NOISE REVIEW

VALENCIA ROAD

WADE ROAD TO AJO HIGHWAY *(AZ 86)*, TUCSON, ARIZONA

Prepared for:

Prepared by:

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June, 2016

Project No. 4RTVWE

Contract #CT-TR-16*205

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1.0 Summary

The purpose of this noise study was to evaluate the traffic noise effects associated with the widening of Valencia Road from Wade Road to Ajo Way (Phase 2) located in southwest Tucson, Arizona within unincorporated Pima County.

It was found that no noise mitigation is needed to meet the PCDOT noise limits.

2.0 Proposed Road Improvement

The second phase of the Valencia Road Improvement Plan will widen the roadway from Wade road to Ajo Highway, as shown in Figure 1. When complete, the roadway will greatly improve our region's east to west mobility by adding a new travel lane in each direction and significant enhancements to improve transit, bicycle, and pedestrian use.

New and wider sidewalks, more signalized crosswalks, improved bicycle lanes, and enhanced landscaping will improve both the pedestrian and bicyclist use and the appearance of Valencia road. A median and managed access will improve safety, and new local access lanes will provide a safer and easier way to get to and from residences in congested areas.

Current land use in the project area includes residential (single-family homes), and vacant land. The density of development in the area is consistent with a suburban setting.

3.0 Noise Study Methodology

For this study, the methods for determining the future noise levels and identifying possible mitigation measures to address those increased noise levels involved a series of steps. In summary these steps included:

- An assessment of existing and planned land uses (residential, commercial, industrial, etc.) and determination of sensitive noise receivers within the project corridor.
- Prediction of existing and the future build scenario for a reasonable worse case noise condition (peak noise hour) using the Federal Highway Administration (FHWA) Traffic Noise Model Version 2.5 (TNM 2.5).
- Measure the existing noise levels and compare them with the predicted existing noise levels. This verifies and calibrates the noise model.
- Comparison of model results with the noise abatement criteria established by Pima County Department of Transportation (PCDOT). Based on the results of the prediction, determine if noise mitigation measures need to be evaluated.

For the benefit of the reader, a summary of acoustic terminology is presented in Appendix C.

4.0 Noise Impact Criteria

Potential negative impact from traffic noise is assessed on the basis of predicted noise levels approaching or exceeding Noise Abatement Criteria (NAC) at noise sensitive receivers.

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 and adopted by the RTA for all their 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.

The Federal Highway Administration (FHWA) noise abatement criteria (NAC) delineates noise-sensitive areas by land use categories and the noise levels in dBA at which abatement should be considered (see Table 1). Abatement should be considered when noise levels "approach" or exceed the NAC, or when future noise levels "substantially increase" over existing levels.

Table 1. FHWA Noise Abatement Criteria[1]

Activity Category	dBA, LAeq1h[2]	Activity Description
A	57 (exterior)	Land 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	67 (exterior)	Residential
C	67 (exterior)	Active sports areas, amphitheaters, auditoriums, campgrounds, cemeteries, day care centers, hospitals, libraries, medical facilities, parks, picnic areas, places of worship, playgrounds, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, recreation areas, Section 4(f) sites, schools, television studios, trails, and trail crossings
D	52 (interior)	Auditoriums, day care centers, hospitals, libraries, medical facilities, places of worship, public meeting rooms, public or nonprofit institutional structures, radio structures, recording studios, schools, and television studios
E	72 (exterior)	Hotels, motels, offices, restaurants/bars, and other developed lands, properties or activities not included in categories A–D or F
F		Agriculture, airports, bus yards, emergency services, industrial, logging, maintenance facilities, manufacturing, mining, rail yards, retail facilities, shipyards, utilities (water resources, water treatment, electrical), and warehousing
G		Undeveloped lands that are not permitted

1 Sources: Federal Highway Administration (2011); 23 Code of Federal Regulations § 772
2 The 1-hour equivalent loudness in A-weighted decibels, which is the logarithmic average of noise over a 1 hour period

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 Rubberized Asphalt Concrete (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 $\$25/ft^2$)
- 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 environmental document

5.0 Noise Model Approach and Assumptions

5.1 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. Both eastbound and westbound lanes are modeled by their respective center lanes separately.

