NOISE STUDY
US-60
Springfield, MO

Prepared for:

MoDOT PROJECT NO. J8P3032C
MoDOT PROJECT NO. J8P3032D

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1.0 EXECUTIVE SUMMARY

This project is located on US-60 (James River Freeway) in Springfield, Greene County. The limits of the project are from Kansas Expressway to National Ave. Because of the addition of interior through lanes, this project qualifies as a Type I Project and therefore requires a noise analysis for potential abatement measures. All areas of the project that included areas considered "Noise Sensitive" by the FHWA Noise Abatement Criteria Table were considered for noise abatement. The project area was divided into five separate Noise Sensitive Areas (NSAs).

Figure 1-1: Noise Sensitive Areas

NSAs 1 and 3 had receivers impacted by noise and were considered for noise abatement measures. After analyzing potential abatement measures, one noise barrier in NSA 3 was acoustically feasible and reasonable per FHWA and MoDOT policies, pending a vote of first-row benefitted owners and residents.

Table 1-1
Executive Summary Table

NSA	Impacted Receptors by Activity Category			Consideration of Noise Abatement Warranted?	Barrier Option	Abatement Feasible?	Benefited Receptors	Square Feet	Square Feet/ Benefited Receptor	Abatement Reasonable?
	B	C	Total							
1	2	-	2	Yes	1	✓	6	8,200	1,367	x
2	-	-	0	No	-	-	-	-	-	-
3a	15	-	15	Yes	2	✓	29	35,978*	1,241	✓
3b	15	-	15	Yes	3	✓	17	38,251	2,250	x
4	-	-	0	No	-	-	-	-	-	-
5	-	-	0	No	-	-	-	-	-	-

*34,000 sqft of noise barrier plus 1,978 sqft equivalent ($70,000) for grade beam and extra drilled shaft depth.

2.0 PROJECT DESCRIPTION

The project extends along US-60 in Springfield, MO. The work will consist of adding interior through lanes in both directions between Kansas Expressway (MO-13) and National Avenue.

The addition of through lanes qualifies this project as a Type I project and therefore requires a noise analysis in accordance with 23 CFR 772, MoDOT Noise Policy EPG 127.13, and all Federal Highway Administration (FHWA) noise standards. Per FHWA and MoDOT regulations, if any part of a project is considered a Type I project, the entire project is considered a Type I project.

