A VALIDATION OF THE NCHRP 117/144 TRAFFIC NOISE LEVEL PREDICTOR MODEL FOR LOW DENSITY, CLOSE DISTANCE TRAFFIC ON I 696 BETWEEN I 75 AND I 94

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TESTING AND RESEARCH DIVISION
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A VALIDATION OF THE NCHRP 117/144 TRAFFIC NOISE LEVEL PREDICTOR MODEL FOR LOW DENSITY, CLOSE DISTANCE TRAFFIC ON I 696 BETWEEN I 75 AND I 94

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ABSTRACT

The purpose of this study was to determine the applicability of the FHWA-approved NCHRP 117/144 traffic noise level prediction method to the special case of low density, low speed, and close distance traffic. The work was conducted in response to an immediate need to accurately determine future traffic noise levels at residences along the service drives of I 696 between I 75 and I 94, north of Detroit in the communities of Roseville, Warren, Centerline, and Madison Heights.

The study shows that a modified version of the NCHRP model is a valid traffic noise predictor if the descriptor used is L_{eq} (L equivalent) and it is calculated on the basis of traffic data which have been modified by transferring the 2D component of commercial traffic to the automobile-light truck category.

L_{50}, L_{10}, and L_{eq} data from the presently used predictor and the proposed predictor are compared to measured data at five representative sites. Also, the report includes site photographs, tabulations of measured and predicted noise levels, and summarized statistical results.

Introduction

As a prerequisite for any proposed noise abatement treatment along the I 696 project between I 75 and I 94 in the Detroit Area, the Federal Highway Administration (FHWA) has requested the Department to validate the approved NCHRP 117/144 (1, 2) noise level predictor model for service drive conditions.

Because this model was developed for high volume freeway conditions, some doubt exists as to its applicability to service drives having low density traffic operating near adjacent residences. The FHWA has approved the use of two noise level descriptors, L_{10} and L_{eq}, in their Federal Noise Standard, FHPM 7-7-3, for traffic noise impact studies. The objective of this investigation is to determine if either of these two descriptors as they now exist in the computer program (3) is acceptable for the subject service drive noise level predictions. If not, then what modification is necessary to achieve acceptability.

In conjunction with this task, the present classification breakdown of automobiles and commercial vehicles is to be investigated as it pertains to the noise model.

Background

The NCHRP 117/144 noise level prediction model is based upon an empirically derived L_{50} descriptor. The L_{10} descriptor is calculated from the L_{50} by a nonlinear adjustment factor, f(A), which is a function of the hourly vehicle volume, V, the average vehicle operating speed, S, and the equivalent lane distance, D_E, namely:

$$L_{10}\ (\text{dbA}) = L_{50}\ (\text{dbA}) + f(A) \qquad (1)$$

where the adjustment argument

$$A = V \frac{D_E}{S} \qquad (2)$$

(The adjustment factor appears as Figure B.10 in NCHRP 117 (1).)

An L_{10} noise level is calculated for automobiles and commercial vehicles separately and later logarithmically summed to obtain the total L_{10}.

The NCHRP 117/144 model only determines L_{50} and L_{10} noise levels. Thus, because we want to also predict energy equivalent noise levels, L_{eq}, the model was modified. By assuming that the noise levels (L_j; j = 0, 1, . . . , 99) are normally distributed, it can be shown (4, 5, 6) that the desired L_{eq} values can be calculated from the L_{50} and L_{10} noise levels as follows:

$$L_{eq} = L_{50} + 0.07\,(L_{10} - L_{50})^2 \tag{3}$$

The above assumption of normally distributed noise levels holds for free flowing, dense traffic (7) such as that found traveling our high volume freeways. The range of geometric and traffic parameters over which this assumption holds was given more precisely (6) in terms of the argument of the previously discussed adjustment factor as:

$$A > 200 \text{ ft - vehicles/mile} \tag{4}$$

This L_{eq} calculation, Eq. (3), has been a supplementary output of the Traffic Noise Level Predictor Computer Program (3) since 1974.

Because Eq. (3) is the only method of obtaining L_{eq} noise levels from the NCHRP 117/144 model, it was decided to investigate whether it was also acceptable for noise level predictions along the I 696 service drives, even though $A < 200$.

Scope

Because of the interdependencies of the predicted L_{50}, L_{10}, and L_{eq} noise levels, all three descriptors were selected for comparison with their respective measured values.

In selecting field measurement sites, an attempt was made to find flat, at-grade and reasonably unobstructed areas, with traffic volumes and speeds similar to those projected for the I 696 service drives during the design year. After surveying the I 696 project area, five sites along its completed service drives were chosen for field measurements. These sites (Appendix A) are:

1) Eastbound 11 Mile Rd, 500 ft west of Schoenherr (Fig. A1).
2) Eastbound 11 Mile Rd, between Grandmont and Roberta (Fig. A2).
3) Eastbound 11 Mile Rd, between Richard and Burg (Fig. A3).
4) Westbound 11 Mile Rd, between Lorraine and Richard (Fig. A4).
5) Westbound 11 Mile Rd, 300 ft west of El Capitain (Fig. A5).

At each of these sites, four measurement distances were selected, namely: 25, 50, 75, and 100 ft from the center of the near lane of traffic. Two model db 601 Metrosonics sound level analyzers, equipped with General Radio 1962-9601 microphones and 1972-9600 preamplifiers were used. The instruments, placed at two of the four measurement distances simultaneously sampled the noise levels over 15 minute periods at a rate of one sample per second. Due to the availability of only two simultaneous measurement channels, the 50 and 100 ft data were taken as one group while the 25 and 75 ft data were taken as another group. From these data, the L_{10}, L_{50}, and L_{eq} were automatically computed by the instruments. A total of 25 data sets were taken at each of the four distances (Appendix B).

