Noise Report

Sunrise Drive,
Craycroft Road to Kolb Road

Pima County, Arizona

FINAL DRAFT

August 2007

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Craycroft Road to Kolb Road

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Table of Contents

List of Figures

List of Tables

Introduction

The purpose of this noise study is to assess the potential noise impacts associated with the widening of Sunrise Drive from Craycroft Road to Kolb Road on adjacent land uses and development. The project area is shown in Figure 1.

The current Sunrise Drive cross section is two lanes from west of Via Zarzosa to Paseo Otono with widening at intersections for left turn lanes. From Paseo Otono to Kolb Road there is a center two way left turn lane. The existing cross section is uncurbed with graded shoulders. The proposed widening of Sunrise Drive will create a 4 lane cross section with a raised median, 6′ paved shoulders on either side without raised curb and a 5′ sidewalk on the north side.

DEFINITIONS

Decibel (dB) - A logarithmic form of any measured physical quantity, typically used in sound and vibration measurements. Each time 10 is added to the sound level (i.e. 60 dB to 70 dB), the value of the sound is actually 10 times higher. Every time the sound level increases by 3 dB, the level of sound is multiplied by 2 or doubled. When the sound level is frequency weighted, the annotation dBA, dBB, or dBC is used.

Energy Equivalent Sound Level (L_{eq}) - The level of a constant sound over a specific time period that has the same sound energy as the actual fluctuating sound over the same period.

Frequency Weighting - Adjustment of the amplitude of sound frequency to reflect the human ear response to various levels of sound.

- *A-Weighting:* Adjustment of the sound frequency in the same way the human ear does when exposed to low levels of sound. This weighting is most often used for evaluation of environmental sounds.
- *B-Weighting:* Adjustment of the sound frequency in the same way the human ear does when exposed to higher levels of sound. This weighting is seldom used in sound analysis.
- *C-Weighting:* Adjustment of the sound frequency in the same way the human ear does when exposed to high levels of sound. This weighting is most often used for evaluation of equipment sounds.

NOISE ABATEMENT CRITERIA

This noise study was performed based on the Pima County Department Procedure Number 03-5, Traffic Noise Analysis and Mitigation Guidance for Major Roadway Projects. The procedure was developed based on Noise Abatement Criteria set by the Federal Highway Administration (FHWA) and was established to protect land uses and their inhabitants from excessive sound generated by roadway traffic. Pima County Department Procedure Number 03-5 states:

> "After applying a 3 dBA benefit for the use of Rubberized Asphalt Concrete (RAC) and rounding to the nearest decibel, traffic noise mitigation shall be considered if either:
>
> 1. The predicted exterior noise level for a sensitive receiver is 66 dBA Leq or above; or,
>
> 2. The predicted exterior noise levels at a sensitive receiver "substantially" increase over existing (pre-project) levels as a result of the major roadway project – "substantial" is defined as 15 dBA or greater."

According to FHWA criteria, sound abatement must be considered when predicted sound levels for a particular land use approach or exceed the sound level threshold for its activity category. The sound level thresholds are provided in Table 1. Example decibel levels of common sound levels are presented in Figure 2 for comparison.

