all located 5 feet above ground level. Meteorological conditions were measured using an automated system mounted 10 feet above the ground. Traffic speeds were recorded using a radar gun.

Table 1 lists the measured noise levels along with other relevant information for each site. Additional technical details regarding these measurements including specific measurement locations, traffic data and meteorological data can be found in Appendix A.

TABLE 1
MEASURED NOISE LEVELS

Site *(---)*	**Measurement** *(---)*	**Date** *(---)*	**Time** *(---)*	**Noise Level** *(Leq - dB(A))*	**Distance to Highway** *(feet)*
Pulpit Rock	M1	5/30/01	13:30 to 13:45, 14:15 to 14:30, 14:45 to 15:15	65	400
	M2			58	700
	M3			56	900
	M4			63	550
Baptist Road	M1	6/5/01	10:00 to 11:00	61	550
	M2			55	1000
	M3			53	1700
	M4			53	1600
	M5			53	1500
Garden of the Gods	M1	6/5/01	13:45 to 14:45	69	200
	M2			64	430
	M3			65	400
	M4			58	570
	M5			58	200

TABLE 1
MEASURED NOISE LEVELS (CONTINUED)

Circle Area	M1	6/6/01	09:45 to 10:45	65	300
	M2			65	630
	M3			64	450
	M4			55	850
	M5			52	670
Circle-Lake	M1	6/6/01	12:30 to 13:30	55	660
	M2			62	730
	M3			71	950
	M4			59	1000
	M5			54	700
Old North End1	M1 (1)	6/12/01	09:30 to 09:45, 10:00 to 10:45	54	600
	M2 (1)			58	700
	M3			53	1500
	M4			49	1100
	M5			54	1000
Old North End2	M1 (1)	6/12/01	12:15 to 13:15	58	640
	M2			58	700
	M3			57	770
	M4 (1)			54	1050
	M5			56	1300
Stratmoor Valley1	M1	6/14/01	10:00 to 11:00	65	230
	M2			59	350
	M3			56	530
	M4			55	650
	M5			56	760
Stratmoor Valley2	M1	6/14/01	11:15 to 12:15	65	250
	M2			59	360
	M3			57	200
	M4			58	350
	M5			61	330
Bijou	M1	8/1/00	11:00 to 11:30	72	80
	M2			61	220
Nevada-Tejon	M1	8/31/98	10:30 to 11:00	71	70
	M2			66	100
	M3			64	220

TABLE 1
MEASURED NOISE LEVELS (CONTINUED)

Woodmen	M1	1/24/01	11:37 to 12:37	66	210
	M2			64	240
	M3		12:57 to 13:57	65	290
	M4			68	150
	M5			58	270
	M6		14:10 to 14:40	62	400
	M7			61	500
	M8			61	600
Mesa Springs[2]	M1-1	1/18/98	14:30 to 16:50	64	280
	M2-1	1/19/98	10:32 to 12:06	66	240
	M2-2			58	420
	M4-1	1/20/98	15:24 to 16:45	64	240
	M4-2			63	340
	M5-1	1/21/98	8:50 to 10:40	64	250
	M5-2			56	600
	M6-1		13:51 to 16:10	65	470
	M6-2			60	720
	M7-1	1/22/98	9:02 to 10:42	63	260
	M7-2			59	480
	M8-1		13:26 to 15:30	62	420
	M8-2			57	840
	M9-1	1/23/98	13:24 to 14:34	63	420
	M9-2			62	400
	M10-1		9:15 to 10:15	64	300
	M10-2			64	300
Park Pavilion[3]	M3-1	1/19/98	11:15 to 12:15	62	240
	M3-1			58	340

(1) Measurements conducted in Monument Valley Park
(2) The measurements taken prior to the construction of the Bijou to Fillmore noise wall on the west side of I-25
(3) The measurements taken prior to the construction of the Park Pavilion noise wall on the east side of I-25

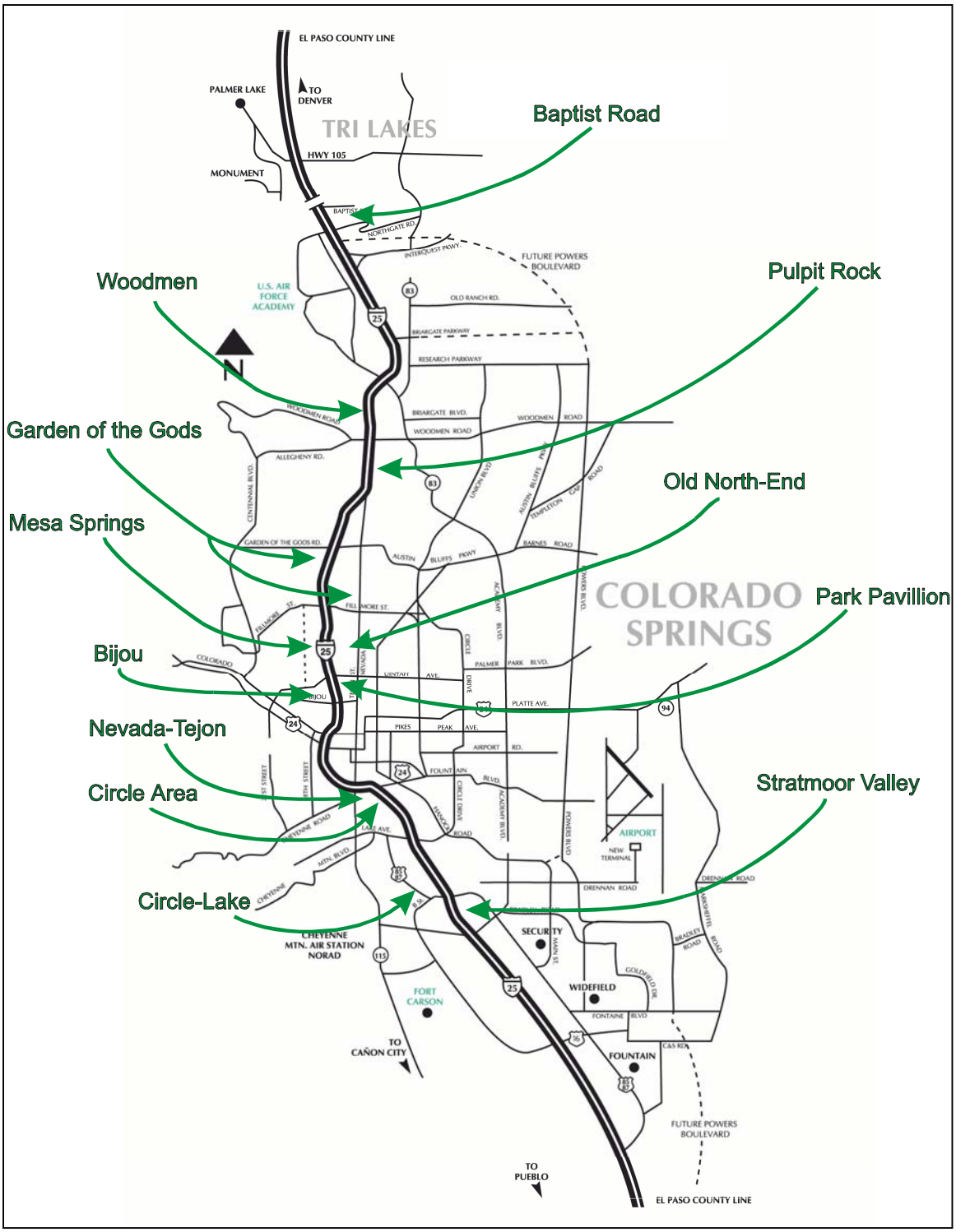

FIGURE 2: NOISE MEASUREMENT SITES

The following paragraphs describe the measurement locations. Refer to Appendix A for detailed plans of the measurement sites.

Pulpit Rock – This site is located on the northern end of Colorado Springs near Pulpit Rock Drive, on the east side of I-25. The neighborhood is elevated 25 to 30 feet above I-25. A row of houses partially blocked the view of I-25 to the north for M1 – M3, and completely blocked the view of I-25 from M4. Wind direction was observed to have significant effect on the perceived direction of the noise source and level. Average wind speed and temperature were 8 mph and 69°F, respectively.

Baptist Road – This site is located just south of Baptist Road on the east side of I-25. There is a grass field located between the measurement locations and I-25. This area is somewhat rural in that there are many open fields. This area is relatively flat with some gradual elevation increases to the east. Just south of the neighborhood is a winding berm that was modeled as a barrier; and is roughly 5 feet above the surrounding area. This is a textbook case of simple hemispherical propagation in which the model is expected to have good accuracy. Noise measurements were taken at distances and locations representative of the nearest residences. Average wind speed, temperature and relative humidity were 13 mph, 51°F, and 90%, respectively.

Garden of the Gods– This site is located between Garden of the Gods Road and Fillmore Street. Measurements were taken on both the east (M1-M3) and west side (M4-M5) of I-25. M1 was taken near the Foxfire West Apartments, M2 was taken near the Salem Church, M3 was taken on the corner of Dunston and Chestnut, M4 and M5 were taken in the Holliday Village Trailer Park near the pool and residence close to I-25, respectively. The elevations of M1 – M3 were about 25 feet above I-25. M1 was located nearest to I-25, while M2 and M3 were behind one row of houses. Locations M4 and M5 were below I-25 and had some shielding of noise from the existing businesses and fence. Average wind speed and temperature were 11 mph and 74°F respectively.

Circle Area – This site is located between US 24 Bypass and Circle-Lake (off Cheyenne Rd.) on the west side of I-25. M1 was located near the Southgate Church. M2 and M3 were located on the west side of Cheyenne Rd. M4 was located along Aspen Road, one block to the west of Cheyenne Rd. M5 was located along Sheridan Rd., two blocks to the west of Cheyenne Rd. This site is a dense neighborhood with the first row of houses set back 550 feet from I-25 with businesses in-between. A 3 dB shielding factor was applied to M4 since it was behind one row of homes and 5 dB of shielding was used for M5 five since it was behind two rows of homes. Average wind speed and temperature were 4 mph and 72°F, respectively.

Circle Lake – This site is located to the West of US85 and is between Circle-Lake and B St. This site is distant and elevated from I-25 with the nearest homes at a distance of 700 feet horizontal and roughly 60 feet above I-25. M1 – M3 were located along Kearney Avenue. M1 was located in some open space between a few homes. M2 was located in the front yard of a residence and had a direct line of sight to I-25. M3 was located near a water tower behind on row of homes. M4 was located down Chamberlin Place and M5 was located along Westmark Avenue. M3 data was corrupted due to a loud car stereo nearby and was eliminated from the analysis. All sites except M3 provided a decent line-of-sight to I-25. The primary barrier for these sites was the hill leading up to the sites, which was modeled. Average wind speed and temperature were 11 mph and 88°F, respectively.

North End 1– This site is located between Uintah and Fillmore Streets on the east side of I-25. In general, this neighborhood is located above I-25. Monument Creek is located between I-25 and this site, forming a valley. M1 was located down in Monument Valley Park near the walking path, with M2 located above M1 adjacent to Culebra Avenue. Both M1 and M2 are in the same line as West Caramillo

Street. M3 was located next to Culebra Avenue near Fontanero Street, with M4 located below it in the Park. M5 was located at the intersection of Wood Terrace Drive and Culebra Avenue. All sites provided a direct line of sight to I-25. Average wind speed and temperature were <1 mph and 84°F, respectively.

North End 2 – This site is located near the intersection of Culebra Avenue and Del Norte Street. The measurements were located in a straight line starting at the walking path in the Park and ending at Culebra Place. M1 was located next to the walking path. M2 was partially up the slope to the east of the path. M3 was on top the slope near Culebra Avenue. M4 was located about 70 feet down Del Norte Street, and M5 was at the intersection of Del Norte Street and Culebra Place. The intent of this measurement was to try and determine how I-25 traffic noise propagates through the Park to the neighborhood. The measured data shows that the noise level drops and then actually increases at the farthest distance from I-25. This is due to noise in the neighborhood from sources other than I-25, which were adding to the noise generated by I-25. Average wind speed and temperature were 1 mph and 95°F, respectively.

Stratmoor Valley 1 – This site is located towards the southern end of Colorado Springs, just to the north of the South Academy Blvd and I-25 Interchange. Measurements were taken on the east side of I-25 along Glenwood Drive. M1 was nearest to I-25 and was in-line with the homes along Cambridge Avenue. M2 was in-line with Cambridge Avenue. M3 and M4 were on opposite sides of Livingston Avenue and M5 was at the intersection of Hartford Avenue and Glenwood Drive. There was a significant berm in-between the measurement locations and I-25 that blocked line-of-sight. Average wind speed and temperature were 3 mph and 84°F, respectively.

Stratmoor Valley 2 – This is the same site as Stratmoor Valley 1, except that three of the measurement locations were moved. M1 and M2 remained in the same location. M3 and M4 were located further south. Average wind speed and temperature were 3 mph and 84°F, respectively.

Bijou – This site is located at the I-25 Bijou Street interchange. M1 is located adjacent to the I-25 southbound on-ramp. M2 is located behind the noise at the east end of Platte Avenue.

Nevada–Tejon – This site is located at the I-25 and Nevada-Tejon interchange. M1 is located adjacent to the southbound I-25 at the end of Arvada Avenue. M2 is located along Arvada between Nevada and Tejon. M3 is located along Nevada Avenue, north of I-25 adjacent to the City Park.

Woodman – This site is located on the west side of I-25, north of Woodmen Road, in the Pine Creek Estates neighborhood. There were eight measurements taken in this area, with six located primarily off Gillen Road and two located on USAF property to the north. M1 – M3 were considered to be the front row locations closest to I-25. M4 and M5 were located on USAF property. M6 – M8 were located in a line along Gillen Road further away from I-25 than M1 – M3. There is a significant berm to the North of M3 that breaks line-of-sight to this portion of I-25. Average wind speed and temperature were 3 mph and 33°F, respectively.

Mesa Springs – This one site includes a total of nine separate sites. Measurements were conducted in January 1998, prior to the installation of the Bijou to Fillmore noise wall or other I-25 alignment changes. A description of each site is as follows.

Site 1 is located at the east end of Monument Street. Receptor 1 is in an open field on the south side of Monument Street at the end of the cul-de-sac, and represents residences located directly behind the wall. This site is directly opposite the location of the Monument Valley Park noise wall. Receptor 1 is 300 feet from and relatively level in elevation with the center of I-25. With the exception of a house to the south, the view to the highway is unobstructed in all directions.

Site 2 is located at the east end of Nichols Court. Receptor 1 is in front of the house on the north side of Nichols Court at the end of the cul-de-sac, and is representative of residences located directly behind the wall. Receptor 2 is in the backyard of a residence on the north side of Nichols Court, three residences west of the wall. It is representative of residences three rows back from the wall. Receptor 1 is 240 feet from and relatively level in elevation with the center of I-25. The view of I-25 is unobstructed in all directions. Receptor 2 is 420 feet from the center of I-25, and approximately 10 feet above the highway. The view of the highway is obstructed by residences in all directions.

Site 4 is located at the east end of Yampa Street. Receptor 1 is in an open area at the end of the cul-de-sac, and is representative of the residences directly behind the wall. Receptor 2 is in the side-yard of the residence on the southeast corner of Yampa Street and Raymond Place. It is representative of residences three rows of houses back from the wall. Receptor 1 is 240 feet from and relatively level with the center of I-25. The view of I-25 is unobstructed in all directions. Receptor 2 is 420 feet from the center of I-25, and approximately 10 feet above the highway. The view of the highway is obstructed by residences in all directions.

Site 5 is located at the east end of San Rafael Street. Receptor 1 is in front of the last residence on the south side of the cul-de-sac, and is representative of the residences directly behind the wall. Receptor 2 is in the front yard of the residence located approximately 175 feet west of Walnut Street. It is representative of residences five rows of houses back from the wall. Receptor 1 is 250 feet from I-25. To the north I-25 is higher than Receptor 1 as it comes down from the Uintah Street overpass. The view of I-25 is partially blocked to the south by a residence. Receptor 2 is 620 feet from the center of I-25, and approximately 20 feet above the highway. The view of the highway is obstructed by residences in all directions except straight down San Rafael Street.

Site 6 is located at the intersection of San Miguel Street and Walnut Street. Receptor 1 is in front of the residence on the northwest corner of this intersection. Receptor 2 is in the front yard of the residence four houses west of Receptor 1. Receptor 1 is 475 feet from and approximately 10 feet above I-25. The view of I-25 is unobstructed in all directions, and the berm which was built as part of the noise wall project almost breaks line of sight to the highway. Receptor 2 is 725 feet from the center of I-25, and approximately 20 feet above the highway. The view of the highway is obstructed by residences in all directions except straight down San Miguel Street.

Site 7 is located at the intersection of Caramillo Street and Cooper Avenue. Receptor 1 is in the side yard of the residence on the southeast corner of this intersection, and is representative of residences directly behind the wall. Receptor 2 is in the side yard of the residence on the southwest corner of this intersection, and is representative of residences one row back from the wall. Receptor 1 is 260 feet from, and level with, I-25. The view of I-25 is unobstructed in all directions. Receptor 2 is 480 feet from the center of I-25, and approximately 10 feet above the highway. The view of the highway is obstructed by residences to the south.

Site 8 is located near the Fontanero interchange. Receptor 1 is in an open field, 130 feet west of the southbound on-ramp from Fontanero Street, and 420 feet from I-25. It is representative of residences directly behind the wall. Receptor 2 is in the side yard of a residence on the west side of Chestnut Avenue, approximately 840 feet from I-25. It is representative of residences many rows back from the wall, and significantly elevated above the base of the wall. I-25 is elevated above Receptor 1, particularly to the north as it passes over Fontanero Street. The view of I-25 from Receptor 1 is unobstructed. Receptor 2 is elevated approximately 30 feet above I-25, and the view of the highway is blocked by residences in most directions.

Site 9 is located on Cooper Avenue between Washington and Jefferson Streets. Receptor 1 is in the front yard of the residence on the southwest corner of Cooper and Jefferson, and representative of residences directly behind the wall. Receptor 2 is in an open field in front of the southbound off-ramp onto Fontanero Street (via Cooper Avenue). Receptor 1 is 415 feet from and level with I-25. The view of I-25 is unobstructed in all directions except to the north where a pile of dirt created as part of the noise wall project breaks line of sight. Receptor 2 is 400 feet from the center of I-25, and also level with the highway. The view of the highway is unobstructed in all directions.

Site 10 is located at the north end of the noise wall on Green Ridge Drive. Receptor 1 is in the front yard of the residence on the north side of Green Ridge Drive where the road turns west. Receptor 2 is in the front yard of the residence on the northwest corner of the intersection of Green Ridge Drive and Cooper Avenue. Both of these receptors are representative of residences located directly behind the wall. The reference location is approximately 50 feet north of the end of the wall. Receptor 1 is 290 feet from and approximately 10 feet above I-25. The view of I-25 is obstructed to the north by area topography. Receptor 2 is 310 feet from the center of I-25, and level with the highway. The view of the highway is unobstructed in all directions

Park Pavilion – This site is located in Monument Valley Park on the east side of I-25. M1 is to the west of the tennis courts and sidewalk, and M2 is just south of the tennis courts. Both of these receptor locations are representative of the active use areas within the park. M1 and M2 are 240 feet and 340 feet from the center of I-25, respectively. Both locations are about 5 feet below the level of I-25, and line of sight to the highway is just broken by the railroad tracks. Measurements for these sites were done in January 1998, prior to the installation of the Bijou to Fillmore noise wall or other I-25 alignment changes.

4.0 Noise Modeling Procedures

The purpose of validating the STAMINA model is to ensure that it is accurately predicting noise levels for a particular site. Accuracy is dependent on the capabilities of the model, the complexity of the site, and the accuracy of the input data used. STAMINA is generally expected to predict noise levels within ±3 dB(A). The complexities of the measurement sites on this project range from simple to complex. Accurate input data was used on this project, including electronic topographic maps with two-foot elevation contours, and traffic volumes and speeds measured on site.

The process of validating the model consists of the following steps:

- Measuring noise levels, and concurrent traffic conditions
- Constructing a model of the site
- Comparing the predicted and measured results

The following sections provide an overview of the STAMINA model, and describe how each of the model validation steps was conducted on this project.

4.1 Overview of STAMINA

STAMINA is an acronym for "Standard Method in Noise Analysis". It is a software program that implements the equations and algorithms contained in FHWA's "Highway Traffic noise Prediction Model" (FHWA-RD-77-108, December 1978). STAMINA v2.0 was released in April 1982. STAMINA calculates the hourly, A-weighted L_{eq} at a receptor location when provided the following data:

- The noise emission level of automobiles, medium, and heavy trucks
- The volume and speed of each of these vehicle types on each roadway of interest
- The relative location and elevation of all roadways and receptors
- The relative location and elevation of terrain features (i.e. natural and man-made barriers)
- The type of terrain between each receptor and each roadway.

STAMINA has built-in noise emission factors, which are based on a four-state study conducted as part of the development of the model. CDOT developed its own emission factors in 1993, and these were used in this study. These emission levels are adjusted to account for distance using line source equations. The model propagates sound at a decay rate of between 3 and 4.5 dB per doubling of distance (dB/dd), depending on the user selected alpha factor. An alpha factor of 0, which results in a propagation decay rate of 3 dB/dd, represents hard ground such as pavement and water, as well as the case where either the source or the receptor is significantly elevated above the ground. An alpha factor of 0.5, which results in a propagation decay rate of 4.5 dB/dd, represents acoustically soft terrain (vegetated ground with both source and receiver located close to the ground). The emission factors are also adjusted to account for traffic volume, mix, and speed. STAMINA uses Fresnel diffraction for barriers, and user input correction factors to account for rows of houses. The user is required to input the locations and elevations of these entities.

4.2 Noise Modeling Procedures

This section describes the input data and procedures used to predict noise levels on this project. The main factors that affect the predicted noise levels are traffic volume, a receptor's distance from the roadway, the presence of any barriers between the roadway and the receptor, and ground type. The following paragraphs describe, in general, the input data used in the modeling. See Appendix A for more specific information.

Location of Roadways
The locations and elevation of all roadways the roadways were determined using Colorado Springs FIMS mapping with 2-foot elevation contours.

Location of Noise Measurements
The locations of the measurements were noted in the field and transferred to the CAD mapping.

Location of Terrain Features
Based on field observations, all existing terrain features such as embankments and structures that blocked line of sight from the receptor to the highway were modeled as barriers. Building rows were modeled using shielding factors (3 dB for one row, 5 dB for 2 rows). Table 2 shows the shielding factors used in the predictions.

Terrain Type
Based on field observations, the terrain type was modeled in STAMINA using the aforementioned alpha factors. Table 2 shows the alpha factor used for each prediction. For "open air" situations where the noise receptor is at a different elevation than the roadway, such that the noise from the roadway is not affected by the ground type, a 0.0 alpha factor was used. Additionally, a 0.0 alpha factor was used for any hard surfaces such as a paved parking lot or large area of water (lake, pond, etc). For most other situations, an alpha factor of 0.5 was used, which corresponds to grassy ground types such as a lawn or grassy field.

Traffic Volumes and Speeds
Traffic volumes on I-25 were monitored using a video camera, which was synchronized to the measurement times. The traffic videotapes were then reviewed and the number of automobiles, medium trucks, and heavy trucks traveling in each direction on I-25 (and any other significant roads) were tabulated. Traffic speeds were monitored periodically during the measurements using a radar gun.

Emission Factors
The Colorado-specific Reference Energy Mean Emission Levels were used for all vehicle types in all of the predictions. These emission levels were developed by CDOT, and are published in the document entitled *Reference Energy Mean Emission Levels Used in STAMINA 2.0 for Highway Noise Prediction in the State of Colorado*, CDOT, and February 1995.

TABLE 2
ALPHA AND SHIELDING FACTORS USED IN STAMINA MODELING

Site	M#	Alpha	Shielding	Barriers (other than building rows)
Pulpit Rock	M1	0.5	0	NB I-25 EOP (Edge of Pavement)
	M2	0.5	1.5	NB I-25 EOP
	M3 - M4	0.5	3	NB I-25 EOP
Baptist Road	M1 - M5	0.5	0	natural berm to south
Garden of the Gods	M1	0	0	none
	M2 - M3	0.5	3	natural berm to east
	M4	0.5	5	fence
	M5	0	0	fence
Circle Area	M1 - M3	0.5	0	none
	M4 - M5	0.5	5	none
Circle-Lake	M1 - M2	0.5	0	natural berm to east
	M3	0.5	3	natural berm to east
	M4 - M5	0.5	0	natural berm to east
Old North End1	M1 - M4	0.5	0	jersey between I-25 lanes
	M5	0.5	3	jersey between I-25 lanes
Old North End2	M1 - M4	0.5	0	jersey between I-25 lanes
	M5	0.5	3	jersey between I-25 lanes
Stratmoor Valley1	M1	0.5	0	terrain line
	M2	0.5	1.5	terrain line
	M3 - M5	0.5	2.5	terrain line
Stratmoor Valley2	M1	0.5	0	terrain line
	M2	0.5	1.5	terrain line
	M3 - M4	0.5	0	terrain line
	M5	0.5	3	terrain line
Bijou	M1	0	0	jersey between I-25 lanes
	M2	0.5	0	noise wall and building
Nevada-Tejon	M1 - M2	0	0	SB EOP, jersey barrier, and buildings
	M3	0.5	0	NB EOP and jersey barrier
Woodmen	M1 - M8	0.5	0	natural berm to north
Mesa Springs	M1-1 - M10-2	0.5	0	houses modeled as barriers
Park Pavilion	M3-1 - M3-2	0.5	0	houses modeled as barriers

5.0 Noise Model Validation Results

Table 3 summarizes the results by showing the average measured noise level, predicted noise level, and the differences between these levels on a per site basis. Additionally, the average distance from I-25 to the respective site is provided.

TABLE 3
MEASURED AND PREDICTED NOISE LEVELS
(L_{eq} dB(A))

Site	Distance To I-25 (feet)	Number of Measurement Locations	Measured	STAMINA	STAMINA Minus Measured
Pulpit Rock	638	4	60	62	2
Baptist Road	1,270	5	55	57	2
Garden of the Gods	360	5	63	61	-2
Circle Area	580	5	60	60	0
Circle-Lake	808	4	57	58	1
Old North End1	980	5	53	57	4
Old North End2	892	5	56	57	1
Stratmoor 1	504	5	58	60	2
Stratmoor 2	298	5	60	64	4
Bijou	150	2	66	65	-1
Nevada-Tejon	130	3	67	67	0
Woodmen	333	8	63	63	0
Mesa Springs	411	17	62	63	1
Park Pavilion	290	2	60	66	6

On average, STAMINA v2.0 predicted noise levels within 1 dB(A) of the measured levels. Reviewing the results per each individual measurement location, it was found that 55 of the 75 locations were predicted within ±3 dB(A), which corresponds to an accuracy of 73%. The range of error was found to be from 5 dB(A) below and 8 dB(A) above the measurement levels, which occurred within the Garden of the Gods site (M2) and Stratmoor 2 site (M3), respectively. The error at the Garden of the Gods site was most likely due to a combination of factors including side road traffic that was not accounted for within the noise model, and the inclusion of a 3 dB(A) shielding factor from I-25 which may be excessive as the terrain barrier between I-25 and the front row of homes already accounts for some of this reduction. The error at the Stratmoor 2 site was most likely due to the unique terrain at the site, which included various sized berms and a billboard in which a slight shift in either the measurement location or terrain line could result in this size of error due to its relatively close location to I-25.

Appendix A

Measurement Details

The following provides measurement details for each site including weather conditions, monitored traffic volumes and speeds, and locations.

WEATHER

Table A1 provides the measured weather data for each noise measurement period measurement as available.

TABLE A1
MEASURED WEATHER DATA DURING NOISE MEASUREMENTS

Site *(---)*	**Date** *(---)*	**Time** *(---)*	**Temperature** *(°F)*	**Average Wind Speed** *(mph)*	**Average Wind Direction** *(---)*
Pulpit Rock	5/30/01	13:30 to 13:45, 14:15 to 14:30, 14:45 to 15:15	69	8	n/a
Baptist Road	6/5/01	10:00 to 11:00	51	13	0
Garden of the Gods	6/5/01	13:45 to 14:45	74	11	358
Circle Area	6/6/01	09:45 to 10:45	72	4	359
Circle-Lake	6/6/01	12:30 to 13:30	88	11	0
Old North End1	6/12/01	09:30 to 09:45, 10:00 to 10:45	84	1	3

TABLE A1 (CONTINUED)

Old North End2	6/12/01	12:15 to 13:15	95	1	0
Stratmoor Valley1	6/14/01	10:00 to 11:00	84	3	2
Stratmoor Valley2	6/14/01	11:15 to 12:15	84	3	2
Bijou	See Individual Technical Noise Reports				
Nevada-Tejon					
Woodmen					
Mesa Springs					
Park Pavilion					

TRAFFIC

Table A2 provides the hourly measured traffic volumes and speeds during each noise measurement period. Some measurement periods were shorter or longer in duration than one-hour. For these locations, the representative hourly traffic volumes are provided. Hourly traffic volumes are used in both STAMINA and TNM.

TABLE A2
MEASURED TRAFFIC VOLUMES AND SPEEDS DURING NOISE MEASUREMENTS

	Measurement	Veh	I25 NB	I25 SB	Speed (mph)
Pulpit Rock	all	cars	3634	3870	60
		med	127	110	60
		hvy	184	189	60

	Measurement	Veh	I25 NB	I25 SB	Speed (mph)
Baptist Road	all	cars	1593	1964	75
		med	105	101	75
		hvy	147	140	75

	Measurement	Veh	I25 NB	I25 SB	Chestnut	Speed (mph)
GoG	all	cars	3040	2560	372	60
		med	170	88	4	60
		hvy	119	196	0	60

	Measurement	Veh	I25 NB	I25 SB	Cheyenne	Speed (mph)
Circle Area	all	cars	1580	1624	180	55
		med	54	112	36	55
		hvy	212	248	20	55

	Measurement	Veh	I25 NB	I25 SB	HWY 85-87	Speed (mph)
Circle-Lake	all	cars	1440	1380	882	65
		med	58	118	6	65
		hvy	208	180	0	65

	Measurement	Veh	I25 NB	I25 SB	Speed (mph)
Old North End 1	all	cars	2704	2893	55
		med	80	145	55
		hvy	179	211	55

TABLE A2 (CONTINUED)

	Measurement	Veh	I25 NB	I25 SB	Speed (mph)
Old North End 2	all	cars	3090	2780	55
		med	122	119	55
		hvy	186	201	55

	Measurement	Veh	I25 NB	I25 SB	Speed (mph)
Stratmoor Valley 1	all	cars	1485	1500	65
		med	84	70	65
		hvy	161	230	65

	Measurement	Veh	I25 NB	I25 SB	Speed (mph)
Stratmoor Valley 2	all	cars	1752	1442	65
		med	74	85	65
		hvy	171	180	65

	Measurement	Veh	I25 NB	I25 SB	Speed (mph)
Bijou	all	cars	1646	2932	55
		med	102	74	55
		hvy	160	158	55

	Measurement	Veh	I25 NB	I25 SB - NPL to SB off	I25 SB - SB on to SPL	ramp mainline to Arvada on-ramp	Arvada on-ramp to SB off 24	Arvada	Speed (mph)
Nevada Tejon	all	cars	2540	2164	1652	512	914	402	55
		med	144	108	92	16	24	8	55
		hvy	158	156	126	30	36	6	55

	Measurement	Veh	I25 NB	I25 SB	Speed (mph)
Woodmen	M1 - 2	cars	2226	2124	60
		med	107	79	60
		hvy	158	170	60
	M3 - 5	cars	2168	2250	60
		med	94	87	60
		hvy	129	179	60
	M6 - 8	cars	2486	2786	60
		med	98	114	60
		hvy	108	152	60

TABLE A2 (CONTINUED)

	Measurement	Veh	I25 NB	I25 SB	Speed (mph)
Mesa Springs	M1	cars	2604	2114	55
		med	30	25	55
		hvy	30	52	55
	M2	cars	2329	2433	55
		med	73	79	55
		hvy	174	216	55
	M4	cars	3644	3480	55
		med	71	65	55
		hvy	120	145	55
	M5	cars	2275	2473	55
		med	80	112	55
		hvy	171	179	55
	M6	cars	2709	3129	55
		med	91	88	55
		hvy	151	173	55
	M7	cars	2284	2571	55
		med	85	95	55
		hvy	186	168	55
	M8	cars	2990	2842	55
		med	114	105	55
		hvy	157	164	55
	M9	cars	3048	2914	55
		med	100	109	55
		hvy	133	152	55
	M10	cars	2396	2528	55
		med	89	107	55
		hvy	164	169	55

TABLE A2 (CONTINUED)

	Measurement	***Veh***	***I25 NB***	***I25 SB***	***Speed (mph)***
Park Pavilion	all	cars	2632	2818	55
		med	101	111	55
		hvy	174	188	55

MEASUREMENT LOCATIONS

Figures A1 through A7 provide the locations of each particular measurement location for each site. Only locations which were measured specifically for the I-25 EA are included here. Figures for other measurement locations can be found in their respective noise technical report.