Vehicles were counted per individual MDSHT classification type during each sample period. Individual vehicle speeds were noted from dual pneumatic tubes spaced at a known distance along the roadway. Pressure switches connected to these tubes controlled a time-lapse counter to produce individual vehicle operating speeds. These detailed vehicle type and speed data were obtained to allow grouping of the various vehicle classifications into the two allowable traffic model parameters, i.e., hourly vehicle volume and percent commercial.

Our present definition of a commercial vehicle is given as: "A commercial vehicle is any motor vehicle having a gross vehicle weight greater than 10,000 lb, and buses having a capacity exceeding 15 passengers."

Data Analysis

In the following, the method of data analysis is described and the reason for its selection is explained. Three model-data variation cases were analyzed. These are:

1) existing prediction model with the existing definition of percent commercial,

2) existing prediction model with a modified definition of percent commercial, and,

3) modified prediction model with a modified definition of percent commercial.

Because of the method of noise level measurement and the interdependencies of certain noise levels, a multivariate analysis of variance method was selected as the most appropriate analysis method.

In this analysis, the hypothesis tested was whether or not two population mean vectors (a four-component vector for both measured and predicted data) are equal at the 0.050 significance level based on 25 dependent pairs of observation vectors. The L_{50}, L_{10}, and L_{eq} data were tested separately. The 95 percent simultaneous confidence intervals for linear compounds of mean differences will be illustrated later in this section.

First, using the present definition of a commercial vehicle, L_{50}, L_{10}, and L_{eq} noise levels were calculated with the present prediction model. This resulted in gross overpredictions for all sample periods at all sites with errors as large as 12.5 dbA. Due to the magnitude of the errors, no further analysis of this case was deemed necessary; the results were unacceptable.

Prior to making these noise level calculations, it was suspected that some of the previously defined commercial vehicles did not possess the same high noise emission levels attributed to heavy commercial vehicles. Specifically, vehicles having a two-wheel steering axle and a four-wheel drive axle, commonly referred to as type '2D' in the MDSHT vehicle classification system, were suspect. On the I 696 service drives, these type 2D vehicles comprise up to 50 percent of all vehicles presently considered as commercial. Due to the sensitivity of the prediction model to the percent commercial input parameter, it is extremely important that they be included in the appropriate category. Thus, the percent commercial figures were adjusted so as to shift the type 2D vehicles from the commercial to the automobile-light truck category.

The resulting predicted noise levels still erred on the high side in general, but to a lesser extent than previously. In order to ascertain whether or not the predicted noise levels were statistically acceptable, the previously discussed multivariate analysis of variance method was applied to the predicted and measured noise levels for each distance. Based upon a 95 percent confidence level, and the modified percent commercial definition, the L_{50}, L_{10}, and L_{eq} descriptors were not acceptable at all four distances. Thus, the present noise prediction program (3) is not an acceptable predictor for low density, close distance service drive traffic.

Next, an attempt was made to modify the present predictor or to derive a new predictor for the service drive applications under study. In reviewing NCHRP Report 117, it was noted that a special low density traffic flow effect was discussed but not included in the graphical method and therefore was not a part of the computer predictor program (3). When discussing this traffic flow model, the previously defined combination of terms, namely $A = V \frac{D_E}{S}$, is an important quantity to consider. There is an 'A' parameter for each of the two vehicle types in the prediction model. For sufficiently low density traffic flow ($A < 1,320$ ft - vehicles/mile), distance behavior of the mean noise level (L_{50}) is dependent not only on the -4.5 db per distance doubling term ($-15 \log_{10} D_E$), but also on the density term ($10 \log_{10} \tanh 1.19 (10^{-3}) A$). For very low density flows ($A < 420$ ft - vehicles/mile), the density term defined above, tends to the value $1.19 (10^{-3})A$, which effectively reduces the total distance dependence of the mean noise level to -1.5 db per distance doubling ($-5 \log_{10} D_E$). In the NCHRP 117 graphs and in the present prediction model, the equivalent lane distance, D_E, was fixed at 100 ft in the hyperbolic density term. Based upon this information a modified predictor program was created which allowed the equivalent lane distance to vary in the density term. Using this modified model and the modified definition of percent commercial (transfer type 2D) for the service drives, new L_{50}, L_{10}, and L_{eq} noise levels were calculated (Appendix B). By observation, only the L_{eq} plot appeared approximately centered about the ideal zero error line.

This data base was then analyzed per the same analysis of variance method used previously. This time, the L_{eq} descriptor with a bias term of -0.8 dbA included in the predicted noise levels was acceptable at the 95 percent confidence level (Table 1). From Table 1, it should be noted that even though a negative bias applied to the predicted data produced an acceptable L_{eq} predictor, the acceptable range of bias was rather narrow (i.e., $-0.843 < \epsilon_{eq} < -0.751$). A bias of -0.8 dbA was chosen. The predicted L_{50} data will be acceptable for a bias in the range of $-2.876 < \epsilon_{50} < -1.932$, while there is no bias which will allow the L_{10} to pass. A linear regression scatter plot (Fig. 1) of predicted vs. measured levels resulted in a correlation coefficient of 0.868.

