



Final Noise Analysis Technical Report

Carefree Highway: Cave Creek Road to Scottsdale Road

City Project No. SH04

Prepared for:

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EXECUTIVE SUMMARY

The City of Scottsdale is proposing improvements on the Carefree Highway to widen it to a 4-lane minor arterial. The project will include a new raised landscaped median, increased travel lane capacity, safety improvements at critical intersections and a new shared-use path along the south side of Carefree Highway. The proposed improvements are consistent with the City's Transportation Master Plan.

Short-term noise level monitoring was conducted within the project limits on November 2, 2023, to depict the existing noise environment. Two measurement locations were selected to represent noise sensitive receptors at residences along the project corridor. Three 10-minute interval equivalent noise level measurements (Leq) were conducted at each site. Measured noise levels ranged from 59 dBA to 64 dBA.

The FHWA-approved Traffic Noise Model version 2.5 (TNM 2.5) was used to predict highway traffic noise and determine if consideration of noise mitigation was warranted. Future Build (2045) peak-hour noise levels ranged from 51 dBA to 71 dBA (Leq) in the AM peak-hour and 51 dBA to 70 dBA in the PM peak-hour. The ADOT NAR threshold of 66 dBA was exceeded at 2 residential receivers. A mitigation analysis determined that noise barriers were not warranted.

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1.0 PROJECT INTRODUCTION

The City of Scottsdale is proposing improvements on the Carefree Highway to widen it to a 4-lane minor arterial. The project will include a new raised landscaped median, increased travel lane capacity, safety improvements at critical intersections and a new shared-use path along the south side of Carefree Highway. The proposed improvements are consistent with the City's Transportation Master Plan.

The project location is shown in Figure 1 and the project study area is shown in Figure 2.

2.0 NOISE STUDY PROCEDURES

This analysis was performed in accordance with the current (May 2017) ADOT *Noise Abatement Requirements* (NAR, May 2017), federal noise requirements as specified in 23 CFR Part 772, and the City of Scottsdale *Roadway Noise Abatement Policy* (RNAP, 2011). The RNAP was amended in April 2022 to be consistent with ADOT and FHWA noise abatement requirements.

The ADOT NAR establishes official policy on highway noise and describes the process that is used in determining traffic noise impacts and evaluating abatement measures. In accordance with the ADOT NAR, the FHWA Traffic Noise Model® (TNM 2.5) was used to predict 2045 design year noise levels at noise-sensitive receptor locations in the vicinity of the proposed project.

Noise study procedures, as specified in 23 C.F.R. § 772, follow a six-step process:

1. Identify noise-sensitive land uses,
2. Determine existing noise levels,
3. Predict future (Design Year) noise levels,
4. Determine traffic noise impacts at the noise-sensitive receptors by comparing future (Design Year) noise levels of the Proposed Alternatives with the existing noise levels,
5. Identify any noise impacts resulting from project construction activities, and
6. Provide and evaluate information from local land use planning agencies regarding predicted future (Design Year) noise levels for use in land development decisions.

