Appendix G. Noise Information

This page is intentionally left blank.

Memo

Date:	Monday, April 09, 2018
Project:	North-South Corridor Study Tier I Draft Environmental Impact Statement
To:	File
Subject:	Noise Technical Memorandum

This memo provides background in support of the noise section of the North-South Corridor Study Tier I Draft Environmental Impact Statement. The information included herein has been largely excerpted from the North-South Corridor Study draft Noise Report, which was prepared for the project-level DEIS, prior to conversion to a Tier 1 DEIS. As the project proceeds to Tier 2 studies, and the design options are refined, additional noise analyses will be required to determine the need for noise-abatement measures.

Introduction

The Arizona Department of Transportation (ADOT), in partnership with the Federal Highway Administration (FHWA), is studying the 45-mile-long North-South Corridor (Corridor) in Pinal County, Arizona. The Corridor is bound by United States Highway 60 (US 60) in the city of Apache Junction to the north and by Interstate 10 (I-10) near the city of Eloy to the south.

The proposed action would provide a new north-to-south transportation facility that connects the growing communities in central Pinal County to US 60 and I-10, as well as the extension of SR 24, which currently connects to the Santan Freeway (SR 202L) to the west of the Corridor. Two action alternatives, a Western Alternative and Eastern Alternative, each of which consists of three travel lanes in each direction, were evaluated as part of the Tier 1 Draft Environmental Impact Statement for the project. Each alternative is divided into four segments with a number of transition areas that allow shifts from the west to the east, or east to the west.

Evaluation Procedures

This study provides a preliminary evaluation of the expected noise impacts of the action alternatives between US 60 and I-10 in Pinal County. A corridor-level noise assessment for the Corridor (the proposed project) was prepared using available data and as described below.

Methodology

To the extent feasible, the evaluation was performed consistent with 23 Code of Federal Regulations 772 (Procedures for Abatement of Highway Traffic Noise and Construction Noise), FHWA guidelines for assessing highway traffic noise, and the most current ADOT Noise-Abatement Requirements (NAR).

The procedure used to evaluate noise impacts included the following steps:

1. Identify noise-sensitive land uses in the Corridor.
2. Determine existing noise levels by taking short-term noise measurements.
3. Predict future (2040) noise levels using available traffic information and the Traffic Noise Model (TNM), Version 2.5.

4. Determine traffic noise impacts at noise-sensitive receivers by comparing predicted noise levels in 2040 with the appropriate Noise-Abatement Criteria (NAC).
5. Qualitatively describe noise impacts from project construction activities.
6. Evaluate potential noise mitigation measures, if warranted.
7. Provide information to local land-use planning agencies regarding future-year noise levels for their use in making land-use decisions regarding undeveloped or unpermitted areas in the Corridor.

This evaluation represents a corridor-level assessment based on limited design information and traffic information and other related assumptions available at the time of the analysis (December 2015). As the project proceeds and the design options develop further, additional noise analyses will be required. The results of this analysis and the mitigation considerations described should not be considered final; they will be verified and refined through Tier 2 studies.

LEVEL OF SERVICE TRAFFIC AND NOISE LEVELS

Traffic flows are described by a series of conditions called *levels of service* (LOS). LOS A describes free-flowing traffic that can travel at or above the posted speed limit with little or no difficulty in changing lanes. As conditions become more congested, the LOS degrades from LOS B to LOS F, which represents stop-and-go traffic.

From a noise perspective, traffic conditions at LOS C usually represent the worst hourly traffic noise impacts because traffic speeds are at or near the posted speed limit and lane capacity is high. When traffic conditions are at LOS D, more vehicles can be accommodated, but the slower speeds reduce tire noise, which is a major source of traffic noise.

The maximum peak-hour traffic volumes in each segment of the Corridor in the design year 2040 were used to model expected noise impacts. As described in ADOT's NAR, LOS C traffic volumes are generally used for noise modeling unless future traffic volumes are less than the maximum LOS C volume. Under such circumstances, the lower volumes are appropriate for noise modeling (ADOT 2011). According to the available traffic information, all segments in the Corridor would operate at LOS A or LOS B in 2040; therefore, the maximum segment volumes were used in the noise modeling (Kimley-Horn 2015).