TABLE 1
MULTIVARIATE ANALYSIS OF VARIANCE:
95 PERCENT SIMULTANEOUS CONFIDENCE
INTERVALS ON L_{eq} MEAN DIFFERENCES

Distance, D_N, ft	Lower Confidence Limit	Upper Confidence Limit
25	-0.043	+3.051
50	-0.064	+2.384
75	-3.057	+0.049
100	-1.586	+1.810

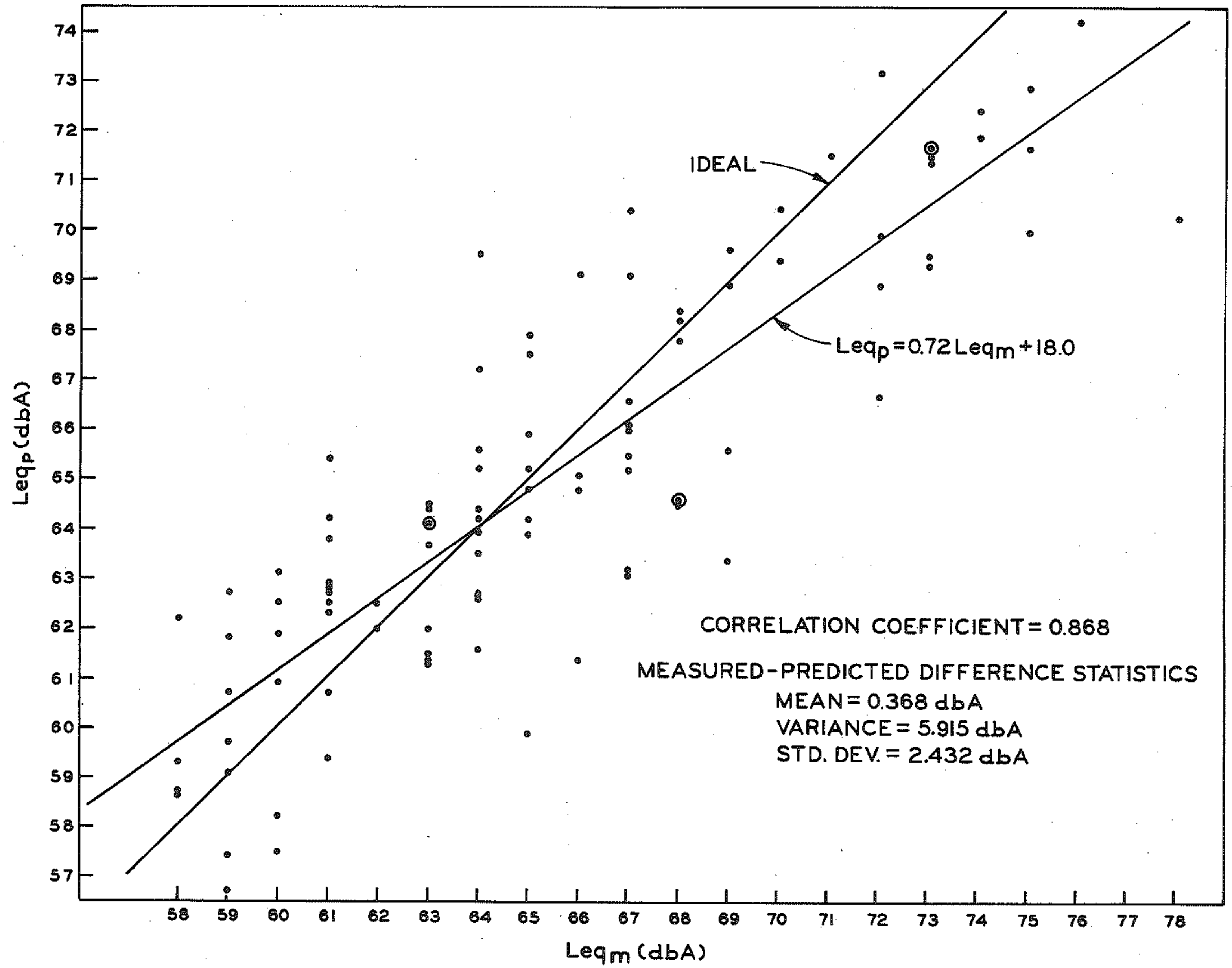

Figure 1. Predicted versus measured L_{eq} (dbA) noise levels for I 696 low density, close distance service drive.

In summary, our proposed L_{eq} noise level predictor for the I 696 service drive conditions tends to underpredict by 0.368 dbA and has a variance and standard deviation of 5.915 dbA and 2.432 dbA, respectively.

Conclusions

Based upon the data taken at the five measurement sites, it appears that the present definition of percent commercial should be modified so as to shift the type 2D vehicles from the commercial category to the automobile and light truck classification. This modification is suggested only for service drives and other roadways having traffic flows similar to that found at the measurement sites.

Also, the present prediction program is not acceptable for predicting either L_{10} or L_{eq} traffic noise levels for conditions similar to those measured.

By modifying the present program so as to include a variable equivalent lane distance quantity in the mean noise level density term, and a bias term, an acceptable L_{eq} predictor has been found for traffic conditions similar to those measured. These traffic conditions cover a range from 430 to 1,650 total vehicles/hour with up to 7.8 percent commercial (modified definition), average automobile and light truck speeds from 30 to 38 mph and commercial vehicle speeds from 23 to 39 mph. Based upon FHPM 7-7-3, the I 696 1990 Design Year volume, percent commercial, commercial speed, and automobile-light truck speed ranged over 500 to 1,800 vehicles/hour, 0.6 to 3.3 percent commercial, 23 to 33 mph and 25 to 35 mph, respectively, for noise level analysis purposes. It can be concluded that the I 696 service drives having traffic flows within the above mentioned ranges can be analyzed by the modified model.

Because the L_{eq} descriptor has been found acceptable for certain low density traffic and the fact that the mainline traffic is a much better approximation of free flowing dense traffic, it is concluded that the original L_{eq} descriptor is acceptable for freeway noise level predictions. However, the definition of percent commercial for freeway traffic will remain unchanged until such evidence, if any, is presented to warrant a modification.

In summary the resultant noise levels will be the db sum of the L_{eq} levels from mainline traffic calculated in the usual manner, plus the L_{eq} levels from service road traffic calculated with the modified predictor model and with type 2D vehicles classified as automobile-light truck.