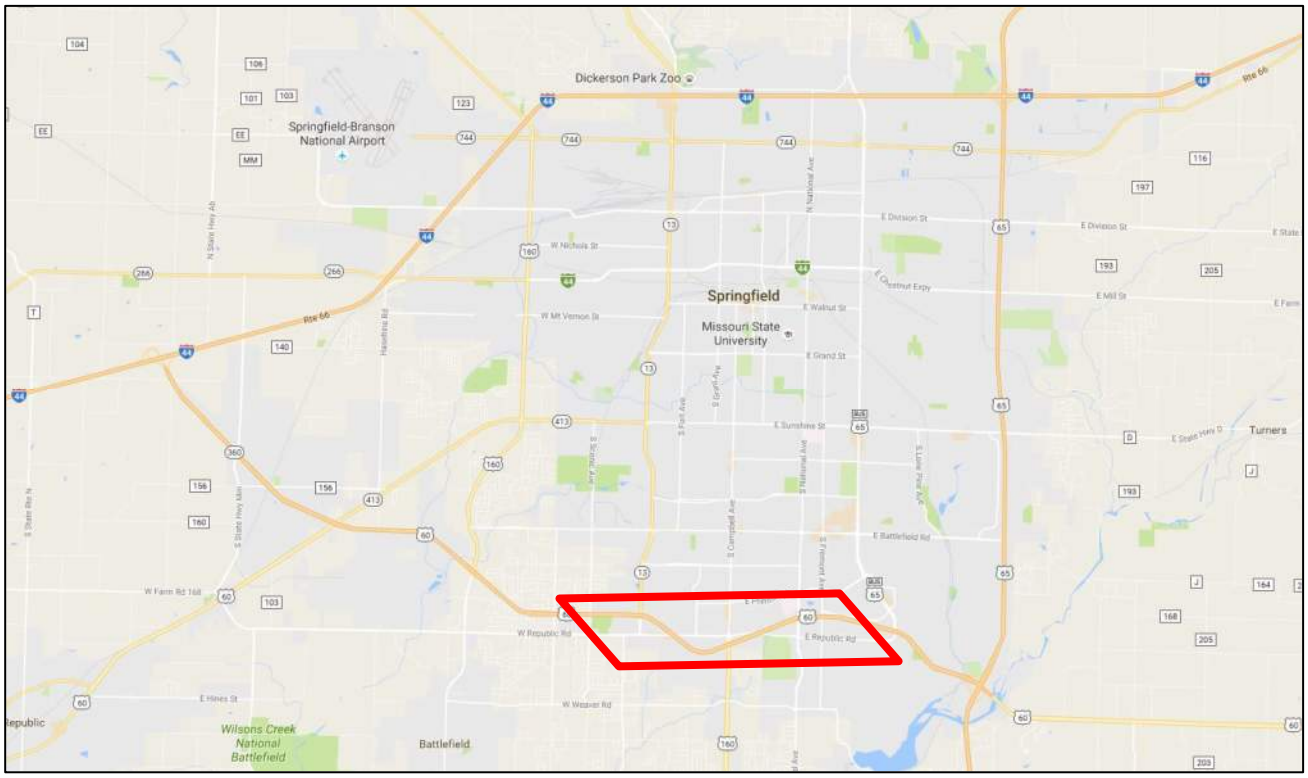

Figure 2-1 Location Map

3.0 CRITERIA FOR DETERMINING IMPACTS

3.1. Traffic Noise Terminology

Alternative Noise Abatement Measures: Any method of noise abatement other than a noise wall, such as an earth berm.

Benefitted Receptor: The recipient of an abatement measure that receives a noise reduction at or above the minimum threshold of 7 dB(A).

Feasibility: Consideration of engineering factors and other constraints as they related to construction of noise abatement.

First-row Receptor: Receptors directly adjacent to the highway, at nearly the same elevation, with no intervening developed lands. Receptors with intervening parcels separating the receptor parcel from abutting the roadway right-of-way are generally considered second row or greater. In the case of multi-story buildings, only ground level receptors are considered to be first-row.

Impacted Receptor: Any receptor that has an average hourly noise level at the loudest traffic noise hour approaching (within 1 dB) or exceeding the Noise Abatement Criteria Table for the corresponding land use category, or exceeding existing noise levels by 15 dBA.

Noise Sensitive Area (NSA): A collection of areas where frequent human use can take place. This can include exterior sitting or eating areas, playgrounds, pools, homes, businesses, or other similar locations where people may gather

Reasonableness: The combination of social, economic, and environmental factors considered in the evaluation of a noise abatement measure. Viewpoints of owners and residents of the benefitted receptors will be obtained. Noise abatement measures shall not exceed 1,300 square feet per benefitted receptor, in the case of noise walls. Where noise walls are not options, other noise abatement techniques may be considered, but cannot exceed $46,000 per benefitted receptor.

Receiver/Receptor: A discrete or representative location of a noise sensitive area(s), for any of the land uses listed in the Noise Abatement Criteria Table.

3.2. Noise Abatement Criteria (NAC)

The corridor is a mixture of residential, retail, and office both north and south of US-60. To be considered for noise abatement, a receiver must be categorized under FHWA Noise Abatement Criteria (NAC) activity categories A-E, shown in Table 3-1. Building reduction factors are used when evaluating interior noise impacts for category D, shown in Table 3-2.

Table 3-1

FHWA Noise Abatement Criteria (Hourly A-Weighted Sound Level - Decibels)

Activity Category	Activity Criteria $L_{eq}(h)$*	Evaluation Location	Activity Descriptions
A	57	Exterior	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended 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, recreational 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 studios, recording studios, schools and television studios.
E	72	Exterior	Hotels, motels, offices, restaurants/bars, and other developed lands, properties or activities not included in 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.