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 – Valencia Road from Wade road to Ajo Highway (AZ 86) – 45 mph
- Traffic Volumes were provided by Kimley Horn traffic report which used Pima Association of Governments (PAG) traffic volumes, shown in Table 2.
- Vehicle Mix was provided by PCDOT Traffic Division and Field Data Services of Arizona. – 85% of the vehicles were automobiles, 14% medium vehicles (2-axle long, buses, 2-axle 6 tire) and 1% heavy vehicles (3 to 6-axle vehicles).
- Elevations – topographic information was used for the roads and receivers. Topographic information was provided by Kimley Horn.
- Ground – “Loose soil”

- Receiver heights – 5 feet above the ground

Table 2. Peak AM (PM) Hour Traffic Volumes

Road	Existing Volumes (2016)		Future Volumes (2040)	
	East Bound	West Bound	East Bound	West Bound
Valencia Road - between Ajo Way and Mountain Eagle Drive	85 (137)	113 (133)	226 (234)	486 (544)
Valencia Road - between Mountain Eagle Drive and Iberia Ave			803 (408)	289 (779)
Valencia Road – Iberia Ave and Wade Road	585 (271)	194 (531)	1178 (678)	400 (1191)
Source: Field Data Serices of Arizona.				

Peak hour traffic volumes are used to predict the loudest hour noise levels which are needed to compare with the noise abatement criteria.

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 presented in LAeq1h, the equivalent average sound level measured for 1 hour, approximating the sensitivity of the human ear.

The vehicles were classified as automobiles (four wheels), medium trucks (six wheels), and heavy trucks (eight or more wheels). 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.

5.2 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 residential, 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 in LAeq1h. 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 the noise levels as they have been presented in the noise evaluation. However, these instantaneous noise levels cannot be predicted. Therefore, they cannot be used in the noise analysis.

6.0 Noise Model Verification

6.1 Noise Measurement Procedure

Noise measurements are conducted to verify and calibrate the noise model. Noise measurement locations were selected in representative areas with varying traffic conditions, topography, distance from the noise source and obstructions (FHWA "Measurements of Highway Related Noise").

Noise measurements were made on Wednesday, May 25, 2016 between 4:30 PM and 7:00 PM. Noise levels were measured for three 10 minutes periods at each of the four measurement locations.

The equipment used for the noise level measurements were Larson Davis (LD) Models 820 precision integrating sound level meters (SLMs). The SLMs were calibrated in the field before use with an LD Model CAL-200 acoustical calibrator. The SLMs used for noise level measurements comply with the American National Standards Institute (ANSI) S1.4-1971 for a Type 1 SLM. The methodology used for the noise level measurements complied with procedures specified in Section 4 of the FHWA document FHWA-PD-96-046/DOT-VNTC-FHWA-96-5, Measurement of Highway-Related Noise (FHWA, 1996).

6.2 Noise Measurement Locations

Noise measurements were made at four locations, listed below and shown in Figure 2.

- Location A - 120 feet east of 6501 S Via Diego De Rivera
- Location B - 600 feet east of South Mountain Eagle Drive
- Location C - 7517 W Tenderfoot Dr northwest corner of S Iberia Ave and W Valencia
- Location D - 6516 S Star Ridge Place

Many of the homes near the noise measurement locations have walls around their lots. Noise measurement were made on the road side of the walls. There were no walls in the noise model verification predictions. Noise measurement forms are located in Appendix B.

6.3 Noise Model Verification Results

The measured and predicted noise levels at these locations are shown in Table 3. Note that the noise measurements and predictions were conducted on the road side of any walls.