Figure 1. Project Location Map

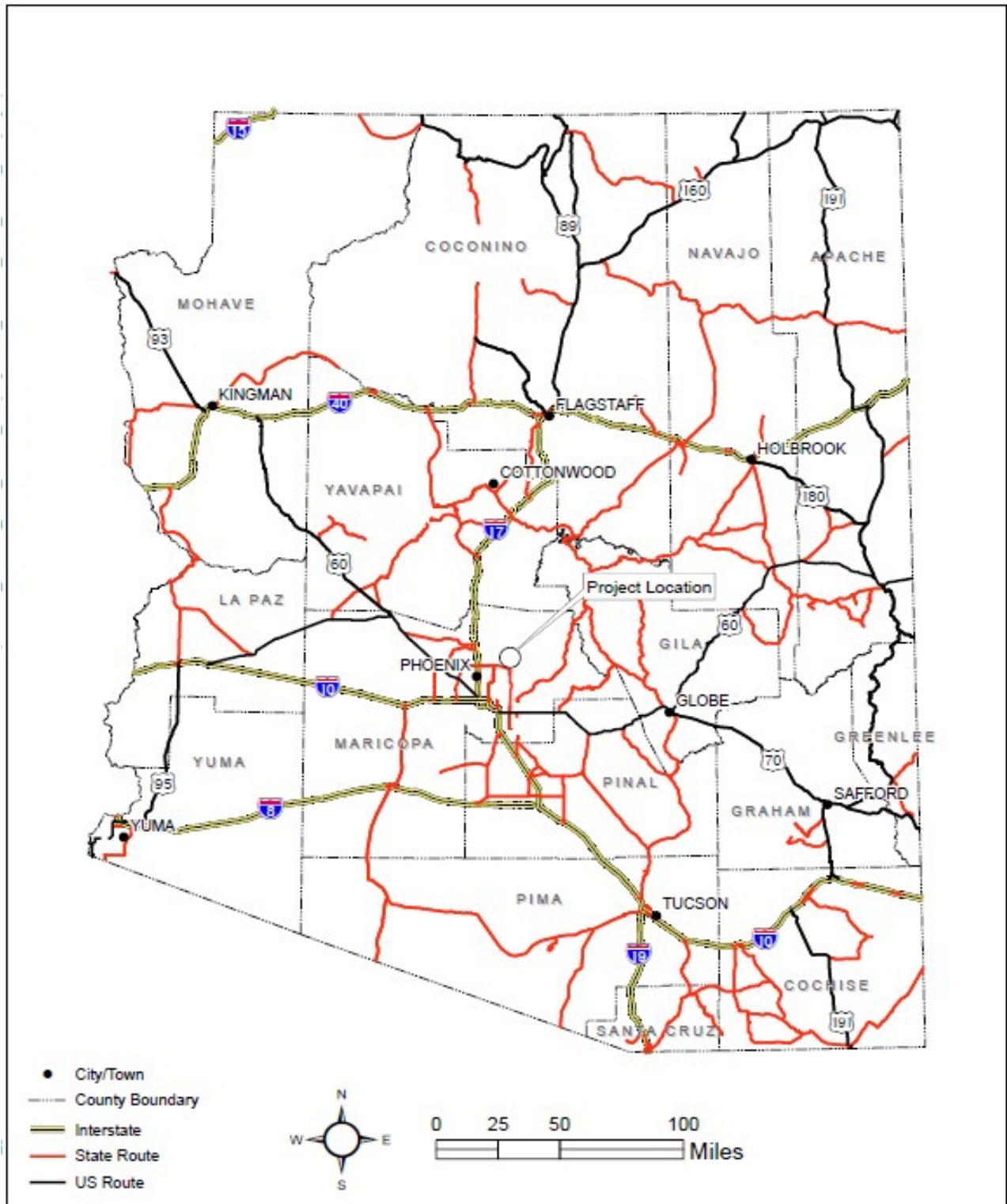
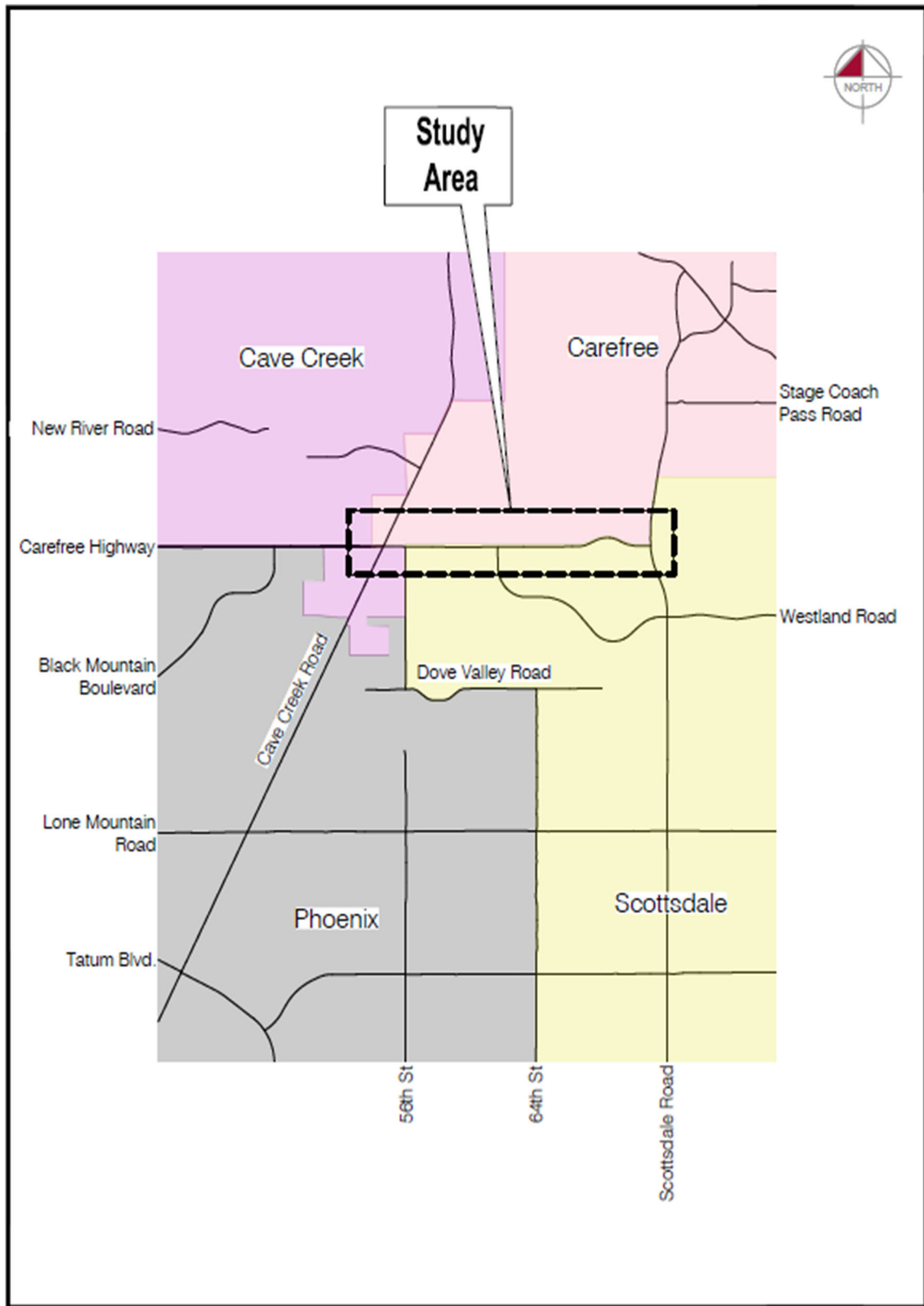
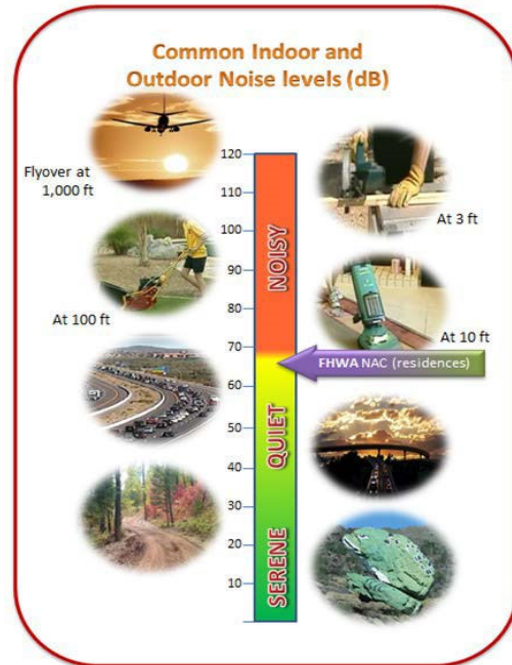


Figure 2. Project Study Area



3.0 FUNDAMENTALS OF TRAFFIC NOISE

Sound is the sensation produced by stimulation of the hearing organs produced by continuous and regular vibrations of a longitudinal pressure wave that travels through an elastic medium (air, water, metal, wood) and can be heard when they reach a person's or animal's ear. When sound travels through air, the atmospheric pressure wave variations occur periodically. Sound travels in air at a speed of approximately 1,087 feet per second at sea level and temperature of 32 °F. Noise is usually defined as any “unwanted sound,” and consists of sounds that are perceived as interfering with communication, work, rest, and recreation. It is characterized as a non-harmonious or discordant group of sounds.



Sound Pressure Levels, Decibels, Frequencies and A-Weighted Decibels-dBA

Noise is measured in Pascals (Pa). A healthy human ear can detect a pressure variation of 20 μ Pa which is referred to as the threshold of hearing. A logarithmic scale is useful for reporting noise levels over a wide range, but for a smaller range, the decibel (dB) scale is used. The sound pressure level (SPL) is calculated using measured sound levels and the hearing threshold of 20 μ Pa or 20×10^{-6} Pa as the reference level, which is defined as 0 dB. The decibel alone is insufficient to describe how the human ear responds to sound pressures at all frequencies. The human ear has peak response in the range of 2,500 to 3,000 Hz and has a somewhat low response at low or high frequencies. In response to the human ear sensitivity, the A-weighted noise level, referenced in units of dBA, was determined to better represent people’s perception of sound levels. This dBA unit of measurement is used in noise studies and reporting. Changes in sound level of less than 3 dBA are not perceptible to the human ear, while people generally perceive a 10 dBA increase in a sound level to be a doubling of sound.

