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EVALUATION OF NOISE BARRIERS

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SUMMARY

Noise measurements were taken at six barrier sites: two wooden, two metal, and one concrete barrier were studied; the sixth site had no barrier and was studied to determine the ground effect. The approach was to determine insertion losses by taking simultaneous measurements behind the barrier at different elevations over the same point. In this procedure, when the uppermost microphone is clearly in the line of sight of the traffic, the difference between the level for the uppermost microphone and the level for one of the lower microphones is the insertion loss at the height of the lower microphone. For the measurements, three microphones were positioned at different heights on a 9.1-m (30-ft) pole and a fourth microphone (with its own support) was placed 1.5 m (5 ft) above ground level. Unfortunately, with the microphones so arranged, the uppermost microphone was in line of sight of only the measurement sites close to the barriers. Thus many of the values derived from the analysis of the data must be viewed as differential insertion losses.

Both predicted and measured noise levels behind the barriers were compared, and the results led to the conclusion that the barriers were performing as they should be expected to. The principal recommendation that could be made, considering the rather limited scope of this study, was that no policy decisions should be made that would eliminate the use of any material or construction technique on the basis of its performance.

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INTRODUCTION

According to Title 23 of the United States Code, agencies responsible for transportation facilities must lessen the noise impact of those facilities when that impact exceeds the current noise standards. The only methods by which that regulation can be satisfied are as follows:

1. By controlling noise emissions of vehicles.
2. By zoning to prevent the juxtaposition of highways and residential communities and other noise sensitive activities.
3. By choosing a location for the facility so as to avoid any impact; as a long-term solution, this method would require that the area be zoned so as to prevent residential development after construction of the facility.
4. By constructing a noise barrier.

The method over which highway departments have the greatest control and on which they have looked most favorably is the construction of a noise barrier on the right-of-way.

The use of barriers located between the highway (source) and the community (receiver) to lessen the impact of highway noise is increasing throughout many of the states. This trend is especially evident in the urban-suburban areas of Virginia.

Factors such as aesthetics, maintenance, structural characteristics, weight, and the need to be responsive to the public's wishes create a need for a variety of materials from which barriers can be constructed. Thus earth berms; metal, wood and concrete walls; and combinations of these types of barriers are used to attenuate noise.

The barriers are designed with a computerized mathematical model that uses the various factors that affect highway traffic noise as input and calculates a predicted noise level. At least ten barriers have been constructed in Virginia and many more are in the planning stage. Up to the present, the costs for constructing barriers have been very high and the projected cost for the barriers in the planning stage is in the millions of dollars. In addition, very few post-construction measurements have been taken to determine the effectiveness of the barriers that have been erected. Because of the investment represented by the Department's commitment to build barriers, the Department's designers wanted information relative to the attenuation achieved by a representative group of barriers that already had been constructed.

PURPOSE

The specific purpose of this study was to determine the effectiveness of some of the noise barriers constructed by the Department and to compare the measured attenuation with the predicted (design) attenuation for those barriers.

MEASUREMENT RATIONALE

Determining the effectiveness of a noise barrier in a real life situation is a more difficult task than might at first be assumed. So many factors have an effect on the results of noise measurements that it is impossible to plan a measurement methodology free of assumptions or corrections because of variations that occur in some of the factors between measurements.

The most frequently suggested methods for determining the effectiveness of noise barriers are as follows:

1. Taking measurements on a before and after basis — The before measurements have the advantage of accurately describing the noise environment without the barrier. However, the after measurements have the disadvantage of requiring assumptions or corrections concerning variations in traffic conditions, changes in terrain that occurred as an unplanned result of the barrier construction (removal of trees, different ground cover), different atmospheric conditions, etc.

2. Choosing two sites along the highway that are as close to identical as possible, one with a barrier and one without — Because the presence of the barrier should be the only difference, its effectiveness could easily be determined. However, finding such a situation in a state like Virginia is very difficult; at the very best, minor differences in tree and ground cover would necessitate making corrections. The traffic conditions would have to be assumed to be identical or would have to be sensed at each site and corrections made to account for any differences in total count, percentage of trucks, or speed. Great difficulty would be experienced in determining and adjusting for differences in the ambient noise levels of the sites.

3. Taking simultaneous measurements from an array of microphones variously spaced on a vertical pole — Some, at least the uppermost, of the microphones would be in line of sight with the traffic and would come as close as possible to sensing the noise as if the barrier did not exist. The other microphones would be at lower elevations so that the barrier would be between them and the traffic. The bottom microphone would be at 1.5 m (5 ft.) above ground level so as to approximate ear level. One possible disadvantage would be that the line of sight microphone would be so high above the ground that it might not be affected by the ground surface effect as the 1.5-m (5-ft) level microphone would be, if there were no barrier.

In the evaluations reported here, the decision to investigate the performance of the barriers was made after they had been installed, which eliminated Method 1 above. Further, none of the barriers were installed in locations which would make Method 2 applicable. Therefore, Method 3 had to be used.

Particulars of the measurements made are given in Table 1. This table includes the distances from the barrier at which the microphones were placed and indicates the numbers of channels of recording made on both the NAGRA analog recorder and a digital recorder. The tape number shown is that of the permanent digital tape, while the figure number refers to the figure in this report in which the geometry of the site is given and in which results are summarized. Also, the results are summarized in Appendix A and the experimental parameters are presented in Appendix B. In addition to the five barriers evaluated, a plain site (No. 7) was included as a reference, especially to evaluate the effects of distance above ground on the measured noise values. Also, results of another study, reported in references 3 and 4 (NCHRP 144 and 173), were included for comparison.