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APPENDIX A

MEASUREMENT SITE PHOTOGRAPHS

Figure A1. Site 1 - 11 Mile Road, eastbound, 500 ft west of Schoenherr.

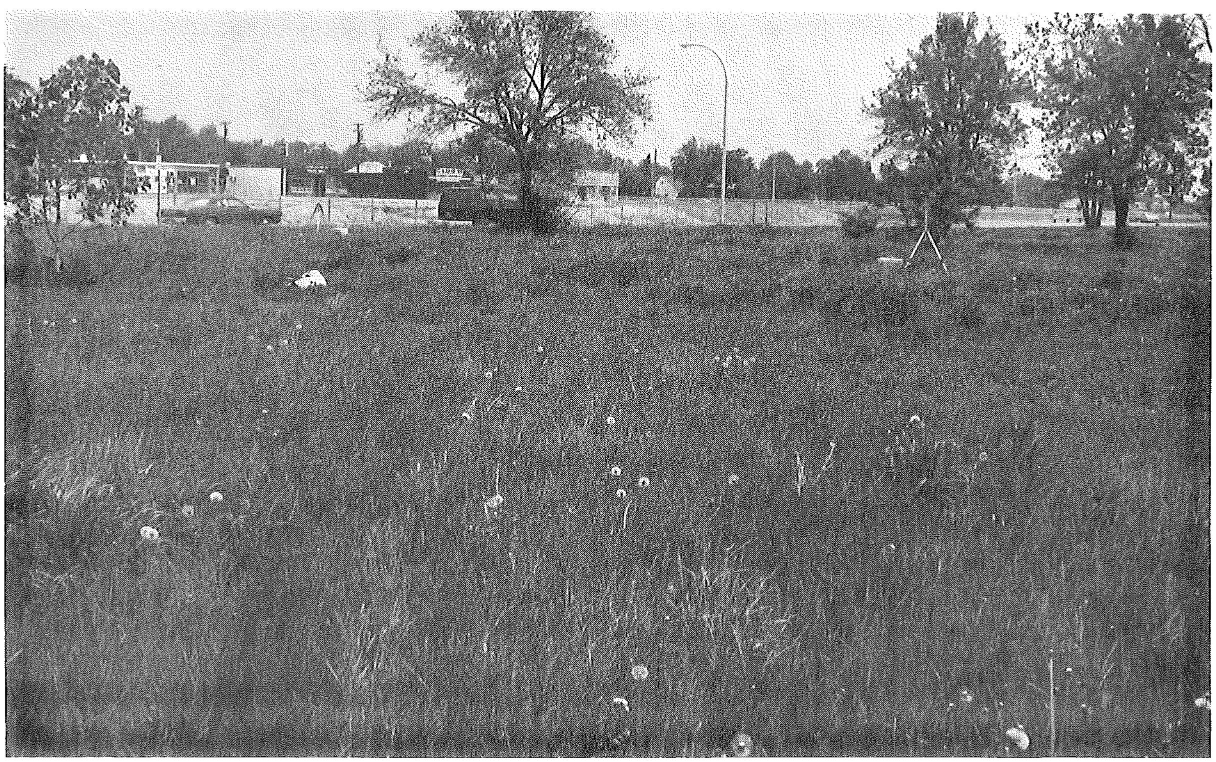

Figure A2. Site 2 - 11 Mile Road, eastbound, between Grandmont and Roberta.

Figure A3. Site 3 - 11 Mile Road, eastbound, between Richard and Burg.

