# Table of Contents

1. Introduction.................................................................................................................1
2. Methods ......................................................................................................................5
3. Noise Abatement Criteria ...............................................................................................8
4. Noise Analysis Results ...............................................................................................10
5. Mitigation Measures .....................................................................................................17
6. Construction Noise ....................................................................................................20
7. Conclusion .................................................................................................................21

Appendix A References

Appendix B Acoustic Terminology

Appendix C Model Input/Output Files Existing AM

Appendix D Model Input/Output Files Existing PM

Appendix E Model Input/Output Files Future Build AM

Appendix F Model Input/Output Files Future Build PM
LIST OF FIGURES

1  County Map ................................................................................................................... 2
2  Project Vicinity ................................................................................................................... 3
3  Project Location ................................................................................................................... 4
4  Existing Eastern Half ............................................................................................................ 11
5  Existing Western Half ......................................................................................................... 12
6  Future Eastern Half ............................................................................................................. 15
7  Future Western Half ........................................................................................................... 16

LIST OF TABLES

1  Peak AM and PM Hour Traffic Volumes ........................................................................... 7
2  Sensitive Receiver Locations ............................................................................................ 10
3  Field Verification Model Results ....................................................................................... 14
4  Noise Prediction Results .................................................................................................. 17
5  Typical Construction Equipment Noise Levels ............................................................... 21
1 Introduction

The purpose of this document is to evaluate the traffic noise effects associated with the widening of Valencia Road from Alvernon Way to Wilmot Road. The traffic noise analysis for the Valencia Road project involved a series of steps. Each of these steps is discussed in detail in the following sections.

Background

The Pima County Department of Transportation (PCDOT) in cooperation with the Regional Transportation Authority (RTA) proposes to widen approximately three miles of Valencia Road (Figure 1) from a four-lane arterial roadway into a six-lane arterial roadway between Alvernon Way and Wilmot Road in order to improve access to Tucson International Airport and business/industrial parks, expand through traffic on a continuous east-west corridor in the urban core of Tucson, improve intersection safety and traffic flow, and add sidewalks to improve pedestrian safety and Americans with Disabilities Act (ADA)-accessibility to transit stops. Additionally, the project will also widen the bridge structure over the Union Pacific Railroad (UPRR). Construction is planned for the 2012 to 2016 implementation period of the 20-year RTA plan.

Project Location

Valencia Road between Alvernon Way and Wilmot Road is found in the jurisdiction of the City of Tucson and incorporated Pima County, Arizona (Figure 1). The project is located approximately 7 miles southeast of downtown Tucson, between Tucson International Airport and Davis-Mothan Air Force Base (Figure 2). Valencia Road between Alvernon Way and Wilmot Road passes under I-10 and over the Julian Wash and the UPRR (Figure 3).

Existing Road Conditions and Land Use

Valencia Road is currently a four-lane, curbed, divided road with traffic signals at the intersections of Alvernon Way, Benson Highway/Swan Road, I-10 Frontage Roads and Wilmot Road.

Current land use in the project area includes of single family housing units, three schools, commercial land use, an Army National Guard recruiter, Davis Monthan Air Force Base, the Pima Air and Space Museum. Single family housing occurs on the north and south side of Valencia Road primarily at the west half of the project. Desert View High School is located at the west end of the project. Billy Lane Lauffer Middle School and Craycroft Elementary are located on the south side of Valencia Road near the middle of the project. Twelve sensitive receivers were identified (see Table 2). Sensitive receiver locations are shown in Figure 4 and 5.
Figure 1
County Map

Valencia Road:
Alvernon Road to Wilmont Road (4VAKDP)

Legend
- Project Location
- General Features
  - Town
  - City
  - Interstate Highway
  - State Route
  - Indian Reservation
  - Pima County

Source:
Project Site: 2010
Base Map: ALRS 2010
Pima County 2009 - 2010
Roads: ADOT 2009
Figure 3

Project Location

Valencia Road:
Alvernon Road to Wilmont Road (4VAKDP)

Source:
Project Area: URS 2010
Base Features: Pima County DOT 2009 - 2010
2 Methods

For this study, the methods for determining the future noise levels and identifying possible mitigation measures to address future noise levels involved the following series of steps:

- Assess the existing and planned land uses (residential, commercial, industrial, etc.) and determination of sensitive noise receivers within the project corridor.
- Assess the existing conditions (including: traffic volumes; vehicle types; vehicle speeds; roadway layout; area topography; existing walls; and; locations of residences relative to the roadway).
- Predict the existing and future build scenario for a reasonable worse case noise condition using the Federal Highway Administration (FHWA) Traffic Noise Model version 2.5 (TNM 2.5).
- Verify the noise model by measuring the existing noise levels at representative noise sensitive receivers.
- Compare the modeled results with the noise abatement criteria established by the Pima County Department of Transportation. Based on the results of the noise monitoring and modeling, potential noise mitigation was examined. This task included noise barrier modeling for noise mitigation as warranted by the results of the noise analysis. Reasonable and feasible mitigation, based on current PCDOT Procedures, is then recommended.

Overview

An assessment of existing and planned land uses (residential, commercial, industrial, etc.) and determination of sensitive noise receivers was undertaken within the project corridor. Aerial photographs and field reconnaissance were used to determine the approximate locations and land use activities of potential sensitive receivers near the roadway. Field measurements were used to determine the existing noise levels throughout the Study Area, as described in Section 4.0, Noise Analysis Results. Noise levels were measured at 10 sensitive receiver locations within the project area. The noise measurement locations are representative locations selected to determine the noise impacts along the project.

The TNM 2.5 model was used to predict the noise levels that would occur with the proposed improvements to Valencia Road receiver locations. Roadway geometry and topography, traffic volumes, existing barriers, land features, and the representative sites were entered into TNM 2.5 to replicate the conditions under which the noise level measurements were taken. Modeled noise levels were calculated and compared with the noise levels measured at sensitive receiver locations. This process examines the accuracy of the traffic noise model in performing noise level calculations for this project. Discrepancies in the model’s calculations were addressed prior to using it for predicting future noise levels. Traffic volumes and speeds used in the modeling for this project represent “worst case” peak-hour traffic conditions.