Noise Analysis

Sound travels through the air as waves of minute air pressure fluctuations caused by vibration. In general, sound waves travel away from the noise source as an expanding spherical surface. As a result, the energy contained in a sound wave is spread over an increasing area as it travels away from the source. This results in a decrease in loudness at greater distances from the noise source.

Sound-level meters measure the actual pressure fluctuations caused by sound waves and record separate measurements for different sound frequency ranges. The decibel (dB) scale used to describe sound is a logarithmic scale that accounts for the large range of sound pressure levels in the environment. Most sounds consist of a broad range of sound frequencies. Several frequency-weighting schemes have been used to develop composite dB scales that approximate the way the human ear responds to sound levels. The A-weighted decibel (dBA) scale is most widely used for this purpose. Table 1 summarizes the typical A-weighted noise levels for various types of sound.

Table 1. Common outdoor and indoor noise levels

Common outdoor noise levels	Noise level (dBA[a])	Common indoor noise levels
—	110	Rock band
Jet flyover at 350 meters	100	—
Gas lawn mower at 1 meter, diesel truck at 15 meters	90	Food blender at 1 meter
Noisy urban daytime	80	Garbage disposal at 1 meter
Gas lawn mower at 30 meters	70	Shouting at 1 meter, vacuum cleaner at 3 meters
Commercial area	60	Normal speech at 1 meter
Quiet urban daytime	50	Large business office, dishwasher next door
Quiet urban nighttime	40	Small theater; large conference room (background)
Quiet suburban nighttime	30	Library
Quiet rural nighttime	20	Concert hall (background)
—	10	Broadcast and recording studio
—	0	Threshold of hearing

Source: American Association of State Highway and Transportation Officials (1993)

[a] A-weighted decibel

Varying noise levels are often described in terms of the equivalent sound level (L_{eq}). Equivalent noise levels are used to develop single-value descriptions of average noise exposure over stated periods of time. The L_{eq} data used for these average noise exposure descriptors are generally based on A-weighted sound-level measurements. Most often, units of hourly L_{eq} values are used to describe traffic noise.

Regulatory Setting

NAC are used to define the noise levels that are considered an impact for each land use activity category. If future noise levels approach or exceed the NAC, they are considered noise impacts under ADOT's NAR. Table 2 lists the NAC. As defined by ADOT, a design-year noise level within 3 dBA of the NAC is considered to approach the NAC, and a noise level greater than or equal to the NAC for the particular activity criterion is considered to exceed the NAC. In addition, a 15-dBA increase over existing noise levels is considered a substantial increase in noise and is also considered an impact.

Table 2. Noise Abatement Criteria

Activity category	dBA L_{eq}[a, b]	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 land, 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 land that is not permitted

Sources: Federal Highway Administration (2011); 23 Code of Federal Regulations 772

Note: Activity Categories B, C, and E include undeveloped land permitted for each activity category.

[a] The 1-hour equivalent loudness in A-weighted decibels, which is the logarithmic average of noise over a 1-hour period.

[b] The $L_{eq}(h)$ activity criteria values are for impact determination only, and are not design standards for noise abatement measures.

Noise-sensitive Land Uses

Table 3 shows the four segments into which the NSCS study area is divided. The table also shows the action corridor alternatives associated with each segment.

Table 3. Approximate limits of study area segments

Segment	Northern limit	Southern limit	Eastern Alternative	Western Alternative
1	United States Route 60	1 mile north of Arizona Farms Road	E1a Alternative E1b Alternative	W1a Alternative W1b Alternative
2	1 mile north of Arizona Farms Road	1.5 miles south of Arizona Farms Road	E2a Alternative E2b Alternative	W2a Alternative W2b Alternative
3	1.5 miles south of Arizona Farms Road	1 mile south of Storey Road	E3a Alternative E3b Alternative E3c Alternative E3d Alternative	W3 Alternative
4	1 mile south of Storey Road	Interstate 10	E4 Alternative	W4 Alternative

Land uses consist of several residential developments in the north and central segments (Segments 1 and 3) and scattered homes or undeveloped and agricultural land throughout the rest of the Corridor.