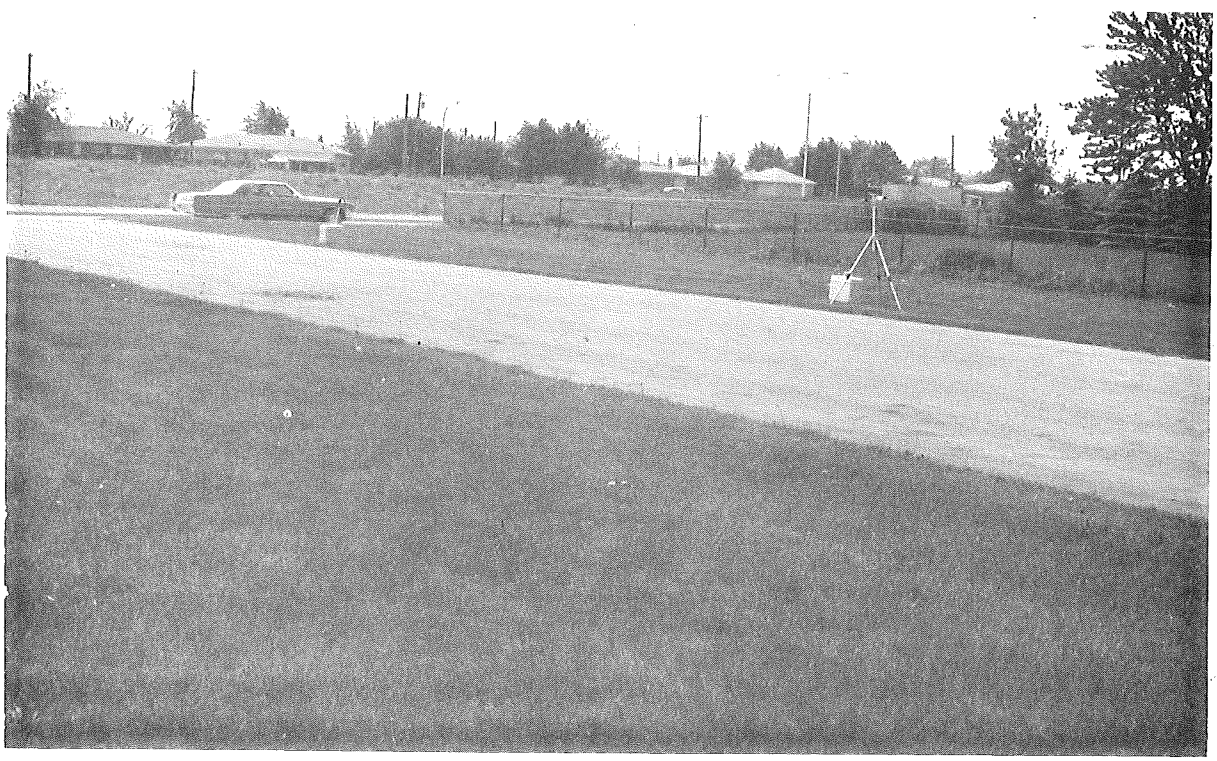

Figure A4. Site 4 - 11 Mile Road, westbound, between Lorraine and Richard.

Figure A5. Site 5 - 11 Mile Road, westbound, 300 ft west of El Capitain.

APPENDIX B

TRAFFIC VOLUMES, SPEEDS AND NOISE LEVELS

TABLE B1
NCHRP 117/144 NOISE MODEL VALIDATION FOR LOW VOLUMES, LOW SPEEDS, AND CLOSE DISTANCES EASTBOUND 11 MILE RD, 500 ft WEST OF SCHOENHERR
(2-lane pavement)

Conditions	Time	Hourly Volume, Q		Percent Commercial Vehicles, TMIX		Average Vehicle Speeds, mph				Distance, ft	Measured Noise Level, dbA			R-942 Predicted Noise Level, dbA						Modified R-942 Noise Level, dbA 2D as Car		
		2D as Truck	2D as Car	2D as Truck	2D as Car	2D as Truck		2D as Car						2D as Truck			2D as Car					
						ST	SA	ST	SA		L_{10}	L_{50}	L_{eq}	L_{10}	L_{50}	L_{eq}	L_{10}	L_{50}	L_{eq}	L_{10}	L_{50}	L_{eq}
May 3, 1977 0 to 8 mph Wind Speed Clear Sky	9:43 to 9:58 a.m.	644	644	7.45	3.73	31.0	34.6	29.9	34.1	50	70	62	67	76.8	65.4	74.5	72.5	62.8	69.4	69.9	60.9	66.6
										100	62	59	61	71.9	61.2	69.1	67.7	58.7	64.4	67.1	58.0	63.8
	10:01 to 10:16 a.m.	540	540	5.93	2.96	29.9	32.3	27.7	32.5	50	69	61	68	74.0	63.0	71.5	70.5	61.2	67.2	68.0	59.2	64.6
										100	64	58	63	69.3	58.8	66.5	65.5	57.0	62.1	64.9	56.3	61.4
	10:18 to 10:33 a.m.	508	508	9.45	2.36	30.4	33.4	31.0	32.7	50	69	60	67	76.8	65.0	74.8	68.9	60.4	65.5	66.7	58.5	63.2
										100	63	58	61	71.9	60.8	69.4	63.6	56.2	60.1	63.0	55.5	59.4
	10:35 to 10:50 a.m.	664	664	8.43	3.01	31.6	34.1	31.0	33.6	50	69	61	67	77.8	66.1	75.6	71.4	62.4	68.0	69.0	60.6	65.5
										100	62	58	61	72.8	62.0	70.1	66.4	58.2	62.9	65.8	57.5	62.3
	10:53 to 11:08 a.m.	568	568	9.15	2.82	30.2	34.3	26.6	33.8	50	69	60	66	77.5	65.7	75.4	70.9	61.7	67.7	68.5	59.8	65.1
										100	62	57	60	72.5	61.5	70.0	65.9	57.5	62.5	65.3	56.8	61.9
October 4, 1977 0 to 8 mph Wind Speed Clear Sky	9:39 to 9:54 a.m.	544	544	7.35	3.68	33.8	37.8	32.5	37.5	25	76	65	73	79.6	68.0	77.5	76.7	66.1	73.9	72.2	62.0	69.3
										75	66	59	63	72.3	61.6	69.6	68.5	59.8	65.2	67.1	58.6	63.7
	10:04 to 10:19 a.m.	524	524	12.2	6.87	33.4	38.0	33.4	36.9	25	76	64	73	82.7	70.4	81.0	79.0	67.4	76.8	73.8	62.6	71.4
										75	65	59	64	75.4	64.0	73.1	71.6	61.0	68.9	70.0	59.6	67.2
	10:23 to 10:38 a.m.	668	668	11.4	6.59	31.4	37.2	31.2	36.1	25	77	66	75	84.4	72.2	82.7	80.6	69.1	78.4	75.5	64.6	72.9
										75	68	60	66	77.1	65.8	74.7	73.4	62.7	70.8	71.9	61.4	69.1
	10:42 to 10:57 a.m.	596	596	6.71	3.36	29.9	37.7	30.1	36.9	25	76	65	73	80.4	68.8	78.2	76.9	66.6	74.0	72.5	62.6	69.5
										75	66	59	63	73.1	62.4	70.5	68.9	60.2	65.5	67.5	59.0	64.1
	11:02 to 11:17 a.m.	756	756	12.7	5.29	32.0	37.2	32.7	35.0	25	77	68	74	86.0	73.7	84.3	79.7	68.7	77.1	74.9	64.8	71.9
										75	67	61	65	78.2	67.4	75.6	72.5	62.3	69.6	71.0	61.1	67.9

TABLE B2

NCHRP 117/144 NOISE MODEL VALIDATION FOR LOW VOLUMES, LOW SPEEDS, AND CLOSE DISTANCES EASTBOUND 11 MILE RD BETWEEN GRANDMONT AND ROBERTA (2-lane pavement)