Noise Descriptors

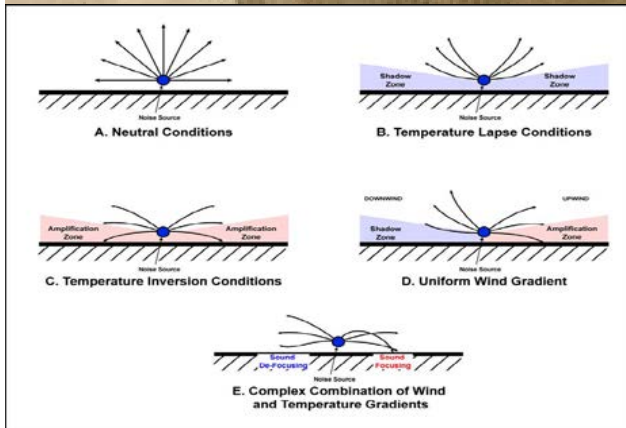
The most commonly used noise descriptor in traffic noise analysis is the Equivalent Sound Level (Leq). The Leq represents an average of the sound energy occurring over a specified period of time (for example, 1 hour). In effect, the Leq is the steady-state sound level containing the same acoustical energy as the time-varying sound that actually occurs during the same period. The 1-hour A-weighted equivalent sound level [LAeq(h)] is the energy average of A-weighted sound levels occurring during a one-hour period and is the basis for noise criteria used by ADOT.

What are source, receiver, receptor, and path when talking about traffic noise?

Traffic noise is a combination of the sounds produced by vehicle engines, vehicle exhaust, and tires. The source of highway traffic comes from vehicles traveling on highways. Source noise levels

depend on pavement type traffic volumes (including the number of heavy trucks and medium trucks), and traffic speeds. The predominant noise sources in vehicles at speeds less than 30 mph are engine and exhaust. At speeds greater than 30 mph, tire noise becomes the dominant noise source.

In the illustration below, the Receptor is any location where people are affected by the traffic noise. It can be a residence, park, school, playground or any other place where frequent human use occurs. An area between the source and the receptor (receiver represents a receptor(s) when modeled in FHWA Traffic Noise Model) is considered a path. Depending on the path surface, propagation of sound may be reduced; such is the case for the soft ground and fresh snow. Doubling the distance between the source and receptor reduces noise by three dBA depending on the ground.



Air changes its density due to variation of humidity and temperature, and wind influences refraction of sound waves. Wind, humidity, and temperature may have a significant impact, but only influences the receptors located a long distance from the source. As residents are usually much closer to the noise source, any atmospheric conditions are insignificant for consideration.

4.0 NOISE ABATEMENT CRITERIA

The ADOT NAR establish the guidelines used to assess the potential for negative impacts from highway traffic noise and determines the need for noise abatement. The noise level impact methodology used for this analysis is based on the current ADOT NAR (May 2017). The Federal Highway Administration (FHWA) has established Noise Abatement Criteria (NAC) and procedures for assessing traffic noise that are used in the planning and design of highways. A summary of the NAC for various land uses are shown in **Table 1**.

The ADOT NAR are based on the noise levels approaching the FHWA NAC. ADOT defines “approaching” as within 1 dBA of the FHWA NAC for Activity Categories A, B, C, D, and E. There are no noise impact thresholds for Activity Category F or G. The ADOT NAR are used to determine highway traffic noise and for evaluating the need for potential mitigation measures such as sound walls.

As implemented by the ADOT NAR, a traffic noise impact for residential land uses (Activity Category B) occurs when the predicted noise level is equal to or greater than the noise impact threshold of 66 dBA. ADOT will also consider mitigation if the transportation improvement project is predicted to result in a substantial increase in noise levels compared to the existing measured noise levels. A substantial noise level increase is equal to or greater than 15 dBA over existing noise levels.

Activity Category	dBA, L _{Aeq1h} ^[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, amphitheatres, 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.
<p>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.</p>		

5.0 LAND USES WITHN PROJECT STUDY AREA

Land uses on Carefree Highway are primarily residential land uses, consisting of single-family detached housing. The south side of Carefree Highway is a combination of land zoned for single-family residential, service residential, central business, and designated open space. The focus of this evaluation is on residential receptors (Activity Category B). **Appendix A** shows the location of receivers used in the evaluation.

6.0 EXISTING NOISE ENVIRONMENT

Short-term noise level monitoring was conducted within the project limits on November 2,, 2023 to depict the existing noise environment. Two measurement locations were selected to represent noise sensitive receptors at residences along the project corridor. Three 10-minute interval equivalent noise level measurements (Leq) were conducted at each site. Noise level monitoring helps describe the existing noise environment throughout the project area and capture the contribution of traffic noise from surrounding roadways. Measured noise levels may include contributions from other noise sources, including but not limited to, airplanes, wind, birds, insects, landscaping equipment, and construction activities.

The equipment used for the noise level monitoring was a Larson Davis Model LXT Class 1 integrating sound level meter (SLM). The SLM was calibrated in the field before each measurement using a Larson Davis Model CAL200. Existing noise measurements were collected under meteorologically acceptable conditions when the pavement was dry, and winds were calm or light. Additional data collected at each monitoring location included atmospheric conditions such as general wind speed and direction, humidity, dewpoint, barometric pressure, and ambient temperature. Measurements were collected based on the acceptable collection of existing noise level readings per FHWA Report number FHWA- HEP-18-065, and “Noise Measurement Handbook.”

The monitoring sites were located adjacent to the back and side yards of residential homes with exposed views to Carefree Highway. The measured noise level ranged from 59 dBA to 65 dBA. **Appendix A** shows the location of the noise level monitoring sites, and **Table 2** shows the summary of the modeled and measured noise levels. **Appendix B** shows the measured noise level data.

Model Validation

Model validation is a process for testing a model to ensure that it produces reliable results and to confirm that traffic noise is the predominant noise source at the receptor locations. In general, validation involves comparing actual noise measurements with the noise levels predicted by the model for existing conditions at the same location. The model is considered to be validated if the model results are within ± 3 dBA of the arithmetic average of the three 10-minute interval field measurements recorded at the site for the same conditions. The monitoring site was modeled within the ± 3 dBA (rounded) measured at site Mon 1 and Mon 2. Therefore, the model is considered valid.

TABLE 2 SUMMARY OF SOUND LEVEL MEASUREMENTS November 2, 2023						
Site Number	Description	Modeled Validation Noise Levels (Leq), dBA	10-Minute Interval Measured Noise Levels (Leq), dBA			
			Interval 1	Interval 2	Interval 3	Arithmetic Average of Intervals
MON 1	Validation Site – 34619 N. Los Reales Dr.	62.0	59.3	58.7	59.1	59.0
MON 2	Validation Site – 6745 E. Carefree Highway	66.0	64.6	61.5	61.3	62.5

7.0 NOISE MODELING METHODOLOGY AND TNM 2.5 VARIABLES

The FHWA-approved Traffic Noise Model version 2.5 (TNM 2.5) is the computer noise model used for the prediction of highway and roadway traffic noise. The output of the model depends on several variables, including atmospheric conditions, roadway geometries, topographic data, ground types, noise receiver locations, traffic volumes, vehicle speed, and vehicle mix.