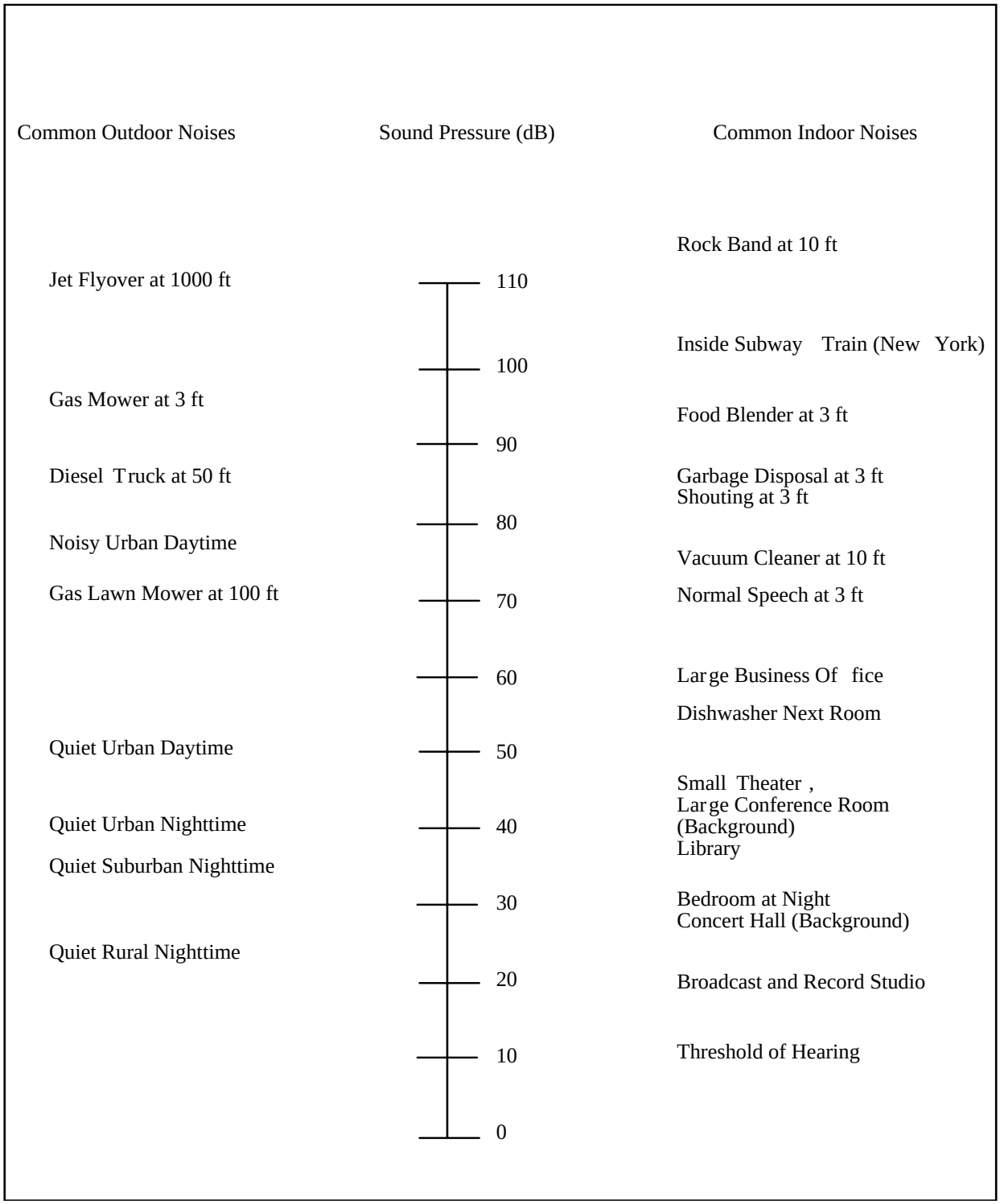
Table 1 FHWA Sound Thresholds

Activity Category	Description	L_{eq} (Decibels)
A	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 purposes.	57 dBA
B	Residences, schools, parks, churches, libraries, hospitals, motels, and hotels.	67 dBA
C	Developed lands not included in Categories A or B above.	72 dBA

Source: Code of Federal Regulations, Title 23, part 772

The Pima County 66 dBA threshold is 1 dB below the FHWA threshold which accounts for locations considered to be approaching the sound threshold. Therefore, in accordance with the Pima County procedure, sound mitigation will be considered at locations were the predicted future sound level exceeds the 66 dBA threshold. Sound mitigation will also be considered if the predicted sound levels are substantially higher over existing levels. A substantial increase is defined as 15 dBA by Pima County. The sound analysis considered only existing development in the project area.

Figure 2 Common Indoor and Outdoor Sound Levels



LAND USE AND TOPOGRAPHY IN THE PROJECT AREA

Current land uses within the Sunrise Drive project limits include those described by FHWA's Categories B and C. Land use adjacent to Sunrise Drive is predominantly made up of residential areas with a commercial node located at Kolb Road. Residential development between Craycroft Road and Kolb Road includes primarily single-family residences and can be described as low density. On the north side of Sunrise Drive, residences are relatively spread out, while residential development on the south side is typically grouped, often linearly, in small subdivisions located either at the top or bottom of a hill. Wide gaps of undeveloped areas exist between subdivisions. The San Ventana apartment complex is near Kolb Road on the north side of Sunrise Drive and is considered a high-density residential area.

The typical topography on this section of Sunrise Drive can be characterized as rolling with several significant cut and fill sections. Elevations along the roadway alignment vary from 2755 feet to 2863 feet.