Conditions	Time	Hourly Volume, Q		Percent Commercial Vehicles, TMIX		Average Vehicle Speeds, mph				Distance, ft	Measured Noise Level, dbA			R-942 Predicted Noise Level, dbA						Modified R-942 Noise Level, dbA 2D as Car		
		2D as Truck	2D as Car	2D as Truck	2D as Car	2D as Truck		2D as Car						2D as Truck			2D as Car					
						ST	SA	ST	SA		L_{10}	L_{50}	L_{eq}	L_{10}	L_{50}	L_{eq}	L_{10}	L_{50}	L_{eq}	L_{10}	L_{50}	L_{eq}
May 3, 1977 0 to 9 mph Wind Speed Clear Sky	12:10 to 12:25 p.m.	528	528	5.30	1.52	34.6	33.2	35.1	33.2	50	65	58	64	72.3	62.0	69.4	68.0	60.4	64.5	66.1	58.8	62.6
										100	60	56	60	67.5	57.8	64.4	62.4	56.2	58.9	61.7	55.4	58.2
	12:27 to 12:42 p.m.	528	528	6.82	0.76	29.2	32.1	23.5	31.8	50	64	57	62	75.0	63.6	72.6	67.3	60.0	63.8	65.6	58.4	62.0
										100	60	56	59	70.2	59.4	67.6	61.6	55.8	58.2	60.9	55.1	57.4
	12:44 to 12:59 p.m.	464	464	4.31	0.86	31.6	31.0	28.8	31.2	50	64	57	63	70.6	60.5	67.6	66.7	59.2	63.2	64.8	57.4	61.3
										100	60	56	59	65.7	56.3	62.5	60.9	55.0	57.5	60.2	54.2	56.7
	1:02 to 1:17 p.m.	496	496	4.84	1.61	27.7	32.5	24.3	32.1	50	64	56	61	72.6	62.0	69.9	68.3	60.0	64.9	66.2	58.2	62.7
										100	59	55	58	67.9	57.8	65.0	62.9	55.9	59.4	62.3	55.1	58.7
	1:19 to 1:34 p.m.	436	436	6.42	1.83	29.0	31.4	31.0	30.8	50	64	57	63	73.1	61.9	70.7	67.2	58.9	63.7	65.0	57.[illegible]	61.5
										100	60	56	60	68.5	57.7	65.9	61.7	54.7	58.1	61.0	54.0	57.5
October 4 and 18, 1977 0 to 10 mph Wind Speed Clear Sky	12:28 to 12:43 p.m.	540	540	6.67	0.74	37.5	37.8	39.4	37.5	25	70	60	68	78.5	67.2	76.2	74.7	65.3	71.6	71.0	61.5	67.8
										75	61	50	59	71.0	60.8	68.0	65.4	58.9	61.8	64.3	57.8	60.7
	12:58 to 1:13 p.m.	464	464	9.48	3.45	30.9	35.9	29.0	35.6	25	71	58	68	80.5	68.3	78.7	75.8	64.9	73.2	71.1	60.5	68.4
										75	62	56	61	73.4	61.9	71.1	67.6	58.6	64.3	66.2	57.3	62.8
	1:14 to 1:29 p.m.	564	564	9.22	7.80	29.6	35.1	29.6	35.1	25	72	61	72	82.0	69.8	80.2	80.8	68.9	78.9	75.5	64.0	73.2
										75	65	57	64	74.8	63.5	72.4	73.7	62.5	71.2	72.1	61.1	69.5
	1:35 to 1:50 p.m.	588	588	8.84	2.72	30.7	34.6	31.0	33.9	25	71	60	68	81.7	69.7	79.8	75.4	65.6	72.4	71.4	61.9	68.2
										75	62	57	61	74.5	63.3	72.1	67.3	59.2	63.8	66.0	58.1	62.5
	1:52 to 2:07 p.m.	568	568	9.86	6.34	33.0	35.6	31.9	35.6	25	71	60	71	81.8	69.7	79.9	79.1	67.7	76.9	74.1	63.1	71.5
										75	63	57	65	74.6	63.3	72.2	71.9	61.3	69.2	70.3	60.0	67.5

TABLE B3
NCHRP 117/144 NOISE MODEL VALIDATION FOR LOW VOLUMES, LOW SPEEDS, AND CLOSE DISTANCES
EASTBOUND 11 MILE RD BETWEEN RICHARD AND BURG
(2-lane pavement)