*Approaching NAC is defined by MoDOT as being 1 dBA less than the NAC for Activity Categories A-E

Table 3-2 Building Noise Reduction Factors		
Building Type	Window Condition	Noise Reduction Due to the Exterior of the Structure
All	Open	10 dB
Light Frame	Ordinary Sash	20 dB
	Storm Windows	25 dB
Masonry	Single Glazed	25 dB
	Double Glazed	35 dB

4.0 IDENTIFICATION OF NOISE-SENSITIVE LAND USES AND NOISE STUDY AREAS

The project area was divided into five separate NSAs to be analyzed, as shown on Figure 4-1. Only receivers within 500 feet of the modified roadways were included, as sufficient evidence indicates the Traffic Noise Model (TNM) software is not reliable beyond this distance. The number of equivalent residential receptors for non-residential land uses was determined by the frontage length compared to the average frontage of nearby residential properties. The average frontages were calculated for each NSA based on a selected sample of single-family homes. See Table 4-1 for all Equivalent Receptors Assumptions.

Figure 4-1: Noise Sensitive Areas

Table 4-1			
Equivalent Receptor Assumptions			
NSA 1	**Receiver**	**# of Receptors**	**Description**
	Not Applicable	-	-
NSA 2	**Receiver**	**# of Receptors**	**Description**
	Park Crest Baptist Church	6	300 feet of frontage / 50 feet of average frontage
	Wesley United Methodist Church	13	650 feet of frontage / 50 feet of average frontage
	Wesley United Methodist Church (Playground)	6	300 feet of frontage / 50 feet of average frontage
	Wesley United Methodist Church (Garden)	6	300 feet of frontage / 50 feet of average frontage
NSA 3	**Receiver**	**# of Receptors**	**Description**
	Cox Learning Center	3	250 feet of frontage / 75 feet of average frontage
NSA 4	**Receiver**	**# of Receptors**	**Description**
	Tennis Court 1	2	150 feet of frontage /75 feet of average frontage
	Tennis Court 2	2	150 feet of frontage /75 feet of average frontage
	Swimming Pool	1	100 feet of frontage /75 feet of average frontage
NSA 5	**Receiver**	**# of Receptors**	**Description**
	Twin Oaks Substation	5	300 feet of frontage / 60 feet of average frontage
	Twin Oaks Office Park (East Area)	6	415 feet of frontage / 75 feet of average frontage
	Twin Oaks Office Park (West Area)	6	415 feet of frontage / 75 feet of average frontage

5.0 DETERMINATION OF EXISTING SOUND LEVELS

Extech HD600 Datalogging Sound Level Meters were used and calibrated before each noise measurement, completed on July 7th and 16th of 2020. Readings were taken at three different locations in the am and pm (see appendices) in 20-minute intervals while traffic along US-60 was counted by lane and categorized by cars, medium trucks, heavy trucks, buses, and motorcycles. These 20-minute traffic volumes were adjusted to hourly volumes to use in the traffic models. The volumes collected in the field are shown in Tables 5-1, 5-2, and 5-3.

Table 5-1 (Count Location 1 - West of National Ave.)											
Validation Measurement Traffic Counts											
Field Measurement Lane	Time Period	Hourly Traffic Based on Concurrent Traffic Counts (1)									
		7/7/2020 PM					7/16/2020 PM				
		Autos	MT	HT	Buses	MC	Autos	MT	HT	Buses	MC
EB Aux	Afternoon	552	9	0	0	0	579	3	0	0	0
EB Right	Afternoon	1320	18	30	0	3	828	24	18	6	6
EB Center	Afternoon	1002	6	15	0	0	792	6	9	0	12
WB Center	Afternoon	1173	12	6	0	6	834	9	15	0	6
WB Right	Afternoon	1560	30	30	0	3	1149	36	48	0	6
WB Aux	Afternoon	1164	12	12	0	3	855	12	6	0	0
NOTES:											
MT = Medium Trucks		HT = Heavy Trucks					MC = Motorcycles				
FHWA TNM = Federal Highway Administration Traffic Noise Model											
(1) Hourly volumes derived by extrapolation of counts taken during 20-minute period to a one-hour value											