Atmospheric Conditions

Noise levels are affected by temperature and humidity. Temperature gradients cause refraction effects. For example, in the morning, when the ground is still cool from the previous night, but the upper air is warming due to the sun, noise can bounce between the gradient and the ground, forming regions of higher and lower noise intensity. Noise attenuation is also affected by humidity. Dry air absorbs more acoustical energy than moist air because dry air has a higher density than moist air at a given temperature. For noise modeling, FHWA recommends the default values of 68 degrees Fahrenheit for the temperature and 50 percent humidity.

Roadway Geometry & Topographic Data and Ground Type

The roadway geometries and topographic data for the project were based on preliminary design plans provided by the design engineer (Kimley-Horn). Loose soil was used to approximate the ground type between the roadway and receptors.

Receptor and Receiver Locations

A “receptor” is a discrete or representative location of a noise sensitive area(s) for any of the land uses listed in **Table 1**. A “Receiver” is a location used in noise modeling to represent the measured and predicted noise level at a particular point. The noise-sensitive receptors are located in the backyard or common outdoor areas of use.

Traffic Volumes

Traffic volumes used in the noise model should represent a “worst-case” approach. In general, this should reflect Level of Service (LOS) C traffic conditions during the peak hour, with traffic

moving at 5 miles per hour (mph) above the posted speed limit. Also, if the future traffic volumes are less than the maximum LOS C volumes, then the future traffic volumes will be used.

If no other traffic information is available, the peak hourly volume should be 10 percent of the annual average weekday traffic (AWDT) volume. Traffic information was provided by Kimley-Horn. The 2045 Build Conditions were modeled with AM and PM peak-hour volumes along Carefree Highway. Traffic volumes are shown in **Appendix C**.

Vehicle Speed

The posted speed limit on Carefree Highway is 45 miles per hour (mph). The vehicle speeds for autos, medium trucks, and heavy trucks were modeled at 5 mph over the posted speed limit on each alignment (that is, at 50 mph).

Vehicle Mix

The percentages of vehicles by type (vehicle mix) is an important input for the noise model, because different vehicle types exhibit different base or reference noise emission levels, such as trucks that produce higher reference levels than cars, and larger trucks that produce higher reference levels than smaller trucks. Vehicle types are defined as follows:

- Cars (Auto): All vehicles with two axles and four wheels designed primarily for passenger transportation or cargo (light trucks). Generally, the gross vehicle weight is less than 10,000 pounds.
- Medium Trucks: All vehicles having two axles and six wheels designed for the transportation of cargo. Generally, the gross vehicle weight is greater than 10,000 pounds but less than 26,400 pounds.
- Heavy Trucks: All vehicles having three or more axles and designed for the transportation of cargo. Generally, the gross weight is greater than 26,400 pounds.

This noise analysis focuses on automobile, medium truck, and heavy truck usage on the roadways. The vehicle mix used in this analysis is shown in **Appendix C**.

8.0 FUTURE NOISE ENVIRONMENT AND IMPACT DETERMINATION

Table 3 shows the modeled 2045 Build results, based on the TNM 2.5 input assumptions and parameters described in the preceding section. A total of 116 receivers were modeled to represent 181 residential homes (Activity Category B land uses) on the north and south side of Carefree Highway. The location of the modeled receivers are shown in **Appendix A**.

<p align="center">TABLE 3 Modeled Noise Level Results Carefree Highway: Cave Creek Road to Scottsdale Road</p>										
Receiver ID	NAC Category	No of Dwelling Units	Description	2045 Build AM Peak Unmitigated Noise Level (dBA)	Mitigated Noise Levels	Insertion Loss	2045 Build PM Peak Unmitigated Noise Level (dBA)	Mitigated Noise Levels	Insertion Loss	Mitigation Considerations
N1	B	1	Single Family Residence	54	---	---	52	---	---	Noise levels less than Category B threshold of 66 dBA
N2	B	1	Single Family Residence	53	---	---	52	---	---	
N3	B	1	Single Family Residence	53	---	---	52	---	---	
N4	B	1	Single Family Residence	55	---	---	54	---	---	
N5	B	1	Single Family Residence	58	---	---	57	---	---	
N6	B	1	Single Family Residence	53	---	---	52	---	---	
N7	B	1	Single Family Residence	57	---	---	57	---	---	
N8	B	1	Single Family Residence	54	---	---	53	---	---	
N9	B	1	Single Family Residence	57	---	---	57	---	---	
N10	B	1	Single Family Residence	57	---	---	56	---	---	
N11	B	1	Single Family Residence	58	---	---	58	---	---	
N12	B	1	Single Family Residence	58	---	---	57	---	---	
N13	B	1	Single Family Residence	58	---	---	57	---	---	
N15	B	1	Single Family Residence	64	---	---	64	---	---	
N14	B	1	Single Family Residence	58	--	--	57	--	--	
N16	B	1	Single Family Residence	65	--	--	65	--	--	
N18	C	1	Single Family Residence	56	--	--	56	--	--	
N17	B	1	Single Family Residence	63	---	---	63	---	---	
N19	B	1	Single Family Residence	57	---	---	56	---	---	
N20	B	1	Single Family Residence	61	---	---	61	---	---	
N21	B	1	Single Family Residence	56	---	---	55	---	---	
N22	B	1	Single Family Residence	64	---	---	64	---	---	
N23	B	1	Single Family Residence	64	---	---	64	---	---	
N24	B	1	Single Family Residence	55	---	---	54	---	---	
N25	B	1	Single Family Residence	65	---	---	65	---	---	
N26	B	1	Single Family Residence	56	---	---	55	---	---	
N27	B	1	Single Family Residence	60	---	---	60	---	---	
N28	B	1	Single Family Residence	57	---	---	56	---	---	
N29	B	1	Single Family Residence	65	---	---	64	---	---	
N30	B	1	Single Family Residence	65	--	--	65	--	--	
N31	B	1	Single Family Residence	63	59	5	63	--	--	
N32	B	1	Single Family Residence	58	---	---	58	---	---	
N33	B	1	Single Family Residence	63	---	---	63	---	---	
N34	B	1	Single Family Residence	59	---	---	58	---	---	
N35	B	1	Single Family Residence	55	---	---	54	---	---	
N36	B	1	Single Family Residence	64	---	---	63	---	---	
N37	B	1	Single Family Residence	54	---	---	53	---	---	
N38	B	1	Single Family Residence	64	---	---	64	---	---	