Under the ADOT NAR, noise-sensitive land uses are defined as residences and outdoor areas with frequent human use. Outdoor areas include patios, balconies, playgrounds, parks, and passive recreation areas. As shown in Table 3, active residential developments are classified as Activity Category B land uses, while other outdoor uses are classified as Activity Category C. Both categories are subject to the 67-dBA NAC.

Agricultural and undeveloped land that is not permitted (Activity Categories F and G, respectively) account for most of the Corridor and are not considered noise-sensitive. These land uses have no associated NAC.

Existing Noise Environment

Existing noise level measurements were recorded at 23 locations in the study area between July 27 and July 28, 2015, and are shown in Table 4.

Table 4. Existing noise level measurements

Location	L_{eq}[a]	Notes	Type of location
Segment 1			
Apache Golf Course	65	Local traffic on Baseline Road; aircraft	Near development
38th/Winchester Road	51	Local traffic on Winchester Road; cannot hear traffic on US 60	Near development
Baseline Road/Goldfield Road	53	Passby traffic on Baseline and Goldfield Roads	Near development
Race car track on Ironwood Drive	60	Traffic on Ironwood Drive	Near development
Germann Road east of Coyote Road	60	Local traffic on Germann Road	Near development
Eastern end of Ocotillo Road	42	No traffic; very quiet	Near development
Combs Road/Sierra Vista Drive	51	Slight breeze; no traffic	Nearly undeveloped
Skyline Drive (east of Quail Run Lane)	47	Local traffic	Undeveloped area
Corner of Skyline Drive/Felix Road	48	Light breeze; aircraft	Undeveloped area
East Judd Road/Felix Road	45	Local residential traffic; two aircrafts	Near development
Segment 2			
Heritage Road/Felix Road (Crestview Manor)	43	Light traffic on Felix Road; aircraft; birds	Near development
Segment 3			
Hunt Highway (west of Largo Road)	55	Traffic on Hunt Highway	Undeveloped area
Hunt Highway/Poston Butte Road	54	Traffic on Hunt Highway	Undeveloped area
Florence's Heritage Park	44	Operating pump at aquatic center	Near development
Adamsville Road (west of Florence)	53	Light traffic on Adamsville Road	Nearly undeveloped
Valley Farms Road/Vah Ki Inn Road	40	Plowing in adjacent field	Nearly undeveloped
Clemans Road/Martin Road	47	Dirt farm roads, no traffic; aircraft	Nearly undeveloped
Randolph Road/Vail Road	47	Farm road; no traffic	Nearly undeveloped

Table 4. Existing noise level measurements

Location	L_{eq}[a]	Notes	Type of location
Segment 4			
Steele Road/Fast Track Road	46	Farm roads; no traffic	Undeveloped area
SR 87/Selma Road (east of railroad)	40	Dirt road, no traffic; aircraft; birds	Undeveloped area
Shedd Road at railroad tracks	40	Dirt road, no traffic; cannot hear SR 87	Nearly undeveloped
SR 87/Battaglia Road (east of railroad)	37	Dirt farm road; no traffic	Undeveloped area
Milligan Road/Vail Road (east of railroad)	42	Local road, no traffic	Undeveloped area

Notes: SR = State Route, US 60 = U.S. Route 60
[a] equivalent sound level

Segment 1, which is the segment closest to US 60, has the highest traffic volumes in the study area and includes the Palmas del Sol East and Desert Harbor residential developments to the west and other commercial land uses on Ironwood Drive and Baseline Road. Measurements at locations in Segment 1, north of Baseline Road, consisted of three 15-minute-long measurements that were then averaged and rounded to the nearest whole dBA. South of Baseline Road and throughout the rest of the study area, the noise monitoring locations were generally in undeveloped or agricultural areas with few nearby sources of noise, such as passby traffic or industrial activities. At these locations, a single noise measurement was taken for a 15-minute period.