Two conditions were modeled using TNM 2.5. Traffic Volumes used in the model were provided by PCDOT Traffic Division and the Psomas traffic report (Psomas 2011) which used Pima Association of Governments (PAG) traffic volumes. Existing traffic volumes on I-10 were obtained from the Arizona Department of Transportation (ADOT) State Highway Traffic Log. Future I-10 traffic volumes were obtained from the February, 2009 I-10 Corridor Study (I-19 to
the Cochise County Line) (ADOT 2009). The model estimated the peak-hour traffic noise levels for:

- Existing traffic conditions – the model included the current street configuration and 2011 traffic volumes.
- Future build condition – the model included proposed road improvements and future projected 2035 traffic volumes. The project area used projected condition with a noise reduction credit of 3 dBA for the application of rubberized asphalt concrete (RAC). Noise abatement criteria including the use of RAC are described in Section 3 Noise Abatement Criteria.

Noise levels for the 2035 traffic and improved roadway conditions were compared with the appropriate noise abatement criterion to determine whether traffic noise mitigation should be considered. Generally, the mitigation considerations consist of noise barriers in the right-of-way (R/W). Although other mitigation considerations are possible, noise barriers are considered the most cost-effective and accepted technique when they are warranted.

**TNM 2.5 Modeling**

The TNM 2.5 model translated the roads in the Study Area into a series of endpoints on a three-dimensional X, Y, and Z coordinate system. This computer model was developed to comply with FHWA noise regulations and is considered the current standard for roadway noise analyses.

The TNM model requires input data regarding the geometry of roadways in the Study Area, vehicle mix, traffic volumes, and vehicle speeds. The following data were used in the models:

- **Vehicle Speeds** – as follows
  - Valencia Road from Alvernon Way to Columbus Blvd – 45 mph
  - Valencia Road from Columbus Blvd to Wilmot Road – 50 mph
  - I-10 – 55 mph
  - I-10 Frontage Road – 45 mph
  - Swan Road, Benson Highway – 45 mph
  - Littletown Road – 35 mph
  - Craycroft Road – 45 mph
  - Side streets have a 25 mph posted speed limit
- **Traffic Volumes** were provided by PCDOT Traffic Division and Psomas traffic report (Psomas 2011) which used PAG traffic volumes, shown in Table 1.
- **Vehicle Mix** was provided by PCDOT Traffic Division and Psomas traffic report (Psomas 2011).
  - West of I-10 the vehicle mix is: 72% of the vehicles were automobiles, 19% light trucks, 4% medium trucks and buses, 5% heavy vehicles (tractor trailers).
  - East of I-10 the vehicle mix is: 73% of the vehicles were automobiles, 22% light trucks, 3% medium trucks and buses, 2% heavy vehicles (tractor trailers).
- **Elevations** – topographic information was used for the roads and receivers.
- **Ground** – “Hard soil”
- **Receiver heights** – 5 feet above the ground
The proposed roadway and the surrounding arterial streets were defined by a series of roadway segment endpoints. Existing barriers, including residential privacy walls, were included in the model. Receivers were identified as single points and assigned an elevation of 5 feet above the ground to simulate the average height of human hearing. The sound levels were modeled using the A-weighted decibel (dBA), which is the measurement of sound that most closely approximates the sensitivity of the human ear. The noise level results are discussed in Section 4. *Existing Noise Environment*—are presented in LAeq₁h, the equivalent average sound level measured for 1 hour, approximating the sensitivity of the human ear.

<table>
<thead>
<tr>
<th>Road</th>
<th>Existing Volumes (2011)</th>
<th>Future Volumes (2035)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AM</td>
<td>PM</td>
</tr>
<tr>
<td>Alvernon Way (north of Valencia Road)</td>
<td>1433</td>
<td>1480</td>
</tr>
<tr>
<td>Alvernon Way (south of Valencia Road)</td>
<td>1403</td>
<td>1300</td>
</tr>
<tr>
<td>Valencia Road (between Alvernon &amp; Palo Verde Rd)</td>
<td>2235</td>
<td>2582</td>
</tr>
<tr>
<td>Valencia Road (between Alvernon &amp; Benson Hwy)</td>
<td>2017</td>
<td>2348</td>
</tr>
<tr>
<td>Valencia Road (between Benson Hwy &amp; I-10 Frontage Road Eastbound)</td>
<td>2962</td>
<td>2637</td>
</tr>
<tr>
<td>Valencia Road (between I-10 Frontage Road Eastbound &amp; I-10 Frontage Rd Westbound)</td>
<td>3015</td>
<td>2832</td>
</tr>
<tr>
<td>Valencia Road (between I-10 Frontage Rd Westbound &amp; Littleton Rd)</td>
<td>2963</td>
<td>2645</td>
</tr>
<tr>
<td>Valencia Road (between Littleton Rd &amp; Craycroft Rd)</td>
<td>2466</td>
<td>2186</td>
</tr>
<tr>
<td>Valencia Road (between Craycroft Rd &amp; Wilmot Rd)</td>
<td>2481</td>
<td>2267</td>
</tr>
<tr>
<td>Valencia Road (between Wilmot Rd &amp; Kolb Rd)</td>
<td>2502</td>
<td>2270</td>
</tr>
<tr>
<td>E Benson Highway</td>
<td>498</td>
<td>574</td>
</tr>
<tr>
<td>S Swan Road</td>
<td>524</td>
<td>475</td>
</tr>
<tr>
<td>I-10 Frontage Road Westbound (north of Valencia Rd)</td>
<td>699</td>
<td>481</td>
</tr>
<tr>
<td>I-10 Frontage Road Westbound (south of Valencia Rd)</td>
<td>485</td>
<td>465</td>
</tr>
<tr>
<td>I-10 Frontage Road Eastbound (north of Valencia Rd)</td>
<td>359</td>
<td>506</td>
</tr>
<tr>
<td>I-10 Frontage Road Eastbound (south of Valencia Rd)</td>
<td>316</td>
<td>477</td>
</tr>
<tr>
<td>I-10 (north of Valencia Rd)</td>
<td>5625</td>
<td>5625</td>
</tr>
<tr>
<td>I-10 (south of Valencia Rd)</td>
<td>4770</td>
<td>4770</td>
</tr>
<tr>
<td>E Littleton Road</td>
<td>550</td>
<td>388</td>
</tr>
<tr>
<td>S Craycroft Road</td>
<td>153</td>
<td>156</td>
</tr>
<tr>
<td>S Wilmot Rd (north of Valencia Rd)</td>
<td>17</td>
<td>42</td>
</tr>
<tr>
<td>S Wilmot Rd (south of Valencia Rd)</td>
<td>366</td>
<td>385</td>
</tr>
</tbody>
</table>