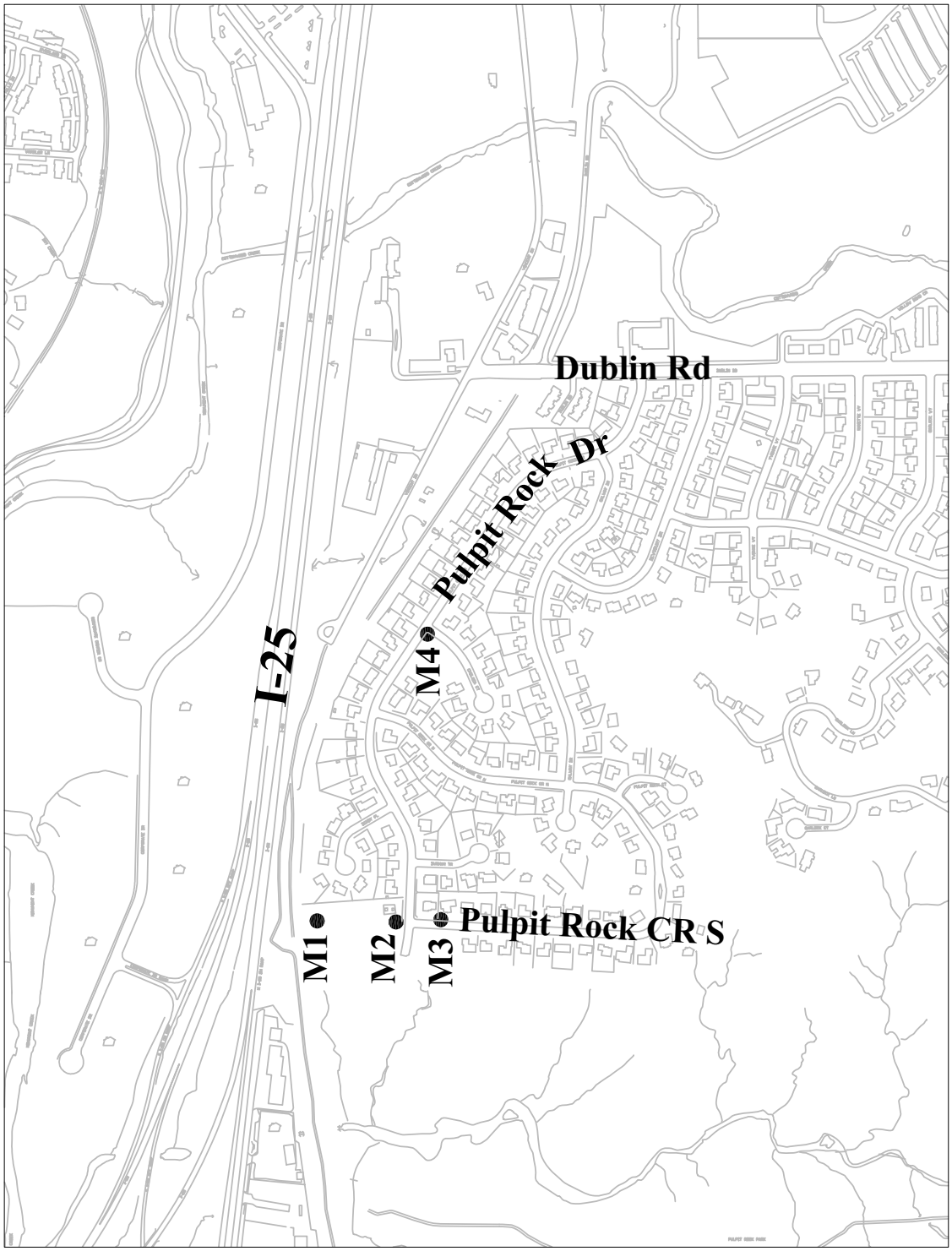

FIGURE A1: PULPIT ROCK NOISE MEASUREMENT LOCATIONS

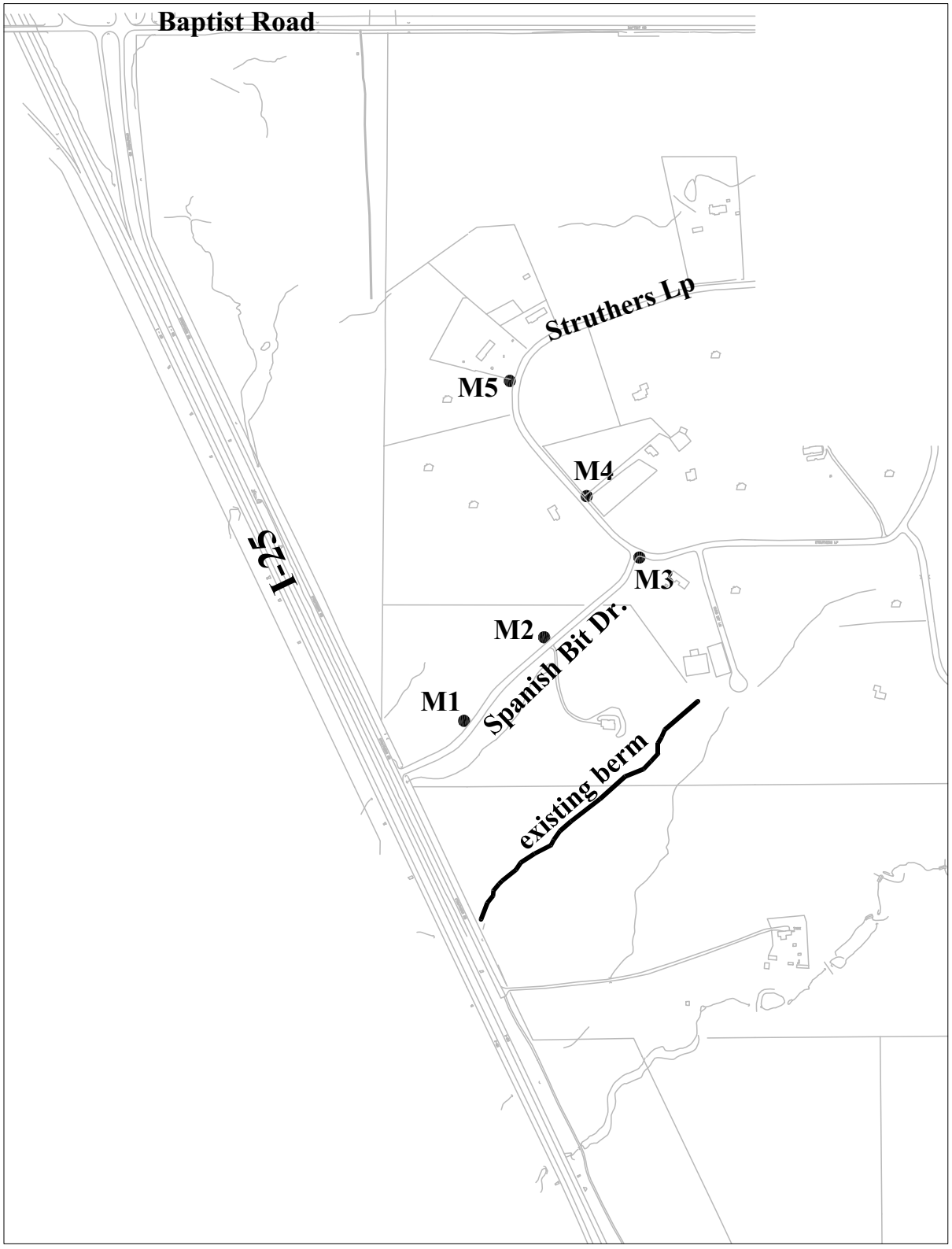

FIGURE A2: BAPTIST ROAD NOISE MEASUREMENT LOCATIONS

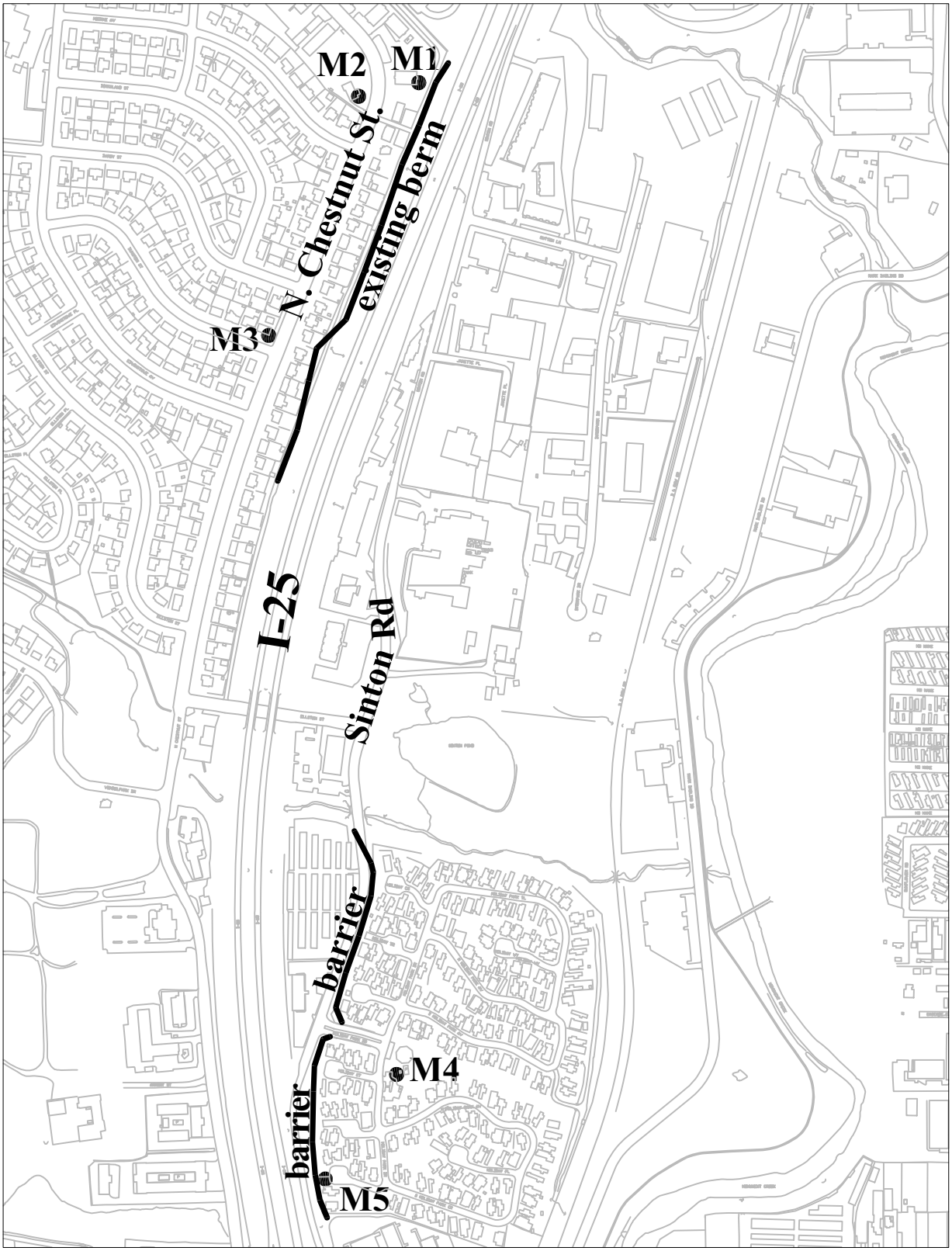

FIGURE A3: GARDEN OF THE GODS NOISE MEASUREMENT LOCATIONS

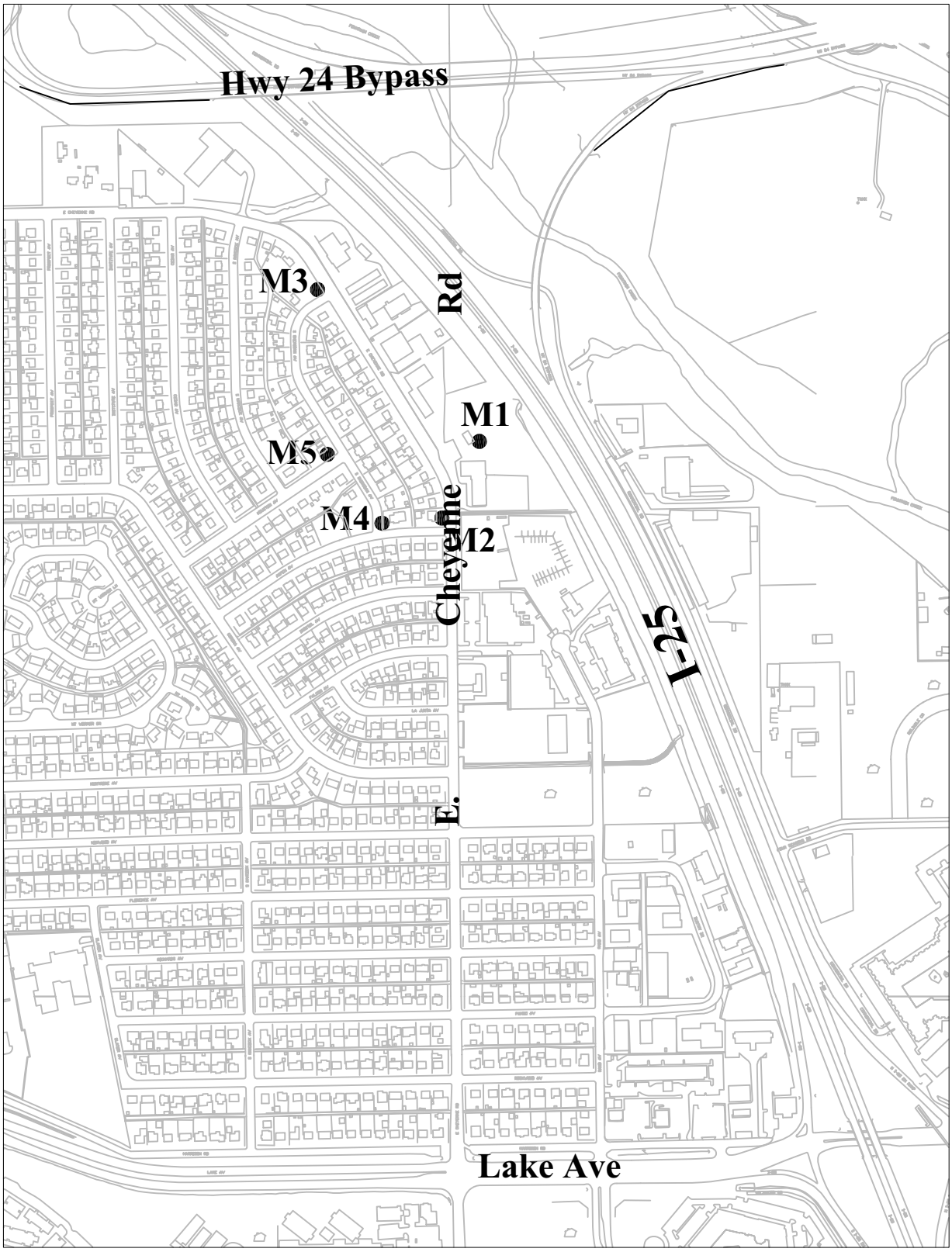

FIGURE A4: CIRCLE AREA NOISE MEASUREMENT LOCATIONS

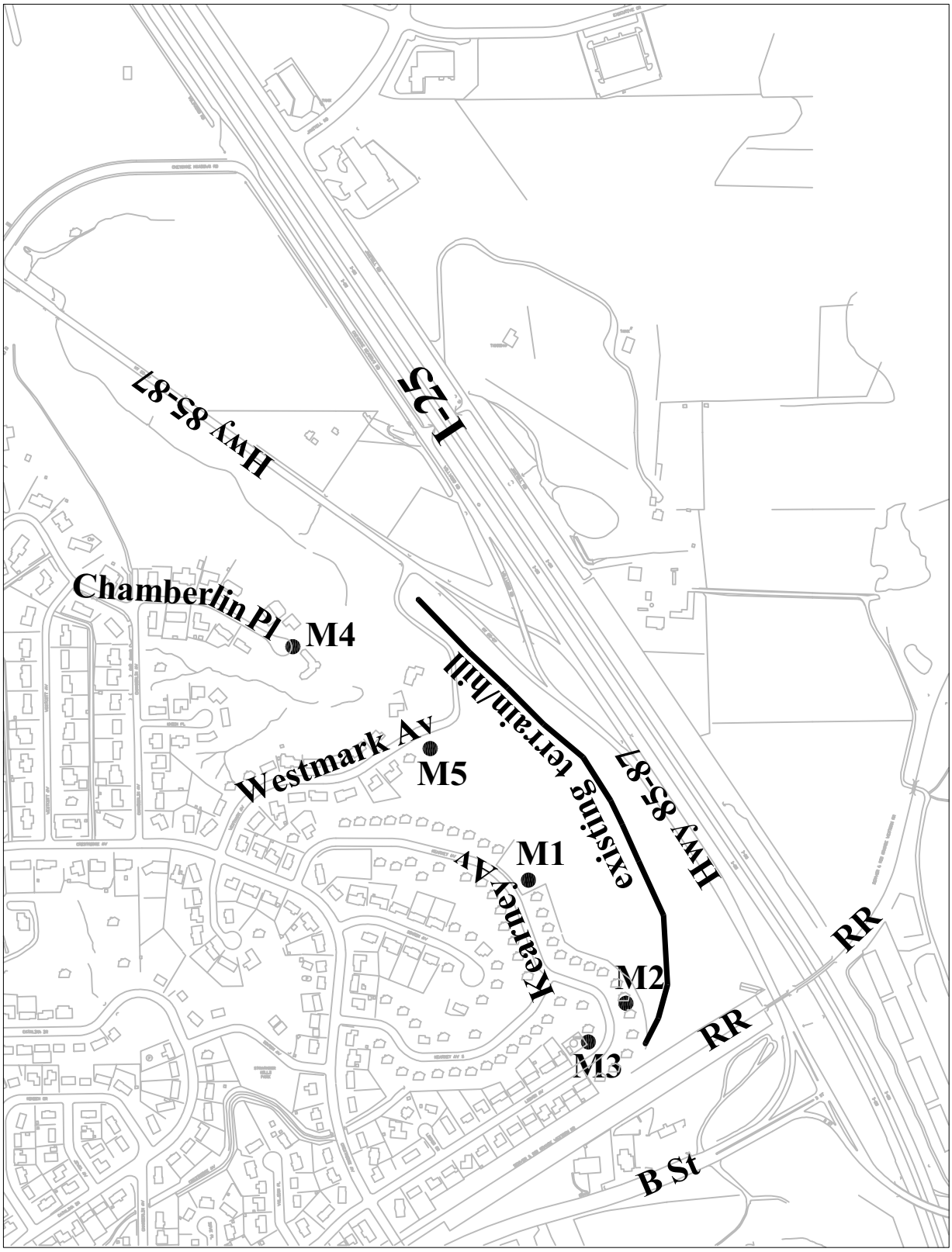

FIGURE A5: CIRCLE-LAKE NOISE MEASUREMENT LOCATIONS

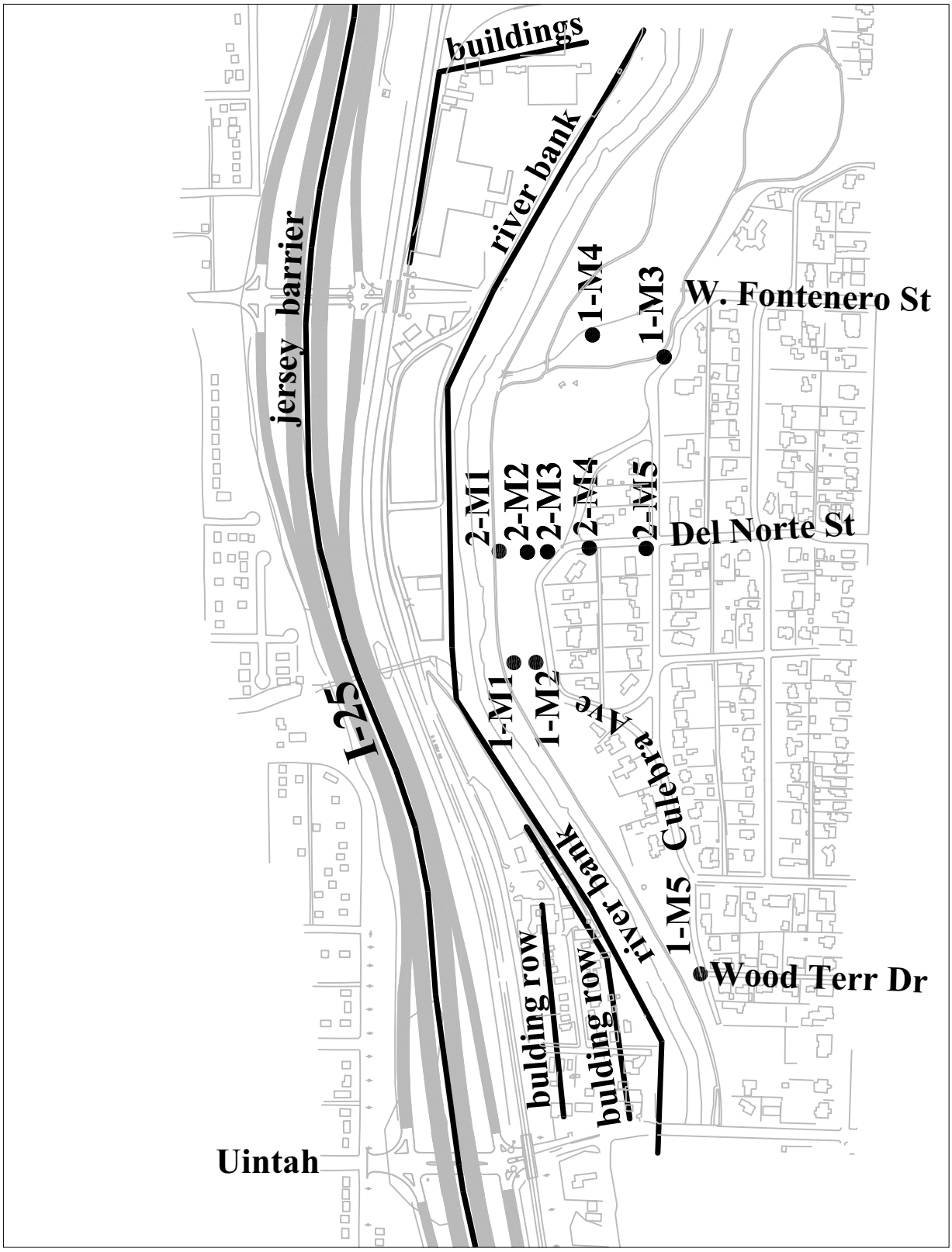

FIGURE A6: OLD NORTH END (1 & 2) NOISE MEASUREMENT LOCATIONS

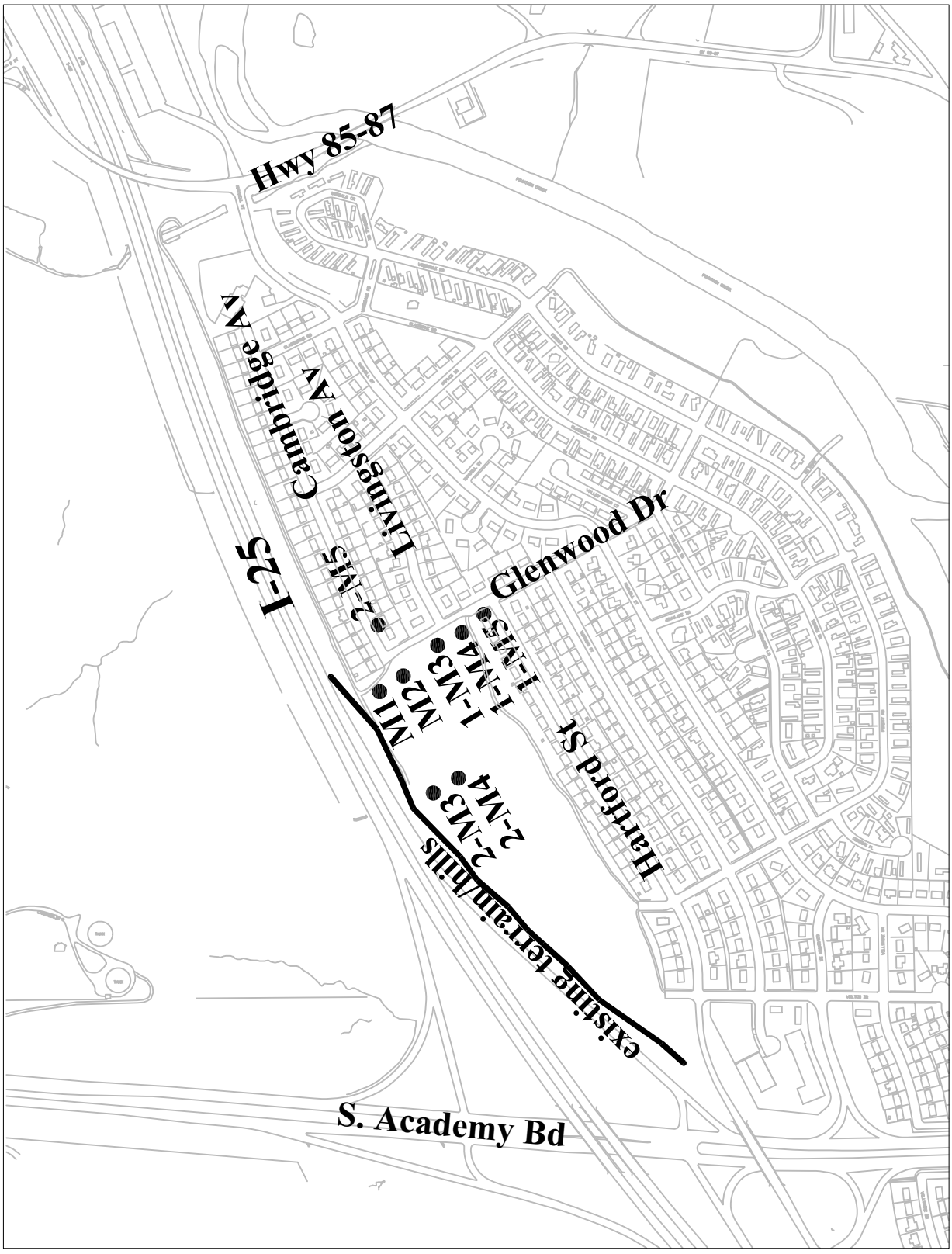

FIGURE A7: STRATMOOR VALLEY (1 &2) NOISE MEASUREMENT LOCATIONS

ATTACHMENT F – I25 EA NOISE TECHNICAL REPORT

Letter From City of Colorado Springs

PARKS, RECREATION & CULTURAL SERVICES

CITY OF COLORADO SPRINGS

January 7, 2002

Doug Eberhart
Senior Transportation Planner
Wilson and Company
455 E. Pikes Peak Avenue, Suite 200
Colorado Springs, CO 80903

Dear Doug,

Thank you for the opportunity over the past several months to review and provide comment on the proposed noise mitigation measures for Monument Valley Park. As you are aware, we took your findings through a two-step process; an internal review by Parks, Recreation and Cultural Services staff members and a public review by the Parks and Recreation Advisory Board. We are pleased that there was close consensus between both staff and our citizen advisory board on the key issues. The Parks Board, as reflected in their formal vote on December 12, 2002, wishes to reserve the option to amend their recommendations once the draft Environmental Assessment is available for review. I believe their concerns revolve primarily around any significant findings that may come out of the historic resources inventory that was conducted on Monument Valley Park.

Attached for your file are the following documents:

- Copy of the November 14, 2002 Parks Board agenda packet
- Copy of the November 14, 2002 Parks Board meeting minutes
- Copy of the December 12, 2002 Parks Board agenda packet
- Copy of the December 12, 2002 Parks Board meeting minutes

For space reasons, we have included only those portions of the agenda and minutes that pertain to this issue.

In terms of official positions of staff and the Parks Board, the minutes of the December 12th meeting contain a copy of the staff recommendation and the official Parks Board motion. I trust those two items will meet your needs for the documentation you need to prepare.

If you have any additional questions or the need for additional information, please do not hesitate to call me (385-6501).

Sincerely,

Paul D. Butcher

Paul D. Butcher
Director
Parks, Recreation and Cultural Services

Attachments

1401 Recreation Way • TEL 719-385-5940 FAX 719-578-6934
Colorado Springs, Colorado 80905-1075

CITY OF COLORADO SPRINGS

AGENDA

Parks and Recreation Advisory Board
December 12, 2002 7:30 a.m.
1401 Recreation Way

CITIZEN DISCUSSION

Time for any individual to bring before the Parks and Recreation Advisory Board any matter of interest they wish to discuss that is not on the agenda.

APPROVAL OF MINUTES

Minutes from November 14, 2002 meeting

PRESENTATION

1. Service Awards	
- Mike (Dennis) Guerin (15 Years)	Tim Pluemer, Skilled Maintenance Supervisor
- Mike Stone (15)	Tim Pluemer, Skilled Maintenance Supervisor
- Andrew Morris (5)	Gene Smith, Visitor Services Supervisor
2. Cemetery Year-End Report	Will DeBoer, Manager, Cemetery
3. Golf Year-End Report	Dal Lockwood, Manager, Golf
4. Beidleman Environmental Center Transition Update	Matt Mayberry, Manager, Cultural Services
5. Design and Development Construction Update	Fred Mais, Manager, Design and Development

CONTINUING BUSINESS

6. Update on County Courthouse Expansion	Steve Tuck, Senior Planner, City Planning
7. Air Force Memorial	Fred Mais, Manager, Design and Development
8. Noise Wall Options Along I-25 and Monument Valley Park	Paul Butcher, Director, PR&CS
9. Garden of the Gods Restoration Report Update	Kurt Schroeder, Manager, Parks Maintenance, Trails and Open Space

NEW BUSINESS

10. Easement Request at Pike Park	Terry Putman, Manager, Park Planning and TCPS

*****Break: 9:30 a.m. - Holiday Reception*****

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COLORADO SPRINGS PARKS AND RECREATION DEPARTMENT

PARKS AND RECREATION ADVISORY BOARD

Date: December 12, 2002

Item Number: Continuing Business - Item #8

Item Name: Noise Wall Options Along I-25 and Monument Valley Park

BACKGROUND:

The Colorado Department of Transportation (CDOT), as part of its federal review process for the proposed expansion of I-25, must conduct noise studies and analysis along properties adjacent to the interstate. In the late 1990's, a study of highway noise on Monument Valley Park concluded that the large picnic pavilion located in South Monument Valley Park (west of the swimming pool) was eligible for noise mitigation. After reviewing numerous options, it was determined that a pre-cast sound wall, located on the park's westside property boundary, was the most acceptable solution. The barrier was constructed and anecdotal comments from park users have been that the barrier has accomplished its intended purpose.