The results of the noise measurements indicate that the noise levels throughout the study area near developed areas range from a low of 42 dBA to a high of 65 dBA, and have an average of 51 dBA. In undeveloped areas, where no existing noise-sensitive receptors are located, noise levels range from a low of 35 dBA to a high of 55 dBA, with an average of 46 dBA. Areas that are nearly undeveloped—that is, where very few sensitive receptors could be affected by traffic noise—noise levels range from a low of 40 dBA to a high of 53 dBA, and have an average of 47 dBA. In general, measured noise levels were consistent with the prevailing land uses, with higher noise levels in the more urban areas and lower noise levels elsewhere.

Noise Impact Analysis

Traffic Noise Model, Version 2.5

Traffic noise levels were modeled using FHWA's TNM, Version 2.5, with predicted 2040 traffic volumes. TNM estimates acoustic intensity at receiver locations based on the sound energy generated from a series of straight-line road segments. Where appropriate, the effects of local shielding from existing structures (for example, privacy walls or intervening rows of homes), vegetation, terrain, and other adjustment factors can be included in the model to provide greater levels of detail and accuracy. Elevations used in the model were derived from the United States Geological Survey National Elevation Dataset and represent the best data available at this stage of the project.

The goal of the noise impact analysis was to determine whether the predicted noise levels associated with the proposed alignment corridors would approach or exceed the applicable NAC, thereby warranting consideration of noise-abatement measures.

Traffic Noise Modeling

Two approaches were used to model traffic noise, depending on the activity category of the land use and the intensity of development in each segment. Sample modeling of potential traffic noise in the study area was performed for two land use categories: Activity Categories B (residential) and G (undeveloped land). As discussed in ADOT's NAR, no highway noise analysis is required for agricultural land uses (Activity Category F), the third type of land use category near the action corridor alternatives in the study area.

Residential Developments (Activity Category B Modeling)

For Activity Category B, the noise evaluation focused on areas of active, permitted residential developments. Under ADOT's NAR, permitted developments are those locations with a definite commitment to develop land with an approved specific design of land use activities as evidenced by the issuance of a building permit.

The action corridor alternatives are very close to two areas of active, ongoing residential development, both of which are in Segment 1: Dolce Vita, east of Goldfield Road, and Palmas del Sol East and Desert Harbor, west of Ironwood Drive.

Because these residential developments are near the action corridor alternatives, preliminary noise modeling was conducted at these locations.

RESIDENTIAL DEVELOPMENT EAST OF GOLDFIELD ROAD

The E1a, E1b, and W1b Alternatives connect with US 60 near the homes in the Dolce Vita development, located east of Goldfield Road. Depending on the 400-foot-wide alignment selected during Tier 2 studies, the proposed freeway may be located anywhere from adjacent to the development's edge to more than 1,000 feet from the nearest home. Ten receptors were modeled in the Dolce Vita development based on potential distances of 300 or more feet from the edge of corridor. Modeled noise levels in the residential development ranged from 49 dBA to 62 dBA; therefore, the residential NAC would not be exceeded.

RESIDENTIAL DEVELOPMENTS WEST OF IRONWOOD DRIVE

Two residential developments (Palmas del Sol East and Desert Harbor) are just south of US 60, along Ironwood Drive, close to the W1a Alternative. A 400-foot-wide alignment within the 1,500-foot-wide action corridor alternative would likely require the acquisition of property from either the homes to the west or the adjacent Apache Golf Course to the east, or both. Given the high potential for property acquisitions in the Palmas del Sol East development to accommodate the proposed action, noise impacts would likely affect nearby homes not acquired.

Eleven receptors were modeled in this location, and the existing privacy wall adjacent to Ironwood Drive was included in the model as a 5-foot-tall barrier. In addition, rows of homes were included in the noise model to account for additional noise attenuation resulting from intervening rows of homes. A background noise level of 65 dBA was used in the model to reflect the short-term noise measurement taken at the Apache Golf Course monitoring location. The modeled noise levels ranged from 55 dBA to 69 dBA at a distance of at least 300 feet from the potential edge of the corridor. The residential NAC was approached at two receptors and was exceeded at one receptor. Therefore, there is a high potential for noise impacts at sensitive receptors associated with the W1a Alternative.