The vehicles were classified as automobiles (four wheels), medium trucks (2-axle long, buses, 2-axle 6 tire), and heavy trucks (3 to 6-axle vehicles). Each of these vehicle types generates noise from a different height above the roadway, called the source height.
TNM 2.5 uses the above-described information to calculate the noise contribution from each roadway segment to each receiver and then determine the cumulative effect of all roadway noise sources for each receiver. Validation studies conducted at the Volpe National Transportation Systems Center, a facility of the United States Department of Transportation Research and Innovative Technology Administration, show that the TNM 2.5 model typically predicts noise levels within an acceptable range of accuracy.

**Analysis Limitations**

This noise analysis is based on design and traffic information available at the time of the analysis. The following assumptions were made to reach conclusions during the analysis phase:

- The project designs as evaluated in this report will not change.
- Future traffic volumes, vehicle mix and speed will remain consistent with those predicted in the traffic study for this project.
- The nature of the land use will remain consistent with current use and planned development (i.e., industrial businesses will not be constructed where retail and professional offices are currently planned)
- The area where people are most likely to spend time outside of their homes is in their yards, near their homes.

While the TNM 2.5 model has been calibrated and tested against actual noise measurements for several years, it should be noted that it is still a noise prediction model. The results of this analysis assume the predicting capabilities of TNM are sufficient. Assumptions have been made to simplify the calculations for TNM.

- The receiver (representing human hearing) is 5 feet above ground.
- The angle of view from the receiver to the road is 180 degrees.
- The terrain between the roadway and the receiver is flat.
- The ground type is consistent throughout the project area.

The noise levels used in the predictions are measured as peak hour A-weighted Leq (LAeq1h). As stated in Section 2, this is the A-weighted average that represents the steady level over 1 hour that would produce the same energy as the actual signal. The actual instantaneous noise levels fluctuate above and below the measured Leq during the measurement period (e.g., a police siren, a particularly noisy truck, or unusually high traffic volumes). Therefore, the use of LAeq1h for predicting noise levels and conducting the noise evaluation does not consider the noise levels as they may occur in their full range. The fluctuation of instantaneous noise levels will result in sounds that temporarily exceed (and be below) the Leq noise levels as they have been presented in the noise evaluation.

### 3 Noise Abatement Criteria

Potential negative impact from traffic noise is assessed on the basis of predicted noise levels approaching or exceeding Noise Abatement Criteria (NAC). Pima County NAC is described below.

The PCDOT Procedure Number 03-5, entitled “Traffic Noise Analysis and Mitigation Guidance for Major Roadway Projects,” dated December 1, 2003, was developed to provide guidance for
the development of noise mitigation for Pima County’s major roadway projects. The procedure, commonly called the Pima County Noise Abatement Procedure (PC NAP), contains methods for noise analysis, criteria for traffic noise abatement, and requirements for noise reports. Effective April 7, 2008, the Pima County “Revision of Traffic Noise Analysis and Mitigation Guidance for Major Road Projects” was implemented to address changes in the cost of noise mitigation measures. This report reflects the updated mitigation costs per benefited receiver and barrier construction cost per square foot.

According to the PC NAP, noise abatement should be considered if noise levels reach 66 dBA or higher at noise-sensitive properties. Additionally, mitigation measures will be considered for noise-sensitive properties if predicted traffic noise levels substantially exceed existing levels. “Substantially exceed” is defined as a 15-dBA increase between the existing noise levels and the future noise levels. The area at noise-sensitive properties from which the noise level is used to determine abatement consideration, is at an out-of-doors location assumed to be most frequented by the residents. For example, the noise levels used in consideration for abatement at a residence would be from a location outside of the house, but near the house. Noise abatement is only considered for the first floor of multi-floor units.

Noise-sensitive properties include single family or multi-family housing units. Each first floor apartment in an apartment complex or duplex is counted as a separate housing unit. Noise-sensitive properties may also include facilities such as picnic areas, recreation areas, playgrounds, active sports areas, parks, schools, churches, libraries, hospitals, places of worship, and cemeteries.

The PC NAP noise limit for traffic noise reaching commercial properties (and other properties not described above) is 71 dBA. At or above which noise abatement should be considered.

The PC NAP contains a provision allowing a noise reduction credit of 3 dBA for the use of RAC. As part of the noise abatement procedure described in the PC NAP, this credit is applied during the mitigation determination process as described below.

The PC NAP provides criteria for use of noise walls for noise abatement mitigation. Where a sound wall is considered all of the following criteria must be met in order to recommend the barrier:

- A reduction of at least 5 dBA must be achieved at noise sensitive receivers
- The barrier must benefit two or more adjacent receivers
- The cost of the barrier will not exceed $35,000 per benefitted receiver (using a cost of $25/ft²)
- A majority of the property owners must approve the mitigation
- Mitigation is for only the first floor of multi-story residences
- Barriers must be less than 10 feet tall
- No mitigation will be provided for undeveloped properties unless building permit issued prior to the final EAMR document
4 Noise Analysis Results

Existing Noise Levels

Sensitive Noise Receivers

Sensitive noise receivers in the study area consist of single family housing units, three schools, an Army National Guard recruiter and the Pima Air and Space Museum. Single family housing occurs on the north and south side of Valencia Road primarily at the west half of the project. Desert View High School is located at the west end of the project. Billy Lane Lauffer Middle School and Craycroft Elementary are located on the south side of Valencia Road near the middle of the project. Twelve sensitive receivers were identified (see Table 2). Noise sensitive receiver locations are shown in Figure 4 and 5.