On November 14, 2002, CDOT and their consultants presented the Parks Board with noise mitigation options for various segments of Monument Valley Park. Parks Department staff and a representative from Colorado Springs Utilities provided the Board with comments on each of the proposed options.

CURRENT STATUS:

CDOT is requesting a formal position from the Parks Department and the Parks Board that can be incorporated into their final report on noise issues as relates to Monument Valley Park. At the November 14th meeting Ms. Chesley Miller with the Friends of Monument Valley Park indicated that her group is studying the options but have no formal recommendations at this time. They are in contact with a physics professor from the University of Colorado who is helping them with the sound issues. Colorado Springs Utilities is strongly opposed to the closing of Recreation Way, but has no position of the other issues.

STAFF RECOMMENDATION:

Staff has prepared (see attached) its final recommendations on the options presented by CDOT and its consultants. Staff would point out that CDOT is still finalizing its Historic Resource Survey for Monument Valley Park and that may have some impacts on the proposed noise mitigation measures. Pending the outcome of that report, staff has reserved the right with CDOT to revise its recommendations based on additional findings.

ACTION NEEDED BY THE BOARD:

Motion to accept, reject, or otherwise modify the recommendations of the Parks and Recreation staff as they relate to noise mitigation measures proposed for Monument Valley Park.

PARTIES NOTIFIED OF THIS MEETING:

Friends of Monument Valley Park
Lee Cook, Colorado Springs Utilities
Steve Watt, Wilson and Company

Parks, Recreation and Cultural Services
Colorado Springs Utilities
Final Recommendations
I-25 and Monument Valley Park
- Proposed Noise Mitigation Measures -

NOTE: These recommendations pertaining only to the draft Noise Mitigation Plan for the above project may not represent the entirety of the City's official position.

Recommendations: (heading South to North along the park)

Area "A" Sound Barrier

Proposed Design: An earth berm from 5' to 25' high.
Location: In CDOT right-of-way between I-25 and railroad.
Area of the Park Receiving Benefit: Southern part of the ballfield and the trails and gardens south of the ballfield.
Position of Park Staff: No objection to earth berm, but at this time the City has no funds for landscape maintenance.

Area "B" Visual Barrier

Proposed Design: Additional trees planted between existing large cottonwood trees.
Location: In the park, along the west property line, just south of the existing sound barrier.
Area of the Park Receiving Benefit: This is a visual barrier only (in-fill with lower growing trees blocking the view of highway), no sound benefit.
Position of Park Staff: No objections.

Area "C" Sound Barrier

Proposed Design: (Wall Options)
Option C.1: 10' high x 300' long sound barrier (east side of Glen Avenue).
Option C.2: 20' high x 470' long sound barrier (west side of Glen Avenue).
Option C.3: 20' high x 625' long sound barrier (east edge of CDOT ROW).
Location: Option C.1: Between Demonstration Garden and Glen Avenue.
Option C.2: Between Glen Avenue and the railroad ROW.
Option C.3: Between the fence line between the railroad corridor and the highway.
Area of the Park Receiving Benefit: Demonstration Garden.
Position of Park Staff: Eliminate Option C.1 as it poses park-user safety concerns. Option C.3 is preferable, Option C.2 is a consideration.
Comments by Wilson & Co.: C.2 will take away the illegal parking that is currently occuring in the railroad right-of-way. CDOT is not sure if wall can be squeezed in but it is an option under study.

Area "D" Sound Barrier

Proposed Design: (Wall Options)
Option D.1: 20' high x 1,060' long sound barrier.
Option D.2: 20' high x 1,080' long sound barrier.

Location: Option D.1: Two segments (in "gore area" and east edge of CDOT ROW between the railroad and the highway).
Option D.2: Between Glen Avenue and the railroad.

Area of the Park Receiving Benefit: This will protect the ponds area and trail south of Uintah Street.

Position of Park Staff: Either option is acceptable but there is some concern that D.2 is closer to the park and may have a "crowding" effect to Glen Avenue and the ponds.

Area "E" Sound Barrier

Proposed Design: 21' high x 750'long sound barrier.

Location: Between Recreation Way and the railroad.

Area of the Park Receiving Benefit: This wall was proposed for the San Miguel residential neighborhood and perhaps may also benefit the park.

Position of Park Staff: Check on Colorado College's plan for acquisition. Stop noise wall (north edge) short of Parks and Recreation building.

Area "F" Sound Barrier

Proposed Design: An earth berm 15' high x approximately 1,500' long.

Location: Replaces portion of Recreation Way between Parks and Recreation Headquarters and Fleet Parking Lot.

Area of the Park Receiving Benefit: Approximately 50' of trail (west side of the creek).

Position of Park Staff: Major concern with closing of Recreation Way and loss of parking lots, maintenance yards and Forestry Operation Center No direct access for vehicles to fuel yards without going on and off I-25.
Traffic and City Engineering/Fire would probably object to this long cul-de-sac.
Proposed that CDOT build a short pedestrian bridge to span Mesa Creek drainage and move trail out of the noise contour area. City to plant screening trees on west side of Recreation Way to provide visual barrier similar to that which exists opposite Headquarters Building.

(COMMENTS FROM LEE LOCK - C.S. UTILITIES)

I – 25 Sound Mitigation Proposals
For Monument Valley Park

- Area F Sound Barrier (Replacing Recreation Way)
  - This proposal presents unacceptable consequences for the City and CSU operations out of the Fontanero Complex north of the proposed berm
    - Operations affected:
      - Street Department
      - Fleet Department
      - Facilities
      - Machine Weld
      - Radio Communications
      - CSU Field Operations
  - Eliminates one access to and from downtown (Recreation Way)
    - In cases where I-25 is closed for weather, accidents, or backed up during rush-hour, response times to support downtown facilities would be greatly increased
      - Vehicles would have to go North to Filmore, East to, at least Cascade and then South to support downtown
      - Would put more truck traffic through the North End Neighborhood
    - Recreation Way has always been open when I-25 has been closed
    - Costs of operations would be greatly increased due to longer distances to drive resulting in higher mileage and manhour costs
    - The estimated average vehicle count in and out of the Fontanero complex each week day is approximately 2,000 vehicles per day
      - Not all use Recreation Way, but a significant number do
    - These consequences relate to vehicle operations either coming into or going out of the Fontanero complex
- The sound barrier closing Recreation Way would also affect Parks & Recreation operations by imposing greater driving distances on vehicles needing access to the north.

~~Mr. Case reiterated what he said earlier and said that his is concerned about the precedent that the Board may set on the Department's ability to get parks in the future. He said that the Department is purchasing open space and parks all the time and that is not an easy task as it is but to try to add additional component might be difficult for the staff. Mr. Case said that the letter needs to be clarified that the view ordinance should apply only to this particular site and that the Board is not suggesting that this ordinance go beyond that.~~

~~**The Board voted and the motion carried unanimously.**~~

~~*NOTE: Due to several people waiting for the Item #8 and conflicts of meeting with staff, citizens, and Board members, Item #8 was moved as the next item.*~~

Noise Wall Options Along I-25 and Monument Valley Park (Item #8)

Paul Butcher, Director of Parks, Recreation and Cultural Services, said that this item was presented to the Board as an information item at the November Board meeting. At that time, CDOT's consultant (Wilson and Company) presented various options on noise mitigation measures within Monument Valley Park and staff provided input as well. Included in the Board packet are the minutes from the last Board meeting and the noise mitigation options that are described in detail and the final recommendation from the Parks Department and Colorado Springs Utilities (CSU).

Referring to the Sound Barrier "F", Mr. Butcher said that both the Parks Department and CSU had a considerable concern with closing down and cul-de-sacing Recreation Way and putting approximately 1,500 linear foot of berm in its place. Both departments share Recreation Way to get to their facilities and closing that road would cut off access to their facilities and to north and south roadways, which are vital to operations. The north and south roadways are two access point from Recreation Way to major thoroughfares.

In discussions with Wilson and Company an idea was proposed to protect a trail segment that crosses Mesa Springs Creek. This falls within the 66 decibel contour line. The Department's proposal is to work cooperatively with CDOT and have a pedestrian bridge that would cross that creek farther to the east to take the trail outside of the noise contour line. The Department has started a tree planting program on Recreation Way with evergreen trees that would mirror what we have out in this area and try to build a linear forest to provide a visual barrier. This does not necessarily attenuate the sound as a wall would but it would provide a visual barrier.

Mr. Butcher said approximately 90% of the recommendations or the concerns and comments that the Board has heard at the last meeting are still in valid agreement. The only major change is the agreement that perhaps the best way to handle the trail system at the north end of the project is to build a bridge over the creek and commit over a period of years to planting evergreen trees to provide the visual barrier.

Mr. Butcher said the representatives from CDOT and Wilson and Company are present at the meeting to answer any questions.

Larry Royal asked if the six recommendations are for six different locations. Mr. Butcher said yes.

Steve Harris said that he had a question concerning the process and asked if the recommendation that the Board makes today would be incorporated into the draft of the Environmental Assessment.

Doug Eberhart with Wilson and Company said that in the environmental process, they look at all the different environmental factors with noise being one of them. There are criteria for identifying when there is enough of an impact to consider mitigation, which brought them to this point to look at different mitigation options. In the EA, the various options that were evaluated and considered in different locations will be discussed and that the land owners or those whose properties are effected, such as the Parks Department, have a key say in whether or not something that is reasonable and feasible. There are many cases where mitigation is found to be justifiable, warranted, cost effective, etc. but if the adjacent landowner does not want that in there then it will not happen. For that reason, CDOT/Wilson and Company need to know the Board's position.

Mr. Harris asked that after the Board's recommendation, then there will be EA prepared and then that would still be subject to public comments later if other people want to comment on that?

Mr. Eberhart said yes, and there will be a final public hearing at the end of the process and that is a formal public hearing. In addition, there will be informational public meetings planned for late January/early February and it will be presented at that time.

Mr. Eberhart said that as a point of clarification on the pedestrian bridge that Mr. Butcher mentioned earlier, they have been looking at that since that time to see what it might be and what it might do. In general, compared to designing and constructing something that would actually reduce the noise, that would only be done if they can achieve certain amount of reduction. Looking at this proposal, which they have very carefully, they find that the amount of reduction that can actually get from moving the trail would be less than they usually are able to achieve, therefore, they actually have not reached an agreement that this is something that they could in fact be funded through the Federal Highways process but something that they would be in generally in support of. It needs further exploration but they have not reached an agreement that in fact it is something that Federal Highways would be able to fund.

Mr. Royal asked if they could move the bridge further east and pay for it?

Mr. Eberhart said that at the last meeting, that concept was mentioned instead of a berm on Recreation Way. They have been up to the site and had an engineer to look at it and see what the cost and the benefit would be. They have found one minor benefit but perhaps not commensurate with the cost. They have been exploring it and had not closed the loop on that issue and they have agreed to go look at it which they did but it looks like something that they may not in fact do for noise mitigation. It was an option that was explored.

Randy Case asked to clarify what the Board needs to do today and said there are six different options and he is not fond of the walls because he would like to see the other side but does not like the noise.

Mr. Butcher said that this item comes to the Parks Board as one of the parties of interest since the Board has the advisory role on the park issues. The action needed by the Board is a motion to accept, reject, or otherwise modify the recommendations of the Parks and Recreation staff, which is included in the Board packet, as they relate to noise mitigation measures proposed for the Monument Valley Park.

As a part of the EA process, staff will forward a letter and the Board, as an advisory committee and same as any other parties of interest, will have an opportunity to comment in the EA on this issue.

Mr. Case asked if the City has funds to maintain the berms and asked if there are funds from the State or Federal government for that?

Mr. Eberhart said that those are equally in short supply.

Mr. Case asked when berming is done in other locations if there is another way of dealing with it.

Mr. Eberhart said that they are typically designed at a slope such as they can be maintained by a simple mowing once or twice a year.

Mr. Butcher said that it is a current level of maintenance on I-25, which is mowing twice a year by the State.

Betty Nuhn said that her concern is on the Area "F". She said that the park does not seem to be affected much but the trail path is and wanted to know where on the map is the trail that Mr. Butcher mentioned that will be relocated over to the east. She also asked how important the noise mitigation is on that trail and to the neighborhood.

Mr. Butcher said a concern that was raised at the last Board meeting was that there are a number of trails that run adjacent to the roadways (i.e. State highways, Academy Boulevard, Powers Boulevard, I-25, etc.). The Department was not concerned, particularly for the fact that the area that falls within the noise contour is a very short section (± 50 feet). The Board said that if the staff was comfortable with it then the Board was okay with it. Mr. Butcher said that the Department will gladly trade 50 feet of trail with noise exceedance over 1500 feet of berming that would cut off all access to the Department and CSU facilities. Staff felt that option might solve both issues; build a bridge that moves the trail over and out of the noise contour and plant trees off the road way outside the noise area and provide a visual barrier. This was laid out to CDOT and Wilson and Company at the last minute so staff has not had a chance to discuss what Mr. Eberhart said earlier. Staff felt that the cost benefit of the 50 feet of trail versus the 1500 feet of berming, which the Department would have to maintain and have all the access cut off, was unacceptable.

Lynn Londry asked if the Area "F" was the only rejection from the Department.

Mr. Butcher said that the Department also had a major concern with the Area "C" Option 1, which took the noise barrier right around the Demonstration Garden. The Department rejected that option because it poses safety concern for park users.

Mr. Londry asked if staff accepts the Areas "A" through "E", with the exception of a couple of concerns in the Area "C". Mr. Butcher said yes, but this is a part of the process that will still continue and that staff does not have to select any particular option at this time

Mr. Londry asked if the Board would have the opportunity to hear further discussions on this subject even if the Board makes a decision today. Mr. Butcher said that Mr. Eberhart mentioned that there will be another process with the Environmental Assessment. After that, this process will be similar to the sound barrier that was put in near the pavilion at the Monument Valley Park where the Board saw the design phase, colors, wall design, etc. Mr. Butcher explained again the actions that the Board could take on the staff recommendation (i.e. accept, reject or modify).

Mr. Royal asked who might be affected on the 50 feet trail other than the walker and runners. Mr. Butcher said that from the noise contour line, trail users who are on the 50 feet of trail are exposed to greater than 66 decibels.

Mr. Eberhart made a comment that the relocation of the trail with a pedestrian bridge is something that could be accomplished under other programs such as the enhancement funding so if it is not done here for the noise mitigation it does not mean that it is something that could not happen and that CDOT would participate in supporting that sort of project.

Mr. Butcher said that is appropriate because the Department did not say that they had to pay for it. The Department found a bridge, any type of bridge and movement on the trail, much more acceptable than the 1500 foot earth berm, maintenance, and the closure of the road.

Chair Rooks Nauer asked for public input.

Allison Jones with the Horticultural Arts Society (HAS) said that they maintain the Demonstration Garden in the Monument Valley Park and they support the choice of the option C.3 for the sound barrier. They are glad that is being considered because they currently have difficulties carrying conversations with the people who are only ten feet away in that garden.

Ms. Jones said another concern was that when the infrastructure work was done along the railroad right-of-way, there was a fence that separated the tracks from the Glen Avenue. The fence has now been down for eighteen to twenty month, since the work has been completed. Ms. Jones asked if CDOT would consider working with the railroad to replace the fence or perhaps replace it with a berm. She said that top of a berm would alleviate the noise and that would be an abatement issue.

Ms. Jones reiterated that HAS endorses option C.3 and would like the fence replaced as a safety issue.

Ralph Spory said that he lives adjacent to the park and he is a park user.

Mr. Spory said that in regards to the 67 decibel contour line that interferes with the 50 feet of the trail described earlier, he said that although the 67 decibel contour touches a small portion of the park the noise level is still loud and intolerable throughout the remainder of the park. It is 67decibels on that contour line but the noise decreases gradually, from 66, 65, and so on to probably 55 decibels, to the east side of the park and anyone that uses the park can say that the park is noisy. It may not be at 67 decibels but it is close that.

Mr. Spory mentioned that he is speaking from the notes that he prepared from what he knew about this issue earlier and it is based on what he thought the proposal was at that time so he may be off a little.

Mr. Spory said that neither the City nor the Parks Department should have an obligation to give up any real estate to mitigate the noise from the freeway. He said that Mr. Butcher has stated in the past that he saw no requirements for the park to give up land to mitigate noise coming from the freeway.

Mr. Spory said that looking at the history, if a proper environmental analysis have been performed prior to the construction and realignment of I-25 that is there now for safety improvements, they would have identified the need for noise mitigation and provided for effective solution at that time. However, that was not done because CDOT used the "Categorical Exclusion" provisions of the Federal regulations and as a part of that process both CDOT and Wilson and Company stated that there was no impact to Monument Valley Park by the improvements to the freeway.

CDOT now has determined that there is a small impact because of their 67 decibel contour line adjacent to the park and proposes some mitigation in the form of walls and berms. However, they claim that there is not sufficient space to construct the walls or berm on CDOT property because of the slope. Mr. Spory said that there are other options besides what they are proposing in the form of walls adjacent and closer to the freeway.

The area on the west side of the freeway south of Fontanero the wall is no more than one lane from the freeway for several hundred yards. He said that it was stated at a meeting that CDOT could not put a wall on the east side of the freeway because of snow removal problem but they have constructed a wall down south at Harrison School. CDOT put a noise wall on the east side of the freeway for noise protection and they were not concerned about snow removal for the slope of the terrain and they were able to do it.

Mr. Spory made a comment that he could not believe that with proper engineering that CDOT cannot find noise solutions adjacent to the freeway and insists that it has to be on the east of the railroad or on park property or city property.

Another issue that Mr. Spory mentioned was the effectiveness of the noise wall that is near the pavilion that is constructed on the east side of the railroad and not adjacent to the freeway. Mr.

Spory said that he attended a numerous events that were held in the pavilion where they used microphones but the audiences still could not hear the speakers even with the noise walls.

Mr. Spory said that he would like to see other options looked at to mitigate the noise in the park. CDOT is only obligated to look at 67 decibels but he thinks that morally they have an issue to look at noise levels less than 67 decibels that affect the rest of the park and with proper engineering, they can find solutions adjacent to the freeway as they did on the west side, which are very effective.

Mr. Spory asked that the Board not approve what is being requested by the CDOT and Wilson and Company but to have them look at other options that do not use city or park land to provide mitigation.

Chesley Miller said that she is with the Friends of Monument Valley Park and is on its Administrative Team. The Friends of Monument Valley Park has been looking at this issue for some time now and they are pleased to see that CDOT has come up with some recommendations for mitigation.

Ms. Miller said that Judith Rice-Jones delivered a letter to the Board this morning with a recommendation that the Board should wait and hold its assessment and opinions until the EA is out in January 2003 to see what recommendations there are according to them concerning the mitigation.

Ms. Miller reminded the Board that it was said at the last Board meeting that the standards would be higher for mitigation if the park is on the National Historic Register. She said that the Friends group has been informed, though it is not official yet and it will come with the EA, that this park will be qualified to be on the National Historic Register. In the meantime, the Friends group is pursuing and doing whatever research they need to do at this time to establish that status.

Ms. Miller said that Wilson and Company said that they do not believe that there is any point in mitigating certain parts of the park because it is not going to do much good. She said that the Friends group is a small group compared to Wilson and Company who has many more resources but the Friends group has had help from Dr. Richard Blade, a physics professor from the University of Colorado, who has done far-field noise calculations. The group feels that Dr. Blade's studies are most appropriate and that his findings are different from the CDOT's findings. Dr. Blade said that the mitigation will achieve reduction much farther back into the park than the noise mitigation according to what CDOT will do. Also, if the park has a National Historic Register status, it is not talking about just a trail but the entire park.

Ms. Miller said she goes to rivers or parks on rivers whenever she is in a new town and people who come to this town will seek a walk in a park. This community has a great asset with a park and a river in the middle of the town and she would like to see this park in a different category than from any other parks because it is a centerpiece in the heart of Colorado Springs. This park started to take a shape in 1904 with a donation of land by General Palmer and this is very special, it is the gateway, it is the showcase and it is the heart of the city that needs more attention. The Board should take a special note of this and give a special attention to the status that this park should have in this community.

Also, the Friends group has a different perspective than CDOT concerning the park. Governor Owens has dedicated significant resources towards transportation and CDOT has done a great job with the highways but they did not plan for the park with regards to the noise. Ms. Miller had the opportunity to speak with Governor Owens concerning the impact of I-25 on Monument Valley Park and he said that he was aware that there was very little buffer between the interstate and the park. He believed that it should be a joint city, state and county effort to buffer the park from the interstate. Ms. Miller believes that most mitigation should come from CDOT because they are the ones who put the highway right through the middle of the city. The interstate was built in 1960 when the population was fewer than 60,000 but now there are approximately 500,000 people and there has been nothing done to protect the heart and center of the city and park to this time and the situation is deteriorated.

Ms. Miller said that as a friend of the Monument Valley Park and as a user of the park, she asks that the Board give a full consideration to the absolute highest and best mitigation between the interstate and the park and do everything possible to make the heart of Colorado Springs the most beautiful and most protected place in the park system. She also recommended that the Board consider not making a recommendation today and wait until the EA is in and hear the ultimate status of the National Historic Register eligibility for the Monument Valley Park.

In response to Larry Royal's question, Ms. Miller said that as a part of the EA, they did studies on different aspects of expansion of the interstate. A part of that study revealed by historians is that this park is eligible for Historic Register status. She said that some features go back to General Palmer's time and some features are WPA which is 1950's.

Mr. Royal rephrased his question and asked what affect does the application for the historical recognition have to do with what the Board is going to do today or the EA.

Ms. Miller said that it would be the different standards, higher standards, for mitigation for the park if it is on the Historic Register.

Cindy Cohen said that she is a citizen who has been using the park almost on a daily basis for the past thirteen years, mostly for running and walking. Her children use the park as well.

Over the last several years, since the highway has been expanded and changed, the noise has increased significantly so that Ms. Cohen cannot walk and run without headphones because of the distracting noise and she cannot relax. Ms. Cohen said that it is important that something needs to be done about the noise in the park.

Daisy Chun Rhodes asked if in the EA there be a recommendation for Monument Valley Park to go on the Historic Register? Would a determination be based on the national level? And then once it is on the historic registry, the significance in terms of decibel levels that would make a difference here between our recommendation and what might transpire because of the EA for which seems to be directed towards the historical registration?

Wynetta Massey, Senior Attorney, said she does not know. Ms. Massey is not sure if the EA is done and then the historic designation comes after that, if the EA has to be done over again or it has to be amended.

Mr. Eberhart said that he mentioned earlier that a number of resources will be looked at and how proposed actions would affect to them. One of those is noise and adjacent land use regardless of what that use is. If it is subdivision, noise mitigation may be needed there. If it is the pavilion in the park, studies were done years ago and working with the Parks Board it was determined that was the resource that needed to be protected. The noise studies were done, Categorical Exclusion was pursued and noise mitigation was provided as a result of that. Another resource looked at included historical properties. What is the impact of this action on historical property?

In response to Mr. Royal's question, the process of designating the park as on the Historic Register really has nothing to do with the EA process. That process happens whenever it happens. Generally for most things they are not considered until they are closer to 50 years old, then the State will look at the unique aspects of that resource to determine if it is worthy of being on that list depending on the condition and other things.

Ms. Chun Rhodes asked if there was a difference between the Federal historical and the local noise levels where the decibels are actually counted and determined in terms of its stand from east to west and west to east? Being on Historic Register would either make it possible for a determination as a Board or any recommendation for noise mitigation. She wanted to know what the potential would be if the Board makes a mistake.

Mr. Eberhart said the mitigation proposed is for the purpose of protecting those portions that would be subjected to noise levels about the threshold. It does not change the way that you measure the noise of the threshold. What you look to there is whether or not you are actually making that property unusable for its original intended purpose.

Chair Rooks Nauer asked if there are not two different kinds of standards; one for the historical property and one for the non-historical. Mr. Eberhart said no.

Paula Pearl asked what the advantage was for the Board to wait on the EA for this proposal.

Mr. Eberhart said what the EA will do is to describe the existing environment (what is out there), what is proposed as action, what the expected impacts would be and what is proposed mitigation for those impacts. The decisions along this nature need to be in the EA for the EA to make any conclusions about what the bottom line overall impacts would be. He actively needs to be able to propose mitigation in order to write the EA so you cannot wait for an EA, it would say no decision has been made on what to do about this so it would not be helpful.

Terry Putman, Manager of Park Planning and TOPS, said that there would not be a historical designation by January.

Mr. Eberhart said that was correct. He said that as a part of that process you look to see if there is anything that can be in the future would qualify it and that they are the ones who went through the process to determine that this is an eligible property and be very careful with it.

Steve Harris said that he is not in a very good position to evaluate the different recommendations because he is not an expert in this matter. Also, he does not feel that the Board has been provided with sufficient information to understand what the best alternative is but for that purpose the Board relies on staff and he is comfortable with the staff as they do a good job in evaluating these things.

Mr. Harris said that he would like to include the following in the motion:

1. Include a statement that would reflect "the mitigation to the fullest extent possible." Monument Valley Park is the linear park that is the heart of the city and the Board, as stewards of all parks, has to make it very clear to any decision makers who are looking at these options along the way that the Board want the fullest mitigation that is possible.

2. Even though Mr. Harris agrees that the Board needs to make a recommendation in order for the EA process to go forward and that has to be considered, he would like to see a statement in the motion that states that "to qualify these recommendations that once the EA is out and there is another public comment period that the Board reserves the right to change its opinions after the Board sees what other information there may be included in the EA." The Board/Parks Department, certainly as a group and a concerned stakeholder in this process, needs to have the ability to comment during that public process that would occur after the issuance of the draft EA. Mr. Harris wanted to make it clear that the recommendation of the Board could change after the Board receives more information when the draft document is available.

3. If there will be a process and whatever process there is for registering this site as an historic site, one of the things that Mr. Eberhart mentioned is that one of the consideration would be the condition of the resource. So to the extent that there is increased mitigation that could actually impair the city's ability to list something on the historic register and even though there may not be a difference in the decibel levels or subjective standards that apply, this is a historic site and it dates back more than 50 years and it is a legacy of our founder General Palmer that Mr. Harris urges to keep an eye on this to the extent that we do not preclude the listing of this site as a historic site because of some impacts that later on would deem to prevent that listing.

Randy Case asked if the Confluence Park would be dealt in the same manner.

Mr. Eberhart said that his understanding of Confluence Park is that there is a desire to not have a visual obstruction there. The noise level has been looked at and at the current time there is no mitigation for the noise in the Confluence Park area.

Mr. Case asked if there is going to be mitigation on the highway right-of-way itself.

Mr. Eberhart said to his knowledge, no, and he does not have mitigation proposed for the Confluence Park area.

Mr. Case asked if Gossage Park, up north as the highway continues to be expanded beyond Fillmore, is impacted by highway noise.

Mr. Butcher said when CDOT gets to that point, the Department will look at it.

Mr. Case said that in the proposal in Area C, the height of the walls are identified as 10 feet and 20 feet and asked if the 20 foot wall is going to reduce more sound than the 10 foot wall.

Mr. Eberhart said that depends on the topography and where you are. Generally speaking, the higher wall will block the sound because it does bend over. What that barrier does is protecting the first use beyond it and that provides the maximum benefit. In the case where 20 feet is recommended is because it would be necessary to be that high in order to get a five decibel reduction behind it for the first affected use.

Mr. Case asked what the CDOT is doing in terms of the road surface and asked if they have discussed putting a rubber-based material in the surface of the road to reduce the noise.

Mr. Eberhart said that every aspect of the entire project is a trade off of a number of different things and when it comes to the road surface itself that has a very big impact into that decision as the durability of the surface. The pavement of the surface is based on the life cycle, cost and durability and the noise issue is a minor issue and it is not the primary determining factor in what pavements there would be. CDOT has spent significant time and money looking at the surfacing techniques and different surfaces and he expects to see a concrete surface on I-25.

Mr. Royal said the Sound Barrier "A" (berm) is from 5 feet to 25 feet high and it does not explain how long it is or what dimension.

Mr. Eberhart said it is at the south end of the entire situation, on Bijou Street. Tim Rugg explained that it is the triangular-shaped area in the south part of the map.

Mr. Royal asked how far from the CDOT right-of-way is the base or the eastern edge of the earth berm, the land CDOT is taking from the Park.

Mr. Rugg said the earth berm on Area "A" will be within the CDOT property.

Mr. Royal asked the cost of the earth versus concrete. Mr. Eberhart said that depends on what is being done and it is not a straight equation.

Mr. Royal asked what impact there is on the Areas "B". Mr. Eberhart explained the impacts on the map but the impact is mainly just behind the wall. There is less impact further away from the wall.

In response to Mr. Royal's question concerning the Area "E", Mr. Eberhart said that area is for the neighborhood and not the park.

In response Mr. Harris' question concerning a possible reduction of the speed limit and its impact, Mr. Eberhart said the speed reduction does reduce the noise level but the intended speed limit will remain at the current level of 55 miles per hour. Also, there had been some work done to eliminate some curves and safety-related issues.

Mr. Case is not in favor of the walls since they block the views and prefers to see the greenry and asked if CDOT has consider different alternatives such as the transparent-type walls.

Mr. Eberhart said the wall design that they have in town have been based upon interactive collaborative approach with the community looking at different types of designs, etc. That portion of the work remains to be done to the side exactly as to what these walls would look like.

Chair Rooks Nauer said they looked at berming and tree boundaries but to get the same amount of noise mitigation, there would have to be 200 feet of densely planted trees and but they would have to take a lot of the space from the park. Ms. Rooks Nauer also mentioned that there had been community input at that time that people literally could not hear themselves talk at the pavilion before the walls were built. Even though Ms. Rooks Nauer does not favor the walls but she feels that the walls are a part of the future just because of the mitigation.

Mr. Case said that he is not sure if he will advocate for berming completely and he is concern about the wall, thought that alternative seems to satisfy the neighborhood. He asked if the Parks Department could encourage advising the Board if there is some type of a transparent wall.

Ms. Ryan mentioned a possibility of having the artists' community help with the designing of the walls. Ms. Nuhn agreed.

Mr. Harris said that there should be a barrier between the Railroad property and the Park property.

Mr. Harris thanked the Friends of Monument Valley Park and especially Chesley Miller who represented the Friends group. Mr. Harris encouraged that the Friends group, which plays a large role in advocacy for the park, to submit comments on their own as a non-profit organization and stay with the process until the EA is completely done.

Randy Case made a motion to accept the staff's recommendation as follows:

Area "A" - Accept

Area "B" - Accept

Area "C" - Accept, but clarifying that C has option C.3 identified at two differen locations and believes they are intended for both C.3s to be dealt with

Area "D" - Suggested to state, with emphasis, that the Board has much concern about "crowding" of the park on "D.2" but object to "D.2" being acceptable at all.

Area "E" - This is not a park issue.

Area "F" - Proposed that the Board does not advocate in anyway and harshly object to the closing of the Recreation Way.

The motion should also include the three issues that Mr. Harris mentioned earlier:

1. **Mitigation of the fullest extent possible.**
2. **At public comment, Parks Board reserves right to change its input on the EA.**
3. **If the mitigation measures adversely impact the park's listing of the historic registry then that be brought back.**

Motion seconded by Larry Royal and carried unanimously.

For the purpose of the record, the final recommendations by the Parks Department and CSU, concerning the proposed noise mitigation measures at I-25 and Monument Valley Park, has been attached below.

Parks, Recreation and Cultural Services
Colorado Springs Utilities
Final Recommendations
I-25 and Monument Valley Park
- Proposed Noise Mitigation Measures -

NOTE: These recommendations pertaining only to the draft Noise Mitigation Plan for the above project may not represent the entirety of the City's official position.

Recommendations: (heading South to North along the park)

Area "A" Sound Barrier
Proposed Design: An earth berm from 5' to 25' high.
Location: In CDOT right-of-way between I-25 and railroad.
Area of the Park Receiving Benefit: Southern part of the ballfield and the trails and gardens south of the ballfield.
Position of Park Staff: No objection to earth berm, but at this time the City has no funds for landscape maintenance.