Conditions	Time	Hourly Volume, Q		Percent Commercial Vehicles, TMIX		Average Vehicle Speeds, mph				Distance, ft	Measured Noise Level, dbA			R-942 Predicted Noise Level, dbA						Modified R-942 Noise Level, dbA 2D as Car		
		2D as Truck	2D as Car	2D as Truck	2D as Car	2D as Truck		2D as Car						2D as Truck			2D as Car					
						ST	SA	ST	SA		L_{10}	L_{50}	L_{eq}	L_{10}	L_{50}	L_{eq}	L_{10}	L_{50}	L_{eq}	L_{10}	L_{50}	L_{eq}
May 11, 1977 0 to 2 mph Wind Speed Clear Sky	9:00 to 9:15 a.m.	604	604	7.28	2.65	33.2	35.1	28.0	35.3	50	67	58	65	75.7	64.5	73.2	71.0	62.2	67.6	68.7	60.3	65.2
										100	61	55	59	70.8	60.3	68.1	65.9	58.0	62.4	65.3	57.2	61.8
	9:17 to 9:32 a.m.	640	640	5.00	3.12	32.1	36.1	32.9	35.8	50	67	59	64	73.9	63.7	71.0	71.4	62.6	68.0	69.1	60.7	65.6
										100	60	55	58	69.2	59.5	66.0	66.3	58.4	62.8	65.7	57.6	62.2
	9:35 to 9:50 a.m.	696	696	6.32	2.87	29.9	34.3	28.5	33.8	50	67	58	67	76.4	65.3	74.0	71.8	62.8	68.5	69.4	61.0	66.0
										100	60	53	61	71.5	61.1	68.7	66.9	58.6	63.5	66.3	57.9	62.9
	9:53 to 10:08 a.m.	704	704	3.41	1.14	32.3	34.1	30.4	34.1	50	67	59	64	72.2	63.0	68.9	69.0	62.0	65.4	67.4	60.6	63.9
										100	60	55	58	67.3	58.8	63.9	63.5	57.8	60.1	62.7	57.0	59.3
	10:10 to 10:25 a.m.	676	676	8.88	2.96	32.3	34.6	29.5	34.3	50	67	58	65	78.1	66.5	75.9	71.7	62.7	68.4	69.3	60.9	65.9
										100	60	54	59	73.1	62.3	70.5	66.8	58.5	63.3	66.2	57.8	62.7
October 18, 1977 6 to 9 mph Wind Speed Clear Sky	11:03 to 11:18 a.m.	656	656	7.32	2.44	32.6	37.9	31.1	37.1	25	71	60	67	81.0	69.4	78.8	76.2	66.7	73.1	72.4	63.2	69.1
										75	62	55	60	73.8	63.1	71.1	68.0	60.3	64.4	66.7	59.2	63.1
	11:21 to 11:36 a.m.	680	680	4.71	2.94	30.3	36.5	29.6	36.2	25	71	60	69	79.0	68.1	76.3	76.9	67.0	73.9	72.8	63.5	69.6
										75	62	55	61	71.6	61.7	68.6	69.0	60.6	65.6	67.7	59.5	64.2
	11:38 to 11:53 a.m.	736	736	5.43	3.80	34.2	36.5	33.2	36.5	25	72	61	70	79.5	68.7	76.9	77.9	67.8	74.9	73.7	64.2	70.4
										75	62	55	61	72.3	62.3	69.3	70.3	61.4	66.9	68.9	60.3	65.4
	11:55 to 12:10 p.m.	756	756	6.35	1.59	33.0	36.5	30.3	36.0	25	72	61	69	80.9	69.6	78.5	75.6	66.9	72.2	72.4	64.0	68.9
										75	62	56	60	73.7	63.2	70.9	67.2	60.5	63.6	66.0	59.5	62.5
	12:12 to 12:27 p.m.	824	824	3.88	0.97	34.7	37.9	32.4	37.9	25	71	62	70	78.6	68.6	75.6	75.7	67.5	72.2	72.9	64.8	69.4
										75	62	56	62	71.0	62.2	67.7	66.9	61.1	63.5	65.9	60.2	62.5

TABLE B4
NCHRP 117/144 NOISE MODEL VALIDATION FOR LOW VOLUMES, LOW SPEEDS, AND CLOSE DISTANCES
WESTBOUND 11 MILE RD BETWEEN LORRAINE AND RICHARD
(2-lane pavement)

	Time	Hourly Volume, Q		Percent Commercial Vehicles, TMIX		Average Vehicle Speeds, mph				Distance, ft	Measured Noise Level, dbA			R-942 Predicted Noise Level, dbA						Modified R-942 Noise Level, dbA 2D as Car		
		2D as Truck	2D as Car	2D as Truck	2D as Car	2D as Truck		2D as Car						2D as Truck			2D as Car					
						ST	SA	ST	SA		L_{10}	L_{50}	L_{eq}	L_{10}	L_{50}	L_{eq}	L_{10}	L_{50}	L_{eq}	L_{10}	L_{50}	L_{eq}
May 11, 1977 0 to 7 mph Wind Speed Clear Sky	11:26 to 11:51 a.m.	668	668	7.18	1.80	32.1	37.0	29.1	36.5	50	68	56	66	76.6	65.5	74.2	70.4	62.5	66.8	68.4	60.9	64.8
										100	61	54	61	71.7	61.3	68.9	65.0	58.3	61.4	64.3	57.6	60.7
	11:43 to 11:58 a.m.	708	708	6.21	0.56	31.1	34.7	31.5	33.9	50	67	55	64	76.2	65.2	73.6	68.4	61.9	64.8	67.0	60.6	63.5
										100	61	52	58	71.3	61.0	68.4	62.7	57.7	59.4	61.9	56.9	58.6
	12:01 to 12:16 p.m.	764	764	7.33	2.09	31.9	33.5	33.0	33.2	50	68	57	65	77.7	66.3	75.4	70.3	62.5	66.7	68.4	61.1	64.8
										100	61	54	60	72.7	62.1	70.0	65.2	58.3	61.6	64.5	57.5	60.9
	12:18 to 12:33 p.m.	796	796	3.52	1.00	28.9	33.9	26.5	33.5	50	67	57	64	73.7	64.0	70.6	69.2	62.5	65.7	67.7	61.2	64.2
										100	61	54	59	69.0	59.8	65.7	63.8	58.3	60.4	63.1	57.5	59.7
	12:36 to 12:51 p.m.	796	796	3.52	0.50	30.0	34.2	23.8	33.7	50	68	58	65	73.5	64.0	70.3	68.7	62.4	65.1	67.4	61.2	63.9
										100	61	56	59	68.8	59.8	65.5	63.0	58.2	59.8	62.3	57.4	59.1
October 4, 1977 Variable Wind Clear Sky	1:23 to 1:38 p.m.	832	832	6.25	2.40	31.7	38.2	28.9	37.3	25	75	64	78	81.8	70.5	79.4	77.4	68.0	74.1	73.7	65.0	70.3
										75	65	57	68	74.6	64.2	71.7	69.5	61.7	66.0	68.2	60.7	64.6
	1:44 to 1:59 p.m.	780	780	6.67	2.56	32.6	38.8	32.6	37.3	25	75	63	72	81.6	70.3	79.3	76.9	67.6	73.7	73.3	64.5	69.9
										75	65	57	63	74.4	63.9	71.6	68.9	61.2	65.4	67.6	60.2	64.1
	2:03 to 2:18 p.m.	976	976	9.02	5.74	32.1	36.5	31.9	36.2	25	76	67	76	85.4	73.4	83.4	82.2	71.0	79.8	77.3	67.2	74.3
										75	68	60	67	77.8	67.0	75.1	75.0	64.6	72.1	73.4	63.3	70.4
	2:22 to 2:37 p.m.	852	852	2.82	0.94	30.7	35.7	29.2	34.9	25	75	64	72	77.5	68.0	74.4	75.0	67.0	71.4	72.4	64.6	68.9
										75	65	58	63	69.9	61.6	66.4	66.4	60.6	62.9	65.4	59.7	62.0
	2:41 to 2:55 p.m.	1068	1068	4.87	1.12	31.1	36.5	30.9	35.4	25	76	67	75	81.9	71.0	79.3	75.9	68.2	72.3	73.5	66.3	70.0
										75	66	61	67	74.7	64.6	71.7	67.5	61.8	64.1	66.5	61.0	63.1