There are solid block barriers between all of the residences and roadways except the Town and Country Mobile Estates have an acoustically transparent chain link fence.

Table 2. Sensitive Receiver Locations

<table>
<thead>
<tr>
<th>Location Number</th>
<th>Location Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Southern most part of Desert View High School – 250 feet north of the centerline of Valencia Road No barrier</td>
</tr>
<tr>
<td>2</td>
<td>6472 S Acacia Desert Ave – 135 feet north of the centerline of Valencia Road 5-foot high barrier on the north side of Valencia – open at Columbus Blvd and Mesquite Desert Trail</td>
</tr>
<tr>
<td>3</td>
<td>4348 E Cholla Desert Trail - 112 feet north of the centerline of Valencia Road Top of the barrier 2-feet higher than Valencia Road</td>
</tr>
<tr>
<td>4</td>
<td>4444 E Mesquite Desert Trail – 145 feet north of the centerline of Valencia Road 5-foot high barrier on the north side of Valencia – open at Columbus Blvd and Mesquite Desert Trail</td>
</tr>
<tr>
<td>5</td>
<td>South end of the Town &amp; Country Mobile Estates - 290 feet north of the centerline of Valencia Road Chain link fence with plastic slats between mobile home park and Valencia</td>
</tr>
<tr>
<td>6</td>
<td>4721 E American Beauty Drive - 260 feet south of the centerline of Valencia Road Wall on the north side of the homes – 6 to 6.5-feet high. A 5-foot wall extends along the west side.</td>
</tr>
<tr>
<td>7</td>
<td>Between 4811 &amp; 4817 E American Beauty Drive - 300 feet south of the centerline of Valencia Road Block wall on the north side of the homes – 5-feet high.</td>
</tr>
<tr>
<td>8</td>
<td>5135 E Agave Vista Drive - 260 feet south of the centerline of Valencia Road 5-foot high wall on north and west side of homes</td>
</tr>
<tr>
<td>9</td>
<td>5205 E Agave Vista Drive - 510 feet southeast of the centerline of Valencia Road 5-foot high wall around homes, encloses side and back yards</td>
</tr>
<tr>
<td>10</td>
<td>NW corner of Billy Lane Lauffer Middle School - 750 feet SE of the centerline of Valencia Road No barrier</td>
</tr>
<tr>
<td>11</td>
<td>NW corner of Craycroft Elementary School - 1370 feet SE of the centerline of Valencia Road No barrier</td>
</tr>
<tr>
<td>12</td>
<td>East side of Thomas Jay Regional Park – 2100 feet south and west of Valencia Road. No barrier</td>
</tr>
<tr>
<td>13</td>
<td>Army National Guard Recruiter - 5500 East Valencia Road - 230 feet south of the centerline of Valencia Road Chain linked fence</td>
</tr>
<tr>
<td>14</td>
<td>Pima Air &amp; Space Museum - 6000 East Valencia Rd - 160 feet south of the centerline of Valencia Rd No barrier</td>
</tr>
</tbody>
</table>
Traffic Noise Monitoring

An assessment of existing traffic noise conditions was made. The monitoring program focused on residential and other sensitive land uses within the project area. A series of noise measurements were performed at ten monitoring locations in the study area to document existing conditions. Monitoring was conducted according to PCDOT and ADOT procedures. Noise levels were measured using two Larson Davis 820 sound level meters, which meet the American National Standard Institute (ANSI) requirements for Type 1 sound level meters. The detectors of the meters were set for "slow" response (1 second samples). The microphones were located approximately five feet above the ground. The sound level meters were calibrated prior to and immediately after each noise measurement. Noise levels were measured for three 10 minutes periods at each of the ten measurement locations.

Noise was measured during peak AM and PM traffic hours on Wednesday, January 19, 2011 and Thursday, January 20, 2011. Peak AM and PM traffic hours were from 7 to 9 AM and 5 to 7 PM, respectively. These times were selected to represent peak traffic hours. Midday noise measurements were made on January 19, 2011 as an off peak time period verification. Actual traffic counts were used in the verification model.

The primary noise source at all of the sensitive receivers was traffic on Valencia Road. At sensitive receivers 5-9, traffic on I-10 was significant as well. Noise from traffic on I-10 was audible at all other sensitive receivers when there was a lull in traffic on Valencia Road. Other noise sources included: aircraft, trains on the Union Pacific railroad, and birds. Measurements were made to minimize the impact of extraneous noise sources.

The atmospheric conditions during the measurement periods were in compliance with PCDOT and ADOT noise measurement guidelines. Since atmospheric conditions affect sound propagation, the conditions are entered into the noise model.

- Wednesday, January 19, 2011 – During the morning measurement period the temperature was about 50°F, the relative humidity was about 54%, it was clear with a slight breeze from the south (0-2 mph). In the afternoon the temperature was about 71°F, the relative humidity was 26%, it was clear and there was a slight wind from the northwest (1-3 mph).

- Thursday, January 20, 2011 AM – During the morning measurement period the temperature was about 46°F, the relative humidity was about 70%, it was clear with a slight breeze from the south (1-3 mph). In the afternoon the temperature was about 63°F, the relative humidity was 27%, it was clear and there was a slight wind from the northwest (2-4 mph).