Area "B" Visual Barrier
Proposed Design: Additional trees planted between existing large cottonwood trees.
Location: In the park, along the west property line, just south of the existing sound barrier.
Area of the Park Receiving Benefit: This is a visual barrier only (in-fill with lower growing trees blocking the view of highway), no sound benefit.
Position of Park Staff: No objections.

Area "C" Sound Barrier
Proposed Design: (Wall Options)
Option C.1: 10' high x 300' long sound barrier (east side of Glen Avenue).
Option C.2: 20' high x 470' long sound barrier (west side of Glen Avenue).
Option C.3: 20' high x 625' long sound barrier (east edge of CDOT ROW).
Location: Option C.1: Between Demonstration Garden and Glen Avenue.
Option C.2: Between Glen Avenue and the railroad ROW.
Option C.3: Between the fence line between the railroad corridor and the highway.
Area of the Park Receiving Benefit: Demonstration Garden.
Position of Park Staff: Eliminate Option C.1 as it poses park-user safety concerns. Option C.3 is preferable, Option C.2 is a consideration.
Comments by Wilson & Co.: C.2 will take away the illegal parking that is currently occurring in the railroad right-of-way. CDOT is not sure if wall can be squeezed in but it is an option under study.

Area "D" Sound Barrier

Proposed Design: (Wall Options)
Option D.1: 20' high x 1,060' long sound barrier.
Option D.2: 20' high x 1,080' long sound barrier.

Location: Option D.1: Two segments (in "gore area" and east edge of CDOT ROW between the railroad and the highway).
Option D.2: Between Glen Avenue and the railroad.

Area of the Park Receiving Benefit: This will protect the ponds area and trail south of Uintah Street.

Position of Park Staff: Either option is acceptable but there is some concern that D.2 is closer to the park and may have a "crowding" effect to Glen Avenue and the ponds.

Area "E" Sound Barrier

Proposed Design: 21' high x 750'long sound barrier.

Location: Between Recreation Way and the railroad.

Area of the Park Receiving Benefit: This wall was proposed for the San Miguel residential neighborhood and perhaps may also benefit the park.

Position of Park Staff: Check on Colorado College's plan for acquisition. Stop noise wall (north edge) short of Parks and Recreation building.

Area "F" Sound Barrier

Proposed Design: An earth berm 15' high x approximately 1,500' long.

Location: Replaces portion of Recreation Way between Parks and Recreation Headquarters and Fleet Parking Lot.

Area of the Park Receiving Benefit: Approximately 50' of trail (west side of the creek).

Position of Park Staff: Major concern with closing of Recreation Way and loss of parking lots, maintenance yards and Forestry Operation Center.
No direct access for vehicles to fuel yards without going on and off I-25.
Traffic and City Engineering/Fire would probably object to this long cul-de-sac.
Proposed that CDOT build a short pedestrian bridge to span Mesa Creek drainage and move trail out of the noise contour area. City to plant screening trees on west side of Recreation Way to provide visual barrier similar to that which exists opposite Headquarters Building.

~~*Note: Daisy Chun Rhodes left the meeting at 11:28 a.m. due to a meeting conflict.*~~

~~Air Force Memorial (Item #.)~~
~~Fred Main, Manager of Design and Development, said that several months ago, the Board approved the master plan amendment for the Memorial Park to expand the existing War Memorial area to add a second "ring" to accommodate additional memorials. At that time, the Air Force Association expressed an interest in placing an Air Force memorial and said that they would actively pursue a concept plan to bring it forward to the Department for its review.~~

PARKS, RECREATION & CULTURAL SERVICES

CITY OF COLORADO SPRINGS

March 19, 2003

Doug Eberhart
Senior Transportation Planner
Wilson and Company
455 E. Pikes Peak Avenue, Suite 200
Colorado Springs, CO 80903

Dear Doug,

Attached please find a memo from myself to the Colorado Springs Parks and Recreation Advisory Board regarding noise issues in the proposed Confluence Park. This memo was in response to Board member requests for an update on I-25 noise contours along the corridor. As you can see from the attached document, I summarized the meeting between you, myself, Tim Rugg, Jim Rees and Fred Mais on February 27, 2003. The memo was included in the March 13, 2003 Parks and Recreation Advisory Board agenda packet as information to the Board. This is a common practice for issues where the Board wants additional information without requesting a full presentation. During the agenda section entitled "Board Member Concerns/Discussion", no request was made for further clarification of the matter.

Tim Rugg suggested I forward this item to your attention for your files.

Sincerely,

Paul D. Butcher
Director
Parks, Recreation and Cultural Services

1401 Recreation Way • TEL 719-385-5940 FAX 719-578-6934
Colorado Springs, Colorado 80905-1075

AGENDA

Parks and Recreation Advisory Board
March 13, 2003 7:30 a.m.
1401 Recreation Way

CITIZEN DISCUSSION

Time for any individual to bring before the Parks and Recreation Advisory Board any matter of interest they wish to discuss that is not on the agenda.

APPROVAL OF MINUTES

Minutes from February 13, 2003 meeting

PRESENTATION

1. Annual State of the Urban Forest Report — Jim McGannon, Manager, Forestry

CONTINUING BUSINESS

2. Prospect Lake Beach Update — J.J. Klikus, Manager, Youth and Recreation
3. Revisions to Park Planning Policies — Terry Putman, Manager, Park Planning and TOPS

NEW BUSINESS

4. United States Submarine Association Memorial — Fred Mais, Manager, Design and Development

TOPS BUSINESS

5. Appropriation for High Chaparral Open Space Trailhead — Chris Lieber, TOPS Administrator
6. Appropriation for Bluestem Prairie Open Space Trailhead — Chris Lieber, TOPS Administrator
7. Appropriation for La Foret Trail — Chris Lieber, TOPS Administrator

BOARD BUSINESS

- Board Committee Reports
- Board Members Concerns/Discussions

DIRECTOR'S REPORT

CITY OF COLORADO SPRINGS

MEMORANDUM

Date: March 4, 2003

To: Colorado Springs Parks and Recreation Advisory Board

From: Paul D. Butcher, Director, Parks, Recreation and Cultural Services

Subject: Issues Surrounding Confluence Park

At the February 13, 2003 Parks Board meeting, two issues were raised regarding the presentation on Confluence Park progress. As a result of the Board's interests in these two matters (interstate traffic noise and east/west trail access across I-25) a meeting was set with the I-25 consulting firm Wilson and Company. On February 27 City staff members (Paul Butcher, Jim Rees and Fred Mais) met with Wilson and Company staff to discuss these two items.

NOISE

Wilson and Company provided a noise contour map for the park, indicating the projected noise contour lines for full build-out and traffic volumes in the year 2025. The site map indicated a 71 dB(a) contour line and a 66 dB(a) contour line. The 66 dB(a) line protruded farthest into the park, probably reaching the area of the proposed fountain/sculpture feature. While discussing this issue, the following facts were laid out:

1. The interstate will probably be twenty feet above the general elevation of the park.
2. Because of the topography adjacent to the east side of I-25 (steep drop-off) any noise wall would have to be directly attached to the highway shoulder. For the most part, the highway will be cantilevered through this section.
3. In order to be effective, the noise wall would need to be fifteen to twenty feet high to provide the required 5 dB(a) noise reduction. The wall would also need to extend past the ends of the park to avoid the noise going around the wall.

In looking at these facts, and relying on one of the basic design tenets of this park (that it be visible from the interstate), staff rejected the notion to pursue further work on a potential noise barrier. City staff did ask if any design features for this section were available to might help deaden noise, particularly tire noise. One suggestion made by Wilson and Company was that the safety barriers (guard rails) could be designed to have no open space between the support posts. An additional thought was to use the traditional concrete jersey barrier as a sound-deadening feature. Wilson staff indicated that typically these safety barriers were approximately three feet high, which would allow for viewing into the park, but would provide only a 1dB(a) noise reduction.

City staff felt that the views into and out of the park where of much higher importance to the visual quality of Confluence Park than the noise reduction issue. Staff's feedback to Wilson was to involve the City in the design process when it came time to work on the safety barrier aspect of the interstate.

Items of Information for Parks and Recreation Advisory Board Members

- Update on Cheyenne Mountain State Park

- Attachments:
  - Letter to Marge McCarthy Concerning Hot Tub at Cottonwood Creek Recreation Center
  - Memo from Paul Butcher Regarding Issues Surrounding Confluence Park

- Calendar of Events:
  - Thursday, March 13, 3:30 p.m. - Sand Creek Trail Bridge Dedication at the El Pomar Youth Sports Complex along the Pikes Peak Greenway
  - Monday, March 17, 9:30 a.m. - SCIP Shooks Run Drainage Project on the Shooks Run Trail, South of Kiowa and El Paso Streets
  - Friday, May 2, 9:00 a.m. - Arbor Day Event at the Vera Scott Elementary School

- Articles from the Cheyenne Edition, February 14, 2003
  1. "City pushes ahead to protect view from Pioneers Museum"
  2. "Insects wreak havoc on drought-stressed trees"
  3. "Boy's paradise"

- Articles from the Gazette
  1. "Works of art by chain saw sculptors emerge from drought-stricken trees", February 10, 2003
  2. "Springs wants to deter new lawns in hot months", February 10, 2003
  3. "A small coffin, a big loss", February 24, 2003
  4. "TOPS extension would help preserve open space" and "Trails group, TOPS are not the same thing", February 27, 2003
  5. "Past becomes personal quest: Curiosity leads researcher on journey to her heritage", March 3, 2003
  6. "TOPS extension sets apart candidates", March 4, 2003
  7. "Snow just not enough : Recent moisture helps, but much more needed to reverse drought", March 4, 2003

Thank you Letter from:
1. Raul Acosta on behalf of Terry Putman, Manager of Park Planning and TOPS

- Minutes:
  - Parks and Recreation Advisory Board Minutes - February 13, 2003
  - TOPS Working Committee Minutes - February 12, 2003
  - Garden of the Gods Advisory Committee Minutes - January 23, 2003 and February 26, 2003

TRAIL ACCESS

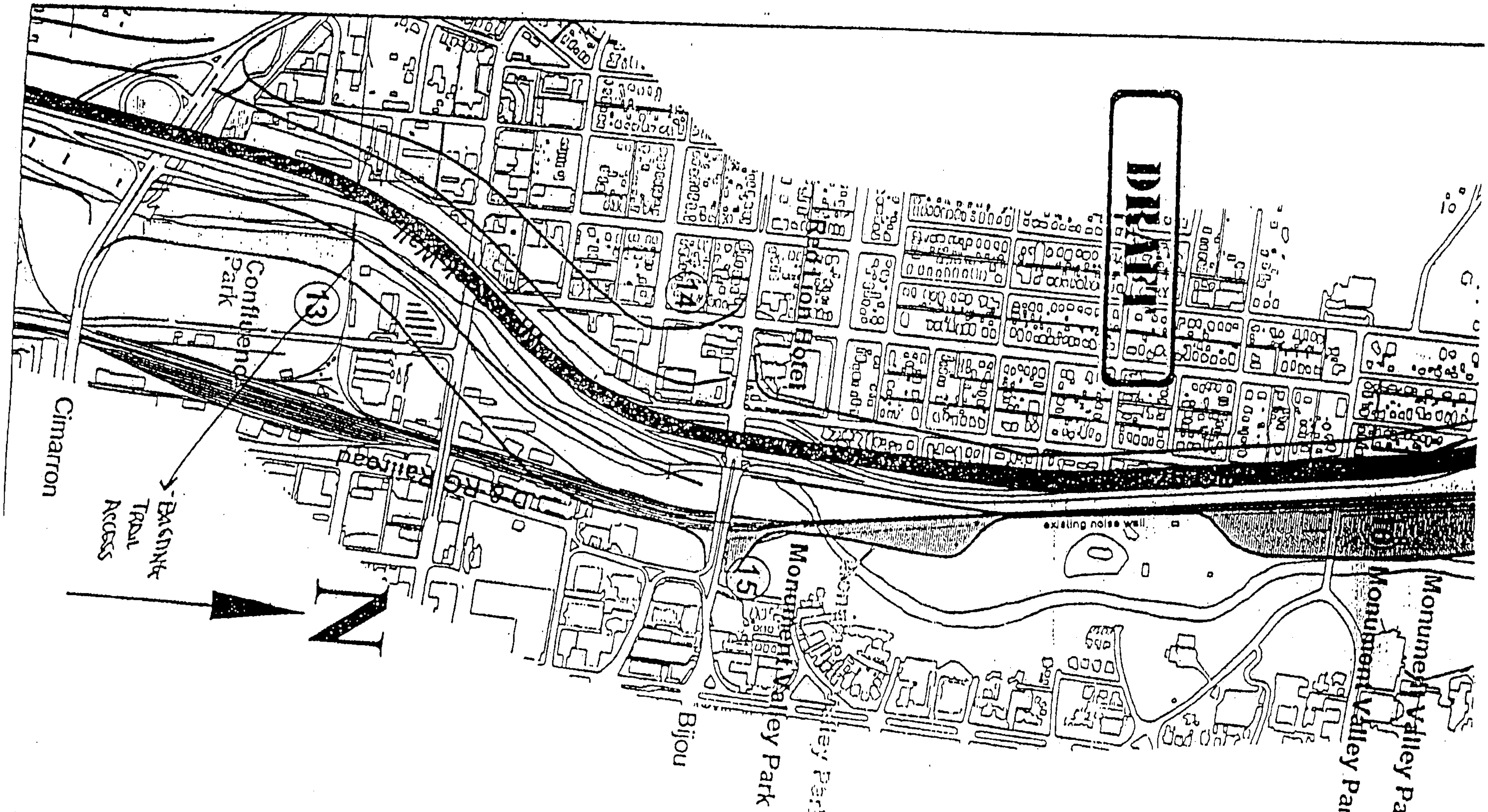
Following the discussion on noise issues, City staff asked Wilson and Company as to what the possibilities were to keep the old railroad underpass open to provide additional access from the west side of the interstate to the park. Through an examination of the preliminary designs available for this section of the interstate:

1. At the section of the interstate where the existing railroad bed lies, the new roadway will be approximately 150 feet wide (shoulder to shoulder). This represents a considerable length if a tunnel were to be considered, not only from a cost perspective but also from a perceived "user safety" perspective. One of the primary reasons the old access tunnel in South Monument Valley Park was closed (in favor of a pedestrian overpass) was that 50 yards was thought to be an uncomfortable tunnel distance for users to traverse and feel personally safe. Additionally, there is no opportunity at this stage in the highway design to create an opening above the tunnel to the road surface, which might help in alleviating the claustrophobic nature of a long tunnel.

2. The second option examined was to design this section as a short bridge over the trail thus eliminating the need for an enclosed tunnel. Preliminary cost estimates were that such structures (one northbound, one southbound) would have a combined construction cost of $2.0 million, which would represent a sizable investment in highway resources.

Staff again reaffirms its position that the access points at the north and south ends of Confluence Park are sufficient to meet the needs for park users. It seems fiscally unwise to require a mid-park crossing given the preliminary expenses tied to that effort.

Staff will be available to answer questions on either of these items.



Noise Impact Areas	Noise Contour Lines	Noise Increase Points
Residential	71 dB(A)	# Predicted 1990 to 2025
Commercial	66 dB(A)	0 — 500' 1 inch = 500 feet
Parks		
Historical		

Hankard Environmental
103 East Simpson St.
Lafayette, Colorado 80026
Phone: 303-666-0617
Fax: 303-666-1053

I-25 Colorado Springs EA
Noise Analysis Site Plan
Year 2025

Figure 3.7

Attachment G consists of the STAMINA 2.0 input files for the I-25 Improvements Through Colorado Springs Urbanized Area Environmental Assessment. These files are relatively complex and should be analyzed only by a professional familiar with STAMINA. Please contact James Flohr, Colorado Department of Transportation, at (719) 634-2323 for instructions on obtaining a copy of these files on CD.

ATTACHMENT H – I25 EA NOISE TECHNICAL REPORT

Summary of Noise Mitigation

Summary of Noise Mitigation Analyses – I-25 EA Noise Technical Report – January 2004

Neighborhood	Distance From Nearest Residence To Center Of I-25 (feet)	1990 Noise Level (dBA)[1]	2025 Noise Level and Rating (dBA)[2]	Noise Level Increase and Rating (dBA)	Noise Barrier Feasible?[3]	Dimensions of Noise Wall Analyzed (feet)	Cost Using $30 Per Sq. Ft. ($)	Front-row Noise Reduction (dBA)[4]	Number of Benefited Receptors[5]	Cost-Benefit and Rating	% Residential Development and Rating	Wall to be Included in Project[6]?
Stratmoor Valley – S. of Academy (south area)	325	60	67 (Reasonable)	7 (Reasonable)	Yes	Length: 1540 Height: 19	$877,800	4.4	41	$4,866 (Marginally Reasonable[7])	> 75% (Extremely Reasonable)	Yes
Stratmoor Valley – S. of Academy (north area)	425	60	67 (Reasonable)	7 (Reasonable)	Yes	Length: 790 Height: 12	$284,400	4.8	40	$1,481 (Extremely Reasonable)	> 75% (Extremely Reasonable)	Yes
Stratmoor Valley – North of Academy	225	66	69 (Reasonable)	3 (Marginally Reasonable)	Yes	Length: 2070 Height: 12	$745,200	5.4	62	$2,226 (Extremely Reasonable)	> 75% (Extremely Reasonable)	Yes
Stratton Meadows	250	70	69 (Reasonable)	-1 (Unreasonable)	Yes	Length: 3830 Height: 20	$2,298,000	4.3	80	$6,680 (Unreasonable)	25 – 50 % (Marginally Reasonable)	No[8]
Glen Avenue Residences	400	60	66 (Reasonable)	6 (Reasonable)	Yes	Length: 600 Height: 20	$360,000	5.5	8	$8,181 (Unreasonable)	50 – 75 % (Reasonable)	No[8]
San Miguel	500	62	66 (Reasonable)	4 (Marginally Reasonable)	Yes	Length: 740 Height: 21	$466,200	4.5	9	$11,511 (Unreasonable)	25 – 50 % (Marginally Reasonable)	No[8]
Mesa Springs	400	62	68 (N/a)	6 (N/a)	No	N/a	N/a	N/a	N/a	N/a	N/a	No[9]

Neighborhood	Distance From Nearest Residence To Center Of I-25 (feet)	1990 Noise Level (dBA)[1]	2025 Noise Level and Rating (dBA)[2]	Noise Level Increase and Rating (dBA)	Noise Barrier Feasible?[3]	Dimensions of Noise Wall Analyzed (feet)	Cost Using $30 Per Sq. Ft. ($)	Front-row Noise Reduction (dBA)[4]	Number of Benefited Receptors[5]	Cost-Benefit and Rating	% Residential Development and Rating	Wall to be Included in Project[6]?
Holiday Village	200	58	63 (Marginally Reasonable)	5 (Reasonable)	Yes	Length: 860 Height: 8	$206,400	4.6	13	$3,451 (Reasonable)	> 75% (Extremely Reasonable)	Yes
Park Terrace Apartments	250	65	70 (Reasonable)	5 (Reasonable)	Yes	Length: 540 Height: 20	$324,000	5.2	14	$4,450 (Unreasonable)	50% (Marginally Reasonable)	No[8]
Holland Park	225	65	70 (Reasonable)	5 (Reasonable)	Yes	Length: 2820 Height: 16	$1,353,600	5.7	70	$3,392 (Reasonable)	> 75% (Extremely Reasonable)	Yes
Garden Terrace Apartments	250	69	74 (Extremely Reasonable)	5 (Reasonable)	Yes	Length: 1010 Height: 20	$606,000	4.1	18	$8,211 (Unreasonable)	50% (Marginally Reasonable)	No[8]
Pulpit Rock	250	66	70 (Reasonable)	4 (Marginally Reasonable)	Yes	Length: 1885 Height: 15	$848,250	5.6	38	$3,986 (Reasonable)	> 75% (Extremely Reasonable)	Yes

1 Predicted noise level at representative front-row residence for 1990 traffic and roadway conditions
2 Predicted noise level at representative front-row residence for 2025 traffic and roadway conditions, rating from CDOT Noise Guidelines (refer to Attachment A)
3 Per CDOT Noise Guidelines, a wall is feasible if it is physically possible to construct a continuous barrier, the barrier is predicted to achieve a noise reduction of at least 5 dBA at one or more front-row receptors, and has no associated "fatal flaw" safety or maintenance concerns
4 Average predicted noise reduction at "benefited" receptors (see Note 5)
5 "Benefited" receptors are those where 3 dBA or more of noise reduction is predicted to be achieved by the noise barrier
6 From the CDOT Guidelines, the "Impacted Persons Desires" and "Development Existence" Reasonableness factors are "Extremely Reasonable" for all areas
7 Was considered "marginally reasonable" as there is a possibility of reduced cost if berm can be implemented
8 Not recommended based on reasonableness factors from CDOT Noise Guidelines
9 Not recommended based on feasibility factors from CDOT Noise Guidelines

ATTACHMENT I – I25 EA NOISE TECHNICAL REPORT

CDOT Noise Abatement Determination Forms

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION

Instructions: ***To complete this form refer to CDOT Noise Analysis Guidelines***

Project # **IM 0252-316**	Project code (SA#) **12210**	STIP # **SP 4002**	Project Location: **I-25 CO Springs-Stratmoor Valley, S. of Academy, S Area**

A. FEASIBILITY:

1. Can a continuous noise barrier or berm be constructed? ☑ YES ☐ NO
2. Can a substantial noise reduction be achieved by constructing a noise barrier or berm?…
   10 dBA: ☐ YES ☐ NO 7-10 dBA: ☐ YES ☐ NO 5-7 dBA: ☑ YES ☐ NO
3. Are there any "fatal flaw" safety or maintenance issues involving the proposed noise barrier or berm? ☐ YES ☑ NO

B. REASONABLENESS:

	EXTREMELY REASONABLE	REASONABLE	MARGINALLY REASONABLE	UNREASONABLE
1. Cost Benefit Index (per receiver per dBA)	☐ Less than $3000	☐ $3000-$3750	☑ $3750-$4000	☐ More than $4000
2. Average Build Noise Level	☐ 70 dBA or More	☑ 66 - 70 dBA	☐ 63 - 66 dBA	☐ Less than 63 dBA
3. Impacted persons' desires	☑ More than 75%	☐ 50% - 75%	☐ 25% - 50%	☐ Less than 25%
4. Development Type (Category B*)	☑ More than 75%	☐ 50% - 75%	☐ 25% - 50%	☐ Less than 25%
5. Development Existence (15 years or more)	☑ More than 75%	☐ 50% - 75%	☐ 25% - 50%	☐ Less than 25%
6. Build Noise Level vs. Existing Noise Level	☐ Greater than 10 dBA	☑ 5 - 10 dBA	☐ 0 - 5 dBA	☐ Noise Level Decrease

***Category B – Residential, School, Hospital, Park, Picnic/Active Sports Area, Motel, Church, Library**

C. INSULATION CONSIDERATION:

1. Are normal noise abatement measures physically infeasible or economically unreasonable? ☐ YES ☑ NO

If the answer to 1 is YES, then:

2. a. Does this project have noise impacts to public or non-profit buildings? ☐ YES ☐ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings? ☐ YES ☐ NO
3. a. Is private residential property affected by a 30 dB(A) or more noise level increase? ☐ YES ☐ NO
   b. Are private residences impacted by 75 dB(A) or more? ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

The cost per benefited receptor per dB of reduction was calculated to be $4,866 for this area. However, as there is some possiblitiy of constructing a berm at a lower cost, this was given a "marginally reasonable" rating.

E. DECISION:

1. Are noise mitigation measures feasible? ☑ YES ☐ NO
2. Are noise mitigation measures reasonable? ☑ YES ☐ NO
3. Is insulation of buildings both feasible and reasonable? ☐ YES ☑ NO
4. Shall noise mitigation measures be provided? ☑ YES ☐ NO

F. DECISION DESCRIPTION AND JUSTIFICATION

While the average noise reduction of 4.4 dBA reported in the EA and Noise Technical Report does not meet the 5 dBA minimum, 5 dBA is achieved at some front row residences. Furthermore, the wall (or berm) would protect a substantial number of residences and is recommended.

Completed by:	**Date:**
Michael Hankard - Hankard Environmental Inc.	***January 8, 2004***

CDOT Form #1209 12/02

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION

Instructions: ***To complete this form refer to CDOT Noise Analysis Guidelines***

Project # **IM 0252-316**	Project code (SA#) **12210**	STIP # **SP 4002**	Project Location: **I-25 CO Springs-Stratmoor Valley, S. of Academy, N Area**

A. FEASIBILITY:

1. Can a continuous noise barrier or berm be constructed? ☑ YES ☐ NO
2. Can a substantial noise reduction be achieved by constructing a noise barrier or berm?…
   10 dBA: ☐ YES ☐ NO 7-10 dBA: ☐ YES ☐ NO 5-7 dBA: ☑ YES ☐ NO
3. Are there any "fatal flaw" safety or maintenance issues involving the proposed noise barrier or berm? ☐ YES ☑ NO

B. REASONABLENESS:

	EXTREMELY REASONABLE	REASONABLE	MARGINALLY REASONABLE	UNREASONABLE
1. Cost Benefit Index (per receiver per dBA)	☑ Less than $3000	☐ $3000-$3750	☐ $3750-$4000	☐ More than $4000
2. Average Build Noise Level	☐ 70 dBA or More	☑ 66 - 70 dBA	☐ 63 - 66 dBA	☐ Less than 63 dBA
3. Impacted persons' desires	☑ More than 75%	☐ 50% - 75%	☐ 25% - 50%	☐ Less than 25%
4. Development Type (Category B*)	☑ More than 75%	☐ 50% - 75%	☐ 25% - 50%	☐ Less than 25%
5. Development Existence (15 years or more)	☑ More than 75%	☐ 50% - 75%	☐ 25% - 50%	☐ Less than 25%
6. Build Noise Level vs. Existing Noise Level	☐ Greater than 10 dBA	☑ 5 - 10 dBA	☐ 0 - 5 dBA	☐ Noise Level Decrease

***Category B – Residential, School, Hospital, Park, Picnic/Active Sports Area, Motel, Church, Library**

C. INSULATION CONSIDERATION:

1. Are normal noise abatement measures physically infeasible or economically unreasonable? ☐ YES ☑ NO

   If the answer to 1 is YES, then:

2. a. Does this project have noise impacts to public or non-profit buildings? ☐ YES ☐ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings? ☐ YES ☐ NO
3. a. Is private residential property affected by a 30 dB(A) or more noise level increase? ☐ YES ☐ NO
   b. Are private residences impacted by 75 dB(A) or more? ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

E. DECISION:

1. Are noise mitigation measures feasible? ☑ YES ☐ NO
2. Are noise mitigation measures reasonable? ☑ YES ☐ NO
3. Is insulation of buildings both feasible and reasonable? ☐ YES ☑ NO
4. Shall noise mitigation measures be provided? ☑ YES ☐ NO

F. DECISION DESCRIPTION AND JUSTIFICATION

While the average noise reduction of 4.8 dBA reported in the EA and Noise Technical Report does not meet the 5 dBA minimum, 5 dBA is achieved at some front row residences. Furthermore, the wall (or berm) would protect a substantial number of residences and is recommended.

Completed by:	**Date:**
Michael Hankard - Hankard Environmental Inc.	***January 8, 2004***

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION

Instructions: ***To complete this form refer to CDOT Noise Analysis Guidelines***

Project # **IM 0252-316**	Project code (SA#) **12210**	STIP # **SP 4002**	Project Location: **I-25 CO Springs-Stratmoor Valley, N of Academy**

A. FEASIBILITY:

1. Can a continuous noise barrier or berm be constructed? ☑ YES ☐ NO
2. Can a substantial noise reduction be achieved by constructing a noise barrier or berm?…
   10 dBA: ☐ YES ☐ NO 7-10 dBA: ☐ YES ☐ NO 5-7 dBA: ☑ YES ☐ NO
3. Are there any "fatal flaw" safety or maintenance issues involving the proposed noise barrier or berm? ☐ YES ☑ NO

B. REASONABLENESS:

	EXTREMELY REASONABLE	REASONABLE	MARGINALLY REASONABLE	UNREASONABLE
1. Cost Benefit Index (per receiver per dBA)	☑ Less than $3000	☐ $3000-$3750	☐ $3750-$4000	☐ More than $4000
2. Average Build Noise Level	☐ 70 dBA or More	☑ 66 - 70 dBA	☐ 63 - 66 dBA	☐ Less than 63 dBA
3. Impacted persons' desires	☑ More than 75%	☐ 50% - 75%	☐ 25% - 50%	☐ Less than 25%
4. Development Type (Category B*)	☑ More than 75%	☐ 50% - 75%	☐ 25% - 50%	☐ Less than 25%
5. Development Existence (15 years or more)	☑ More than 75%	☐ 50% - 75%	☐ 25% - 50%	☐ Less than 25%
6. Build Noise Level vs. Existing Noise Level	☐ Greater than 10 dBA	☐ 5 - 10 dBA	☑ 0 - 5 dBA	☐ Noise Level Decrease

***Category B – Residential, School, Hospital, Park, Picnic/Active Sports Area, Motel, Church, Library**

C. INSULATION CONSIDERATION:

1. Are normal noise abatement measures physically infeasible or economically unreasonable? ☐ YES ☑ NO

If the answer to 1 is YES, then:

2. a. Does this project have noise impacts to public or non-profit buildings? ☐ YES ☐ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings? ☐ YES ☐ NO
3. a. Is private residential property affected by a 30 dB(A) or more noise level increase? ☐ YES ☐ NO
   b. Are private residences impacted by 75 dB(A) or more? ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

The cost per benefited receptor per dB of reduction was calculated to be $4,866 for this area. However, as there is some possiblitiy of constructing a berm at a lower cost, this was given a "marginally reasonable" rating.

E. DECISION:

1. Are noise mitigation measures feasible? ☑ YES ☐ NO
2. Are noise mitigation measures reasonable? ☑ YES ☐ NO
3. Is insulation of buildings both feasible and reasonable? ☐ YES ☑ NO
4. Shall noise mitigation measures be provided? ☑ YES ☐ NO

F. DECISION DESCRIPTION AND JUSTIFICATION

This wall is feasible, and will provide a substantial noise reduction to a relatvely large number of residences. It is therefore recommended.

Completed by:	**Date:**
Michael Hankard - Hankard Environmental Inc.	***January 8, 2004***

CDOT Form #1209 12/02

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION

Instructions: ***To complete this form refer to CDOT Noise Analysis Guidelines***

Project # **IM 0252-316**	Project code (SA#) **12210**	STIP # **SP 4002**	Project Location: **I-25 CO Springs-Stratton Meadows**

A. FEASIBILITY:

1. Can a continuous noise barrier or berm be constructed? ☑ YES ☐ NO
2. Can a substantial noise reduction be achieved by constructing a noise barrier or berm?…
   10 dBA: ☐ YES ☐ NO 7-10 dBA: ☐ YES ☐ NO 5-7 dBA: ☑ YES ☐ NO
3. Are there any "fatal flaw" safety or maintenance issues involving the proposed noise barrier or berm? ☐ YES ☑ NO

B. REASONABLENESS:

	EXTREMELY REASONABLE	REASONABLE	MARGINALLY REASONABLE	UNREASONABLE
1. Cost Benefit Index (per receiver per dBA)	☐ Less than $3000	☐ $3000-$3750	☐ $3750-$4000	☑ More than $4000
2. Average Build Noise Level	☐ 70 dBA or More	☑ 66 - 70 dBA	☐ 63 - 66 dBA	☐ Less than 63 dBA
3. Impacted persons' desires	☑ More than 75%	☐ 50% - 75%	☐ 25% - 50%	☐ Less than 25%
4. Development Type (Category B*)	☐ More than 75%	☐ 50% - 75%	☑ 25% - 50%	☐ Less than 25%
5. Development Existence (15 years or more)	☑ More than 75%	☐ 50% - 75%	☐ 25% - 50%	☐ Less than 25%
6. Build Noise Level vs. Existing Noise Level	☐ Greater than 10 dBA	☐ 5 - 10 dBA	☐ 0 - 5 dBA	☑ Noise Level Decrease

***Category B – Residential, School, Hospital, Park, Picnic/Active Sports Area, Motel, Church, Library**

C. INSULATION CONSIDERATION:

1. Are normal noise abatement measures physically infeasible or economically unreasonable? ☑ YES ☐ NO

If the answer to 1 is YES, then:

2. a. Does this project have noise impacts to public or non-profit buildings? ☐ YES ☑ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings? ☐ YES ☐ NO
3. a. Is private residential property affected by a 30 dB(A) or more noise level increase? ☐ YES ☑ NO
   b. Are private residences impacted by 75 dB(A) or more? ☐ YES ☑ NO

D. ADDITIONAL CONSIDERATIONS:

A recent safety improvement improvement project relocated southbound I-25 onramp traffic from the frontage road to a new ramp. This resulted in a decrease in noise levels at adjacent homes.