Table 5-2 (Count Location 2 - East of Campbell Ave.)											
Validation Measurement Traffic Counts											
Field Measurement Lane	Time Period	Hourly Traffic Based on Concurrent Traffic Counts (1)									
		7/7/2020 PM					7/16/2020 PM				
		Autos	MT	HT	Buses	MC	Autos	MT	HT	Buses	MC
EB Aux	Afternoon	798	6	3	3	0	570	18	3	0	3
EB Right	Afternoon	855	3	15	0	3	1257	81	33	0	3
EB Center	Afternoon	537	0	3	0	0	660	24	24	0	3
WB Center	Afternoon	456	0	12	0	3	1125	30	18	0	0
WB Right	Afternoon	1026	3	36	0	3	1413	39	39	0	0
WB Aux	Afternoon	927	3	3	0	6	1002	27	3	0	0
NOTES:											
MT = Medium Trucks		HT = Heavy Trucks					MC = Motorcycles				
FHWA TNM = Federal Highway Administration Traffic Noise Model											
(1) Hourly volumes derived by extrapolation of counts taken during 20-minute period to a one-hour value											

Table 5-3 (Count Location 3 - East of Kansas Expwy.)											
Validation Measurement Traffic Counts											
Field Measurement Lane	Time Period	Hourly Traffic Based on Concurrent Traffic Counts (1)									
		7/7/2020 PM					7/16/2020 PM				
		Autos	MT	HT	Buses	MC	Autos	MT	HT	Buses	MC
EB Aux	Afternoon	318	3	6	0	3	594	2	1	1	0
EB Right	Afternoon	825	15	18	0	3	1194	4	12	0	1
EB Center	Afternoon	321	0	6	0	6	690	2	3	0	1
WB Center	Afternoon	363	3	0	0	3	1026	6	18	0	6
WB Right	Afternoon	774	12	24	0	3	1092	24	21	0	0
WB Aux	Afternoon	543	0	3	0	9	1119	15	0	0	3
NOTES:											
MT = Medium Trucks		HT = Heavy Trucks					MC = Motorcycles				
FHWA TNM = Federal Highway Administration Traffic Noise Model											
(1) Hourly volumes derived by extrapolation of counts taken during 20-minute period to a one-hour value											

The FHWA Traffic Noise Model, TNM 2.5, was used to model all relevant roadways, receivers, terrain lines, barriers, building rows, and ground zones in the project area for the existing condition. The field measurements and their corresponding traffic counts validated the model by ensuring less than a 3 dBA difference between the measured noise levels and the modeled noise levels at each location, as shown in Table 5-4.

Table 5-4					
Measurement and Validation Data					
Field Measurement Locations	Short-Term Measurements			FHWA TNM L_{eq} (h) Noise Levels dBA	Measured Minus Modeled Noise Levels dB
	Date	Time Period	Measured Noise Levels (dBA) L_{eq}		
1	7/7/2020	5:15-5:35 PM	72.7	72.1	0.6
2	7/7/2020	5:15-5:35 PM	70.0	71.8	-1.8
3	7/7/2020	5:50-6:10 PM	59.5	60.2	-0.7
4	7/7/2020	5:50-6:10 PM	70.3	71.6	-1.3
5	7/7/2020	6:40-7:00 PM	59.8	58.6	1.2
6	7/7/2020	6:40-7:00 PM	63.3	61.3	2.0
1	7/16/2020	3:30-3:50 PM	71.6	72.0	-0.4
2	7/16/2020	3:30-3:50 PM	70.0	71.1	-1.1
3	7/16/2020	4:10-4:30 PM	58.8	61.6	-2.8
4	7/16/2020	4:10-4:30 PM	71.4	73.2	-1.8
5	7/16/2020	5:20-5:40 PM	60.7	60.7	0.0
6	7/16/2020	5:20-5:40 PM	62.5	62.5	0.0
L_{eq} = Equivalent Noise Level			dB = Decibel	dBA = A-weighted Sound Level	
L_{eq} (h) = Hourly L_{eq}					