Noise Model Verification

The monitoring site conditions were modeled in TNM 2.5 to evaluate the accuracy of TNM 2.5 to predict noise levels for the Study Area. Reported noise levels are the average of the three noise level readings taken at each monitoring site during the morning and evening peak traffic hours. These levels were compared with predicted sound levels from the modeled conditions. This comparison was used to make any necessary adjustments to the model input to most accurately reflect site conditions. The noise model verification results are summarized in Table 3.
Table 3. Field Verification Model Results

<table>
<thead>
<tr>
<th>Measurement Location</th>
<th>Measurement Period</th>
<th>Average Measured Noise Level (dBA)</th>
<th>Modeled Noise Level (dBA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - Desert View High School</td>
<td>1/19/11 7:00-7:30 AM</td>
<td>62</td>
<td>65</td>
</tr>
<tr>
<td>4 - 4444 E Mesquite Desert Trail</td>
<td>1/19/11 7:45-8:15 AM</td>
<td>64</td>
<td>68</td>
</tr>
<tr>
<td>5 - Town &amp; Country Mobile Estates</td>
<td>1/19/11 12:00-12:30 PM</td>
<td>60</td>
<td>64</td>
</tr>
<tr>
<td>6 – 4721 E American Beauty Drive</td>
<td>1/19/11 5:00-5:30 PM</td>
<td>68</td>
<td>68</td>
</tr>
<tr>
<td>7 - 4811 &amp; 4817 E American Beauty Drive</td>
<td>1/19/11 12:45-1:15 PM</td>
<td>65</td>
<td>65</td>
</tr>
<tr>
<td>8 - 5135 E Agave Vista Drive</td>
<td>1/19/11 12:45-1:15 PM</td>
<td>64</td>
<td>66</td>
</tr>
<tr>
<td>9 - 5205 E Agave Vista Drive</td>
<td>1/19/11 12:45-1:15 PM</td>
<td>64</td>
<td>66</td>
</tr>
<tr>
<td>10 - Billy Lane Lauffer Middle School</td>
<td>1/20/11 7:00-7:30 AM</td>
<td>62</td>
<td>62</td>
</tr>
<tr>
<td>11- Craycroft Elementary School</td>
<td>1/20/11 7:00-7:30 AM</td>
<td>62</td>
<td>62</td>
</tr>
<tr>
<td>13 – Army National Guard Recruiter</td>
<td>1/20/11 5:00-5:30 PM</td>
<td>63</td>
<td>65</td>
</tr>
</tbody>
</table>

Source: Calculations and measurements performed by Sound Solutions using TNM 2.5

As shown in Table 3, the modeled noise levels are equal to or higher than the measured noise levels, showing that the predictions are conservative. These results reflect good agreement between measured and modeled values. Variations between measured and modeled are due to many factors including: slight wind (not accounted for in the model), specific vehicles that may be louder or quieter than the modeled level, and other noise sources (aircraft, trains, and birds) not included in the noise model.

Future Noise Levels

Noise levels were modeled for 14 sensitive receiver locations. Modeled sensitive receiver locations are shown in Figure 6 and 7. Potential traffic noise impacts were evaluated relative to the PCDOT noise limit of 66 dBA for residential land use and 71 dBA for commercial land use. The future build scenario was computed using projected future traffic data provided by PAG, ADOT and Psomas traffic report (Psomas 2011).

Results

As shown in Table 4, the predicted Future Build noise levels are between 1 dBA lower to 3 dBA higher than the existing noise levels. The future levels are lower at locations where noise from traffic on Valencia Road is dominant (locations 1, 2, 4, 5, 14). Future noise levels are lower at these locations because the model applied a 3 dBA reduction to the noise radiating from Valencia Road for the use of RAC (see Section 3). The use of RAC on Valencia Road did not appreciably reduce noise levels at locations where noise from I-10 is a significant noise source (locations 6, 7, 9, 10, 11, 12). The predicted Future Build noise levels exceed the PCDOT noise limits at locations 3 (existing 68 dBA, future 68 dBA), 4 (existing 68 dBA, future 67 dBA), 6 (existing 66 dBA, future 67 dBA), and 7 (existing 66 dBA, future 68 dBA).

At seven of the 14 locations, the predicted Future Build noise levels are the same or lower than the existing noise levels (locations 1, 2, 3, 4, 11, 12).
Table 4 Noise Prediction Results

<table>
<thead>
<tr>
<th>Sensitive Receiver Location</th>
<th>Existing Noise Level (dBA)</th>
<th>Future Build Noise Level (dBA)</th>
<th>Noise Criteria (dBA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - Desert View High School</td>
<td>66</td>
<td>65</td>
<td>66</td>
</tr>
<tr>
<td>2 - 6472 S Acacia Desert Ave</td>
<td>65</td>
<td>64</td>
<td>66</td>
</tr>
<tr>
<td>3 - 4348 E Cholla Desert Trail</td>
<td>68</td>
<td>68</td>
<td>66</td>
</tr>
<tr>
<td>4 - 4444 E Mesquite Desert Trail</td>
<td>68</td>
<td>67</td>
<td>66</td>
</tr>
<tr>
<td>5 - Town &amp; Country Mobile Estates</td>
<td>65</td>
<td>64</td>
<td>66</td>
</tr>
<tr>
<td>6 - 4721 E American Beauty Drive</td>
<td>63</td>
<td>64</td>
<td>66</td>
</tr>
<tr>
<td>7 - 4811 &amp; 4817 E American Beauty Drive</td>
<td>66</td>
<td>67</td>
<td>66</td>
</tr>
<tr>
<td>8 - 5135 E Agave Vista Drive</td>
<td>66</td>
<td>68</td>
<td>66</td>
</tr>
<tr>
<td>9 - 5205 E Agave Vista Drive</td>
<td>62</td>
<td>65</td>
<td>66</td>
</tr>
<tr>
<td>10 - Billy Lane Lauffer Middle School</td>
<td>60</td>
<td>62</td>
<td>66</td>
</tr>
<tr>
<td>11 - Craycroft Elementary School</td>
<td>57</td>
<td>59</td>
<td>66</td>
</tr>
<tr>
<td>12 – Thomas Jay Regional Park</td>
<td>56</td>
<td>58</td>
<td>66</td>
</tr>
<tr>
<td>13 – Army National Guard Recruiter</td>
<td>65</td>
<td>65</td>
<td>71</td>
</tr>
<tr>
<td>14 - Pima Air &amp; Space Museum</td>
<td>68</td>
<td>67</td>
<td>71</td>
</tr>
</tbody>
</table>

Source: Calculations performed by Sound Solutions using TNM 2.5
Numbers in **bold** exceed noise limits
1 Includes 3 dBA noise reduction for RAC on Valencia Road

5 Mitigation Measures

A number of mitigation strategies are available that may be applied independently or in combination to achieve the desired results. These involve elements of the road design, road surface, and restrictions on the use of road, as well as construction of noise barriers. These mitigation strategies are introduced below and analyzed for reasonability, feasibility, and desirable qualities as they relate to this project. The discussion of these measures in this report does not obligate Pima County to implement them. Pima County may choose to modify, delete, or add measures to mitigate impacts.