E. DECISION:

1. Are noise mitigation measures feasible? ☑ YES ☐ NO
2. Are noise mitigation measures reasonable? ☐ YES ☑ NO
3. Is insulation of buildings both feasible and reasonable? ☐ YES ☑ NO
4. Shall noise mitigation measures be provided? ☐ YES ☑ NO

F. DECISION DESCRIPTION AND JUSTIFICATION

This area consists of mixed residential-commercial land use along the highway, and a mix of single family homes and apartments further south. A barrier is feasible, although much of it would need to be constructed across the bridge strucutre. Noise reduction at the residences is limited by the considerable amount of local traffic, which would not be mitigated by the wall. The number of residences with outdoor use that would recieve a substantial benefit from a wall is unreasonably low. Therefore, no mitigation is recommended.

Completed by:	**Date:**
Michael Hankard - Hankard Environmental Inc.	***January 8, 2004***

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION

Instructions: ***To complete this form refer to CDOT Noise Analysis Guidelines***

Project # **IM 0252-316**	Project code (SA#) **12210**	STIP # **SP 4002**	Project Location: **I-25 CO Springs-Glen Avenue Residences**

A. FEASIBILITY:

1. Can a continuous noise barrier or berm be constructed? ☑ YES ☐ NO
2. Can a substantial noise reduction be achieved by constructing a noise barrier or berm?…
   10 dBA: ☐ YES ☐ NO 7-10 dBA: ☐ YES ☐ NO 5-7 dBA: ☑ YES ☐ NO
3. Are there any "fatal flaw" safety or maintenance issues involving the proposed noise barrier or berm? ☐ YES ☑ NO

B. REASONABLENESS:

	EXTREMELY REASONABLE	REASONABLE	MARGINALLY REASONABLE	UNREASONABLE
1. Cost Benefit Index (per receiver per dBA)	☐ Less than $3000	☐ $3000-$3750	☐ $3750-$4000	☑ More than $4000
2. Average Build Noise Level	☐ 70 dBA or More	☑ 66 - 70 dBA	☐ 63 - 66 dBA	☐ Less than 63 dBA
3. Impacted persons' desires	☑ More than 75%	☐ 50% - 75%	☐ 25% - 50%	☐ Less than 25%
4. Development Type (Category B*)	☐ More than 75%	☑ 50% - 75%	☐ 25% - 50%	☐ Less than 25%
5. Development Existence (15 years or more)	☑ More than 75%	☐ 50% - 75%	☐ 25% - 50%	☐ Less than 25%
6. Build Noise Level vs. Existing Noise Level	☐ Greater than 10 dBA	☑ 5 - 10 dBA	☐ 0 - 5 dBA	☐ Noise Level Decrease

***Category B – Residential, School, Hospital, Park, Picnic/Active Sports Area, Motel, Church, Library**

C. INSULATION CONSIDERATION:

1. Are normal noise abatement measures physically infeasible or economically unreasonable? ☑ YES ☐ NO

If the answer to 1 is YES, then:

2. a. Does this project have noise impacts to public or non-profit buildings? ☐ YES ☑ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings? ☐ YES ☐ NO
3. a. Is private residential property affected by a 30 dB(A) or more noise level increase? ☐ YES ☑ NO
   b. Are private residences impacted by 75 dB(A) or more? ☐ YES ☑ NO

D. ADDITIONAL CONSIDERATIONS:

E. DECISION:

1. Are noise mitigation measures feasible? ☑ YES ☐ NO
2. Are noise mitigation measures reasonable? ☑ YES ☐ NO
3. Is insulation of buildings both feasible and reasonable? ☐ YES ☑ NO
4. Shall noise mitigation measures be provided? ☑ YES ☐ NO

F. DECISION DESCRIPTION AND JUSTIFICATION

This wall provides somewhat minimal benefit to only a few residences. However, it would also protect active outdoor use areas in adjacent portions of Monument Valley Park. This wall is recommended as it protects both the park and residences.

Completed by:	**Date:**
Michael Hankard - Hankard Environmental Inc.	***January 8, 2004***

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION

Instructions: ***To complete this form refer to CDOT Noise Analysis Guidelines***

Project # **IM 0252-316**	Project code (SA#) **12210**	STIP # **SP 4002**	Project Location: **I-25 CO Springs-San Miguel Neighborhood**

A. FEASIBILITY:

1. Can a continuous noise barrier or berm be constructed? ☑ YES ☐ NO
2. Can a substantial noise reduction be achieved by constructing a noise barrier or berm?…
   10 dBA: ☐ YES ☐ NO 7-10 dBA: ☐ YES ☐ NO 5-7 dBA: ☑ YES ☐ NO
3. Are there any "fatal flaw" safety or maintenance issues involving the proposed noise barrier or berm? ☐ YES ☑ NO

B. REASONABLENESS:

	EXTREMELY REASONABLE	REASONABLE	MARGINALLY REASONABLE	UNREASONABLE
1. Cost Benefit Index (per receiver per dBA)	☐ Less than $3000	☐ $3000-$3750	☐ $3750-$4000	☑ More than $4000
2. Average Build Noise Level	☐ 70 dBA or More	☑ 66 - 70 dBA	☐ 63 - 66 dBA	☐ Less than 63 dBA
3. Impacted persons' desires	☑ More than 75%	☐ 50% - 75%	☐ 25% - 50%	☐ Less than 25%
4. Development Type (Category B*)	☐ More than 75%	☐ 50% - 75%	☑ 25% - 50%	☐ Less than 25%
5. Development Existence (15 years or more)	☑ More than 75%	☐ 50% - 75%	☐ 25% - 50%	☐ Less than 25%
6. Build Noise Level vs. Existing Noise Level	☐ Greater than 10 dBA	☐ 5 - 10 dBA	☑ 0 - 5 dBA	☐ Noise Level Decrease

***Category B – Residential, School, Hospital, Park, Picnic/Active Sports Area, Motel, Church, Library**

C. INSULATION CONSIDERATION:

1. Are normal noise abatement measures physically infeasible or economically unreasonable? ☑ YES ☐ NO

If the answer to 1 is YES, then:

2. a. Does this project have noise impacts to public or non-profit buildings? ☐ YES ☑ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings? ☐ YES ☐ NO
3. a. Is private residential property affected by a 30 dB(A) or more noise level increase? ☐ YES ☑ NO
   b. Are private residences impacted by 75 dB(A) or more? ☐ YES ☑ NO

D. ADDITIONAL CONSIDERATIONS:

The noise reduction predicted by the noise wall analyzed for this site is 4.5 dBA was rounded to 5 dBA. There is a susbstantial amount of daytime auto and truck traffic on Recreation Way, which would reflect off of the proposed noise wall. RR noise would be mitigated by the wall.

E. DECISION:

1. Are noise mitigation measures feasible? ☑ YES ☐ NO
2. Are noise mitigation measures reasonable? ☐ YES ☑ NO
3. Is insulation of buildings both feasible and reasonable? ☐ YES ☑ NO
4. Shall noise mitigation measures be provided? ☐ YES ☑ NO

F. DECISION DESCRIPTION AND JUSTIFICATION

The noise reduction predicted from this wall barely meets the 5 dBA minimum, and reflection of frontage road traffic noise would make this worse. Furtheremore, the cost-benefit of this wall is unreasonable. Therefore, no mitigation is recommended.

Completed by:	**Date:**
Michael Hankard - Hankard Environmental Inc.	***January 8, 2004***

CDOT Form #1209 12/02

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION

Instructions: ***To complete this form refer to CDOT Noise Analysis Guidelines***

Project # **IM 0252-316**	Project code (SA#) **12210**	STIP # **SP 4002**	Project Location: **I-25 CO Springs-Mesa Springs Area Residences**

A. FEASIBILITY:

1. Can a continuous noise barrier or berm be constructed? . . . . . ☐ YES ☑ NO
2. Can a substantial noise reduction be achieved by constructing a noise barrier or berm?…
   10 dBA: ☐ YES ☐ NO 7-10 dBA: ☐ YES ☐ NO 5-7 dBA: ☐ YES ☑ NO
3. Are there any "fatal flaw" safety or maintenance issues involving the proposed noise barrier or berm? . . . . . ☑ YES ☐ NO

B. REASONABLENESS:

	EXTREMELY REASONABLE	REASONABLE	MARGINALLY REASONABLE	UNREASONABLE
1. Cost Benefit Index (per receiver per dBA)	☐ Less than $3000	☐ $3000-$3750	☐ $3750-$4000	☐ More than $4000
2. Average Build Noise Level	☐ 70 dBA or More	☐ 66 - 70 dBA	☐ 63 - 66 dBA	☐ Less than 63 dBA
3. Impacted persons' desires	☐ More than 75%	☐ 50% - 75%	☐ 25% - 50%	☐ Less than 25%
4. Development Type (Category B*)	☐ More than 75%	☐ 50% - 75%	☐ 25% - 50%	☐ Less than 25%
5. Development Existence (15 years or more)	☐ More than 75%	☐ 50% - 75%	☐ 25% - 50%	☐ Less than 25%
6. Build Noise Level vs. Existing Noise Level	☐ Greater than 10 dBA	☐ 5 - 10 dBA	☐ 0 - 5 dBA	☐ Noise Level Decrease

***Category B – Residential, School, Hospital, Park, Picnic/Active Sports Area, Motel, Church, Library**

C. INSULATION CONSIDERATION:

1. Are normal noise abatement measures physically infeasible or economically unreasonable? . . . . . ☑ YES ☐ NO

If the answer to 1 is YES, then:

2. a. Does this project have noise impacts to public or non-profit buildings? . . . . . ☐ YES ☑ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings? . . . . . ☐ YES ☐ NO
3. a. Is private residential property affected by a 30 dB(A) or more noise level increase? . . . . . ☐ YES ☑ NO
   b. Are private residences impacted by 75 dB(A) or more? . . . . . ☐ YES ☑ NO

D. ADDITIONAL CONSIDERATIONS:

E. DECISION:

1. Are noise mitigation measures feasible? . . . . . ☐ YES ☑ NO
2. Are noise mitigation measures reasonable? . . . . . ☐ YES ☐ NO
3. Is insulation of buildings both feasible and reasonable? . . . . . ☐ YES ☑ NO
4. Shall noise mitigation measures be provided? . . . . . ☐ YES ☑ NO

F. DECISION DESCRIPTION AND JUSTIFICATION

It is physically infeasible to construct a noise wall on the west side of the frontage road due to direct access, and a wall on the east side of the frontage road would not provide at least 5 dB of noise reduction. No analysis of reasonableness was conducted. This area does not qualify for noise insulation. Therefore, no mitigation is recommended.

Completed by:	**Date:**
Michael Hankard - Hankard Environmental Inc.	***January 8, 2004***

CDOT Form #1209 12/02

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION

Instructions: ***To complete this form refer to CDOT Noise Analysis Guidelines***

Project # **IM 0252-316**	Project code (SA#) **12210**	STIP # **SP 4002**	Project Location: **I-25 CO Springs-Holiday Village**

A. FEASIBILITY:

1. Can a continuous noise barrier or berm be constructed? ☑ YES ☐ NO
2. Can a substantial noise reduction be achieved by constructing a noise barrier or berm?…
   10 dBA: ☐ YES ☐ NO 7-10 dBA: ☐ YES ☐ NO 5-7 dBA: ☑ YES ☐ NO
3. Are there any "fatal flaw" safety or maintenance issues involving the proposed noise barrier or berm? ☐ YES ☑ NO

B. REASONABLENESS:

	EXTREMELY REASONABLE	REASONABLE	MARGINALLY REASONABLE	UNREASONABLE
1. Cost Benefit Index (per receiver per dBA)	☐ Less than $3000	☑ $3000-$3750	☐ $3750-$4000	☐ More than $4000
2. Average Build Noise Level	☐ 70 dBA or More	☐ 66 - 70 dBA	☑ 63 - 66 dBA	☐ Less than 63 dBA
3. Impacted persons' desires	☑ More than 75%	☐ 50% - 75%	☐ 25% - 50%	☐ Less than 25%
4. Development Type (Category B*)	☑ More than 75%	☐ 50% - 75%	☐ 25% - 50%	☐ Less than 25%
5. Development Existence (15 years or more)	☑ More than 75%	☐ 50% - 75%	☐ 25% - 50%	☐ Less than 25%
6. Build Noise Level vs. Existing Noise Level	☐ Greater than 10 dBA	☑ 5 - 10 dBA	☐ 0 - 5 dBA	☐ Noise Level Decrease

***Category B – Residential, School, Hospital, Park, Picnic/Active Sports Area, Motel, Church, Library**

C. INSULATION CONSIDERATION:

1. Are normal noise abatement measures physically infeasible or economically unreasonable? ☐ YES ☑ NO

If the answer to 1 is YES, then:

2. a. Does this project have noise impacts to public or non-profit buildings? ☐ YES ☐ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings? ☐ YES ☐ NO
3. a. Is private residential property affected by a 30 dB(A) or more noise level increase? ☐ YES ☐ NO
   b. Are private residences impacted by 75 dB(A) or more? ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

While the average noise reduction of 4.6 dBA reported in the EA and Noise Technical Report does not meet the 5 dBA minimum, 5 dBA is achieved at some front row residences.

E. DECISION:

1. Are noise mitigation measures feasible? ☑ YES ☐ NO
2. Are noise mitigation measures reasonable? ☑ YES ☐ NO
3. Is insulation of buildings both feasible and reasonable? ☐ YES ☑ NO
4. Shall noise mitigation measures be provided? ☑ YES ☐ NO

F. DECISION DESCRIPTION AND JUSTIFICATION

This wall is feasible and reasonable to implement per CDOT Noise Guidelines.

Completed by:	**Date:**
Michael Hankard - Hankard Environmental Inc.	***January 8, 2004***

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION

Instructions: ***To complete this form refer to CDOT Noise Analysis Guidelines***

Project # **IM 0252-316**	Project code (SA#) **12210**	STIP # **SP 4002**	Project Location: **I-25 CO Springs-Park Terrace Apartments**

A. FEASIBILITY:

1. Can a continuous noise barrier or berm be constructed? ☑ YES ☐ NO
2. Can a substantial noise reduction be achieved by constructing a noise barrier or berm?…
   10 dBA: ☐ YES ☐ NO 7-10 dBA: ☐ YES ☐ NO 5-7 dBA: ☑ YES ☐ NO
3. Are there any "fatal flaw" safety or maintenance issues involving the proposed noise barrier or berm? ☐ YES ☑ NO

B. REASONABLENESS:

	EXTREMELY REASONABLE	REASONABLE	MARGINALLY REASONABLE	UNREASONABLE
1. Cost Benefit Index (per receiver per dBA)	☐ Less than $3000	☐ $3000-$3750	☐ $3750-$4000	☑ More than $4000
2. Average Build Noise Level	☐ 70 dBA or More	☑ 66 - 70 dBA	☐ 63 - 66 dBA	☐ Less than 63 dBA
3. Impacted persons' desires	☑ More than 75%	☐ 50% - 75%	☐ 25% - 50%	☐ Less than 25%
4. Development Type (Category B*)	☐ More than 75%	☐ 50% - 75%	☑ 25% - 50%	☐ Less than 25%
5. Development Existence (15 years or more)	☑ More than 75%	☐ 50% - 75%	☐ 25% - 50%	☐ Less than 25%
6. Build Noise Level vs. Existing Noise Level	☐ Greater than 10 dBA	☑ 5 - 10 dBA	☐ 0 - 5 dBA	☐ Noise Level Decrease

***Category B – Residential, School, Hospital, Park, Picnic/Active Sports Area, Motel, Church, Library**

C. INSULATION CONSIDERATION:

1. Are normal noise abatement measures physically infeasible or economically unreasonable? ☑ YES ☐ NO

   If the answer to 1 is YES, then:

2. a. Does this project have noise impacts to public or non-profit buildings? ☐ YES ☑ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings? ☐ YES ☐ NO
3. a. Is private residential property affected by a 30 dB(A) or more noise level increase? ☐ YES ☑ NO
   b. Are private residences impacted by 75 dB(A) or more? ☐ YES ☑ NO

D. ADDITIONAL CONSIDERATIONS:

E. DECISION:

1. Are noise mitigation measures feasible? ☑ YES ☐ NO
2. Are noise mitigation measures reasonable? ☐ YES ☑ NO
3. Is insulation of buildings both feasible and reasonable? ☐ YES ☑ NO
4. Shall noise mitigation measures be provided? ☐ YES ☑ NO

F. DECISION DESCRIPTION AND JUSTIFICATION

A wall built to protect these apartments would protect very few units, and would provide minimal noise reduction due to the reflect of frontage traffic noise off of the wall and back toward the apartments.

Completed by:	**Date:**
Michael Hankard - Hankard Environmental Inc.	***January 8, 2004***

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION

Instructions: ***To complete this form refer to CDOT Noise Analysis Guidelines***

Project # **IM 0252-316**	Project code (SA#) **12210**	STIP # **SP 4002**	Project Location: **I-25 CO Springs-Holland Park Neighborhood**

A. FEASIBILITY:

1. Can a continuous noise barrier or berm be constructed? ☑ YES ☐ NO
2. Can a substantial noise reduction be achieved by constructing a noise barrier or berm?…
   10 dBA: ☐ YES ☐ NO 7-10 dBA: ☐ YES ☐ NO 5-7 dBA: ☑ YES ☐ NO
3. Are there any "fatal flaw" safety or maintenance issues involving the proposed noise barrier or berm? ☐ YES ☑ NO

B. REASONABLENESS:

	EXTREMELY REASONABLE	REASONABLE	MARGINALLY REASONABLE	UNREASONABLE
1. Cost Benefit Index (per receiver per dBA)	☐ Less than $3000	☑ $3000-$3750	☐ $3750-$4000	☐ More than $4000
2. Average Build Noise Level	☐ 70 dBA or More	☑ 66 - 70 dBA	☐ 63 - 66 dBA	☐ Less than 63 dBA
3. Impacted persons' desires	☑ More than 75%	☐ 50% - 75%	☐ 25% - 50%	☐ Less than 25%
4. Development Type (Category B*)	☑ More than 75%	☐ 50% - 75%	☐ 25% - 50%	☐ Less than 25%
5. Development Existence (15 years or more)	☑ More than 75%	☐ 50% - 75%	☐ 25% - 50%	☐ Less than 25%
6. Build Noise Level vs. Existing Noise Level	☐ Greater than 10 dBA	☑ 5 - 10 dBA	☐ 0 - 5 dBA	☐ Noise Level Decrease

***Category B – Residential, School, Hospital, Park, Picnic/Active Sports Area, Motel, Church, Library**

C. INSULATION CONSIDERATION:

1. Are normal noise abatement measures physically infeasible or economically unreasonable? ☐ YES ☑ NO

   If the answer to 1 is YES, then:

2. a. Does this project have noise impacts to public or non-profit buildings? ☐ YES ☐ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings? ☐ YES ☐ NO
3. a. Is private residential property affected by a 30 dB(A) or more noise level increase? ☐ YES ☐ NO
   b. Are private residences impacted by 75 dB(A) or more? ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

E. DECISION:

1. Are noise mitigation measures feasible? ☑ YES ☐ NO
2. Are noise mitigation measures reasonable? ☑ YES ☐ NO
3. Is insulation of buildings both feasible and reasonable? ☐ YES ☑ NO
4. Shall noise mitigation measures be provided? ☑ YES ☐ NO

F. DECISION DESCRIPTION AND JUSTIFICATION

This wall is considered feasible and reasonable to implement per CDOT Noise Guidelines.

Completed by:	**Date:**
Michael Hankard - Hankard Environmental Inc.	***January 8, 2004***

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION

Instructions: ***To complete this form refer to CDOT Noise Analysis Guidelines***

Project # **IM 0252-316**	Project code (SA#) **12210**	STIP # **SP 4002**	Project Location: **I-25 CO Springs-Garden Terrace Apartments**

A. FEASIBILITY:

1. Can a continuous noise barrier or berm be constructed? ☑ YES ☐ NO
2. Can a substantial noise reduction be achieved by constructing a noise barrier or berm?…
   10 dBA: ☐ YES ☐ NO 7-10 dBA: ☐ YES ☐ NO 5-7 dBA: ☑ YES ☐ NO
3. Are there any "fatal flaw" safety or maintenance issues involving the proposed noise barrier or berm? ☐ YES ☑ NO

B. REASONABLENESS:

	EXTREMELY REASONABLE	REASONABLE	MARGINALLY REASONABLE	UNREASONABLE
1. Cost Benefit Index (per receiver per dBA)	☐ Less than $3000	☐ $3000-$3750	☐ $3750-$4000	☑ More than $4000
2. Average Build Noise Level	☑ 70 dBA or More	☐ 66 - 70 dBA	☐ 63 - 66 dBA	☐ Less than 63 dBA
3. Impacted persons' desires	☑ More than 75%	☐ 50% - 75%	☐ 25% - 50%	☐ Less than 25%
4. Development Type (Category B*)	☐ More than 75%	☐ 50% - 75%	☑ 25% - 50%	☐ Less than 25%
5. Development Existence (15 years or more)	☑ More than 75%	☐ 50% - 75%	☐ 25% - 50%	☐ Less than 25%
6. Build Noise Level vs. Existing Noise Level	☐ Greater than 10 dBA	☑ 5 - 10 dBA	☐ 0 - 5 dBA	☐ Noise Level Decrease

***Category B – Residential, School, Hospital, Park, Picnic/Active Sports Area, Motel, Church, Library**

C. INSULATION CONSIDERATION:

1. Are normal noise abatement measures physically infeasible or economically unreasonable? ☑ YES ☐ NO

If the answer to 1 is YES, then:

2. a. Does this project have noise impacts to public or non-profit buildings? ☐ YES ☑ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings? ☐ YES ☐ NO
3. a. Is private residential property affected by a 30 dB(A) or more noise level increase? ☐ YES ☑ NO
   b. Are private residences impacted by 75 dB(A) or more? ☐ YES ☑ NO

D. ADDITIONAL CONSIDERATIONS:

While the average noise reduction of 4.1 dBA reported in the EA and Noise Technical Report does not meet the 5 dBA minimum, 5 dBA is achieved at the very front row apartments.

E. DECISION:

1. Are noise mitigation measures feasible? ☑ YES ☐ NO
2. Are noise mitigation measures reasonable? ☐ YES ☑ NO
3. Is insulation of buildings both feasible and reasonable? ☐ YES ☑ NO
4. Shall noise mitigation measures be provided? ☐ YES ☑ NO

F. DECISION DESCRIPTION AND JUSTIFICATION

A wall built to protect these apartments would protect very few units, and would provide minimal noise reduction due to the reflect of frontage traffic noise off of the wall and back toward the apartments.

Completed by:	**Date:**
Michael Hankard - Hankard Environmental Inc.	***January 8, 2004***

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION

Instructions: ***To complete this form refer to CDOT Noise Analysis Guidelines***

Project # **IM 0252-316**	Project code (SA#) **12210**	STIP # **SP 4002**	Project Location: **I-25 CO Springs-Pulpit Rock Neighborhood**

A. FEASIBILITY:

1. Can a continuous noise barrier or berm be constructed? ☑ YES ☐ NO
2. Can a substantial noise reduction be achieved by constructing a noise barrier or berm?…
   10 dBA: ☐ YES ☐ NO 7-10 dBA: ☐ YES ☐ NO 5-7 dBA: ☑ YES ☐ NO
3. Are there any "fatal flaw" safety or maintenance issues involving the proposed noise barrier or berm? ☐ YES ☑ NO

B. REASONABLENESS:

	EXTREMELY REASONABLE	REASONABLE	MARGINALLY REASONABLE	UNREASONABLE
1. Cost Benefit Index (per receiver per dBA)	☐ Less than $3000	☑ $3000-$3750	☐ $3750-$4000	☐ More than $4000
2. Average Build Noise Level	☐ 70 dBA or More	☑ 66 - 70 dBA	☐ 63 - 66 dBA	☐ Less than 63 dBA
3. Impacted persons' desires	☑ More than 75%	☐ 50% - 75%	☐ 25% - 50%	☐ Less than 25%
4. Development Type (Category B*)	☑ More than 75%	☐ 50% - 75%	☐ 25% - 50%	☐ Less than 25%
5. Development Existence (15 years or more)	☑ More than 75%	☐ 50% - 75%	☐ 25% - 50%	☐ Less than 25%
6. Build Noise Level vs. Existing Noise Level	☐ Greater than 10 dBA	☐ 5 - 10 dBA	☑ 0 - 5 dBA	☐ Noise Level Decrease

***Category B – Residential, School, Hospital, Park, Picnic/Active Sports Area, Motel, Church, Library**

C. INSULATION CONSIDERATION:

1. Are normal noise abatement measures physically infeasible or economically unreasonable? ☐ YES ☑ NO

If the answer to 1 is YES, then:

2. a. Does this project have noise impacts to public or non-profit buildings? ☐ YES ☐ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings? ☐ YES ☐ NO
3. a. Is private residential property affected by a 30 dB(A) or more noise level increase? ☐ YES ☐ NO
   b. Are private residences impacted by 75 dB(A) or more? ☐ YES ☐ NO

D. ADDITIONAL CONSIDERATIONS:

E. DECISION:

1. Are noise mitigation measures feasible? ☑ YES ☐ NO
2. Are noise mitigation measures reasonable? ☑ YES ☐ NO
3. Is insulation of buildings both feasible and reasonable? ☐ YES ☑ NO
4. Shall noise mitigation measures be provided? ☑ YES ☐ NO

F. DECISION DESCRIPTION AND JUSTIFICATION

This wall is feasible and reasonable to implement per CDOT Noise Guidelines.

Completed by:	**Date:**
Michael Hankard - Hankard Environmental Inc.	***January 8, 2004***

SH 16

1

N

Noise Impact Areas

- Residential
- Commercial
- Parks

Noise Contour Lines

- 71 dB(A)
- 66 dB(A)

Noise Increase Points

(#) Predicted 1990 to 2025

0 500'

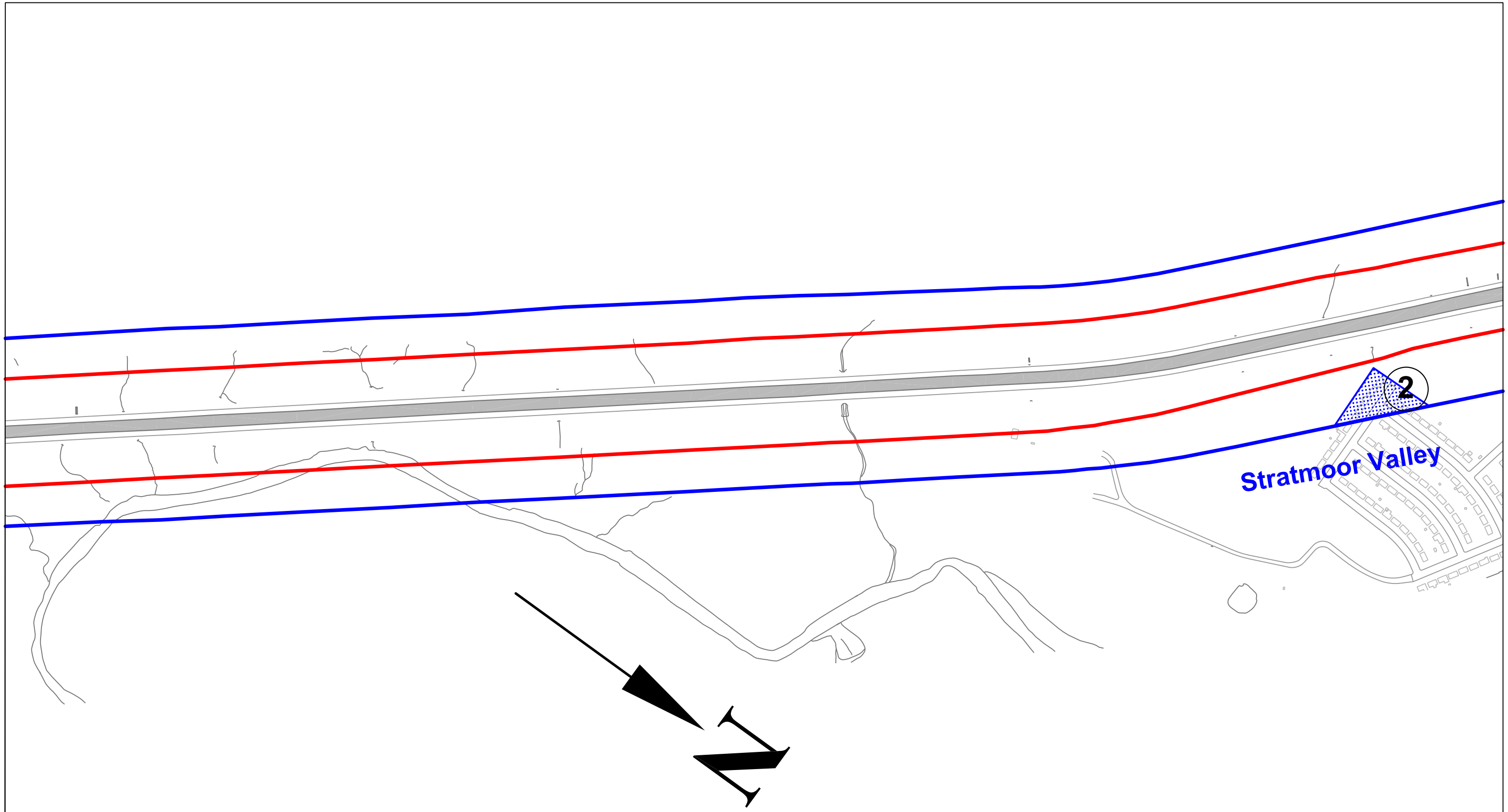
1 inch = 500 feet

Hankard Environmental

19 Old Town Square, #238
Fort Collins, Colorado 80524
Phone: (303) 666-0617
Fax: (303) 600-0282

I-25 Colorado Springs EA
Noise Analysis Site Plan
Year 2025

Figure 5-1



Noise Impact Areas

- Residential
- Commercial
- Parks

Noise Contour Lines

- 71 dB(A)
- 66 dB(A)