<p align="center">TABLE 3 Modeled Noise Level Results Carefree Highway: Cave Creek Road to Scottsdale Road</p>										
Receiver ID	NAC Category	No of Dwelling Units	Description	2045 Build AM Peak Unmitigated Noise Level (dBA)	Mitigated Noise Levels	Insertion Loss	2045 Build PM Peak Unmitigated Noise Level (dBA)	Mitigated Noise Levels	Insertion Loss	Mitigation Considerations
N39	B	1	Single Family Residence	55	---	---	54	---	---	Noise levels less than Category B threshold of 66 dBA
N40	B	1	Single Family Residence	62	---	---	61	---	---	
N41	B	1	Single Family Residence	56	---	---	55	---	---	
N42	B	1	Single Family Residence	64	---	---	63	---	---	
N43	B	1	Single Family Residence	56	---	---	55	---	---	
N44	B	1	Single Family Residence	60	---	---	60	---	---	
N45	B	1	Single Family Residence	63	---	---	63	---	---	
N46	B	1	Single Family Residence	57	---	---	55	---	---	
N47	B	1	Single Family Residence	54	---	---	53	---	---	
N48	B	1	Single Family Residence	55	---	---	54	---	---	
N49	B	1	Single Family Residence	55	---	---	54	---	---	
N50	B	1	Single Family Residence	57	---	---	57	---	---	
N51	B	1	Single Family Residence	62	---	---	61	---	---	
N52	B	1	Single Family Residence	62	---	---	61	---	---	
N53	B	1	Single Family Residence	55	---	---	54	---	---	
N54	B	1	Single Family Residence	56	---	---	56	---	---	
N55	B	1	Single Family Residence	55	---	---	54	---	---	
N56	B	1	Single Family Residence	58	---	---	57	---	---	
N57	B	1	Single Family Residence	55	---	---	54	---	---	
N58	B	1	Single Family Residence	56	---	---	56	---	---	
N59	B	1	Single Family Residence	55	---	---	54	---	---	
N60	B	1	Single Family Residence	62	---	---	62	---	---	
N61	B	1	Single Family Residence	57	---	---	57	---	---	
N62	B	1	Single Family Residence	59	---	---	58	---	---	
N63	B	1	Single Family Residence	62	---	---	61	---	---	
N64	B	1	Single Family Residence	65	---	---	65	---	---	
N65	B	1	Single Family Residence	58	---	---	57	---	---	
N66	B	1	Single Family Residence	64	---	---	63	---	---	
N67	B	1	Single Family Residence	59	---	---	58	---	---	
N68	B	1	Single Family Residence	63	---	---	62	---	---	
N69	B	1	Single Family Residence	56	---	---	55	---	---	
N70	B	1	Single Family Residence	59	---	---	58	---	---	
N71	B	2	Single Family Residence	54	---	---	53	---	---	
N72	G	1	Undeveloped	60	---	---	59	---	---	Future Residential
S1	G	1	Undeveloped land	61	---	---	60	---	---	Future Commercial
S2	G	1	Undeveloped land	60	---	---	59	---	---	Future Educational
S3	G	1	Undeveloped land	60	---	---	60	---	---	
S4	C	10	Paradise Valley Community College	54	---	---	54	---	---	Less than 66 dBA

TABLE 3 Modeled Noise Level Results Carefree Highway: Cave Creek Road to Scottsdale Road										
Receiver ID	NAC Category	No of Dwelling Units	Description	2045 Build AM Peak Unmitigated Noise Level (dBA)	Mitigated Noise Levels	Insertion Loss	2045 Build PM Peak Unmitigated Noise Level (dBA)	Mitigated Noise Levels	Insertion Loss	Mitigation Considerations
S5	B	2	Single Family Residence	58	---	---	58	---	---	Less than 66 dBA
S6	C/D	1	Urgent Care Center	71	---	---	70	---	---	No exterior use. Assumed 25 dBA transmission loss, interior noise levels is 45 dBA, less than Cat D threshold of 51 dBA
S7	B	3	Single Family Residence	55	---	---	55	---	---	Noise levels less than Category B threshold of 66 dBA
S8	B	2	Single Family Residence	58	---	---	58	---	---	
S9	B	1	Single Family Residence	58	---	---	58	---	---	
S10	B	3	Single Family Residence	55	---	---	55	---	---	
S11	B	2	Single Family Residence	62	---	---	61	---	---	
S12	B	3	Single Family Residence	55	---	---	54	---	---	
S13	B	2	Single Family Residence	61	---	---	61	---	---	
S14	B	2	Single Family Residence	55	---	---	55	---	---	
S15	B	2	Single Family Residence	51	---	---	51	---	---	
S16	B	2	Single Family Residence	55	---	---	54	---	---	
S17	B	3	Single Family Residence	55	---	---	54	---	---	
S18	B	3	Single Family Residence	53	---	---	52	---	---	
S19	B	3	Single Family Residence	55	---	---	54	---	---	
S20	B	2	Single Family Residence	52	---	---	52	---	---	
S21	B	3	Single Family Residence	54	---	---	54	---	---	
S22	B	2	Single Family Residence	52	---	---	51	---	---	
S23	B	3	Single Family Residence	53	---	---	52	---	---	
S24	B	2	Single Family Residence	53	---	---	53	---	---	
S25	B	3	Single Family Residence	52	---	---	52	---	---	
S26	B	3	Single Family Residence	51	---	---	51	---	---	
S27	B	3	Single Family Residence	55	---	---	55	---	---	
S28	B	3	Single Family Residence	57	---	---	56	---	---	
S29	B	3	Single Family Residence	54	---	---	54	---	---	
S30	B	3	Single Family Residence	58	---	---	58	---	---	
S31	B	3	Single Family Residence	57	---	---	56	---	---	
S32	B	3	Single Family Residence	60	---	---	60	---	---	
S33	B	2	Single Family Residence	55	---	---	55	---	---	
S34	B	2	Single Family Residence	57	---	---	57	---	---	
S35	B	1	Single Family Residence	70	63	7	69	61	8	Barrier S1 not recommended
S37	B	1	Single Family Residence	68	63	5	67	61	6	Barrier S1 not recommended
S36	B	2	Single Family Residence	57	---	---	57	---	---	Less than 66 dBA