After validating the model, existing noise levels at each receiver were obtained. Receptors at single-family homes were modeled on the side of the house closest to US-60. At multi-family buildings with balconies, receptors were modeled at each individual balcony. However, per MoDOT policy, only first-story receptors were considered when attempting to benefit impacted residents. For receivers such as churches/restaurants/daycares/etc., an equivalent number of residential receptors were placed at an area of frequent human use. Traffic volumes were based on the Springfield Freeway Study Final Report (dated July 9th, 2018), with traffic data collected in 2017. Existing noise levels can be found in the appendices.

6.0 DETERMINATION OF FUTURE SOUND LEVELS

Using the TNM 2.5 software, the future through lanes between Kansas Expressway and National Avenue were input into the future model. The previously modeled receivers, terrain lines, barriers, building rows, and ground zones were included along

with any necessary adjustments for the future roadway. Future volumes were adjusted to the 2040 projections.

7.0 IMPACT DETERMINATION ANALYSIS

Where traffic noise impacts were identified, noise abatement measures were then evaluated for feasibility and reasonableness. To be considered impacted, a receptor must have an L_{eq} at the loudest traffic noise hour approaching (within 1 dBA) or exceeding the NAC for the corresponding land use category, or exceeding existing noise levels by 15 dBA.

8.0 NOISE ABATEMENT EVALUATION

8.1. Noise Barrier Feasibility

For noise abatement measures to be considered feasible, MoDOT requires at least a 5 dBA insertion loss for a minimum of two first-row, impacted receptors. Feasibility also refers to the engineering limitations, including the physical constraints and other constructability constraint limits such as maintenance, drainage, safety, etc.

8.2. Noise Barrier Reasonableness

If a noise barrier is considered feasible, it is then checked for three mandatory reasonableness factors, all of which must be met. First, noise abatement measures cannot exceed 1,300 ft^2 of noise wall or $46,000 of alternative noise abatement measures, per benefitted receptor. A benefitted receptor is defined as a receptor that receives at least a 7 dBA reduction in noise level after the addition of noise abatement measures. Secondly, noise abatement must provide a 7 dBA reduction for 100 percent of first-row benefitted receptors.

8.3. Ballot Results of Benefitted Property Owners and Residents

First-row benefitted owners and residents will be notified of potential noise abatement measures and their viewpoints will be sought via ballot. The viewpoints of non-owner residents will be evaluated as a portion of an aggregate of 25 percent of the total. The viewpoints of owners will be evaluated as a portion of an aggregate of 75 percent of that total. Over 50 percent of the aggregate response must be in favor of abatement.

8.4. Summary

One hundred eighty-five receivers were evaluated for noise impacts along the corridor. By NAC criteria, 17 were found to be impacted. No receivers were found to have an increase of 15 dBA over existing noise levels. For each NSA, impacted receivers and noise barrier options are detailed below and displayed in the appendices. See Table A-3 for individual receptor data.

Table 1-1
Executive Summary Table

NSA	Impacted Receptors by Activity Category			Consideration of Noise Abatement Warranted?	Barrier Option	Abatement Feasible?	Benefited Receptors	Square Feet	Square Feet/ Benefited Receptor	Abatement Reasonable?
	B	C	Total							
1	2	-	2	Yes	1	✓	6	8,200	1,367	x
2	-	-	0	No	-	-	-	-	-	-
3a	15	-	15	Yes	2	✓	29	35,978*	1,241	✓
3b	15	-	15	Yes	3	✓	17	38,251	2,250	x
4	-	-	0	No	-	-	-	-	-	-
5	-	-	0	No	-	-	-	-	-	-

*34,000 sqft of noise barrier plus 1,978 sqft equivalent ($70,000) for grade beam and extra drilled shaft depth.

NSA 1: Two receivers are impacted of the 41 in the area. Both impacted receivers are single-family homes adjacent to the westbound off ramp at Kansas Expressway.