Noise Increase Points

(#) Predicted 1990 to 2025

0 500'
1 inch = 500 feet

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Fort Collins, Colorado 80524
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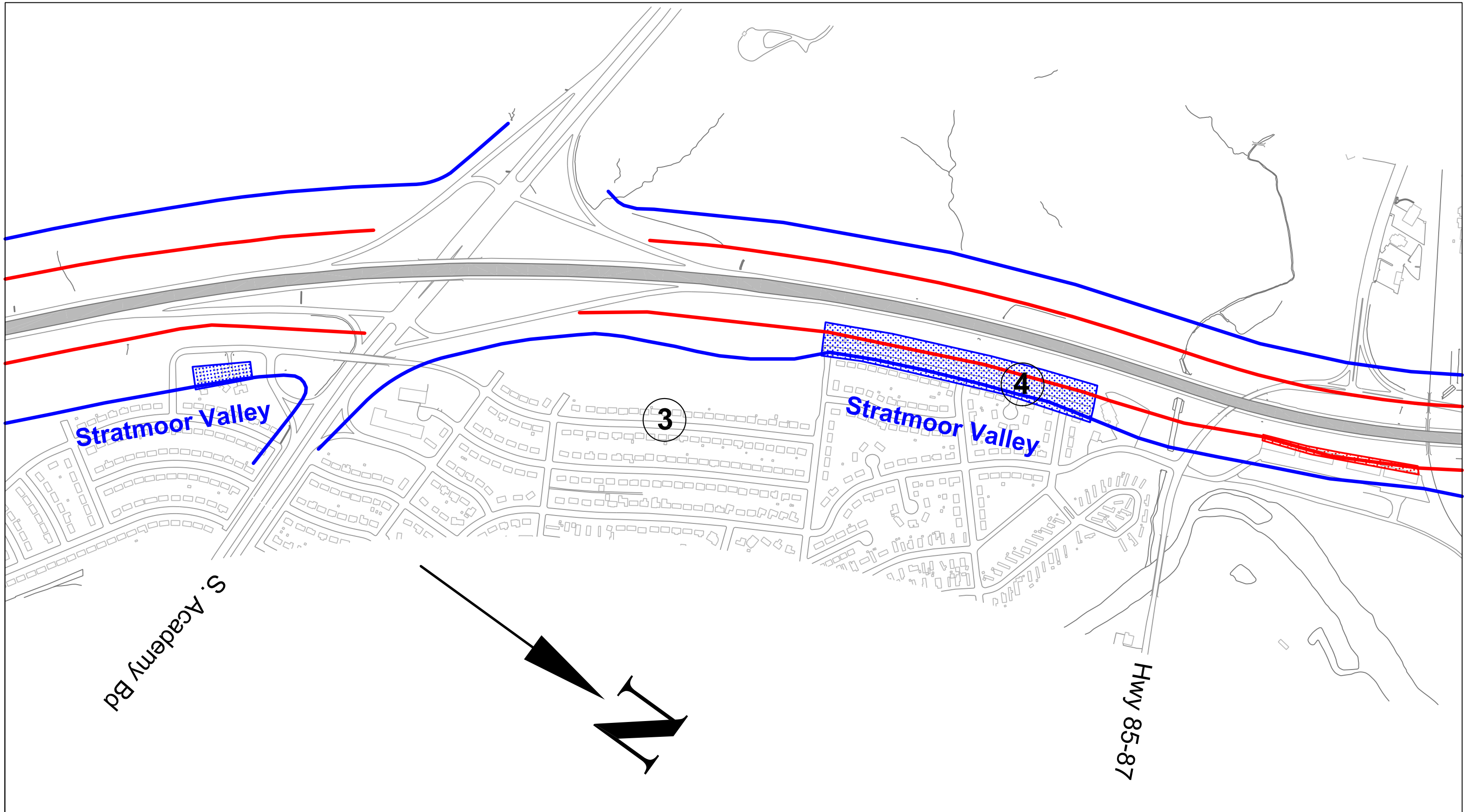
I-25 Colorado Springs EA
Noise Analysis Site Plan
Year 2025

Figure 5-2



Noise Impact Areas

- Residential
- Commercial
- Parks

Noise Contour Lines

- 71 dB(A)
- 66 dB(A)

Noise Increase Points

(#) Predicted 1990 to 2025

0 500'
1 inch = 500 feet

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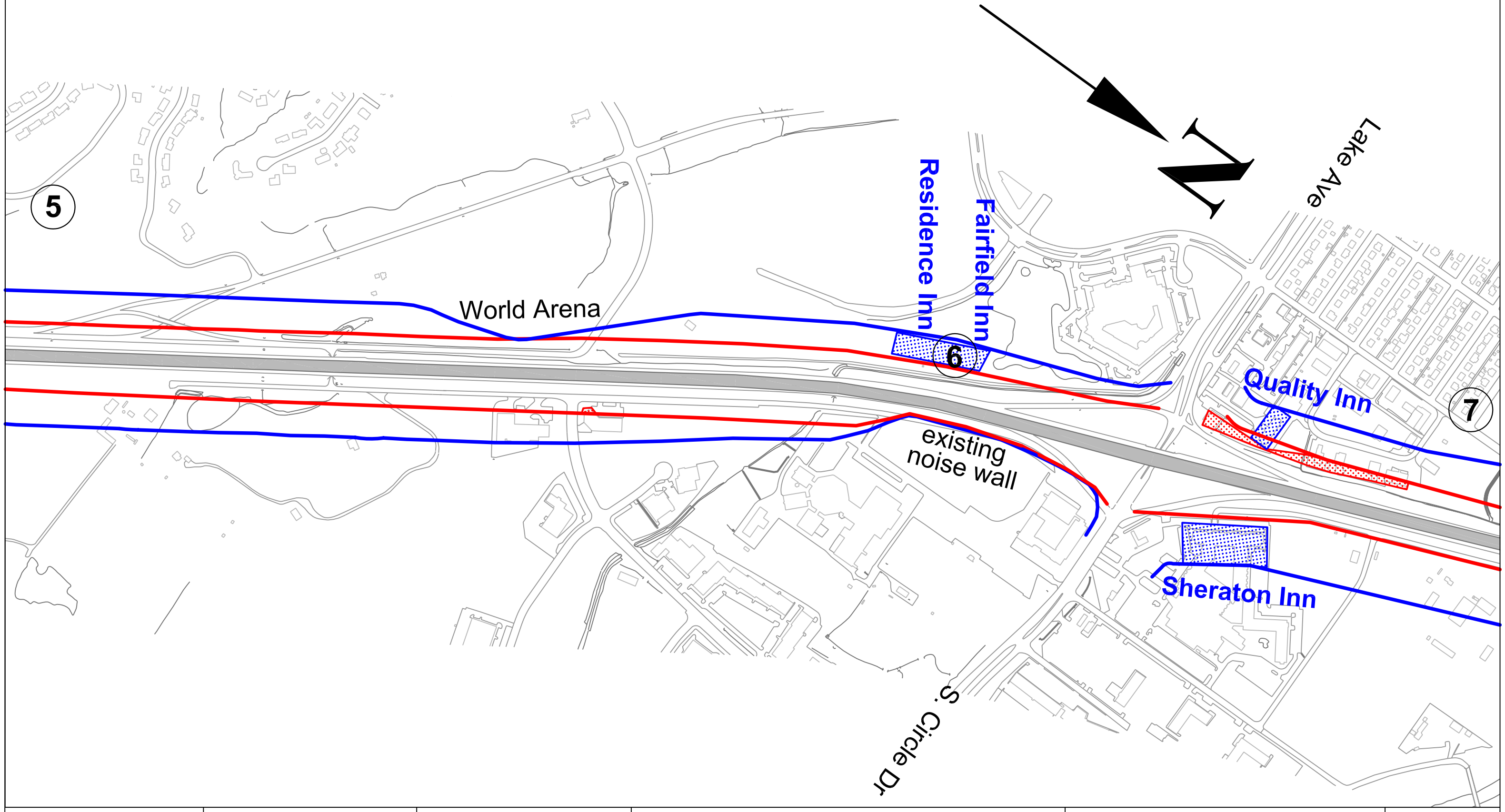
Noise Analysis Site Plan
Year 2025

Figure 5-3



Noise Impact Areas

- Residential
- Commercial
- Parks

Noise Contour Lines

- 71 dB(A)
- 66 dB(A)

Noise Increase Points

(#) Predicted 1990 to 2025

0 500'
1 inch = 500 feet

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I-25 Colorado Springs EA Noise Analysis Site Plan Year 2025

Figure 5-4

N

Stratton Meadows

7

8

9

10

11

MLK Bypass

Noise Impact Areas

- Residential
- Commercial
- Parks

Noise Contour Lines

- 71 dB(A)
- 66 dB(A)

Noise Increase Points

(#) Predicted 1990 to 2025

0 500'

1 inch = 500 feet

Hankard Environmental

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Fort Collins, Colorado 80524
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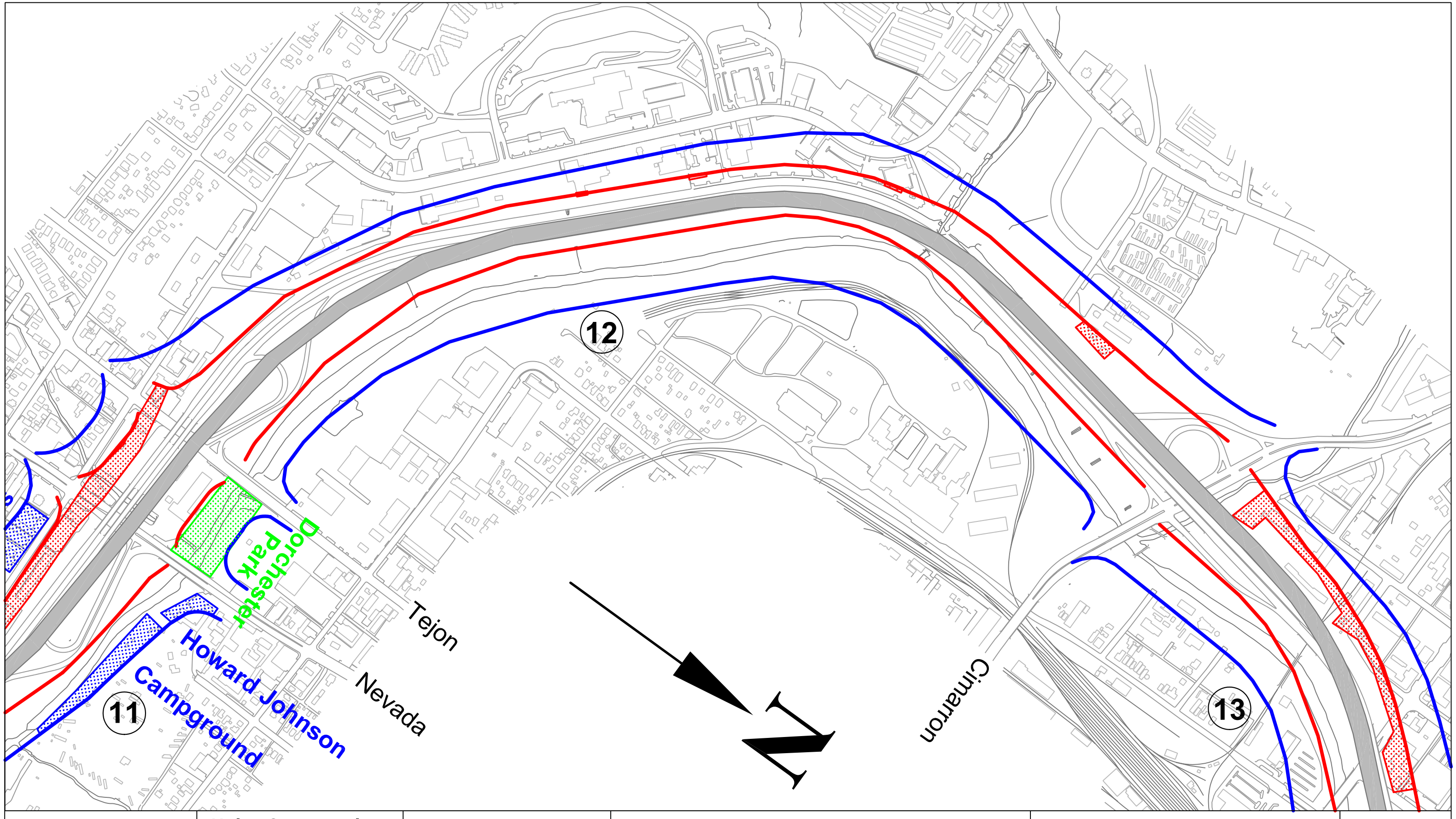
I-25 Colorado Springs EA Noise Analysis Site Plan Year 2025

Figure 5-5



Noise Impact Areas

- Residential
- Commercial
- Parks

Noise Contour Lines

- 71 dB(A)
- 66 dB(A)

Noise Increase Points

(#) Predicted 1990 to 2025

0 500'
1 inch = 500 feet

Hankard Environmental

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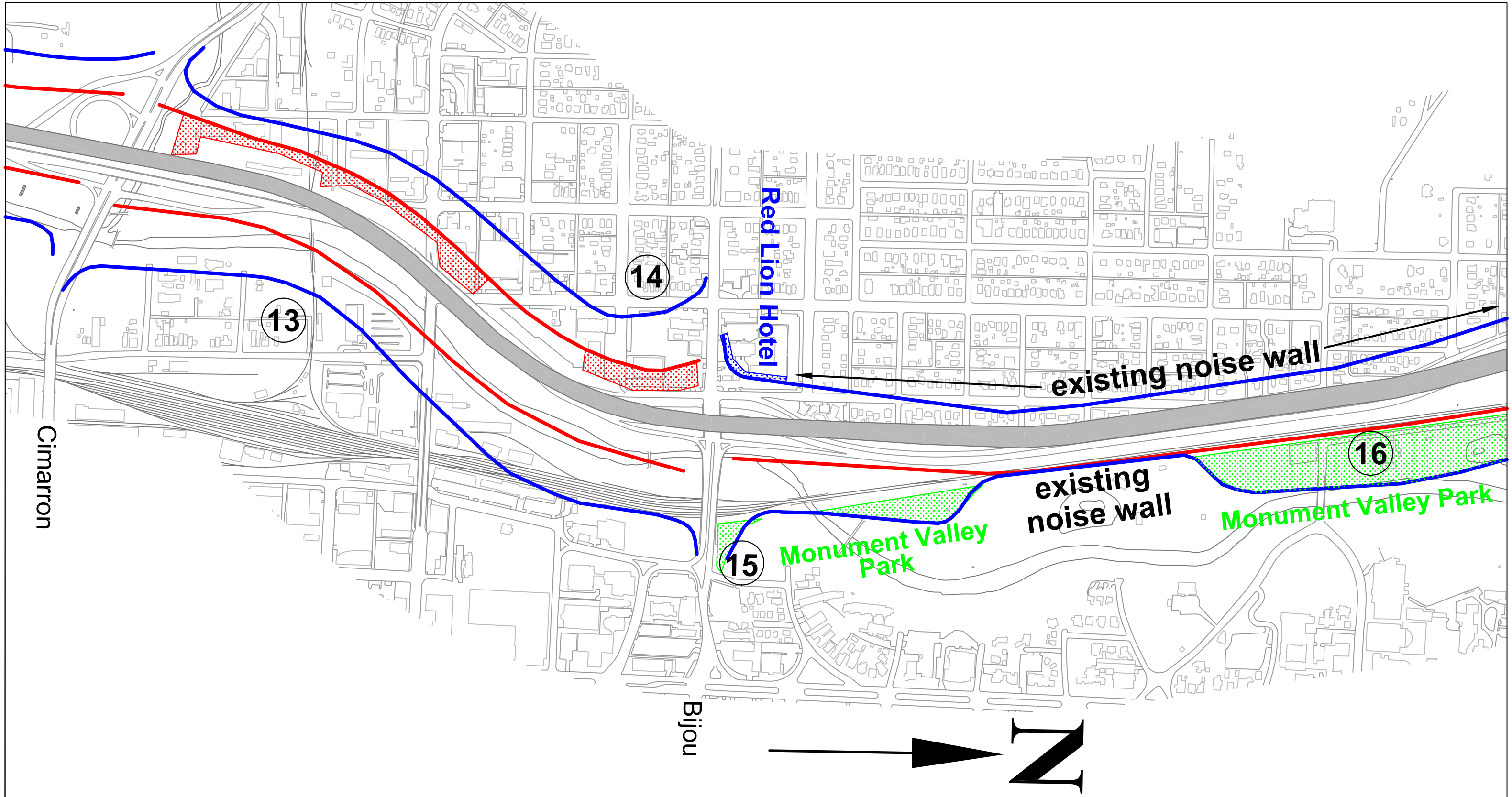
I-25 Colorado Springs EA Noise Analysis Site Plan Year 2025

Figure 5-6



Noise Impact Areas

- Residential
- Commercial
- Parks

Noise Contour Lines

- 71 dB(A)
- 66 dB(A)

Noise Increase Points

(#) Predicted 1990 to 2025

0 500'
1 inch = 500 feet

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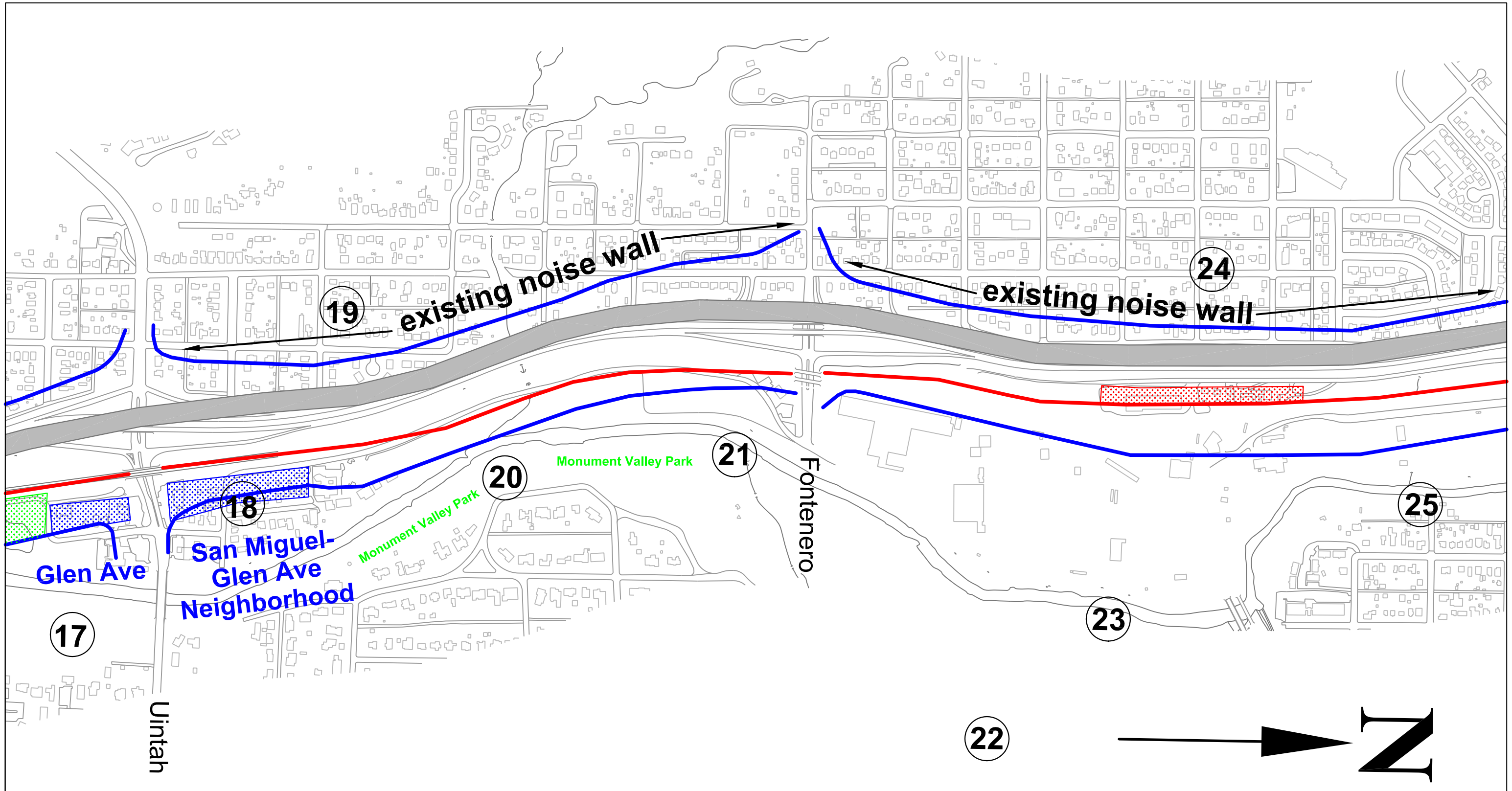
I-25 Colorado Springs EA Noise Analysis Site Plan Year 2025

Figure 5-7



Noise Impact Areas

- Residential
- Commercial
- Parks

Noise Contour Lines

- 71 dB(A)
- 66 dB(A)

Noise Increase Points

(#) Predicted 1990 to 2025

0 500'
1 inch = 500 feet

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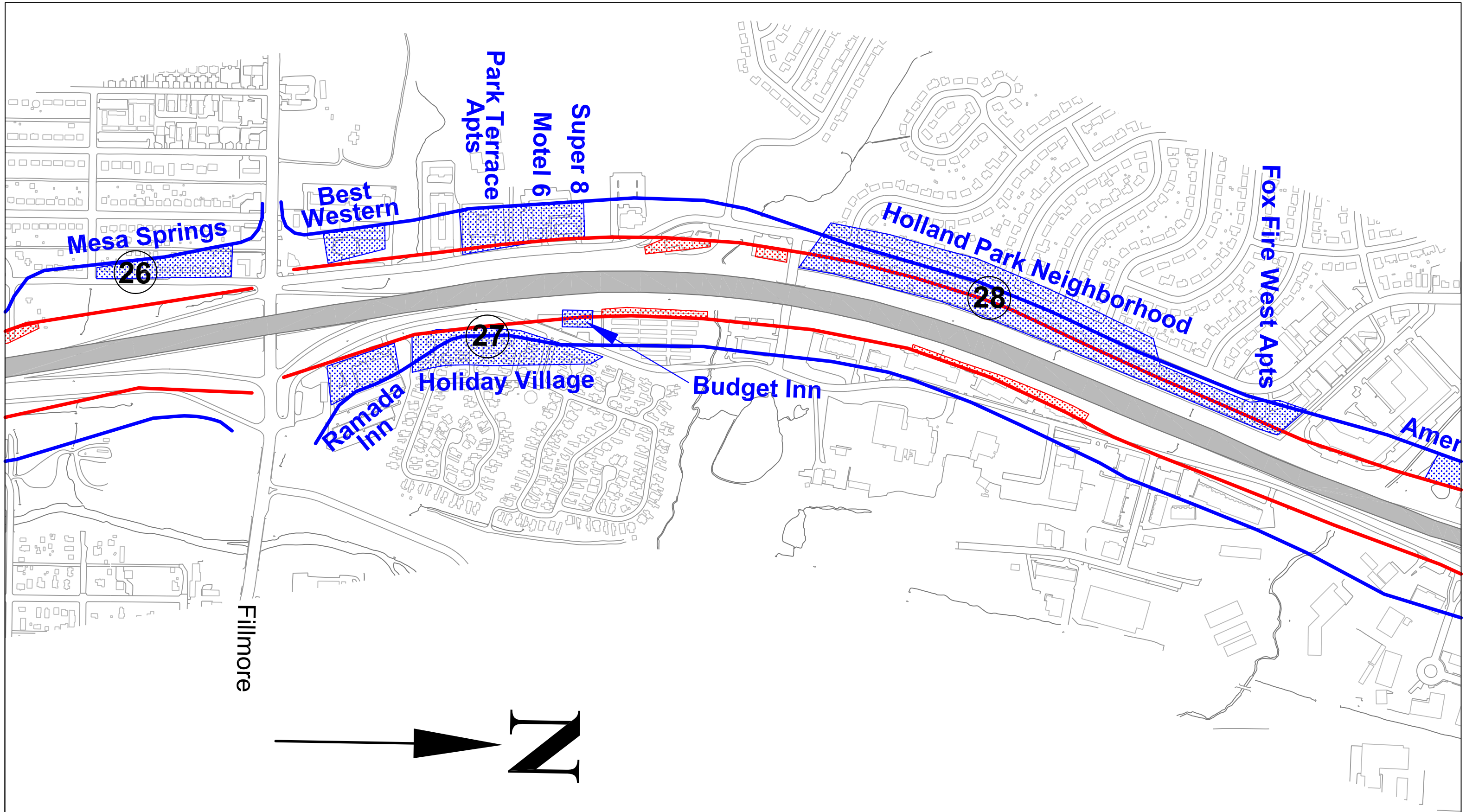
I-25 Colorado Springs EA
Noise Analysis Site Plan
Year 2025

Figure 5-8



Noise Impact Areas

- Residential
- Commercial
- Parks

Noise Contour Lines

- 71 dB(A)
- 66 dB(A)

Noise Increase Points

(#) Predicted 1990 to 2025

0 500'
1 inch = 500 feet

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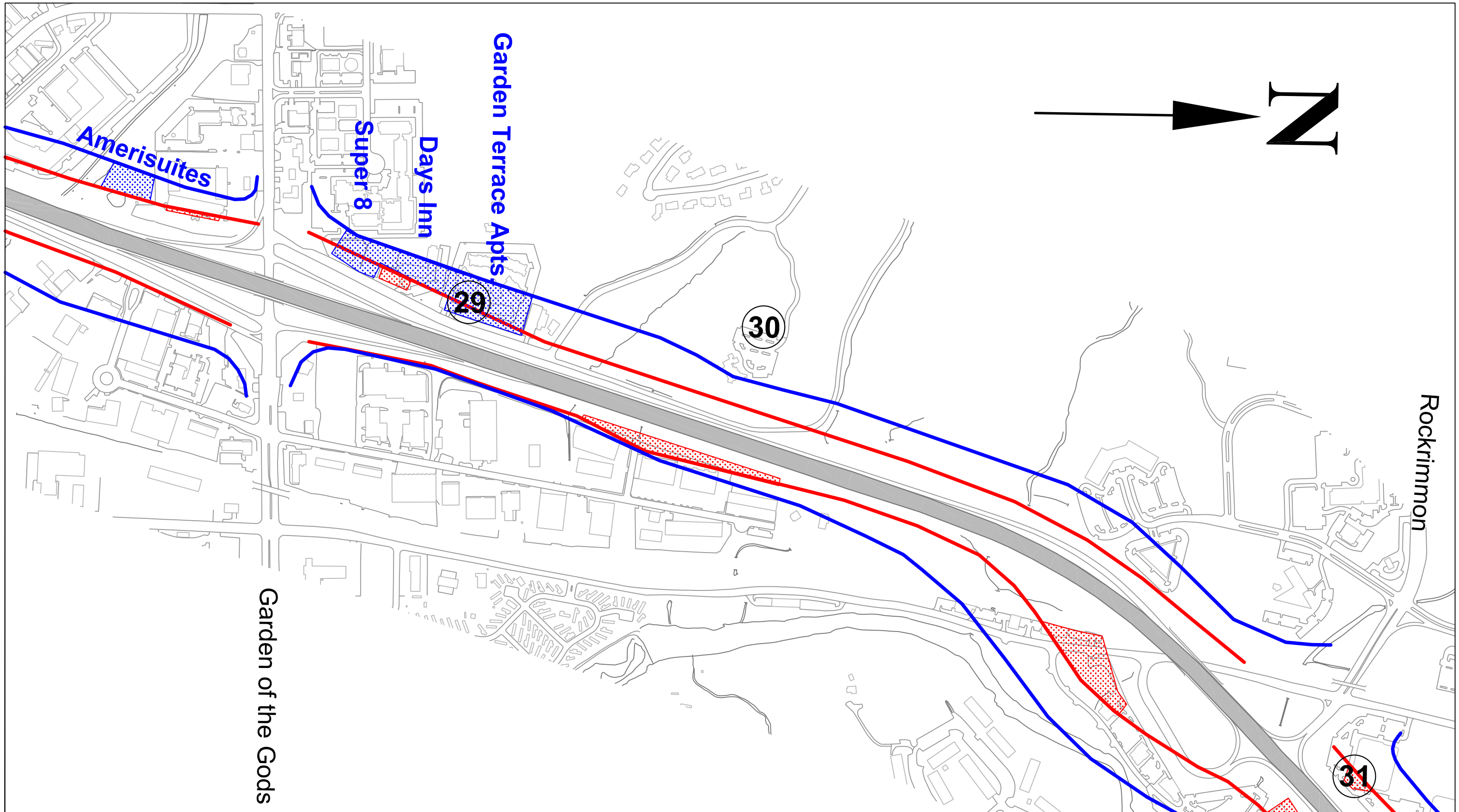
Figure 5-9



Noise Impact Areas

- Residential
- Commercial
- Parks

Noise Contour Lines

- 71 dB(A)
- 66 dB(A)

Noise Increase Points

(#) Predicted 1990 to 2025

0 500'
1 inch = 500 feet

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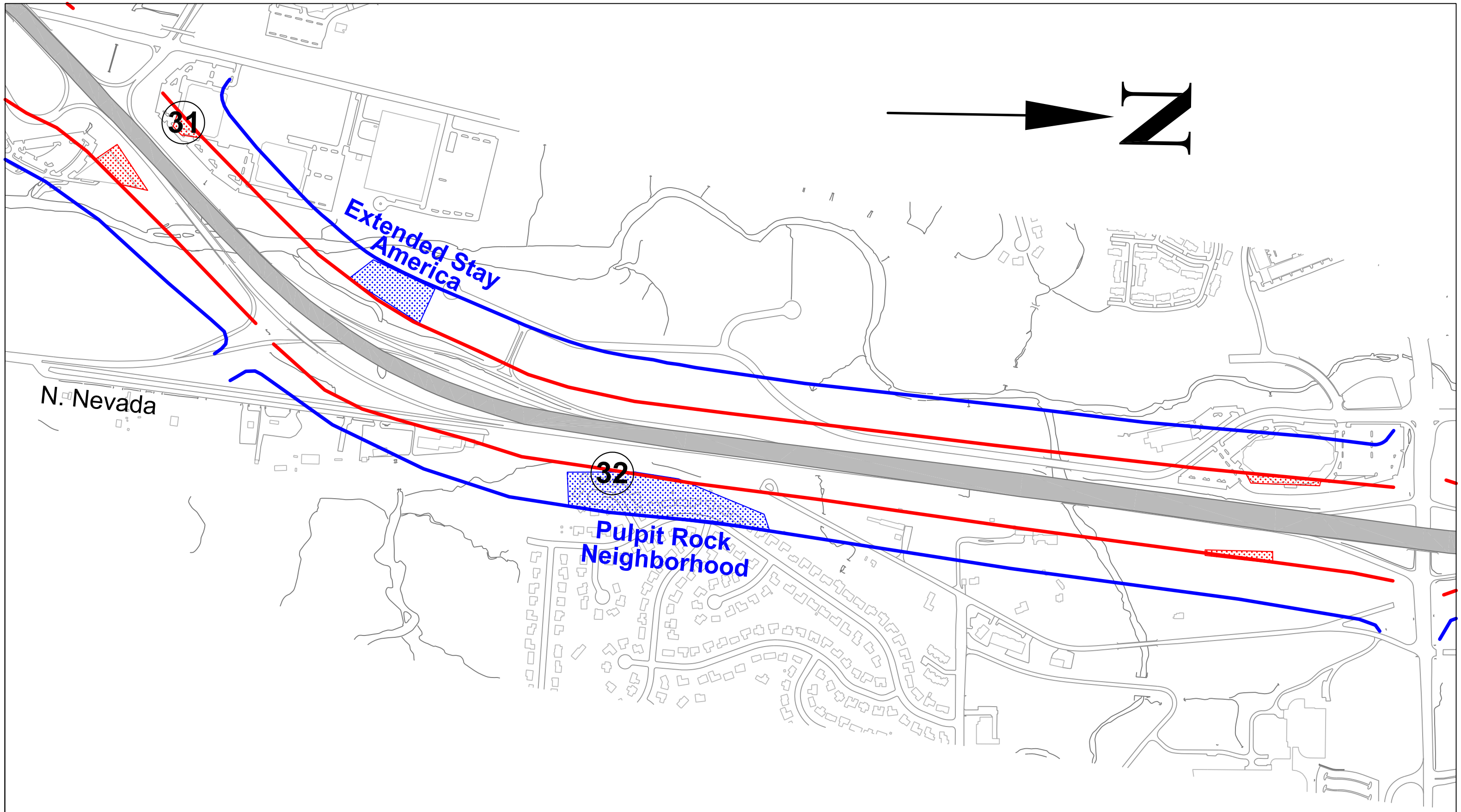
Noise Analysis Site Plan
Year 2025

Figure 5-10



Noise Impact Areas

- Residential
- Commercial
- Parks

Noise Contour Lines

- 71 dB(A)
- 66 dB(A)