TABLE 3 Modeled Noise Level Results Carefree Highway: Cave Creek Road to Scottsdale Road										
Receiver ID	NAC Category	No of Dwelling Units	Description	2045 Build AM Peak Unmitigated Noise Level (dBA)	Mitigated Noise Levels	Insertion Loss	2045 Build PM Peak Unmitigated Noise Level (dBA)	Mitigated Noise Levels	Insertion Loss	Mitigation Considerations
S38	B	3	Single Family Residence	56	---	---	55	---	---	Category B threshold of 66 dBA
S39	B	1	Single Family Residence	65	---	---	64	---	---	
S40	B	3	Single Family Residence	55	---	---	54	---	---	
S41	B	3	Single Family Residence	53	---	---	52	---	---	
S42	B	3	Single Family Residence	54	---	---	54	---	---	
S43	B	1	Single Family Residence	64	---	---	63	---	---	
S44	B	3	Single Family Residence	53	---	---	52	---	---	
S45	B	3	Single Family Residence	55	---	---	55	---	---	
S46	B	3	Single Family Residence	57	---	---	57	---	---	
S47	B	2	Single Family Residence	56	---	---	55	---	---	
S48	B	3	Single Family Residence	60	---	---	59	---	---	
S49	B	2	Single Family Residence	57	---	---	57	---	---	
S50	B	2	Single Family Residence	63	---	---	62	---	---	
S51	E	1	Liberty Station (traditional American)	65	---	---	64	---	---	Noise levels less than Category E threshold of 71 dBA
S52	E	1	Wells Fargo Bank	67	---	---	65	---	---	

As shown in **Table 3**, the ADOT NAR threshold for residential receivers (Activity Category B) of 66 dBA was exceeded at two receivers in the AM and PM peak hour. A mitigation evaluation was conducted according to ADOT NAR. The mitigation evaluation results are shown below in **Table 4**.

9.0 MITIGATION SUMMARY

Table 4 Barrier Evaluation						
Noise Barrier Description	Barrier Height Range, ft	Length, ft	Area, ft ²	Cost	Number of Benefitted Receptors	Cost per Benefitted Receptor
Barrier S1	16	547	8,753	\$306,355	2	\$153,178
Notes: \$35/ft ² used to calculate barrier cost City of Scottsdale Allowed cost: \$74,142 per benefitted receptor						

Under the City of Scottsdale Roadway Noise Abatement Policy Amendment (2022), noise barriers are not warranted if the cost per benefitted receptor exceeds \$74,142 per benefitted receptor. As shown in **Table 4**, the cost per benefitted receptor exceeded the allowed cost for Barrier S1. Noise barriers are not warranted for the proposed project.

Even though Barrier S1 is not warranted because of cost, it is important to note that Carefree Highway will be constructed with asphalt pavement. Initially new asphalt can provide a 3 dBA to 5 dBA reduction in tire pavement noise, but the reduction reduces over time as the pavement ages and wears. With proper and more frequent maintenance to the asphalt pavement, the integrity and noise attenuation properties will be preserved over the life cycle of the pavement.

10.0 CONSTRUCTION NOISE

Construction noise is anticipated for roadway improvement projects and lasts for the duration of the construction. Construction activities are generally of a short-term nature. Depending on the nature of construction operations, the duration of the noise could last from seconds (e.g., a truck passing a customer) to months (e.g., constructing a bridge). Construction noise is also intermittent and depends on the type of operation, location, and function of the equipment and the equipment usage cycle. **Table 5** shows the overall predicted maximum noise level (L_{max}) of the construction equipment at 50 feet for different phases of roadway construction.

TABLE 5 CONSTRUCTION EQUIPMENT NOISE ^[1]		
Phase	Equipment	Noise Limit (L_{max}) At 50 feet, dBA
Site Clearing	Dozer	85
	Backhoe	80
Grading & Earthwork	Scraper	85
	Grader	85
Foundation	Backhoe	80
	Front Loader	80
Base Preparation	Compressor (air)	80
	Dozer	85

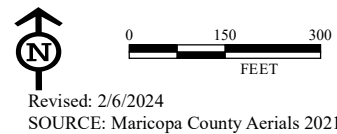
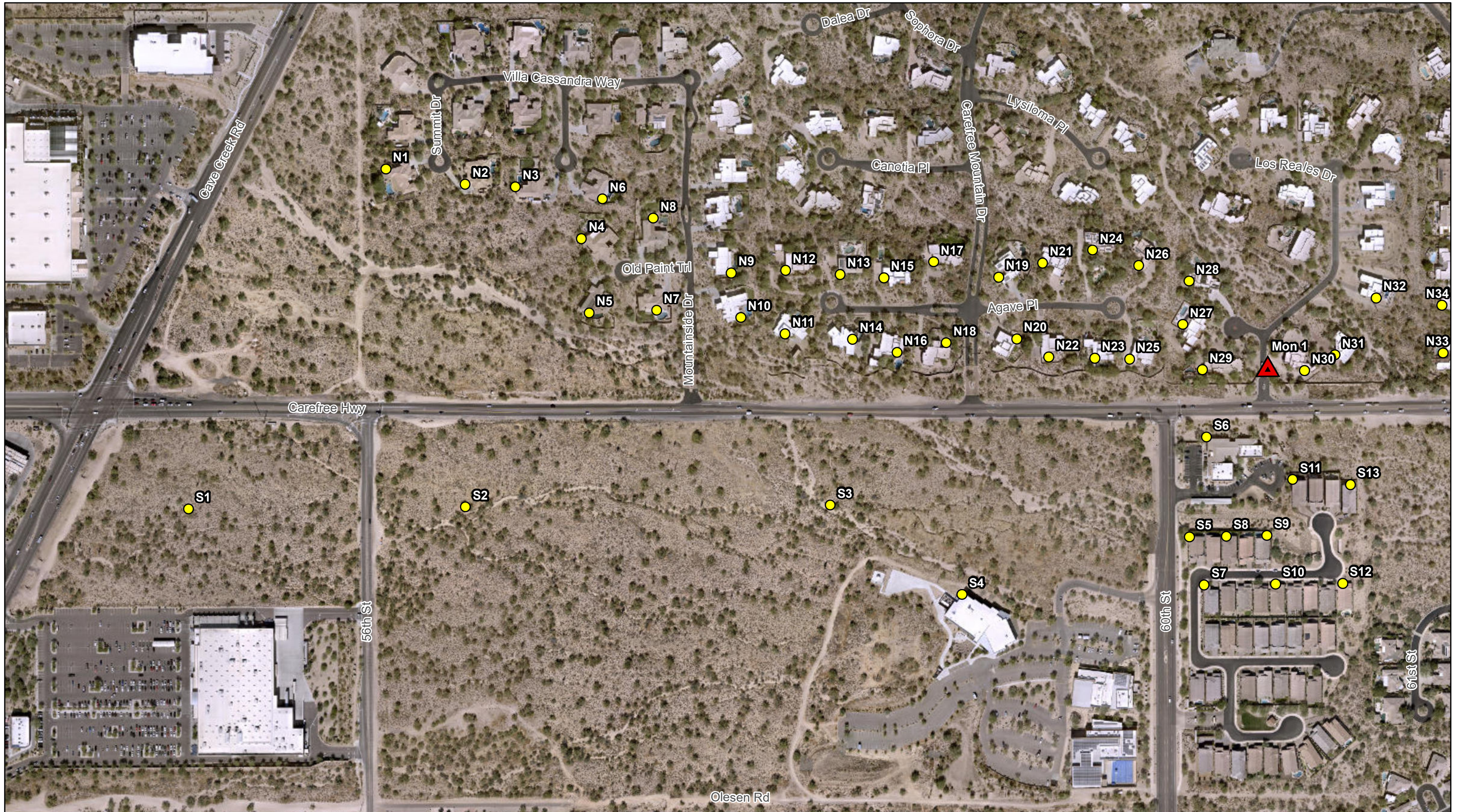
1. Source- FHWA Highway Construction Noise Handbook, page 3; August 2006

Ground vibration and ground-born noise can also be a source of annoyance to individuals who live or work close to vibration-generating activities. Pile driving, demolition activity, blasting, and crack-and-seat operations are the primary sources of vibration, while the impact pile driving can be the most significant source of vibration at construction sites. It is recommended to apply methods that may be practical and appropriate in specific situations, to reduce vibration to an acceptable level.