TABLE B5

NCHRP 117/144 NOISE MODEL VALIDATION FOR LOW VOLUMES, LOW SPEEDS, AND CLOSE DISTANCES WESTBOUND 11 MILE RD, 300 ft WEST OF EL CAPITAIN (2-lane pavement)

Conditions	Time	Hourly Volume, Q		Percent Commercial Vehicles, TMIX		Average Vehicle Speeds, mph				Distance, ft	Measured Noise Level, dbA			R-942 Predicted Noise Level, dbA						Modified R-942 Noise Level, dbA 2D as Car		
		2D as Truck	2D as Car	2D as Truck	2D as Car	2D as Truck		2D as Car						2D as Truck			2D as Car					
						ST	SA	ST	SA		L_{10}	L_{50}	L_{eq}	L_{10}	L_{50}	L_{eq}	L_{10}	L_{50}	L_{eq}	L_{10}	L_{50}	L_{eq}
April 27, 1977 Gusts to 16, 6 to 7 Average Clear Sky	9:18 to 9:33 a.m.	892	892	4.93	1.35	29.1	36.5	26.5	35.9	50	70	63	69	76.8	66.2	74.1	70.8	63.7	67.3	69.2	62.4	65.6
										100	66	60	66	71.9	62.0	68.8	65.6	59.5	62.1	64.9	58.7	61.4
	9:36 to 9:51 a.m.	744	744	4.30	2.69	30.1	36.5	27.1	36.2	50	70	62	72	74.4	64.5	71.4	72.5	63.6	69.1	70.1	61.9	66.7
										100	66	59	69	69.7	60.3	66.4	67.5	59.4	64.0	66.9	58.7	63.4
	9:53 to 10:08 a.m.	752	752	5.32	1.06	33.2	35.9	30.3	35.7	50	69	60	68	75.2	64.8	72.3	69.5	62.7	66.0	68.0	61.3	64.5
										100	65	59	65	70.4	60.6	67.3	64.0	58.5	60.6	63.2	57.7	59.9
	10:11 to 10:26 a.m.	724	724	5.52	2.21	30.9	34.4	29.1	34.2	50	70	61	67	75.5	64.8	72.9	70.9	62.9	67.4	68.8	61.1	65.2
										100	66	60	64	70.7	60.6	67.8	65.8	58.4	62.2	65.1	57.7	61.6
	10:28 to 10:43 a.m.	784	784	5.61	2.55	32.3	35.2	30.3	35.2	50	70	62	67	76.0	65.3	73.3	71.9	63.4	68.4	69.7	61.8	66.1
										100	66	60	64	71.1	61.1	68.1	66.9	59.2	63.3	66.2	58.5	62.7
October 4, 1977 0 to 7 mph Wind Speed Sunny-Partly Cloudy	3:30 to 3:45 p.m.	1644	1644	1.70	0.24	30.0	39.1	27.7	37.3	25	75	71	75	79.4	71.3	75.9	76.4	70.4	72.9	75.2	69.2	71.7
										75	65	61	65	71.8	65.0	68.3	67.9	64.0	65.1	67.1	63.2	64.2
	3:49 to 4:04 p.m.	1452	1452	1.93	0.83	30.0	38.2	28.9	37.3	25	75	70	73	79.2	70.7	75.7	76.9	69.9	73.3	75.0	68.5	71.5
										75	65	61	64	71.6	64.4	68.0	68.6	63.6	65.3	67.6	62.7	64.4
	4:08 to 4:23 p.m.	1584	1584	1.52	0.51	32.8	37.6	27.7	37.6	25	75	70	73	78.3	70.7	74.7	76.7	70.3	73.2	75.2	69.0	71.7
										75	64	61	63	70.5	64.3	67.0	68.3	63.9	65.3	67.4	63.1	64.4
	4:27 to 4:42 p.m.	1644	1644	2.68	0.73	33.5	33.9	33.7	37.0	25	76	71	73	80.4	71.0	77.2	76.8	70.4	73.2	75.2	69.1	71.7
										75	65	[illegible]	63	73.3	64.6	69.9	68.5	64.0	65.4	67.6	63.2	64.5
	4:45 to 5:00 p.m.	1612	1612	1.74	1.24	32.6	36.8	32.6	36.8	25	75	70	74	78.7	70.7	75.2	77.6	70.4	74.0	75.5	69.0	71.9
										75	65	61	64	71.1	64.4	67.6	69.8	64.1	66.3	68.6	63.2	65.2