Road Design

Road design measures include altering the road alignment or depressing road sections. Altering the road alignment could involve realigning the road along a new centerline to move the road away from a sensitive receiver. Depressing the road lowers the road below grade, also moving traffic farther away from affected receivers.

Feasibility – Design plans can be developed to shift road away from the sensitive receivers on one side.

Reasonability – Road alignment changes may be reasonable where changing the road alignment can move traffic far enough away from sensitive receivers to achieve adequate noise reduction. However, a substantial amount of space would be necessary to move the road far enough away from the receivers to achieve the desired noise level reduction. Furthermore, changing road alignment for a sensitive receiver could result in the undesired affect of increase noise levels for other sensitive receivers. Acquisition of properties to create the necessary space, realignment of...
connecting roads, and the relocation of utilities would make the cost unreasonable.

**Rubberized Asphalt Pavement**

Rubberized asphalt pavement has been shown to reduce noise impacts, averaging 4 dBA or better, at adjacent properties when compared with standard concrete pavement (Henderson, M. JHK and Associates 1996). Pima County uses RAC on all road projects and allows a noise analysis credit of 3 dBA to account for the noise reduction properties of the pavement. RAC will be used on the Valencia Road, Alvernon Way to Wilmot Road, project and the credit will be reflected in the noise analysis results for the Pima County portion of the project.

Feasibility – RAC is relatively easy to include in the project construction. It can be used effectively in the local climate and terrain.

Reasonability – Use of RAC is reasonable because it is included in the construction plans. It entails a low level of maintenance. The high durability equates to a reasonable cost for the life cycle of the pavement.

**Traffic Management**

Traffic management measures include restricting truck traffic entirely or during certain hours of the day and reducing the posted speed limit. Both strategies would reduce the noise levels at adjacent properties because trucks produce more noise than automobiles and because higher vehicle speeds generate more noise than lower vehicle speeds (FHWA 1995).

Feasibility – Restrictions on truck traffic is not feasible because displacing the truck traffic may conflict with the planned function of the road. An arterial road, such as Valencia Road, generally carries truck traffic. Businesses located along Valencia Road require use of trucks for normal operation.

Reasonability – Implementing restrictions on truck use may be reasonable if an adequate noise reduction can be achieved. However, the level of truck traffic on Valencia Road is not high enough for truck restrictions to be effective in reducing noise levels. Displacing truck traffic may shift noise impacts to another area.

**Noise Barriers**

Construction of noise barriers between the roads and the affected receivers reduces noise levels by physically blocking the transmission of traffic-generated noise. Barriers can be constructed as walls or earthen berms. Noise barriers should be high enough to break the line-of-sight between the noise source and the receiver. They must also be long enough to prevent noise from transmitting around the ends of the barrier. Openings in a barrier, for driveways or sidewalks, can significantly reduce the barrier’s effectiveness. Earthen berms require more right-of-way than do walls. They are usually constructed at a 3-to-1 slope in each direction. Thus, a berm 8 feet high would slope 24 feet in each direction, for a total width of 48 feet.

Feasibility – Construction of noise barriers are not feasible where the walls would limit sight distances for motorists and where safety barriers would limit the length of the walls.

Reasonability – Construction of noise barriers are reasonable where noise reduction is adequate and cost effective.
The PCDOT regulation states that mitigation measures must be considered when either: 1) the projected noise levels at noise sensitive receivers are 66 dBA or more; or, 2) the projected noise levels are 15 dBA or more above the existing noise levels. Substantial increases in noise levels over existing levels were not found in this analysis.

The FHWA guideline states that when noise abatement measures are being considered, every reasonable effort shall be made to obtain substantial noise reduction. PCDOT sets a maximum cost of noise abatement per benefited developed property at $35,000 (using a construction cost of $25/ft²). Benefited receivers are those that receive a 5 dBA noise reduction from the proposed mitigation. PCDOT states that noise barrier construction shall not be constructed unless two or more adjacent receivers are benefited.

**Potential Mitigation Locations**

Mitigation measures were evaluated at four sensitive receiver locations (3, 4, 6, and 7).

**Location 3**
Location 3 is representative of the 10 homes on the north side of Valencia Road between Columbus Blvd and E Ocotillo Desert Trail. The noise level exceeds the PCDOT limits at four of these residences. There is an existing wall, approximately 630 feet long, between the 10 residences and Valencia Road. The top of existing wall is between two and five feet above the elevation of Valencia Road.

A wall with a height of 8 feet high would provide at least 5 dBA noise reduction at six of the ten residences. All of the 10 residences will have future peak hour noise levels below the PCDOT limits. Using the cost of $25/ft², the total cost of the wall would be $126,000. In addition, a water line needs to be relocated from the proposed noise wall location. The cost of relocating the water line is at least $142,000. The total cost is at least $288,000. The cost per benefited receiver is $48,000, which is more than the required $35,000. Therefore a sound wall is not considered reasonable.

**Location 4**
Location 4 is located on the north side of Valencia Road on the west side of Mesquite Desert Trail. There is a 5-foot high barrier that extends along Valencia Road; however, there is an opening in the barrier at Mesquite Desert Trail (and Columbus Blvd) that greatly reduces the effectiveness of the barrier. Replacing the existing barrier with a 10-foot high barrier (the highest allowable by PCDOT) is predicted to provide a 2.7 dBA noise reduction. Similar to the existing barrier, the opening at Mesquite Desert Trail would reduce the effectiveness of a taller barrier. Because of the large opening for the road, it will not provide the 5 dBA noise reduction by PCDOT. Therefore, a noise barrier is not recommended because it does not meet the noise reduction criteria.