Sound Assessment

Analysis of existing and future sound levels and mitigation was carried out using a sound prediction model calibrated for local conditions. The FHWA Traffic Noise Model (TNM) Version 1.1 was used. TNM uses site-specific information including traffic volumes and speed, percentage of vehicles by type, roadway geometry, area topography, and site acoustical properties to predict sound levels at receiver locations selected by the user. Once calibrated using existing sound level measurements, the TNM model was used to assess the sound impacts of future roadway geometry and traffic conditions on adjacent land uses.

DATA COLLECTION

Sound level and traffic volume measurements were collected at three locations within the project limits for use in model calibration to reflect existing conditions. Sound level measurements were taken using a Larson-Davis Model 820 noise meter with a current factory calibration certificate. The measurement locations were selected based on accessibility, land use, spacing, topography, proximity to major intersections, and potential for the location to be affected by the roadway widening. The sound measurement locations are shown in Figure 3. The horizontal and vertical position of each measurement location relative to the roadway centerline was determined from field measurements and by using a topographic map.

Sound level measurements were collected for 15-minute intervals during the morning (7:00-9:00 am) weekday peak traffic period on March 20 and 21, 2007. Fifteen-minute traffic counts on Sunrise Drive, including number of heavy vehicles, buses and motorcycles, were collected concurrently. The sound level measurements and traffic volume data collected are summarized in Table 2. Information on peak period travel speeds was determined using a test vehicle. Observed travel speeds ranged from 40 to 55 miles per hour (mph). The posted speed limit on Sunrise Drive is 45 mph.

Peak hour sound level measurements at the three measured locations ranged from a high of 69.9 dBA at location B to a low of 65.7 dBA at Location C. Existing sound levels are dependent upon several factors including volume of traffic, location (horizontally and vertically) relative to surrounding roadways, and the amount of shielding provided by either natural or man-made barriers and the grade of the roadway. Three important characteristics along Sunrise Drive that will affect the existing sound levels are how dense the natural vegetation is between a receiver and the roadway, the location and size of the cut and fill slopes throughout the project area and the severity of the roadway grades that cause vehicles to have to accelerate or decelerate. An additional challenge in this area is the location of several washes and the non-tangent horizontal alignment, which causes the sound energy to be reflected causing the source of sound to appear to move.

Figure 3 Common Indoor and Outdoor Sound Levels

Table 2 Measured Sound Levels

No.	Location Description	Distance from Existing Roadway Centerline (ft)	Elevation Difference Relative to Roadway (ft)[1]	15-minute Traffic Counts (2-way)		Measured Sound Level L_{eq} (dBA)
				Autos	HV[2]	
A	South of Sunrise Drive; East of Zarzosa Road	45	+1	313	10	67.9
B	South of Sunrise Drive; East of Wilmot Road	40	+2	288	13	69.9
C	South of Sunrise Drive; West of Paseo Otono	65	-3	299	9	65.7

1. Elevation difference is from the sound meter to the top of roadway. The sound meter is 4.9-feet above the surrounding ground.

2. HV – Heavy Vehicles, which include trucks with three or more axles and buses: Autos includes motorcycles.

MODEL DEVELOPMENT

Using the TNM model, a sound prediction model representing existing conditions in the Sunrise Drive study area was created and calibrated based on the field measurements. The following features and characteristics are included in the model.

- Relative humidity of 20% and an average temperature of 85 degrees Fahrenheit
- A default ground setting of "Field Grass" (found to have similar values as desert landscape)
- The existing horizontal and vertical alignments of Sunrise Drive
- Acceleration rates at traffic signals, stop signs, side streets and on steep graded roadway sections
- Existing walls around residential developments (existing walls surrounding single-family homes were not included in the model)
- Large groups of building such as apartment complexes and office parks
- Terrain lines where significant cut and fill slopes and ditches occur
- Ground zones were the ground varies from the default (i.e., pavement)

Sound levels were predicted at each location where field measurements were taken using the traffic volumes and vehicle type classifications that were collected concurrently with the field noise measurement. The model was run to predict a sound level at the same location, and under the same conditions, as field measurement locations. If the predicted levels do not match the measured levels, a receiver adjustment factor can be used on roadway segments to calibrate the model as needed. (i.e., match the measured sound levels with the predicted sound levels)

The measured and predicted sound levels are compared in Table 3. This comparison indicates that prior to calibration; the model is predicting sound levels between -0.7 and +1.1 dBA of the measured levels, which is considered a reasonable deviation. The differences between the predicted and measured sound levels are due to a variety of factors, including the variation in sound levels produced by different vehicle type classifications, the level of ambient or background noise not able to be input into the model, and the shielding effects created by vegetation and rolling

terrain. Since the model predicts values within a reasonable deviation, the model is considered valid for use in analyzing the impacts of increased sound levels on adjacent properties to determine the need for abatement without the use of additional adjustment factors.