Noise Increase Points

(#) Predicted 1990 to 2025

0 500'
1 inch = 500 feet

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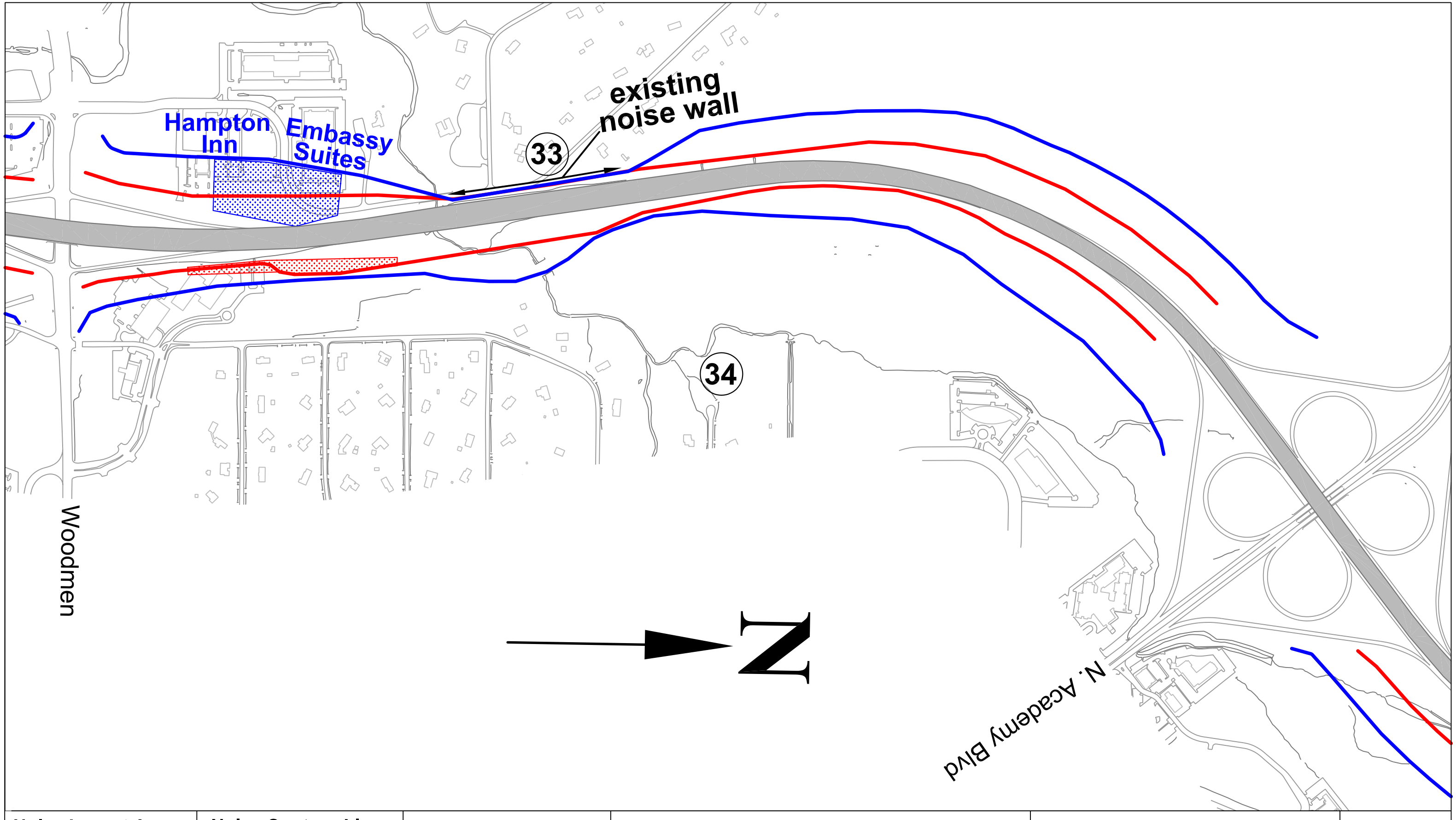
I-25 Colorado Springs EA Noise Analysis Site Plan Year 2025

Figure 5-11



Noise Impact Areas

- Residential
- Commercial
- Parks

Noise Contour Lines

- 71 dB(A)
- 66 dB(A)

Noise Increase Points

(#) Predicted 1990 to 2025

0 500'
1 inch = 500 feet

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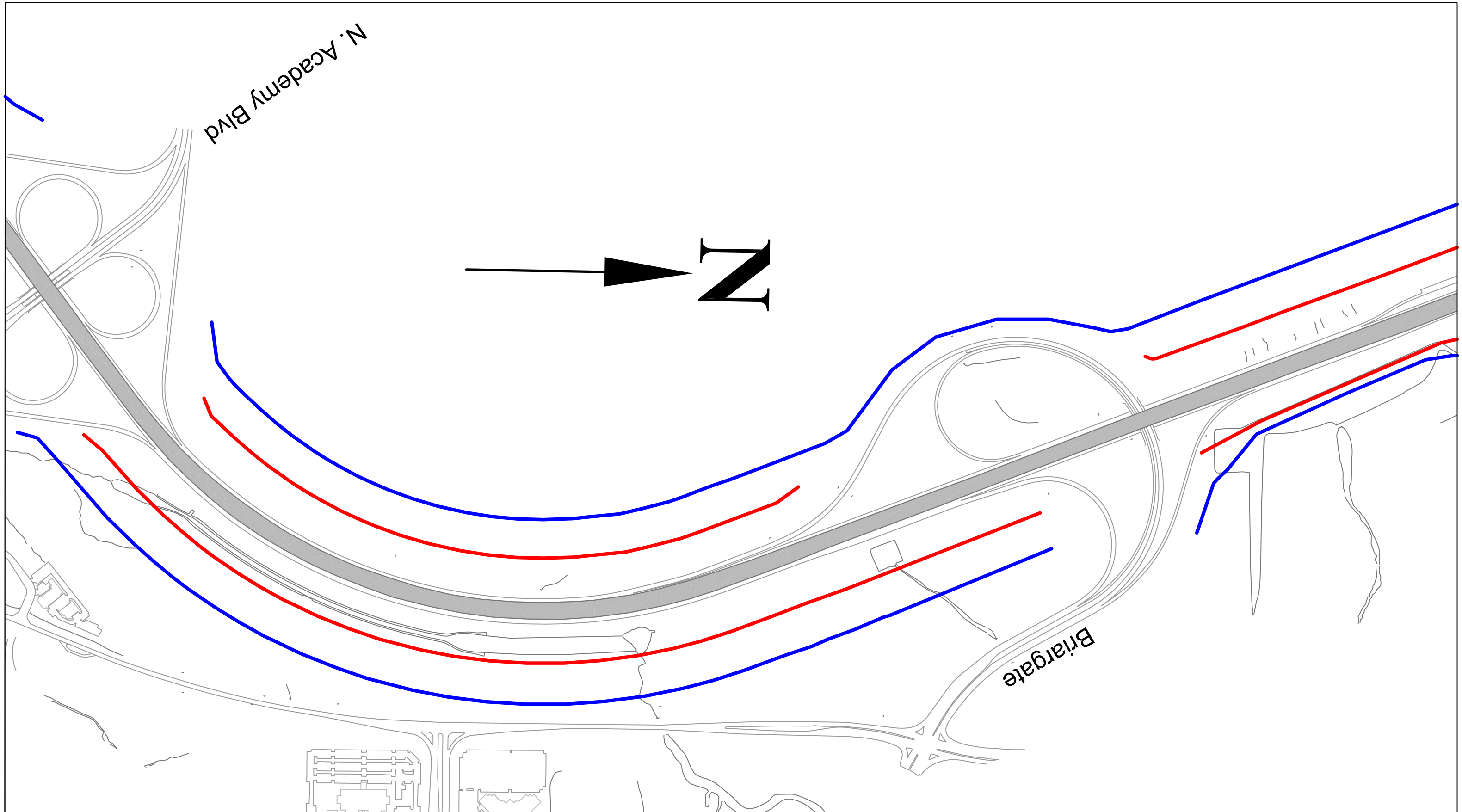
I-25 Colorado Springs EA Noise Analysis Site Plan Year 2025

Figure 5-12



Noise Impact Areas

- Residential
- Commercial
- Parks

Noise Contour Lines

- 71 dB(A)
- 66 dB(A)

Noise Increase Points

(#) Predicted 1990 to 2025

0 500'
1 inch = 500 feet

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I-25 Colorado Springs EA
Noise Analysis Site Plan
Year 2025

Figure 5-13

N

Interquest

35

Noise Impact Areas

- Residential
- Commercial
- Parks

Noise Contour Lines

- 71 dB(A)
- 66 dB(A)

Noise Increase Points

(#) Predicted 1990 to 2025

0 500'
1 inch = 500 feet

Hankard Environmental

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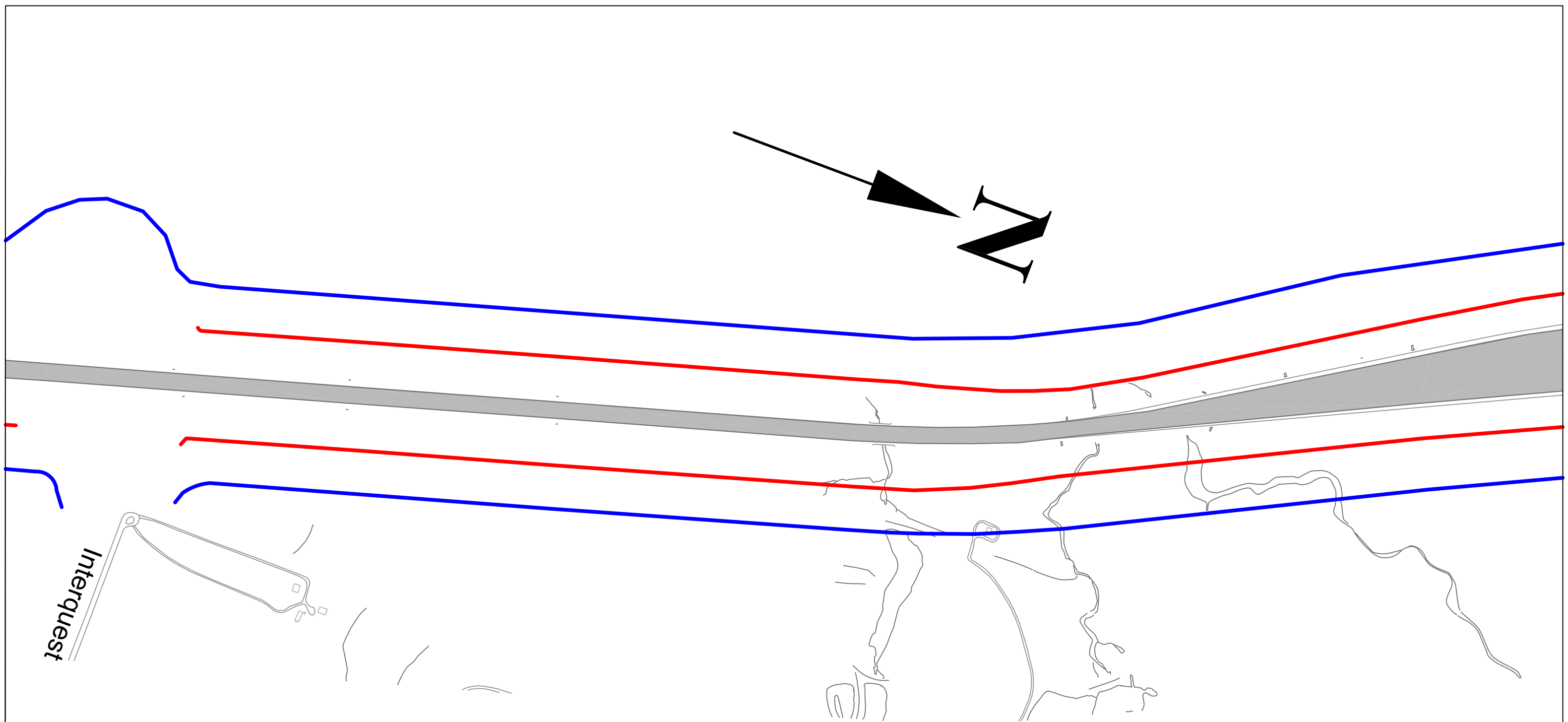
I-25 Colorado Springs EA
Noise Analysis Site Plan
Year 2025

Figure 5-14



Noise Impact Areas

- Residential
- Commercial
- Parks

Noise Contour Lines

- 71 dB(A)
- 66 dB(A)

Noise Increase Points

(#) Predicted 1990 to 2025

0 500'
1 inch = 500 feet

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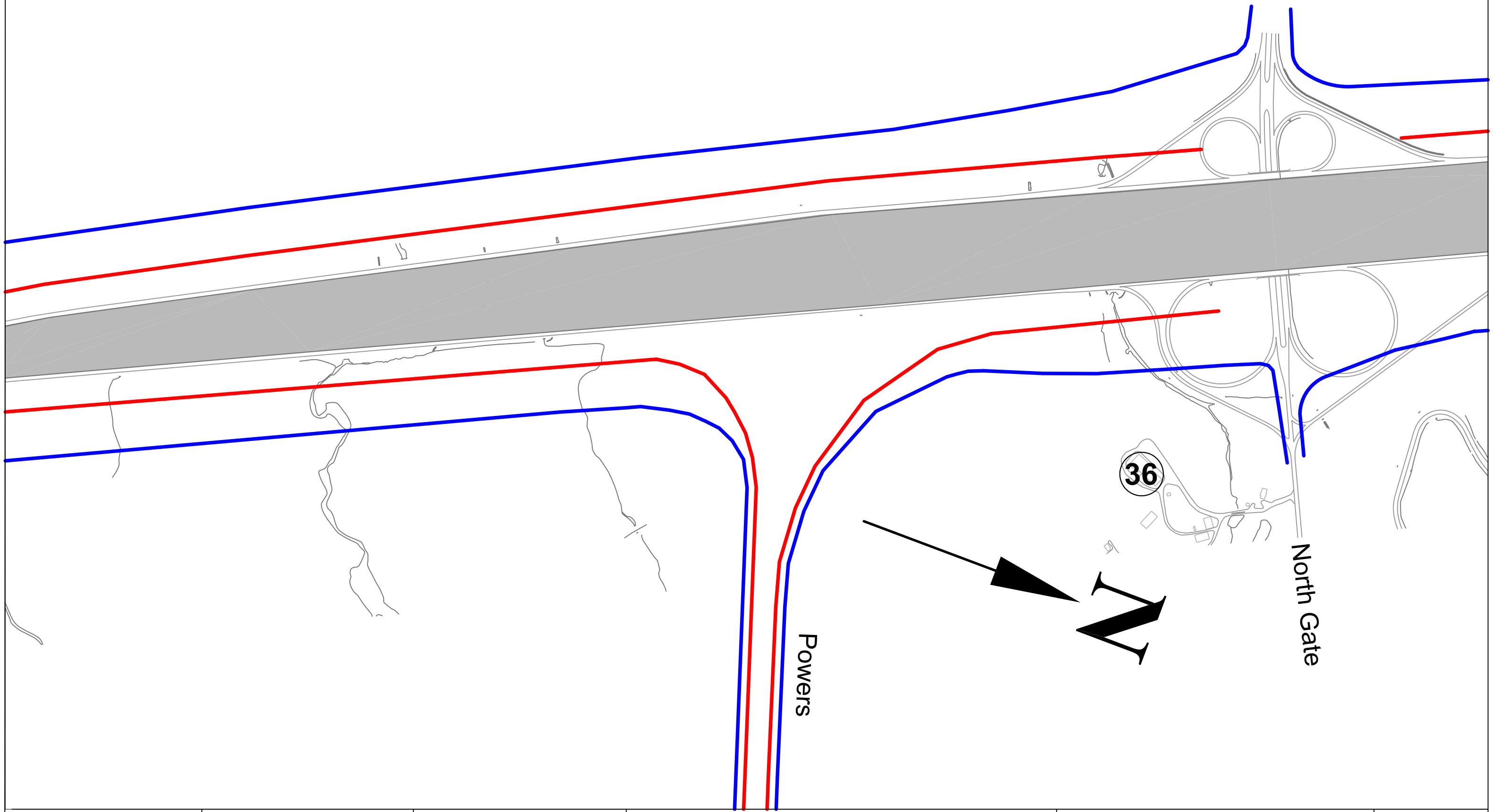
I-25 Colorado Springs EA
Noise Analysis Site Plan
Year 2025

Figure 5-15



Noise Impact Areas

- Residential
- Commercial
- Parks

Noise Contour Lines

- 71 dB(A)
- 66 dB(A)

Noise Increase Points

(#) Predicted 1990 to 2025

0 500'
1 inch = 500 feet

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I-25 Colorado Springs EA
Noise Analysis Site Plan
Year 2025

Figure 5-16

N

North Gate

37

38

Noise Impact Areas

- Residential
- Commercial
- Parks

Noise Contour Lines

- 71 dB(A)
- 66 dB(A)

Noise Increase Points

(#) Predicted 1990 to 2025

0 500'

1 inch = 500 feet

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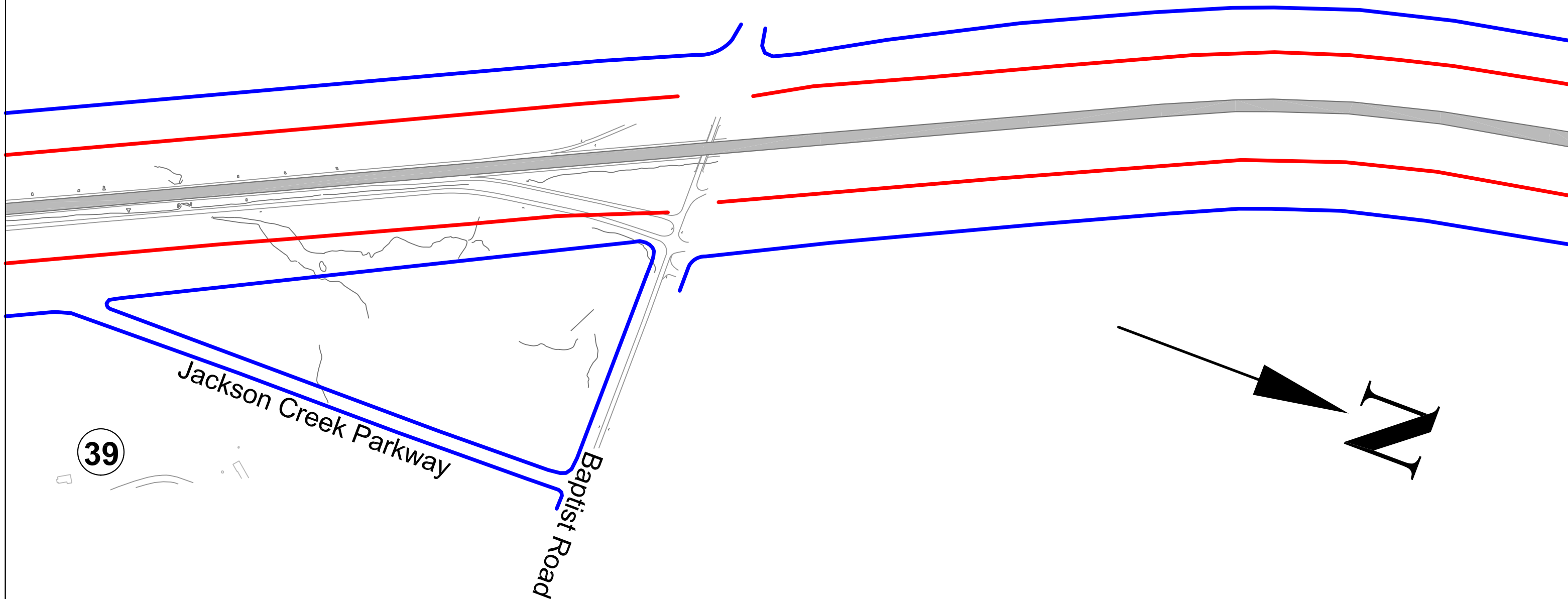
I-25 Colorado Springs EA
Noise Analysis Site Plan
Year 2025

Figure 5-17



Noise Impact Areas

- Residential
- Commercial
- Parks

Noise Contour Lines

- 71 dB(A)
- 66 dB(A)

Noise Increase Points

(#) Predicted 1990 to 2025

0 500'
1 inch = 500 feet

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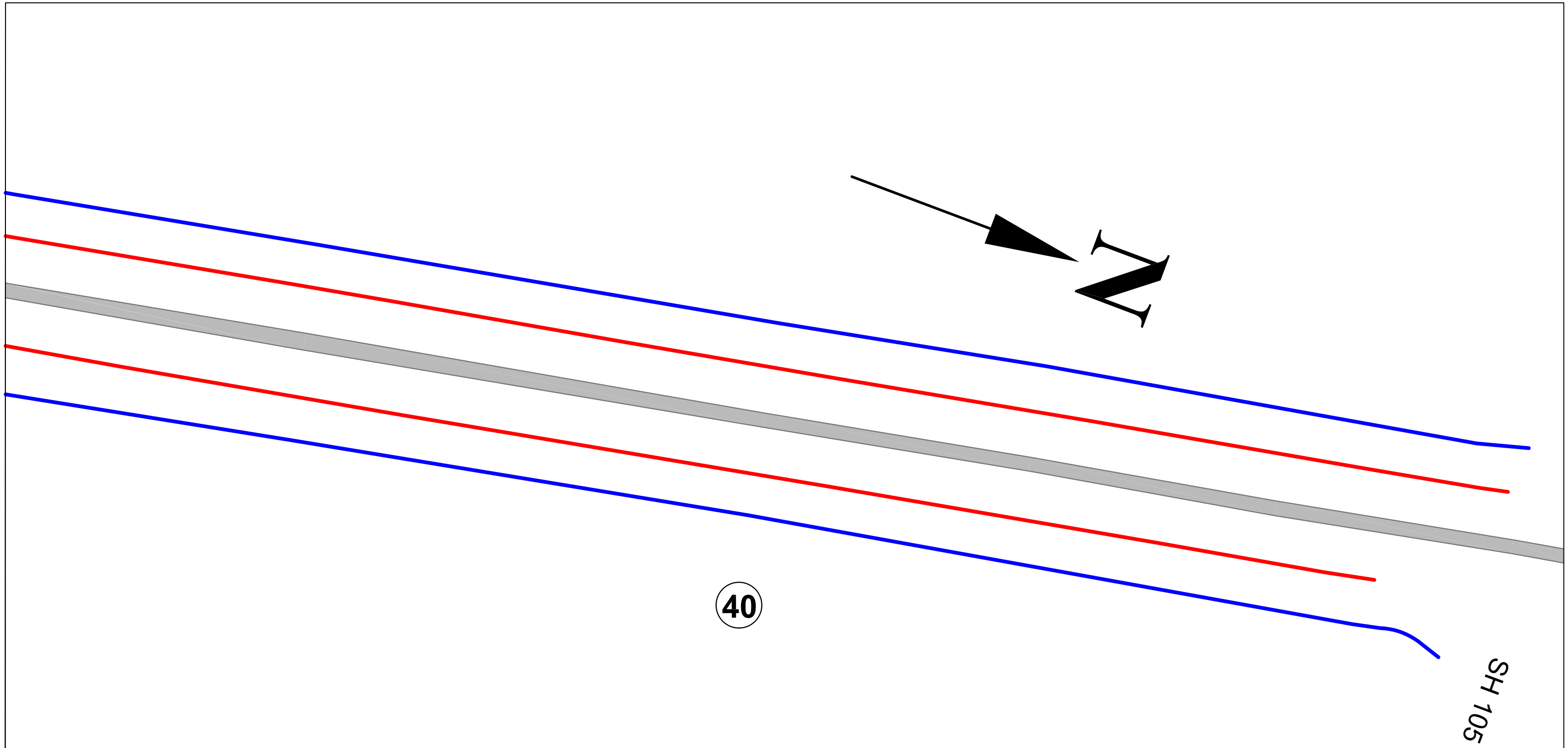
I-25 Colorado Springs EA Noise Analysis Site Plan Year 2025

Figure 5-18



Noise Impact Areas

- Residential
- Commercial
- Parks

Noise Contour Lines

- 71 dB(A)
- 66 dB(A)

Noise Increase Points

(#) Predicted 1990 to 2025

0 500'
1 inch = 500 feet

Hankard Environmental
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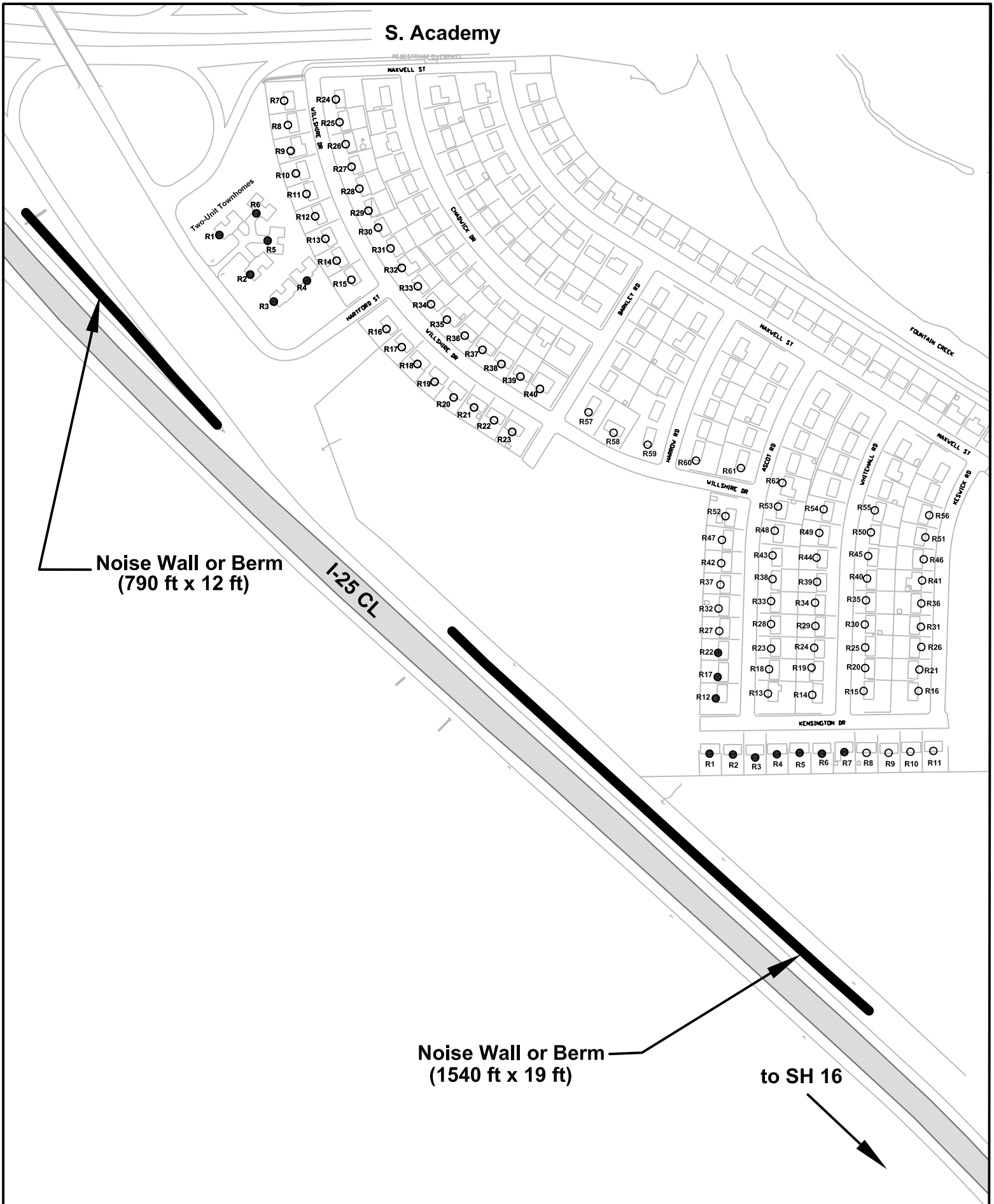
Fax: (303) 600-0282

I-25 Colorado Springs EA
Noise Analysis Site Plan
Year 2025

Figure 5-19



- impacted location
- analyzed location

Hankard Environmental

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Fort Collins, Colorado 80524
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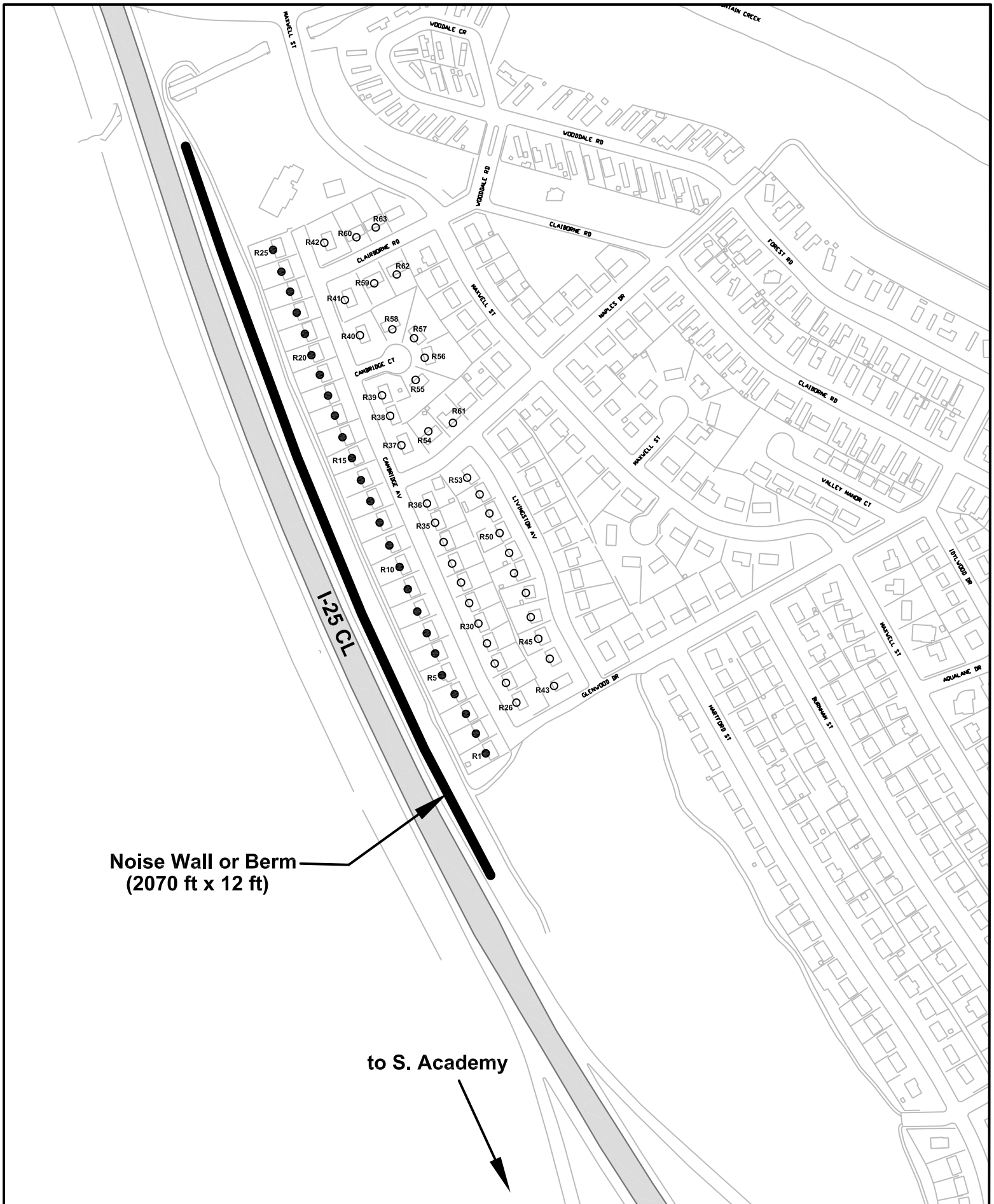
Fax: (303) 600-0282