A noise barrier was analyzed 5' off the right-of-way to allow for access and maintenance. See Table A-1 for full barrier details. Six receptors received a 7 dBA or

greater insertion loss, including both impacted receptors at single-family homes. With an average of 1,367 ft^2 per benefitted receptor, Barrier 1 is feasible, but not reasonable.

NSA 2: No receivers were found to be impacted.

NSA 3: Within NSA 3, fifteen receivers of 54 are impacted, all single-family homes. In the picture below, some lots appear to be available but not constructed, which would cause them to be considered the first-row receptors in this area according to MoDOT's definition:

> *Receptors directly adjacent to the highway, at nearly the same elevation, with no intervening developed lands. Receptors with intervening parcels separating the receptor parcel from abutting the roadway right-of-way are generally considered second row or greater.*

According to the City of Springfield's Assistant Director of Public Works, these properties are within the flood plain and in the early 2000's, the city did a buy-out of these properties due to flooding. The city has no intention to develop or sell these lots. Therefore, the existing houses nearest to US-60 were considered first-row receptors.

Two barrier designs were considered. Barrier design 3a is acoustically feasible and reasonable. Barrier design 3b was considered as an alternate to 3a. It was found to be acoustically feasible, but not reasonable.

Barrier design 3a is a system of two barriers, one 5' off the right-of-way (ROW) and the other along the shoulder of westbound US-60. The ROW barrier is 700' long with an average height of 15.1'. The shoulder barrier is 1,600' long with an average height of 14.6'. The entire barrier system consists of 34,000 ft^2 of noise wall. See Table A-1 for full barrier details. The shoulder barrier crosses above an existing structure (pedestrian tunnel and drainage box culvert), which is below US-60. In order to span the structure, a grade beam and additional drilled shafts are required. The additional costs are estimated to be $55,000 to $70,000. For the evaluation of reasonableness, the higher $70,000 estimate was used and then converted to equivalent square feet. According to the MoDOT Engineering Policy Guide, Section 127.13.7, noise walls shall not exceed 1,300 ft^2 per benefitted receptor, or $46,000 per benefitted receptor for other noise abatement techniques. In discussions with MoDOT staff, using the values above, it is assumed that every $35.38 of additional cost to the barrier system is equivalent to one square foot of noise wall.

$46,000/1,300 ft^2 = $35.38 per square foot

$70,000/ $35.38 per ft^2 = 1,978 ft^2 equivalent

34,000 ft^2 + 1,978 ft^2 = **35,978 ft^2 as shown in Table 1-1**

Twenty-nine receptors were benefitted with an average of 1,241 ft^2 equivalents per benefitted receptor. Therefore, Barrier design 3a is both acoustically feasible and reasonable, pending a vote of first-row benefitted owners and residents.

Barrier design 3b is a system of two barriers, both along the right-of-way adjacent to westbound US-60. The first barrier is 1,775' long with an average height of 17.16'. The second barrier is 500' long with an average height of 15.6'. See Table A-1 for full barrier details. Seventeen receptors were benefitted with an average of 2,250 ft^2 per benefitted receptor. Also, two first-row receptors were not able to obtain a 7 dBA insertion loss. Therefore, Barrier design 3b is feasible, but not reasonable.

NSA 4: No receivers were found to be impacted.

NSA 5: No receivers were found to be impacted.

9.0 CONSTRUCTION NOISE

As required by 23 CFR 772.19, the temporary increase in noise levels due to construction was also considered. These noise impacts will take place in the immediate vicinity of the construction activities and generally be limited to working hours. Figure 6.1, on the following page, shows some typical operating noise levels at a distance of 50 feet. MoDOT construction specifications require all construction equipment to be in good working order. Mufflers are required to help reduce and address construction noise impacts. Interference with speech communication for those passing by, working, or living near the construction sites is to be expected. Overall, however, because of the distance of the construction areas to each NSA and the hours of equipment use, noise impacts due to construction are expected to be minor and to occur infrequently.