Table 3. May, 2016 Noise Measurements and Predictions

Site ID	Location Description	Measured Noise Level (Leq)	Predicted Noise Level (Leq)
A	120 feet east of 6501 S Via Diego De Rivera	55 dBA	55 dBA
B	600 feet east of South Mt Eagle Drive	57 dBA	55 dBA
C	7517 W Tenderfoot Dr northwest corner of S Iberia Ave and W Valencia	59 dBA	59 dBA
D	6516 S Star Ridge Place	60 dBA	59 dBA

The predicted noise levels are within 3 dBA of the measured noise level. This verifies the accuracy of the noise model. The predictions are the noise levels from only Valencia Road where the measured noise level include other sources such as wind through vegetation, birds, and aircraft.

7.0 Noise Analysis Results

7.1 Noise Prediction Locations

Sensitive noise receivers in the study area consist of single family or multi-family housing units. Table 4 shows the prediction locations for the ten representative receivers.

Table 4. Noise Prediction Receiver Locations

Location Number	Location Description
1	9375 W Valencia Road – approximately 50 feet south of the existing centerline. The property is vacant.
2	8581 S Ainslee St– approximately 110 feet north of the existing centerline on Valencia Road. The property is vacant.
3	6540 S Via Molino De Viento – approximately 135 feet south of the existing centerline on Valencia road. This is the first sub division east of Ajo Way on Valencia.
4	8157 S Valencia Road – approximately 100 feet north of the existing centerline. There is a 5-6 foot block wall around the sub division.
5	8153 W True Eagle Ct - approximately 120 feet north of the existing centerline. There is a 5-6 foot block wall around the sub division.
6	7937 W Snake Eagle Ct - approximately 100 feet north of the existing centerline. There is a 5-6 foot high wall between the home and Valencia road.
7	7635 W Tenderfoot Dr - approximately 140 feet north of the existing centerline. There is a 5-6 foot high wall between the home and Valencia Road.
8	6504 South Portical Circle - approximately 65 feet south of the existing centerline. There is a 5-6 foot high wall between the home and Valencia Road
9	7303 West Valencia Circle - approximately 58 feet south of the existing centerline. There is a 5-6 foot high wall between the home and Valencia Road.
10	7655 W Valencia Road - approximately 150 feet south of the existing centerline. The property is vacant.

7.2 Noise Prediction Results

As shown in Table 5, the predicted Future Build noise levels are below the Pima County noise limits. Note that the existing and future noise predictions were made on the residential side of any walls that are located between the road and residences. Noise measurements were made of the road side of any barriers to validate and calibrate the model.

Table 5. Noise Prediction Results PM (AM) – Pima County

Receiver Location	Existing Noise Level (dBA)	Future Build Noise Level (dBA)	Noise Criteria (dBA)
1- 9375 W Valencia Road (vacant lot)	55 (54)	61 (60)	66
2- 8581 S Ainslee St (vacant lot)	56 (55)	61 (60)	66
3 - 16540 S Via Molino De Viento	45 (44)	51 (50)	66
4 - 8157 S Valencia Road	43 (41)	48 (47)	66
5 - 8153 W True Eagle Court	50 (49)	55 (54)	66
6 - 7937 W Snake Eagle Court	54 (54)	58 (59)	66
7 - 7635 W Tenderfoot Drive	54 (54)	58 (59)	66
8 - 6504 S Portical Circle	56 (55)	58 (59)	66
9 - 7303 W Valencia Road	59 (59)	62 (62)	66
10 - 7655 W Valencia Road (vacant lot)	58 (57)	62 (62)	66
Source: Calculations performed by Noise Expert using TNM 2.5			

8.0 Construction Noise

Short-term noise impacts may be experienced during the construction of any part of the proposed improvements within the project Study Area. Properties in the vicinity of the project area would be exposed to noise from construction activities.