**Location 7**
Location 7 is located on the south side of Valencia Road and is west of I-10. There is a 5-foot high existing barrier that encloses the yards (closest to Valencia Road). There is significant noise from I-10, which is elevated from the bridge passing over Valencia Road. Replacing the existing barrier with a 10-foot high barrier (the highest allowable by PCDOT) along the north side of the residences would provide a 3.8 dBA noise reduction. Because the traffic noise on I-10 is higher than the barrier, noise attenuation is limited. PCDOT requires at least a 5 dBA noise reduction to justify building a barrier; hence, a noise barrier is not recommended.
Location 8
Location 8 located south of Valencia Road and east of I-10. As with location 6, there is an existing 5-foot high wall between the residences and Valencia Road and there is significant noise from I-10. Replacing the existing barrier with a 10-foot high wall (the highest allowed by PCDOT) would provide a 2.6 dBA noise reduction. Because the traffic noise on I-10 is higher than the barrier, noise attenuation is limited. A noise barrier is not recommended because the barrier does not meet the PCDOT requirement of providing at least a 5 dBA noise reduction.

6 Construction Noise

Properties in the vicinity of the project area would be exposed to noise from construction activities.

The Pima County Noise Code (Chapter 9.30.070) limits construction activities to between 5 AM and 7 PM, April 15 to October 15 and between 6 AM and 7 PM, October 16 to April 14. A noise variance will be required if nighttime construction is necessary.

Construction noise differs from traffic noise in several ways:

- Construction noise lasts only for the duration of the construction contract, with most construction activities in noise-sensitive areas being conducted during hours that are least disturbing to adjacent and nearby residents.
- Construction activities generally are of a short-term nature, and depend on the nature of construction operations.
- Construction noise also is intermittent and depends on the type of operation, location, and function of the equipment, and the equipment usage cycle. Traffic noise, on the other hand, is present in a more continuous fashion after construction activities are completed.

Adjacent properties in the project area would be exposed to noise from construction activity.

Table 7 shows the noise levels produced by various types of construction equipment. The types of construction equipment used for this project will typically generate noise levels of 80 to 90 dBA at a distance of 15 meters (50 feet) while the equipment is operating. Construction equipment operations can vary from intermittent to fairly continuous, with multiple pieces of equipment operating concurrently.
Table 5 Typical Construction Equipment Noise Levels

<table>
<thead>
<tr>
<th>Type of Equipment</th>
<th>Noise Level in dBA at 50 Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulldozer</td>
<td>80</td>
</tr>
<tr>
<td>Front Loader</td>
<td>72 - 84</td>
</tr>
<tr>
<td>Jack Hammer or Rock Drill</td>
<td>81 - 98</td>
</tr>
<tr>
<td>Crane with Headache Ball</td>
<td>75 - 87</td>
</tr>
<tr>
<td>Backhoe</td>
<td>72 - 93</td>
</tr>
<tr>
<td>Scraper and Grader</td>
<td>80 - 93</td>
</tr>
<tr>
<td>Electrical Generator</td>
<td>71 - 82</td>
</tr>
<tr>
<td>Concrete Pump</td>
<td>81 - 83</td>
</tr>
<tr>
<td>Concrete Vibrator</td>
<td>76</td>
</tr>
<tr>
<td>Concrete and Dump Trucks</td>
<td>83 - 90</td>
</tr>
<tr>
<td>Air Compressor</td>
<td>74 - 87</td>
</tr>
<tr>
<td>Pile Drivers (Peaks)</td>
<td>95 - 106</td>
</tr>
<tr>
<td>Pneumatic Tools</td>
<td>81 - 98</td>
</tr>
<tr>
<td>Roller (Compactor)</td>
<td>73 - 75</td>
</tr>
<tr>
<td>Saws</td>
<td>73 - 82</td>
</tr>
</tbody>
</table>

Source: U.S. EPA Noise from Construction Equipment and Operations

Locations within about 500 meters (1,650 feet) of a construction site are expected to experience occasional episodes of noise levels greater than 60 dBA. Areas within about 150 meters (500 feet) of a construction site will experience episodes with noise levels greater than 70 dBA. Such episodes of high noise levels will not be continuous throughout the day and will generally be restricted to daytime hours.

The following noise mitigation measures are recommended to reduce impacts from construction noise; however, not all measures may be feasible for the Valencia Road project:

- Re-route truck traffic away from residential streets, if possible. Select streets with fewest homes, if no alternatives are available.
- Locate equipment on the construction lot as far away from noise sensitive receivers as possible.
- Combine noisy operations to occur in the same time period. The total noise will not increase significantly and the duration of the noise impact will be less.
- Avoid nighttime activities. Sensitivity to noise increases during the nighttime hours at residential receivers.
- Use specially quieted equipment when possible, such as quieted and enclosed air compressors, residential or critical grade mufflers on all engines.
- Stationary equipment will be located as far away from sensitive receptors as possible. Loud, disrupting construction activities in noise sensitive areas will be conducted during hours that are least disturbing to adjacent and nearby residents.
7 Conclusion

Noise mitigation for the Valencia Road, Alvernon Way to Wilmot Road, project has been evaluated in this report. Future noise levels were predicted using TNM 2.5 with consideration of conditions with the application of RAC as the only mitigation, and conditions with the construction of noise walls and the application of RAC. Potential mitigation measures were evaluated for reasonability and feasibility with consideration of the existing conditions of Valencia Road and the proposed roadway design. The most reasonable and feasible mitigation measures for this project are the use of RAC for the roadway surface.

Noise barriers were evaluated at sensitive receiver locations 3, 4, 7, and 8 and none met the PCDOT criteria. At location 3, a barrier between Columbus Blvd and E Ocotillo Desert Trail does not meet the PCDOT cost per benefited receiver criteria. At location 4, the required noise reduction was not obtained because a large opening is needed for access into the development at Mesquite Desert Trial. At locations 7 and 8, the required noise reduction is not obtained because a large amount of the noise is coming from I-10. The traffic noise on I-10 is higher than the barriers; hence, noise attenuation is limited.