Undeveloped Areas (Activity Category G Modeling)

For unpermitted, undeveloped land uses (Activity Category G), the ADOT NAR recommends modeling at two receptor locations: one at the edge of the right-of-way line (in this evaluation, the edge of corridor)

and a second receptor approximately 300 feet from the first location to determine the degree of noise attenuation over distance from the action corridor alternatives. For this Tier 1-level analysis, where action corridor alternatives are considered and no right-of-way is delineated, this approach was modified and 12 locations were identified in undeveloped areas in the study area, generally six near the Eastern Alternatives and six near the Western Alternatives. These undeveloped areas span all four segments of the study area and exclude the predominantly residential developments previously described and evaluated under Activity Category B. Noise modeling for the Activity Category G land use areas was conducted using the peak-hour traffic volume in 2040 and accounted for minor elevation differences between the locations. Table 5 shows results of the Activity Category G evaluation.

Table 5. Activity Category G modeling (unpermitted, undeveloped land uses)

Segment	Eastern Alternatives' noise levels (dBA)		Western Alternatives' noise levels (dBA)	
	At potential corridor edge	300 feet from potential corridor edge	At potential corridor edge	300 feet from potential corridor edge
1	76	60	79	62
2	75	60	76	61
3	74	58	76	60
4	71	55	74	57

Note: dBA = A-weighted decibel

With the Eastern Alternatives, noise levels would range from 71 dBA to 76 dBA adjacent to the alignment, decreasing to 60 dBA or lower as the distance increases between the alignment and the receptor. Noise levels adjacent to an alignment in the Western Alternatives would be slightly higher across the board—as high as 79 dBA in Segment 1 and decreasing to 74 dBA in Segment 4. As the distance increases between the alignment and the sensitive noise receptor, noise levels would decrease accordingly. The small difference in noise levels between the action corridor alternatives would not be perceptible to the human ear. Modeled noise levels decrease slightly from Segment 1 to Segment 4 because of lower traffic volumes as the proposed action goes from north to south. Based on this assessment, the residential NAC (67 dBA) would not be approached at locations 300 feet or farther from a potential edge of corridor with any of the action corridor alternatives.

However, a 400-foot-wide alignment that is closer than 300 feet from a sensitive noise receptor may approach or exceed the residential NAC (67 dBA) depending on distance. For portions of the 1,500-foot-wide action corridor alternatives that overlay homes, a 400-foot-wide alignment developed and evaluated in more detailed Tier 2 noise analyses has the potential to be within 300 feet of one or more receptors.

In Segment 1, both the W1a and W1b Alternatives overlay up to 20 homes between Rolling Ridge Road and Skyline Drive, west of Quail Run Road, several of which are close to the centers of the 1,500-foot-wide action corridor alternatives. Both the E1a and E1b Alternatives overlay up to 12 homes between Roberts and Asbury Roads, west of Felix Road; however, these homes are closer to the eastern corridor edge of the 1,500-foot-wide action corridor alternatives. Therefore, in Segment 1, the potential for noise impacts attributable to an alignment located closer than 300 feet to the receptors is greater with the W1a and W1b Alternatives than with the E1a and E1b Alternatives.

In Segment 3, the W3 Alternative is close to multiple noise-sensitive receptors in the residential development between Heritage Road and Hunt Highway, and a 400-foot-wide alignment would most likely be located more than 300 feet from the receptors. However, the 1,500-foot-wide W3 Alternative overlays a few isolated developed properties along its length, and there is a low potential of risk for a

400-foot-wide alignment to be developed within 300 feet of these receptors, resulting in less potential for the residential NAC to be approached or exceeded. Similarly, the E3c and E3d Alternatives overlay isolated homes, resulting in a low potential risk for a 400-foot-wide alignment to be developed in Tier 2 noise analyses within 300 feet of receptors. The E3a and E3b Alternatives between Randolph and Kleck Roads overlay 17 developed properties, and there is a moderate potential risk for a 400-foot-wide alignment developed during detailed Tier 2 studies to be located within 300 feet of the properties, resulting in a greater potential for the residential NAC to be approached or exceeded.