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 6 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 6. Typical Construction Equipment Noise Levels

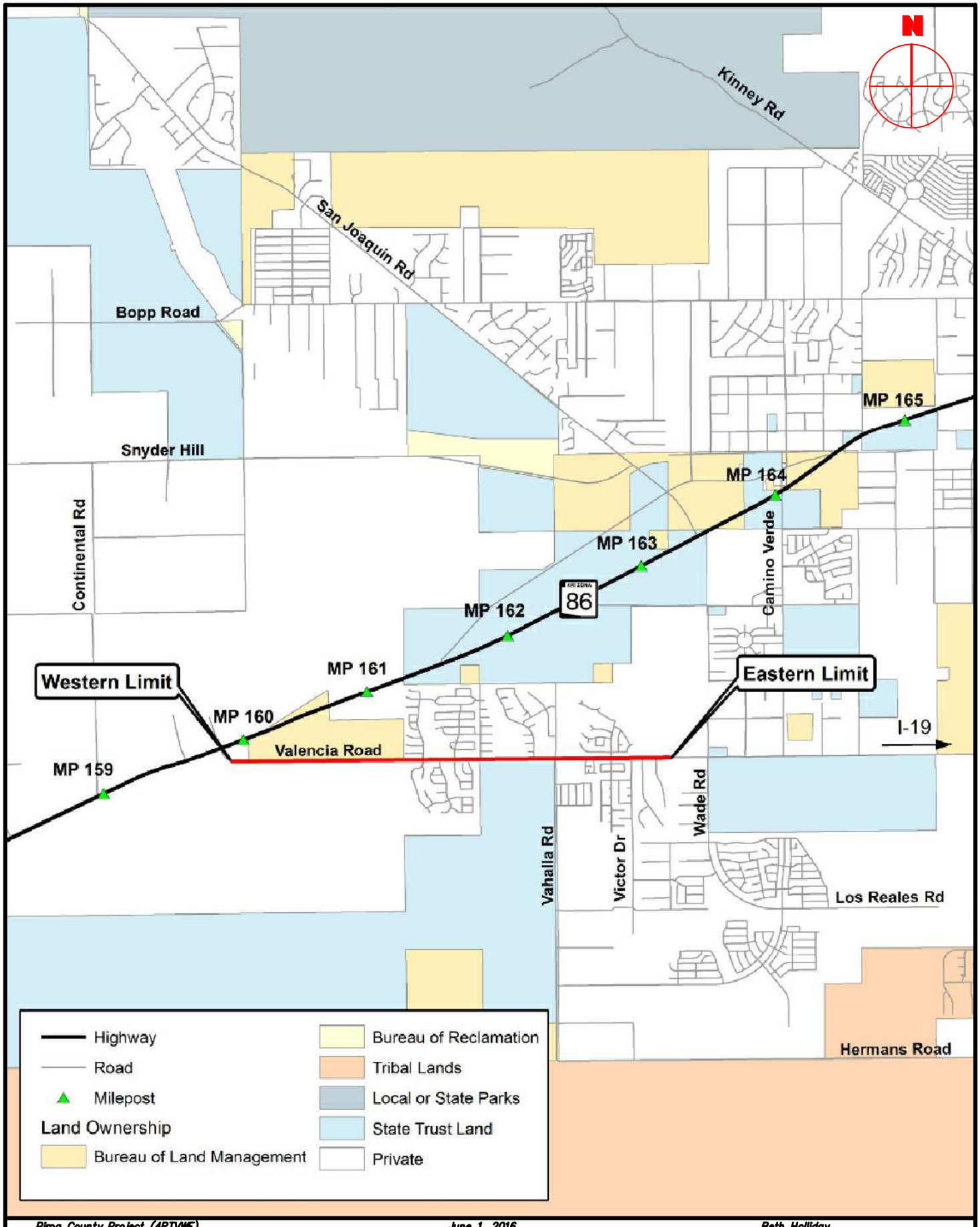
Type of Equipment	Noise Level in dBA at 50 Feet
Bulldozer	80
Front Loader	72 - 84
Jack Hammer or Rock Drill	81 - 98
Crane with Headache Ball	75 - 87
Backhoe	72 - 93
Scraper and Grader	80 - 93
Electrical Generator	71 - 82
Concrete Pump	81 - 83
Concrete Vibrator	76
Concrete and Dump Trucks	83 - 90
Air Compressor	74 - 87
Pile Drivers (Peaks)	95 - 106
Pneumatic Tools	81 - 98
Roller (Compactor)	73 - 75
Saws	73 - 82
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 Pima County ordinance for construction states that, "Construction and repair work may be conducted at different times and at higher noise levels than otherwise permitted, if upon written application, a permit is obtained beforehand from the county administrator or his designee. The permit shall be kept on the work site and shown to county officials on request. In granting such permit, the county administrator or his designee shall consider if construction noise in the vicinity of the proposed work site would be less objectionable at night than during the daytime because of different population levels or different neighboring activities; if obstruction and interference with traffic, particularly on streets of major importance, would be less objectionable at night than during the daytime; if the kind of work to be performed emits noises at such a low level as to not cause significant disturbance in the vicinity of the work site; if the neighborhood of the proposed work site is of such a character wherein sleep could be disturbed; if great economic hardship would occur if the work was spread over a longer time; if the work will abate or prevent hazards to life or property; if proposed early morning or night work is in the general public interest; and, he shall prescribe such conditions, working times, types of construction equipment to be used, and permissible noise emissions as he deems to be required in the public interest."