Table 3 Model Calibration

No.	Location Description	Hourly Traffic Volumes [1]		Measured Sound Level L_{eq} (dBA)	Predicted Sound Level L_{eq} (dBA)	Difference (Predicted minus Measured) (dBA)
		Autos	HV[2]			
A	South of Sunrise Drive; East of Zarzosa Road	1252	40	67.9	69.0	+1.1
B	South of Sunrise Drive; East of Wilmot Road	1152	52	69.9	70.2	+0.3
C	South of Sunrise Drive; West of Paseo Otono	1196	36	65.7	65.0	-0.7

1. Traffic volume of automobiles and heavy vehicles equal to four times the 15-minute count.
2. HV – Heavy Vehicles, which include trucks with three or more axles and busses: Autos includes motorcycles.

NOISE ANALYSIS

Sound levels were predicted for two scenarios: existing conditions (2006) and the future build condition (2030). Twenty-one sound receptors, representing existing residences were coded into the model. The receptor locations are shown in Figure 3. Each receptor was generally located at the side of the residence closest to the roadway. Although not all existing residences were included in the model, those selected were considered to provide a comprehensive evaluation of noise impacts throughout the study area being analyzed. The following assumptions were made and coded into the model.

For both scenarios, existing (2006) conditions and future build (2030) conditions:

- The elevation of each receptor is 4.8 feet above the surrounding grade.
- Roadway and surrounding grade elevations were determined using a contour map with 1-foot intervals.
- Peak hour volumes were generated using average daily traffic, turning movement counts, and K and D factors from the Traffic Engineering Report prepared for Sunrise Drive.
- 1.5% of the traffic volume is medium size vehicles and 0.5% of the traffic is heavy vehicles as determined from the classification counts in the Traffic Engineering Report for Sunrise Drive.
- The roadway elevation was kept constant at the current profile as it is intended that the Sunrise Drive project will essentially follow the vertical alignment of the existing roadway.
- Existing walls that are around housing developments and apartment complexes were modeled, but existing walls around single-family homes were not.
- A travel speed of 50 mph was assumed along Sunrise Drive.

For existing (2006) conditions:

- The existing Sunrise Drive centerline was used with a 3 lane cross section and lane widths of 12 feet.

For future build (2030) conditions:

- The future Sunrise Drive centerline was used with a 4 lane divided cross section with 12-foot lanes, 12-foot median and 6-foot bike lanes.

In addition to these conditions, the items discussed in the previous "Model Development" section were also included in the model. The existing and future peak-hour traffic volumes are compared in Table 4. The traffic volumes and vehicle classifications were developed from the Traffic Engineering Report for Sunrise Drive. The predicted sound levels for the two scenarios are summarized in Table 5, rounded to the nearest decibel as directed by the County procedure. Also note, that these values do not include the 3 dBA benefit for the use of Rubberized Asphalt.

Table 4 Existing and Future Peak-Hour Traffic Volumes

Roadway Segment	2006 Peak Hour Volumes			2030 Peak Hour Volumes		
	Passenger Cars	Medium Vehicles	Heavy Vehicles	Passenger Cars	Medium Vehicles	Heavy Vehicles
Sunrise Drive; Craycroft Road to Wilmot Road	1608	24	8	2001	30	9
Sunrise Drive; Wilmot Road to Kolb Road	1525	23	7	1867	28	9

EXISTING CONDITIONS (2006)

Existing sound levels at the 21 receptors modeled range from 52.4 to 62.7 dBA. The low sound level was predicted at location S5, representing a single-family residence located south of Sunrise Drive along the Apache Hills Trail. The highest existing sound level was at location N11, which represents the San Ventana apartment complex west of Kolb Road on the north side of Sunrise Drive. Locations N10 and N11 are the only modeled receivers that are affected by existing walls included in the analysis. Existing sound levels all fall below the 66.0 dBA threshold that requires noise mitigation to be considered.

FUTURE BUILD (2030)

Increased traffic volumes coupled with the roadway widening and realignment will result in higher sound levels at residences along Sunrise Drive from Craycroft Road to Kolb Road. Predicted future sound levels at the 21 receptors modeled range from 54.2 to 64.9 dBA. Generally, sound levels at receiver locations are predicted to increase from 0.0 to 3.5 dBA. These predicted increases are well below the substantial increase threshold of a 15 dBA increase. There are no predicted sound levels in this project study area that exceed the Pima County threshold of 66 dBA for a residential area. Thus, it is not necessary to consider additional sound mitigation methods along this project.