In Segment 4, the E4 Alternative overlays very few isolated homes, and a 400-foot-wide corridor could likely avoid locations within 300 feet of these receptors. Moreover, the modeled noise level of the proposed freeway adjacent to sensitive receptors in this segment is 71 dBA, much lower than in other segments. Therefore, there is a minimal potential for the residential NAC to be approached or exceeded with the E4 Alternative. On the other hand, the 1,500-foot-wide W4 Alternative corridor overlays multiple homes west of SR 87 between Shedd and Houser Roads, and other isolated properties along SR 87. It is unlikely that a 400-foot-wide alignment would avoid all of these properties and be located more than 300 feet from the receptors; therefore, there is a greater potential for the residential NAC to be approached or exceeded with the W4 Alternative.

Potential Noise Abatement

The ADOT Noise Abatement Policy has specific requirements for analyzing the feasibility, reasonableness, and cost-effectiveness of noise-abatement measures such as sound walls and earthen berms. The abatement evaluation requires specific design details that are not yet available for this project. As a result, a detailed barrier evaluation is not possible at this preliminary stage of the project. As described in Residential Developments (Activity Category B Modeling), expected noise impacts were identified at one active residential development near the Western Alternative in Segment 1 (Desert Harbor) and one residential development (Crestview Manor) in Segment 2. Because of the proximity of the Western Alternative to those developments, especially at Crestview Manor, noise barriers would likely be warranted.

As a general matter, new highway alignments constructed in otherwise quiet noise environments, such as those in the undeveloped areas of the Corridor, will oftentimes result in a substantial noise increase at nearby homes (that is, 15-dBA or greater increases over existing noise levels). Under such circumstances and depending on the number of homes affected, detailed consideration of noise barriers would be warranted.

Analysis Limitations

This evaluation is based on limited design and traffic information and presents preliminary model results. Certain assumptions were made to complete the noise analysis. As the design for the project is developed further and alignments are refined or eliminated, additional noise analyses will be required.

Construction Noise

Constructing roads causes a substantial amount of temporary noise. Noise during construction could be a nuisance to nearby residents and businesses. Both alternatives, Western and Eastern, would generate similar types of noise that would occur sporadically in different locations throughout the construction period.

The most common noise source in construction areas would be from engine-powered machinery such as earth-moving equipment (bulldozers), material-handling equipment (cranes), and stationary equipment (generators). Mobile equipment (such as trucks and excavators) operates in a sporadic manner, while stationary equipment (generators and compressors) generates noise at fairly constant levels.

Typical noise levels from construction equipment range from 69 dBA to 106 dBA at 50 feet from the source; however, most typical construction activities fall in the 75 dBA to 85 dBA range at 50 feet. Peak noise levels from pile driving associated with structures such as interchanges and overpasses are about 106 dBA at 50 feet. To some people, noise at 65 dBA is intrusive and 80 dBA is disruptive. At 80 dBA, people must shout to be heard. Hearing protection is recommended at noise levels above 90 dBA.

Construction noise at locations farther away than 50 feet would decrease by 6 dBA to 8 dBA for each doubling of the distance from the source. For example, if the noise level from a jackhammer is 90 dBA at 50 feet, it would decrease to about 83 dBA at 100 feet and 76 dBA at 200 feet.

ADOT's *Standard Specifications for Highway and Bridge Construction* (2008) stipulate that all exhaust systems on equipment should be in good working order and that properly designed engine enclosures and intake silencers should be used where appropriate. For all projects, ADOT will consider the effects of noise from project construction activities and will determine if additional measures are needed in the plans or specifications to minimize or eliminate adverse impacts from construction noise.

References

American Association of State Highway and Transportation Officials. 1993. *Guide on Evaluation and Abatement of Traffic Noise*. Prepared by the AASHTO Highway Subcommittee on Design, Task Force for Environmental Design.

Arizona Department of Transportation (ADOT). 2008. *Standard Specifications for Road and Bridge Construction*.

———. 2011. *Noise Abatement Policy*. ADOT NAP Rev 2011-07-13.

Federal Highway Administration (FHWA). 1996. *Measurement of Highway-Related Noise*. FHWA-PD-96-046/DOT-VNTSC-FHWA-96-5. May.

———. 2011. *Highway Traffic Noise: Analysis and Abatement Guidance*.

Kimley-Horn and Associates, Inc.. 2015. *ADOT NSCS Traffic Report: Traffic Report Update and Coordination*.