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



Pima County Project (4RTVME) *June 1, 2016* *Beth Holliday*

Figure No. 1

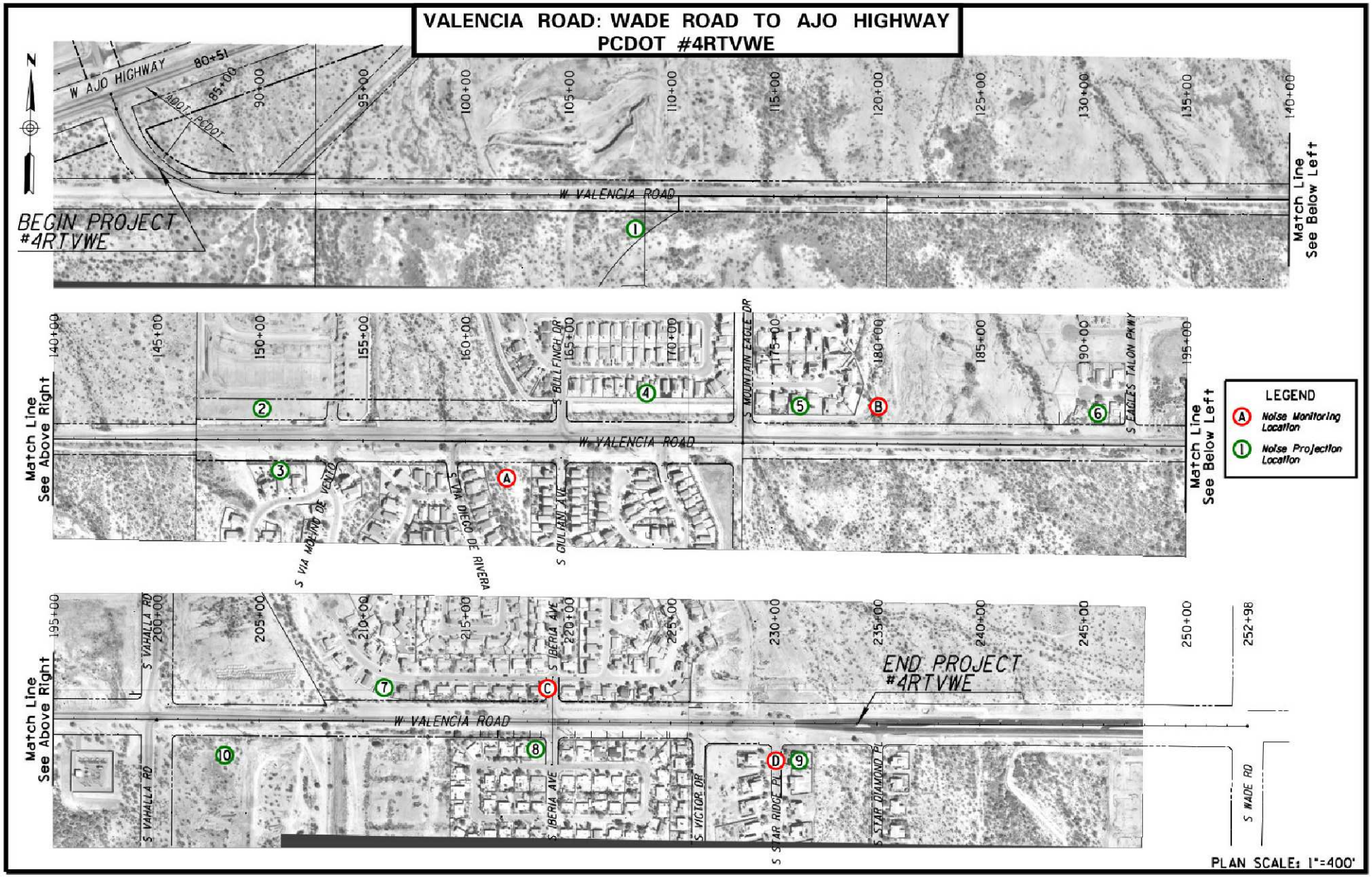
NoiseExpert.com

Phoenix, AZ 480-332-9325
San Diego, CA 619-449-4843
Las Vegas, NV 702-989-2406

Valencia Road: Wade Road to Ajo Way
Tucson, Arizona

DESCRIPTION: Vicinity Map

SCALE: NTS



Pima County Project (4RTVWE)	*April 15, 2013*	*Beth Holliday*

Figure No. 2

NoiseExpert.com
Acoustical Consultants

Phoenix, AZ 480-332-9325
San Diego, CA 619-449-4843
Las Vegas, NV 702-989-2406

Valencia Road: Wade Road to Ajo Way
Tucson, Arizona

DESCRIPTION: Measurement Locations

SCALE: NTS

APPENDIX A

Figures

Noise Expert
Acoustical Consulting

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San Diego, CA 619-449-4843 www.noiseexpert.com
Las Vegas, NV 702-989-2406

Date _5/25/16_ Project Number __NE 15099___ Project Name _Valencia – Wade to Ajo_____

Project Location ___Tucson, ARIZONA _____ Measurement Location Number_____A_____

Measurement Location Description____ south side of Valencia - between S Via Diego de Rivera and S Giuliani Ave___

Measurement Location (address)_____Valencia_____ Time _5:00 PM_ Duration___30 min___

Day of the Week ___Wednesday_____ Wind Speed ___2-7 mph_ Wind Direction __from S_ Clouds _____clear_____

Temperature_85 F__ Humidity ___8___ Weather Condition___ _____clear and warm_____

Average Noise Level _____55_____ Max Noise Level ____68_____ Min Noise Level _____44_____