Noise abatement for construction-related activities will involve limiting construction activities to between the identified hours as described by the Pima County Noise Code (Chapter 9.30.070).
APPENDIX A

References

ADOT Noise Abatement Policy  12/5/2005
Federal Highway Administration, DOT 23 CFR, Chapter 1, Subsection 772  4/1/1998
Traffic Engineering Study for La Cholla Boulevard, Magee Road to Tangerine Road – Pima County Department of Transportation, Traffic Division with Kittelson & Associates, Inc  2009
Environmental Protections Authority – Noise Policy  1/2000
Federal Highway Administration, Measurement of Highway-Related Noise  1995
APPENDIX B

Acoustic Terminology

**Sound Pressure Level**
Sound, or noise, is the term given to variations in air pressure that are capable of being detected by the human ear. Small fluctuations in atmospheric pressure (sound pressure) constitute the physical property measured with a sound pressure level meter. Because the human ear can detect variations in atmospheric pressure over such a large range of magnitudes, sound pressure is expressed on a logarithmic scale in units called decibels (dB). Noise is defined as “unwanted” sound.

Technically, sound pressure level (SPL) is defined as:

\[ \text{SPL} = 20 \log \left( \frac{P}{P_{ref}} \right) \text{ dB} \]

where \( P \) is the sound pressure fluctuation (above or below atmospheric pressure) and \( P_{ref} \) is the reference pressure, 20 µPa, which is approximately the lowest sound pressure that can be detected by the human ear.

The sound pressure level that results from a combination of noise sources is not the arithmetic sum of the individual sound sources, but rather the logarithmic sum. For example, two sound levels of 50 dB produce a combined sound level of 53 dB, not 100 dB. Two sound levels of 40 and 50 dB produce a combined level of 50.4 dB.

Human sensitivity to changes in sound pressure level is highly individualized. Sensitivity to sound depends on frequency content, background noise, time of occurrence, duration, and psychological factors such as emotions and expectations. However, in general, a change of 1 or 2 dB in the level of sound is difficult for most people to detect. A 3 dB change is commonly taken as the smallest perceptible change and a 6 dB change corresponds to a noticeable change in loudness. A 10 dB increase or decrease in sound level corresponds to an approximate doubling or halving of loudness, respectively.

**A-Weighted Sound Level**
Studies have shown conclusively that at equal sound pressure levels, people are generally more sensitive to certain higher frequency sounds (such as made by speech, horns, and whistles) than most lower frequency sounds (such as made by motors and engines)\(^1\) at the same level. To address this preferential response to frequency, the A-weighted scale was developed. The A-weighted scale adjusts the sound level in each frequency band in much the same manner that the human auditory system does. Thus the A-weighted sound

---

level (read as "dBA") becomes a single number that defines the level of a sound and has some correlation with the sensitivity of the human ear to that sound. Different sounds with the same A-weighted sound level are perceived as being equally loud. The A-weighted noise level is commonly used today in environmental noise analysis and in noise regulations. Typical values of the A-weighted sound level of various noise sources are shown below.

**Equivalent Sound Level**
The Equivalent Sound Level ($L_{eq}$) is a type of average which represents the steady level that, integrated over a time period, would produce the same energy as the actual signal. The actual *instantaneous* noise levels typically fluctuate above and below the measured $L_{eq}$ during the measurement period. The A-weighted $L_{eq}$ is a common index for measuring environmental noise.

### Common Sound Levels in dBA

<table>
<thead>
<tr>
<th>Common Outdoor Sounds</th>
<th>Sound Pressure Level (dBA)</th>
<th>Common Indoor Sounds</th>
<th>Subjective Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auto horn at 10’</td>
<td>100</td>
<td>Printing plant</td>
<td>Deafening</td>
</tr>
<tr>
<td>Jackhammer at 50’</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gas lawn mower at 4’</td>
<td>90</td>
<td>Auditorium during applause</td>
<td>Very Loud</td>
</tr>
<tr>
<td>Pneumatic drill at 50’</td>
<td></td>
<td>Food blender at 3’</td>
<td></td>
</tr>
<tr>
<td>Concrete mixer at 50’</td>
<td>80</td>
<td>Telephone ringing at 8’</td>
<td></td>
</tr>
<tr>
<td>Jet flyover at 5000’</td>
<td></td>
<td>Vacuum cleaner at 5’</td>
<td></td>
</tr>
<tr>
<td>Large dog barking at 50’</td>
<td>70</td>
<td>Electric shaver at 1’</td>
<td>Loud</td>
</tr>
<tr>
<td>Large transformer at 50’</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Automobile at 55 mph at 150’</td>
<td>60</td>
<td>Normal conversation at 3’</td>
<td></td>
</tr>
<tr>
<td>Urban residential</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small town residence</td>
<td>50</td>
<td>Office noise</td>
<td>Moderate</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dishwasher in adjacent room</td>
<td></td>
</tr>
<tr>
<td></td>
<td>40</td>
<td>Soft stereo music in residence</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Library</td>
<td></td>
</tr>
<tr>
<td>Rustling leaves</td>
<td>30</td>
<td>Average bedroom at night</td>
<td>Faint</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Soft whisper at 3’</td>
<td></td>
</tr>
<tr>
<td>Quiet rural nighttime</td>
<td>20</td>
<td>Broadcast and recording studio</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>Human breathing</td>
<td>Very Faint</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>Threshold of hearing (audibility)</td>
<td></td>
</tr>
</tbody>
</table>

Source: Sound Solution measurements and reference library
APPENDIX C

Model Input/Output Files
FHWA Traffic Noise Model
Existing AM
APPENDIX D

Model Input/Output Files
FHWA Traffic Noise Model
Existing PM
APPENDIX E

Model Input/Output Files
FHWA Traffic Noise Model
Future No-Build AM
Model Input/Output Files
FHWA Traffic Noise Model
Future No-Build PM
APPENDIX G

Model Input/Output Files
FHWA Traffic Noise Model
Future Build AM
APPENDIX H

Model Input/Output Files
FHWA Traffic Noise Model
Future Build PM