Table 5 Predicted Sound Levels

Rec.	Location	Elevation Difference from Roadway Centerline (ft)	Distance from Roadway Centerline (ft)[1]	Predicted Sound Level Existing (2006) L_{eq} (dBA)	Predicted Sound Level Future (2030) L_{eq} (dBA)	Sound Level (L_{eq}) Increase (dBA)
N1	North Side; West of Via Zarzosa	+2	238	57	58	+1
N2	North Side; East of Via Zarzosa	+37	187	60	62	+2
N3	North Side; Along Via Gerasol	+53	153	58	61	+3
N4	North Side; Along Via Gerasol	+58	296	57	61	+4
N5	North Side; West of Wilmot Rd	+27	219	61	63	+2
N6	North Side; East of Wilmot Rd	+1	168	59	61	+2
N7	North Side; East of Wilmot Rd	+51	158	58	60	+2
N8	North Side; Along Via Amable	+17	182	59	61	+2
N9	North Side; West of Paseo Otono	+7	134	60	61	+1
N10	North Side; East of Paseo Otono	+8	118	62	65	+3
N11	North Side; West of Kolb Rd	-6	124	63	65	+2
S1	South Side; West of Paseo Sonoyta	+26	146	61	61	+0
S2	South Side; East of Paseo Sonoyta	-14	136	60	61	+1
S3	South Side; East of Paseo Sonoyta	-11	128	60	61	+1
S4	South Side; East of Paseo Sonoyta	-2	112	61	62	+1
S5	South Side; Along Apache Hills Tr	-57	367	54	56	+2
S6	South Side; West of Wilmot Rd	-15	327	59	59	+0
S7	South Side; East of Wilmot Rd	+52	277	56	58	+2
S8	South Side; West of Paseo Otono	+24	205	57	60	+3
S9	South Side; East of Paseo Otono	+21	117	58	59	+1
S10	South Side; West of Kolb Rd	-1	166	62	63	+1

1. The centerline was assumed to be in the same location for both existing and future conditions. The difference in roadway input was in the roadway width, 2 lanes for the existing conditions and 4 lanes with a median for the future conditions.

SOUND MITIGATION

Pavement Surface Design

The use of "rubberized" asphalt pavement as a method of reducing the amount of sound generated by vehicle tires has been investigated by state and local transportation agencies around the country. Rubberized pavement has the potential to reduce sound levels up to 3 decibels, versus conventional asphalt pavements. The City of Tucson has adopted the use of rubberized asphalt to increase pavement life and as a sound mitigation measure. Based on the results of recent studies performed in Oro Valley, Scottsdale and Sacramento, Pima County has approved the use of rubberized pavement as an alternative mitigation measure to the construction of sound walls. According to

the Pima County procedure, a 3 dB sound reduction can be applied to the predicted sound levels when rubberized asphalt is being used.

A before-after study of sound levels on Rancho Vistoso Boulevard in Oro Valley concluded that the sound level on new rubberized asphalt pavement was 2.0 to 3.5 decibels lower than on the previous conventional asphalt pavement surface. Compared to conventional asphalt, rubberized asphalt has exhibited equal or superior performance characteristics. Increased pavement durability and service life, and superior resistance to reflective cracking are particularly noted.

As indicated previously, all of the modeled receiver locations fall below the threshold requiring the consideration of noise mitigation methods. However, assuming that rubberized asphalt pavement will be utilized along Sunrise Drive for its other, non-noise related benefits, an additional sound level reduction of 1.5 to 3 dBA can be expected for future predicted sound levels.

Conclusions

Based on the analysis of sound impacts associated with the widening of Sunrise Drive the following conclusions have been determined.

- Based on existing traffic volumes, the noise impacts expected from the widening of Sunrise Drive on any of the adjacent land uses within the project area are not expected to satisfy the requirements for the consideration of noise mitigation.
- When traffic volumes reach the 2030 predicted levels, the noise impacts expected from the widening of Sunrise Drive on any of the adjacent land uses within the project area are not expected to satisfy the requirements for the consideration of noise mitigation.
- The use of rubberized asphalt on this roadway project will provide additional sound mitigation of future sound levels along the entire section of Sunrise Drive that is being reconstructed.