Measurement Data						Traffic Count Data									
Sample	Time		Sound Level (dBA)			Auto		Med Truck		Heavy Truck		Bus		Motorcycle	
	Start	Duration	Leq	Lmin	Lmax	WB	EB	WB	EB	WB	EB	WB	EB	WB	EB
1	5:00	10	55	44	67	37	20								
2	5 10	10	54	46	65	35	16								
3	5:20	10	55	45	68	30	23								

Sample	Background Noise	Secondary Noise Sourcest
1.	traffic on W Valencia,	wind in vegitation, aircraft, birds
2.	traffic on W Valencia,	wind in vegitation, aircraft, birds
3.	traffic on W Valencia,	wind in vegitation, aircraft, birds

Observations
Barriers around homes
Measurement location is on the road side of the barrier

Photos

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Acoustical Consulting

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Las Vegas, NV 702-989-2406

Date _5/25/16_ Project Number __NE 15099___ Project Name _Valencia – Wade to Ajo_____

Project Location ___Tucson, ARIZONA _____ Measurement Location Number_____B_____

Measurement Location Description____north side of Valencia - east of Mountain Eagle Drive___

Measurement Location (address)_____Valencia_____ Time _5:35 PM_ Duration___30 min___

Day of the Week ___Wednesday_____ Wind Speed ___2-7 mph_ Wind Direction __from SW_ Clouds _____clear_____

Temperature_84 F__ Humidity ___8___ Weather Condition___clear and warm_____

Average Noise Level _____57_____ Max Noise Level ____74_____ Min Noise Level _____42_____