Mitigation Analysis

Stratmoor Valley
South of S. Academy

Figure 6-1



- impacted location
- analyzed location

Hankard Environmental

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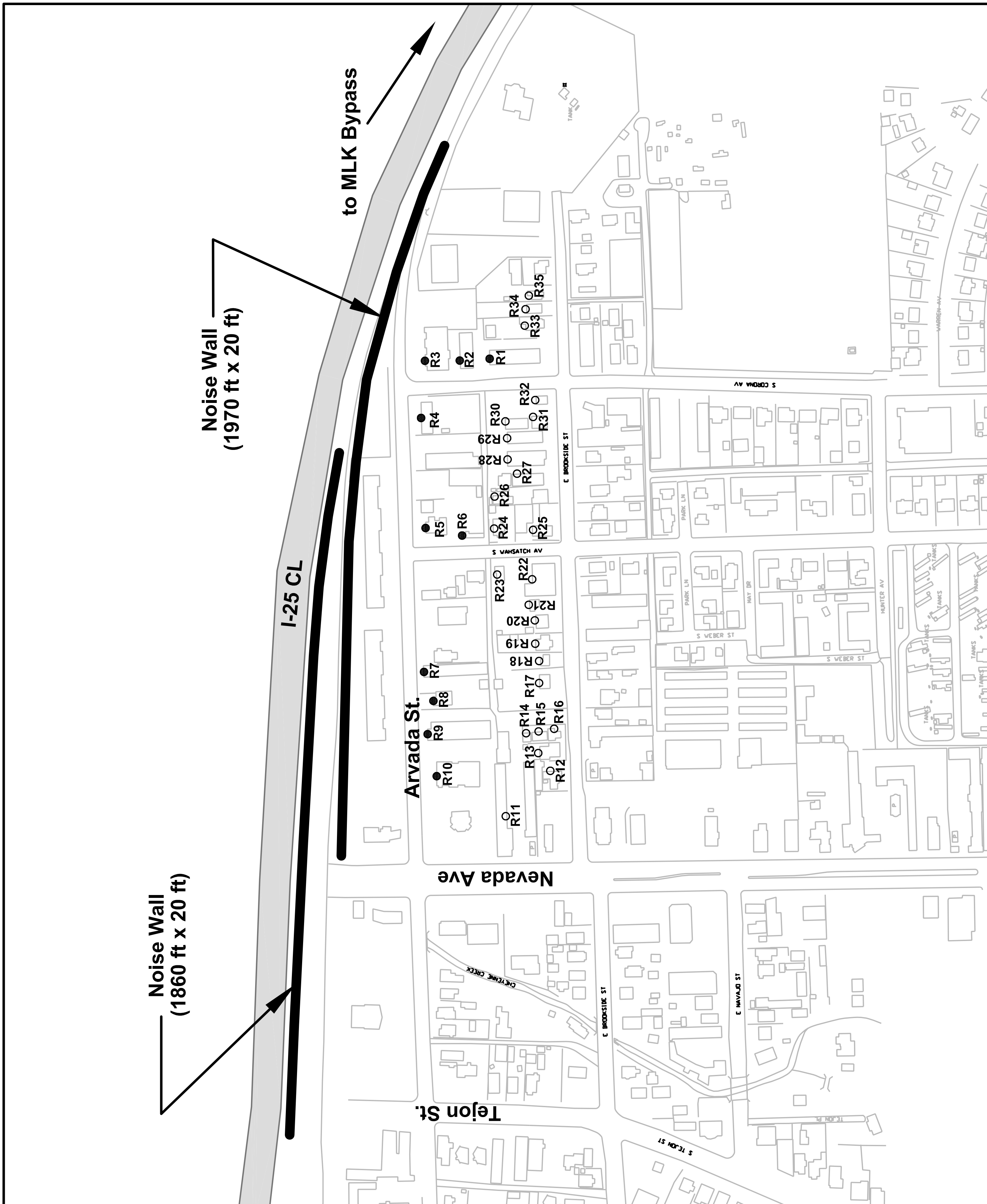
Mitigation Analysis
Stratmoor Valley
North of S. Academy

Figure 6-2



● - impacted location

○ - analyzed location

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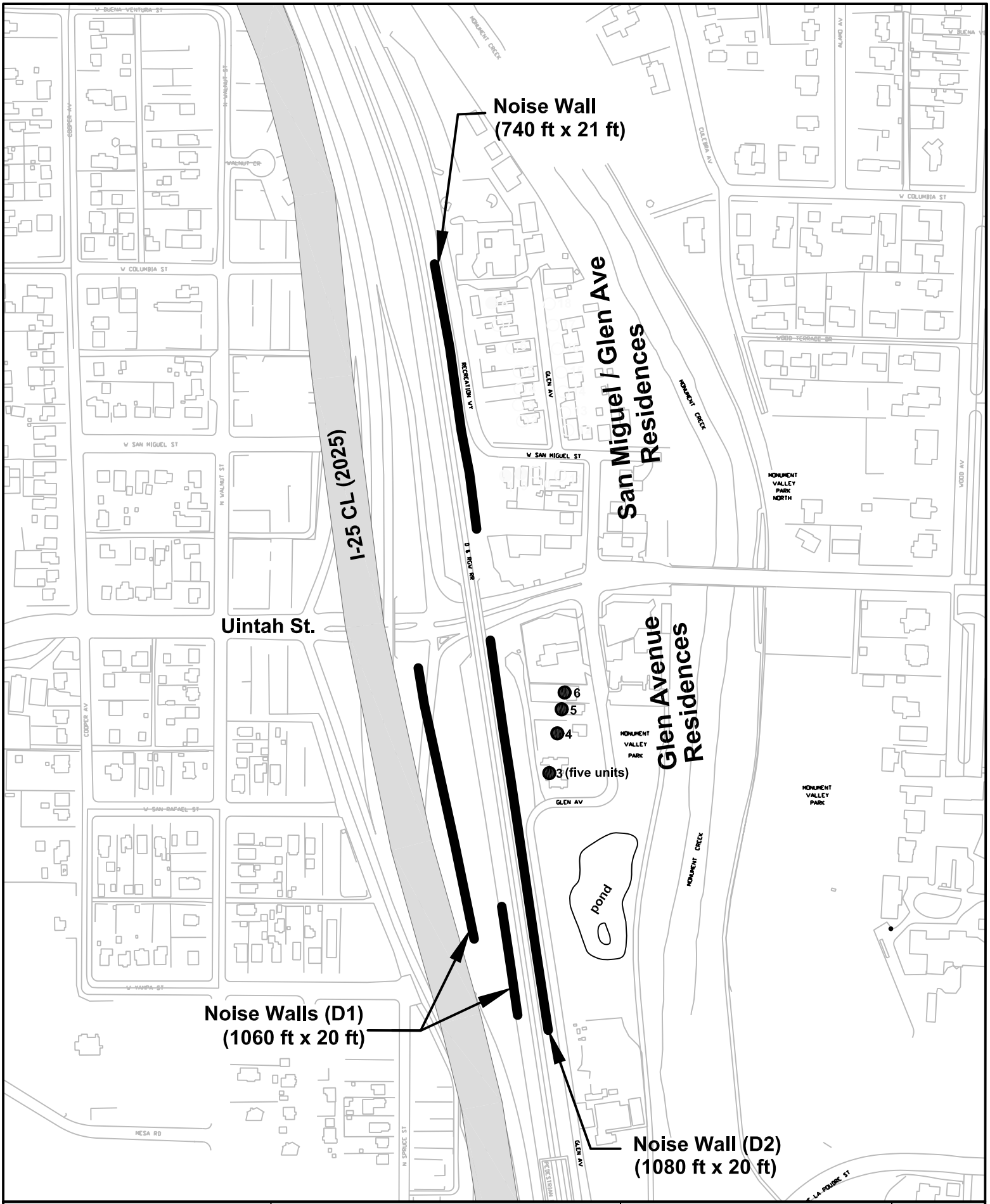
Mitigation Analysis
Stratton Meadows

Figure 6-3



- impacted location
- analyzed location

Hankard Environmental

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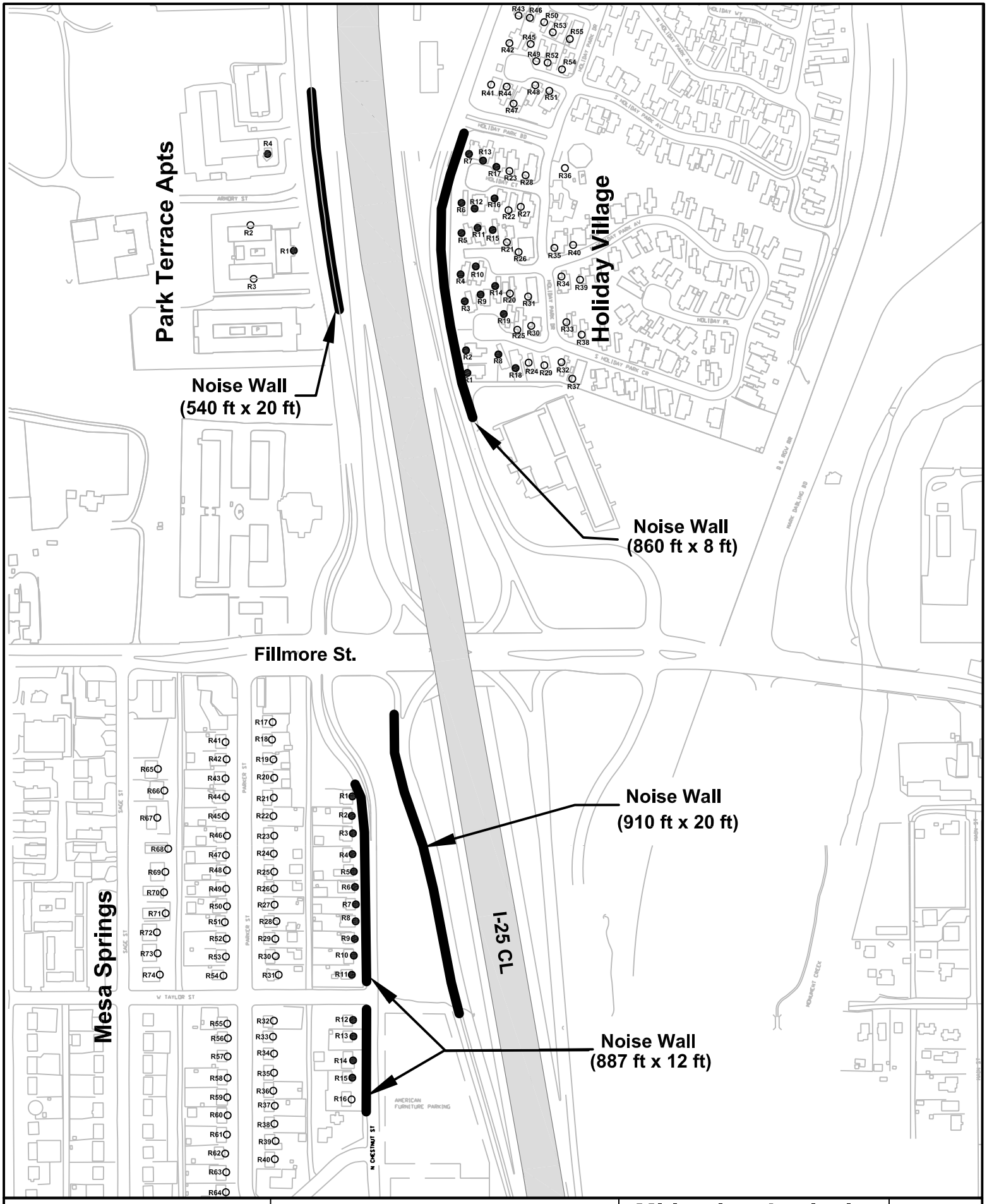
Mitigation Analysis
San Miguel and Glen Ave Residences

Figure 6-4



Hankard Environmental

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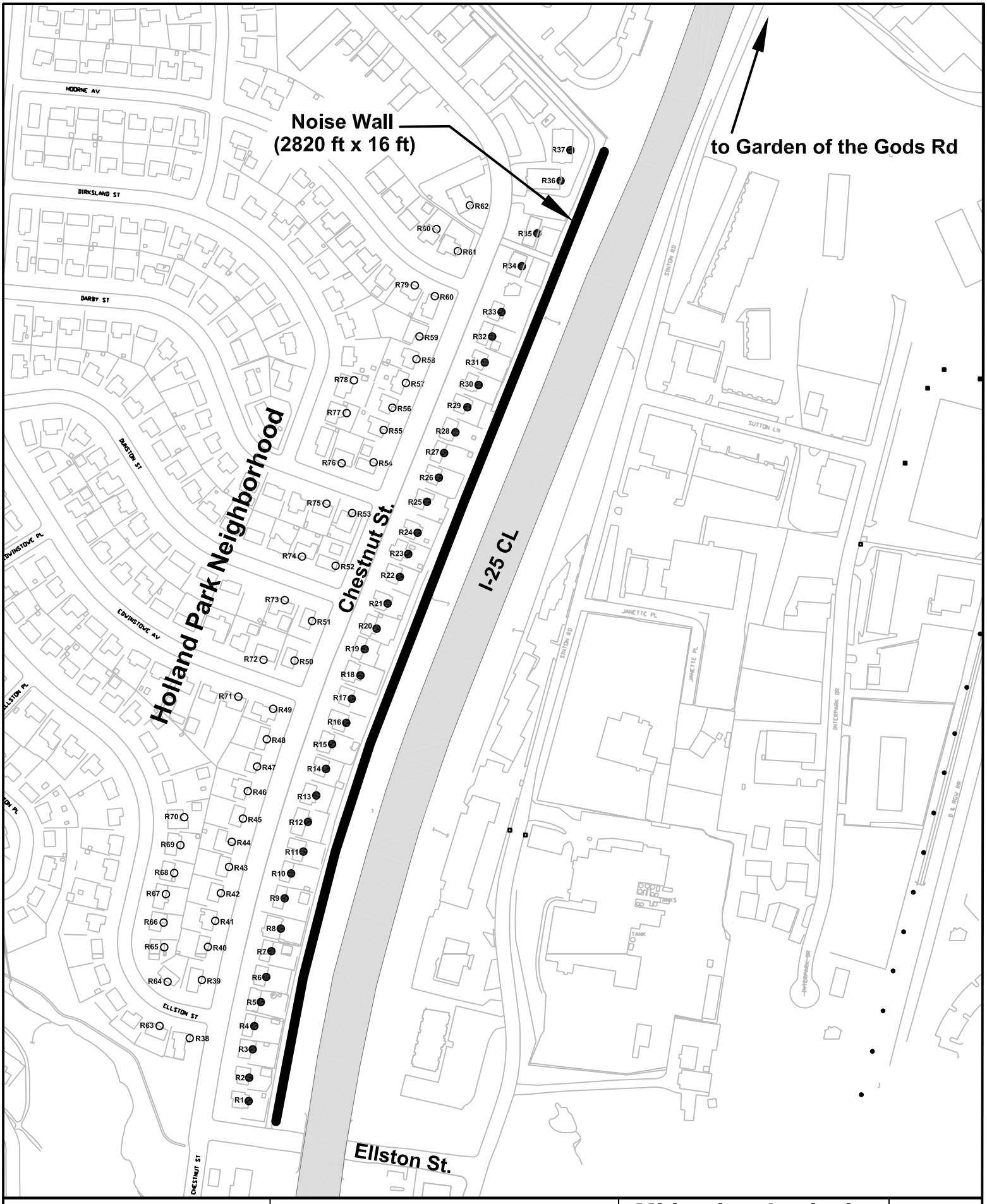
Mitigation Analysis
I-25 & Fillmore Interchange

Figure 6-5



- impacted location
- analyzed location

Hankard Environmental

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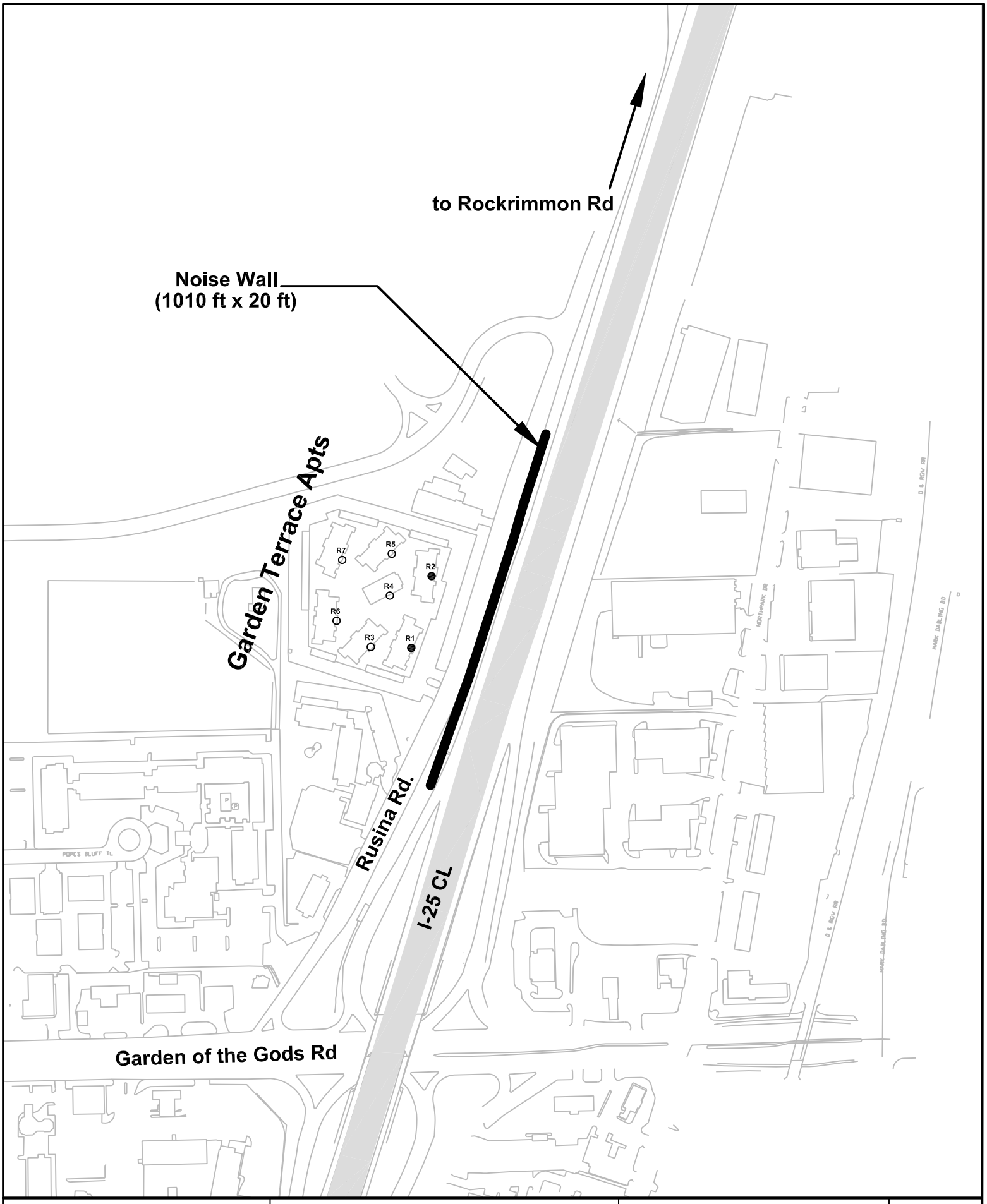
Mitigation Analysis
Holland Park Neighborhood

Figure 6-6



- impacted location
- analyzed location

Hankard Environmental

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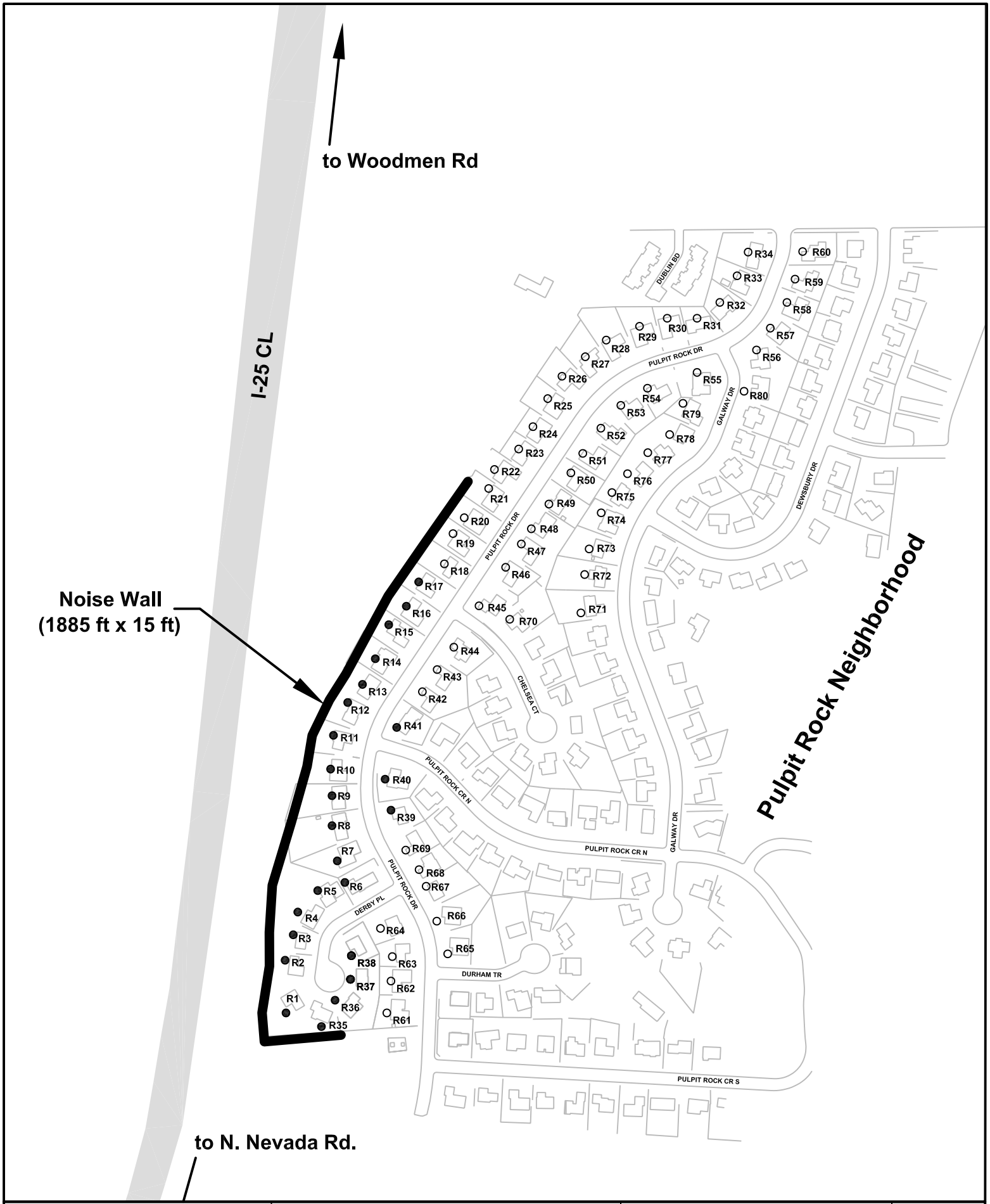
Mitigation Analysis
Garden Terrace Apts

Figure 6-7


to Woodmen Rd
I-25 CL
Noise Wall
(1885 ft x 15 ft)
Pulpit Rock Neighborhood
to N. Nevada Rd.
PULPIT ROCK DR
PULPIT ROCK CR N
PULPIT ROCK CR S
GALWAY DR
DEWSBURY DR
DUBLIN BD
CHELSEA CT
DERBY PL
DURHAM TR
R1
R2
R3
R4
R5
R6
R7
R8
R9
R10
R11
R12
R13
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R74
R75
R76
R77
R78
R79
R80
- impacted location
- analyzed location
Hankard Environmental
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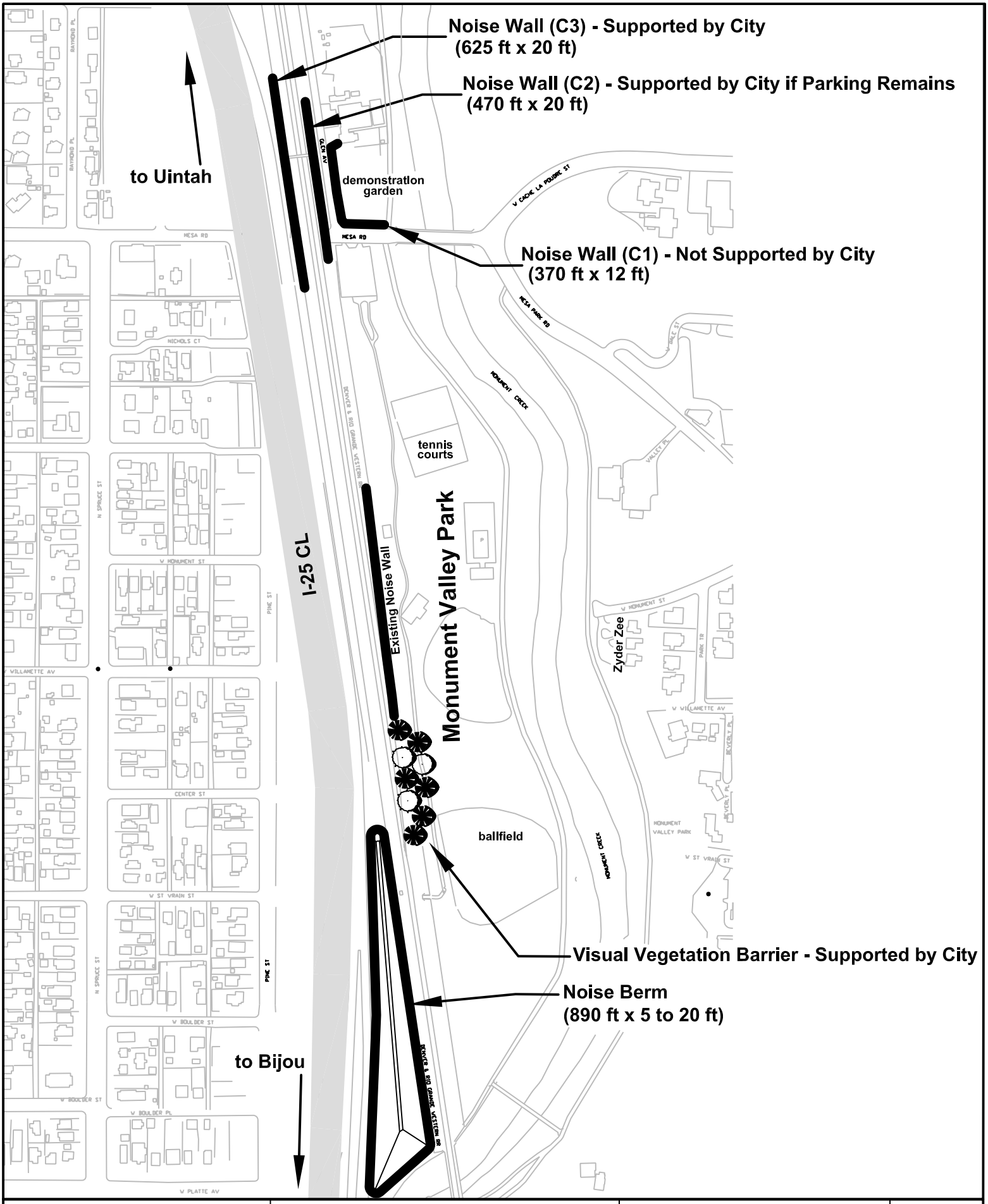
Fort Collins, Colorado 80524
Phone: (303) 666-0617
Fax: (303) 600-0282
Mitigation Analysis
Pulpit Rock
Neighborhood
Figure
6-8



- impacted location
- analyzed location

Hankard Environmental

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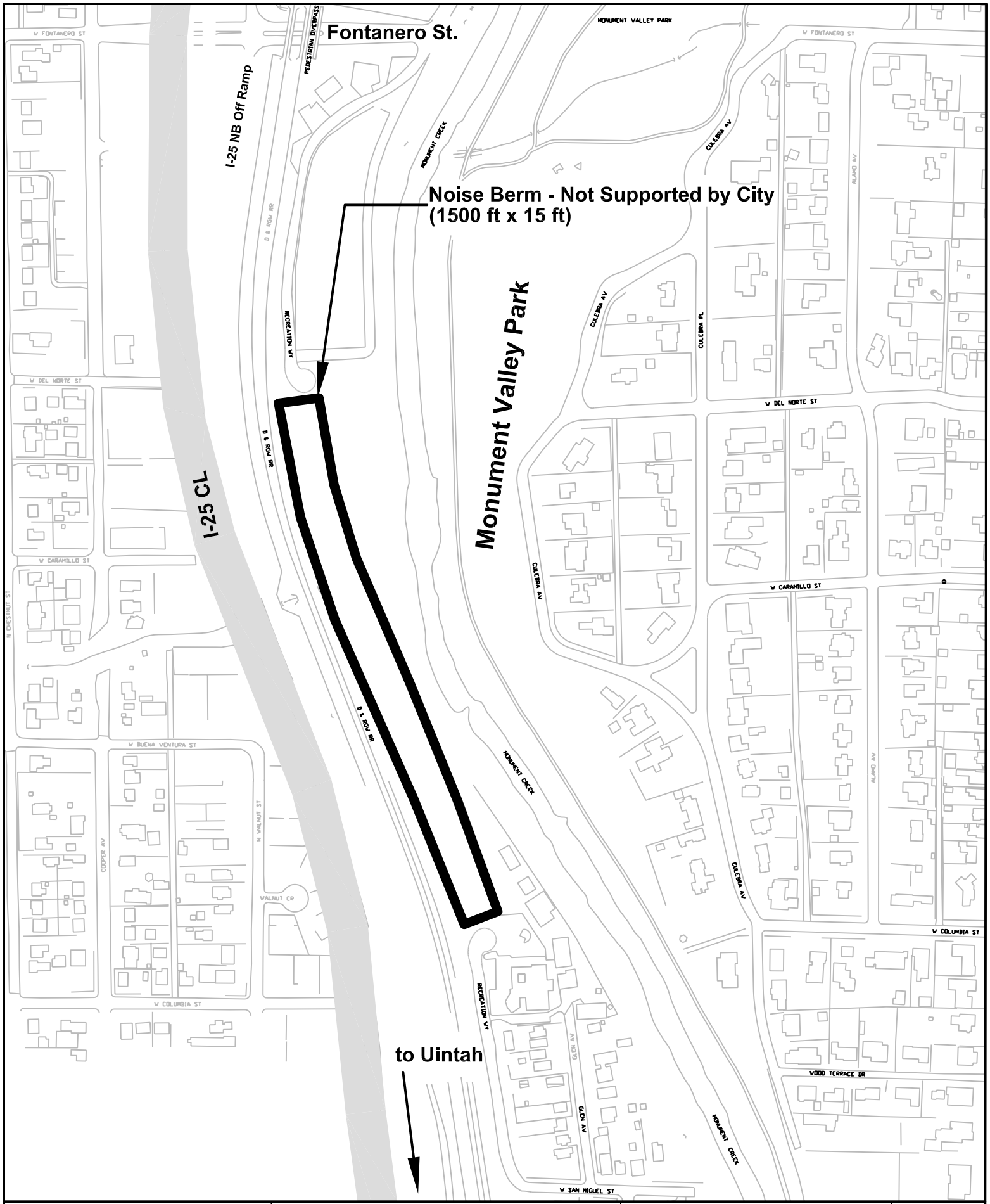
Mitigation Analysis
Monument Valley Park
Bijou to Uintah

Figure 6-9



- impacted location
- analyzed location

Hankard Environmental

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Mitigation Analysis
Monument Valley Park
Uintah to Fontanero

Figure 6-10