11.0 STATEMENT OF LIKELIHOOD

The FHWA-approved noise model TNM2.5 was used to evaluate traffic noise for the 2045 Build Condition in the AM and PM peak-hour. Noise barriers were evaluated but not recommended. A final determination of noise abatement measures, if ultimately determined to be required, will be made upon completion of the project design, the public involvement process, concurrence with the COS RNAP, and City approval.

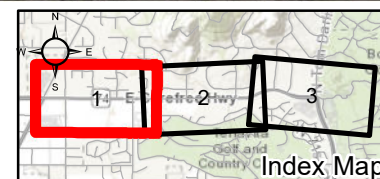
APPENDIX A – RECEIVER AND MONITORING LOCATIONS

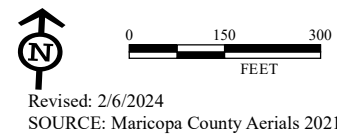


Revised: 2/6/2024
SOURCE: Maricopa County Aerials 2021

Legend

- Noise Receivers
- ▲ Monitoring Sites
- Evaluated Barrier (S1 Not Recommended)

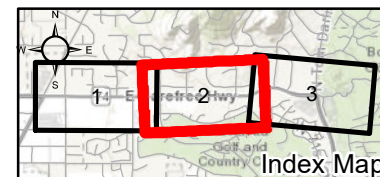




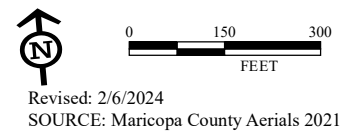
Revised: 2/6/2024
SOURCE: Maricopa County Aerials 2021

Legend

- Noise Receivers
- Evaluated Barrier (S1 Not Recommended)
- ▲ Monitoring Sites

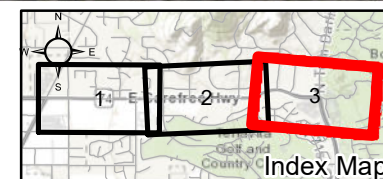


newton
Environmental Consulting, LLC



Legend

- Noise Receivers
- ▬▬▬ Evaluated Barrier (S1 Not Recommended)
- ▲ Monitoring Sites



APPENDIX B – NOISE MEASUREMENT DATA

Roadway Noise Level Measurement Data Sheet

Project Number: 2023 KHA-Carefree **Date:** 11/2/202
Project Name: Carefree Road – Scottsdale to Cave Creek **Site Number:** Mon 1
Site Description: 34619 N Los Reales Dr **Coordinates:** 33°47'58.34"N 111°57'03.20"W
Posted Speed: 45 MPH **Observed Speed:** 45 MPH
SLM: LD LXT **Response:** Slow **Weighting:** A
Calibrator: CAL200 **Begin ±:** 0.0 **End ±:** 0.0 **Battery >50%:** X

Weather Condition: Sunny/Clear
Temperature: 57°F **Humidity:** 38% **Wind:** W 4 mph

Sample	Measurement Data					Traffic Data									
	Time		Decibel (dB)			Auto		Medium Truck		Heavy Truck		Bus		Motorcycle	
	Begin	Duration	L _{eq}	L _{max}	L _{min}	WB	EB	WB	EB	WB	EB	WB	EB	WB	EB
1	8:07 am	10:09 min	59.3	80.0	44.4	45	81	0	4	5	3	0	0	1	0
2	8:18 am	10:00 min	58.7	79.3	43.7	45	123	0	9	2	3	1	0	0	0
3	9:29 am	10:00 min	59.1	77.7	43.8	42	111	0	13	2	3	2	0	0	0

Site Sketch



Notes:

Sample	Background Noise	Unusual Noise Events
1		
2		
3		

Roadway Noise Level Measurement Data Sheet

Project Number: 2023 KHA-Carefree **Date:** 11/2/202
Project Name: Carefree Road – Scottsdale to Cave Creek **Site Number:** Mon 2
Site Description: 6745 E Carefree Hwy **Coordinates:** 33°47'58.90"N 111°56'06.14"W
Posted Speed: 45 MPH **Observed Speed:** 45 MPH
SLM: LD LXT **Response:** Slow **Weighting:** A
Calibrator: CAL200 **Begin ±:** 0.0 **End ±:** 0.0 **Battery >50%:** X

Weather Condition: Sunny/Clear
Temperature: 64°F **Humidity:** 30% **Wind:** W 4 mph

Measurement Data						Traffic Data									
Sample	Time		Decibel (dB)			Auto		Medium Truck		Heavy Truck		Bus		Motorcycle	
	Begin	Duration	L _{eq}	L _{max}	L _{min}	WB	EB	WB	EB	WB	EB	WB	EB	WB	EB
1	9:02 am	10:01 min	64.6	73.8	40.8	83	137	1	8	1	3	0	1	0	0
2	9:18 am	10:04 min	61.5	74.3	44.6	73	130	0	9	4	4	0	0	2	0
3	9:29 am	10:01 min	61.3	72.1	44.1	65	121	4	8	3	2	0	0	2	0

Site Sketch



Notes:

Sample	Background Noise	Unusual Noise Events
1		
2	Aircraft	
3	Aircraft, Birds	

APPENDIX C – TNM 2.5 TRAFFIC VOLUMES

Carefree Highway: Cave Creek Road to Scottsdale Road - TNM Traffic Volumes

Roadway Segment	AM Peak Hour TNM modeled Volume			PM Peak Hour TNM modeled Volume			AM Peak Period Volume	Auto	MT	HT	PM Peak Period Volume	Auto	MT	HT
	Auto Volume	MT Volume	HT Volume	Auto Volume	MT Volume	HT Volume								
Carefree Hwy EB (Cave Creek Rd to Sunset Trail)	1366	240	36	806	141	21	1642	83.20%	14.60%	2.20%	969	83.20%	14.60%	2.20%
Carefree Hwy EB (Sunset Trail to Scottsdale Rd)	1352	176	39	791	103	23	1567	86.30%	11.20%	2.50%	917	86.30%	11.20%	2.50%
Carefree Hwy WB (Cave Creek Rd to Sunset Trail)	850	149	22	1163	204	31	1022	83.20%	14.60%	2.20%	1398	83.20%	14.60%	2.20%
Carefree Hwy WB (Sunset Trail to Scottsdale Rd)	819	106	24	1057	137	31	949	86.30%	11.20%	2.50%	1225	86.30%	11.20%	2.50%
Cave Creek Rd SB (north of Carefree Hwy)	1056	185	28	579	102	15	1269	83.20%	14.60%	2.20%	696	83.20%	14.60%	2.20%
Cave Creek Rd SB (south of Carefree Hwy)	1302	228	34	847	149	22	1565	83.20%	14.60%	2.20%	1018	83.20%	14.60%	2.20%
Cave Creek Rd NB (north of Carefree Hwy)	1111	195	29	493	86	13	1335	83.20%	14.60%	2.20%	592	83.20%	14.60%	2.20%
Cave Creek Rd NB (south of Carefree Hwy)	1127	198	30	972	171	26	1355	83.20%	14.60%	2.20%	1168	83.20%	14.60%	2.20%
Scottsdale Rd SB (north of Carefree Hwy)	600	78	17	447	58	13	695	86.30%	11.20%	2.50%	518	86.30%	11.20%	2.50%
Scottsdale Rd SB (south of Carefree Hwy)	1251	162	36	541	70	16	1450	86.30%	11.20%	2.50%	627	86.30%	11.20%	2.50%
Scottsdale Rd NB (north of Carefree Hwy)	898	116	26	350	45	10	1040	86.30%	11.20%	2.50%	406	86.30%	11.20%	2.50%
Scottsdale Rd NB (south of Carefree Hwy)	1092	142	32	648	84	19	1265	86.30%	11.20%	2.50%	751	86.30%	11.20%	2.50%

Notes:

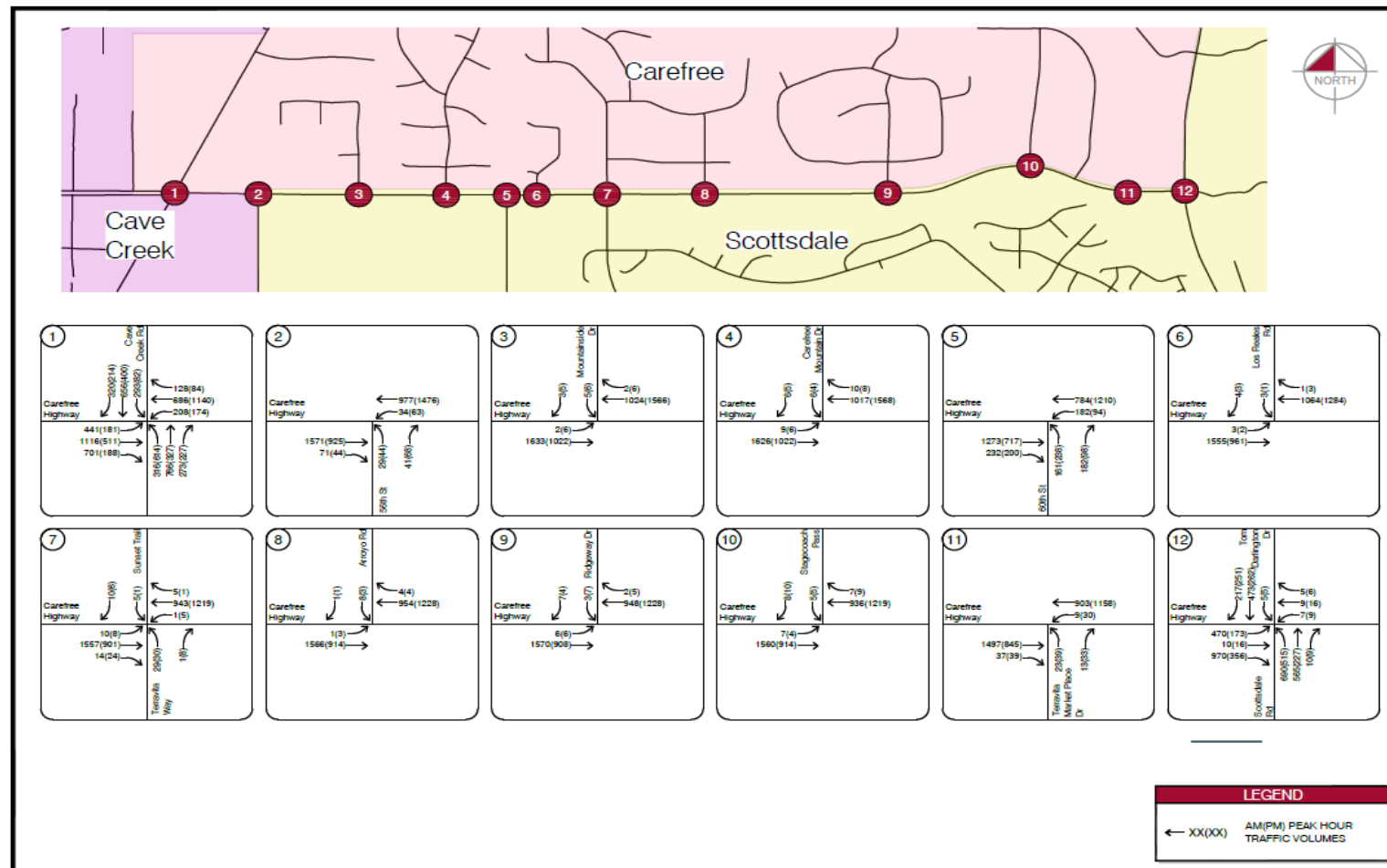
Volumes and traffic mix percentage are provided by KHA
 Carefree Hwy Speed limit: 45 mph
 Cave Creek Road Speed limit: 45 mph
 Scottsdale Rd Speed limit: 45 mph

Hi all,

From the classification count files medium trucks are 2 axle, 6 tire and heavy trucks are 3+ axles. Though included in the truck total percentage in these counts buses are not included in these percentages.

Based on this on Carefree Highway west of Scottsdale Road % medium trucks is 11.2% and % heavy trucks is 2.5%. At the other end, east of Cave Creek Road, medium truck % is 14.6% and heavy truck % is 2.2%.

Thanks!
 ~Taylor



List of TNM Files

- BuildAM_mod – Unmitigated Build file for design year 2045 in the AM peak-hour
- BuildPM_mod – Unmitigated Build file for design year 2045 in the PM peak-hour
- MON1 – Validation file for Monitoring Site #1
- MON2 – Validation file for Monitoring Site #2