Measurement Data						Traffic Count Data									
Sample	Time		Sound Level (dBA)			Auto		Med Truck		Heavy Truck		Bus		Motorcycle	
	Start	Duration	Leq	Lmin	Lmax	WB	EB	WB	EB	WB	EB	WB	EB	WB	EB
1	5:35	10	56	43	69	36	40								
2	5 45	10	58	42	73	41	43	1							
3	5:55	10	56	46	74	35	39								

Sample	Background Noise	Secondary Noise Sourcest
1.	traffic on W Valencia,	dog, wind in vegitation, aircraft, birds
2.	traffic on W Valencia,	wind in vegitation, aircraft, birds
3.	traffic on W Valencia,	wind in vegitation, aircraft, birds

Observations
Barriers around homes
Measurement location is on the road side of the barrier

Photos



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Date _5/25/16_ Project Number __NE 15099___ Project Name _Valencia – Wade to Ajo_____

Project Location ___Tucson, ARIZONA _____ Measurement Location Number_____C_____

Measurement Location Description____ north side of Valencia – west side of Iberia Ave_____

Measurement Location (address)_____Valencia_____ Time _6:10 PM_ Duration___30 min___

Day of the Week ___Wednesday_____ Wind Speed ___2-5 mph_ Wind Direction __from S_ Clouds _____clear_____

Temperature_83 F__ Humidity ___9___ Weather Condition___ _____clear and warm_____

Average Noise Level _____59_____ Max Noise Level ____74_____ Min Noise Level _____44_____

Measurement Data						Traffic Count Data									
Sample	Time		Sound Level (dBA)			Auto		Med Truck		Heavy Truck		Bus		Iberia Ave	
	Start	Duration	Leq	Lmin	Lmax	WB	EB	WB	EB	WB	EB	WB	EB	NB	SB
1	6:10	10	60	49	74	50	50							8	6
2	6 20	10	59	48	70	53	61							6	3
3	6:30	10	59	44	70	54	75							9	5

Sample	Background Noise	Secondary Noise Sourcest
1.	traffic on W Valencia,	wind in vegitation, aircraft, birds
2.	traffic on W Valencia,	wind in vegitation, aircraft, birds
3.	traffic on W Valencia,	wind in vegitation, aircraft, birds

Observations
Barriers around homes
Measurement location is on the road side of the barrier

Photos



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Las Vegas, NV 702-989-2406

Date _5/25/16_ Project Number __NE 15099___ Project Name _Valencia – Wade to Ajo_____

Project Location ___Tucson, ARIZONA _____ Measurement Location Number_____D_____

Measurement Location Description____ south side of Valencia – west side of S Star Ridge Place _____

Measurement Location (address)_____Valencia_____ Time _6:10 PM_ Duration___30 min___

Day of the Week ___Wednesday_____ Wind Speed ___2-4 mph_ Wind Direction __from S_ Clouds _____clear_____

Temperature_81 F__ Humidity ___10___ Weather Condition___ _____clear and warm_____

Average Noise Level _____60_____ Max Noise Level ____71_____ Min Noise Level _____42_____

Measurement Data						Traffic Count Data									
Sample	Time		Sound Level (dBA)			Auto		Med Truck		Heavy Truck		Bus		S Star Ridge Pl	
	Start	Duration	Leq	Lmin	Lmax	WB	EB	WB	EB	WB	EB	WB	EB	NB	SB
1	6:10	10	60	42	69	50	52							2	
2	6 20	10	60	45	69	63	45	1						2	2
3	6:30	10	61	44	71	72	57		1					4	2

Sample	Background Noise	Secondary Noise Sourcest
1.	traffic on W Valencia,	wind in vegitation, aircraft, birds
2.	traffic on W Valencia,	wind in vegitation, aircraft, birds
3.	traffic on W Valencia,	wind in vegitation, aircraft, birds

Observations
Barriers around homes
Measurement location is on the road side of the barrier

Photos

APPENDIX B

Noise Measurement Field Forms

APPENDIX C

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:

$$SPL = 20 \log (P/P_{ref}) \text{ dB}$$

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) 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

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