INSTRUMENTATION

Since simultaneous microphone readings were required at several vertical locations, a 9-m (30-ft) pole was assembled and outfitted to accommodate microphones at three vertically adjustable locations.

The data acquisition system used was that described in reference 2, except that it was expanded to four channels (the recorder can record eight channels). Two additional sound level meters, together with 131 m (430 ft) of cable and an additional NAGRA tape recorder, were borrowed so that recordings could be made on four channels simultaneously. Three 12.7 mm (1/12-in) microphones were mounted at the adjustable locations on the pole, while the fourth, 1.5 m (5 ft) above the ground, was part of the all-weather microphone system. The outputs from the four microphones were A-weighted in the recording van using four B&K 2204 or 2209 sound level meters. The DC outputs were fed to an A-D converter for recording on digital tape, while the AC outputs were fed to the four input channels of two NAGRA recorders.

Table 1

Summary of Recordings

Site #	Description	Locn. #	Distance From Barrier (feet)	No. of NAGRA Channels	No. of Digital Channels	Tape #	Figure #
2	Denbigh Blvd.	1	25	4	4	41	2
	(Newport News)	2	50	4	4	41	
	Metal barrier	3	100	4	4	41	
		4	150	4	4	41	
3	Great Neck Rd.	1	12	4	4	40	3
	(Virginia Beach)	2	25	4	4	40	
	Wooden barrier	3	75	4	4	40	
		4	100	4	4	40	
4	I-64	1	25	4	4	39	4
	(Hampton)	2	50	4	4	39	
	Metal barrier	3	75	4	4	39	
		4	100	4	4	39	
5	Churchland Br.	1	9	4	4	38	5
	(Portsmouth)	2	38.5	4	4	38	
	Wooden barrier						
6	I-495	1	10	4	4	37	6
	(Springfield)	2	25	4	4	37	
	Concrete barrier	3	75	4	4	37	
	on earth berm	4	150	4	4	37	
7	29 North	1	50	4	4*	26	7
	(Near Ch'ville)	2	100	4	4*	26	
	No barrier	3	150	4	4*	26	
		4	200	4	4*	26	
-	I-680	E	20	Results reported in			8
	(Milpitas, CA)	B	50	NCHRP 144 & 173			
	Masonary barrier	C	100				
	on earth berm	D	200				

CONVERSION: 0.305 m = 1 ft.

* Made in the laboratory.

CALIBRATION PROCEDURES

The two quartz-coated microphones that were a part of the original data acquisition system described in reference 2 were first calibrated at each site using the activators in their rain covers, while the two additional microphones were calibrated with B&K calibrators and checked by a B&K piston phone. During this procedure the meter was adjusted so that it would read 12.2 dB (off the scale) at the estimated L_{10}* level. The figure of 12.2 dB was selected because it corresponds to a 5-volt input to the A-D converter, which is half of the maximum 10-volt input. Thus, there was a 6 dB margin on voltage and a 4.7 dB margin on the maximum sound level meter output at the estimated L_{10} level.

After this adjustment was made, the internal reference tones of the sound level meters were turned on and their equivalent levels were read off the meters. Using this information, the equivalent calibration level was determined for each channel. Later, when the internal reference tones were used as calibration signals, the equivalent calibration levels were used to convert the recorded data to decibel levels.

RECORDING PROCEDURES

For the evaluation of the barriers, six sites were selected as shown in Table 1. At each of the six sites (numbered from 2 to 7), up to four locations were selected for making recordings, taking into account the following criteria.

a. Distances behind the barrier should vary from about 3 m (10 ft) to about 61 m (200 ft).

b. Obstacles such as trees and houses should be avoided as much as possible.

c. Nontraffic noise should be minimized.

d. The top two microphones should be higher than the barrier at their closest location to the barrier.

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* See list of abbreviations on page 25.

Fifteen-minute recordings were made at each location, both on the digital tape recorder and on the NAGRAs. The digital recorder malfunctioned at site #7; however, the NAGRA tapes were played back to obtain the digital tapes in the laboratory after the digital recorder had been repaired. Table 1 summarizes the recordings made.

DATA ANALYSES

Using the computer analysis programs reported in reference 2, all of the available digital tapes were analyzed to obtain L_E (percentage exceedance) levels, L_{EQ}, LNP, NPL, TNI, and the variances L_{SIG} and L_{EPS}. Strip chart recordings were made of the NAGRA tapes. It was immediately obvious that the threshold levels on the all-weather microphone were excessive, as had been feared during the measurements. Subsequent investigations in the laboratory have shown that the trouble came from a noisy heater power supply. (This trouble has since been rectified.)

Values for L_1, L_{10}, L_{50}, L_{90}, and L_{EQ}, obtained in the data analysis are given in Appendix A.

PREDICTIVE ANALYSES

The MICNOISE 10 computer program was used to predict L_{50}, L_{10}, and L_{EQ} values for comparison with measured data, and these are also shown in Appendix A. For this purpose, the version of the program used by the Department was modified as follows.

1. Data output was modified to give decibels to two significant figures after the decimal.

2. L_{EQ} was derived from total traffic noise (i.e., by the correct method) in addition to the present calculation from L_{10} and L_{50} used in the Virginia program.

3. Truck stack height was included as a parameter. The Virginia program uses 4 m (13 1/2 ft).

4. Provisions were made to choose the NCHRP 174 barrier attenuation curve or the presently used NCHRP 117 curve. A comparison of these two curves is given in Figure 1.

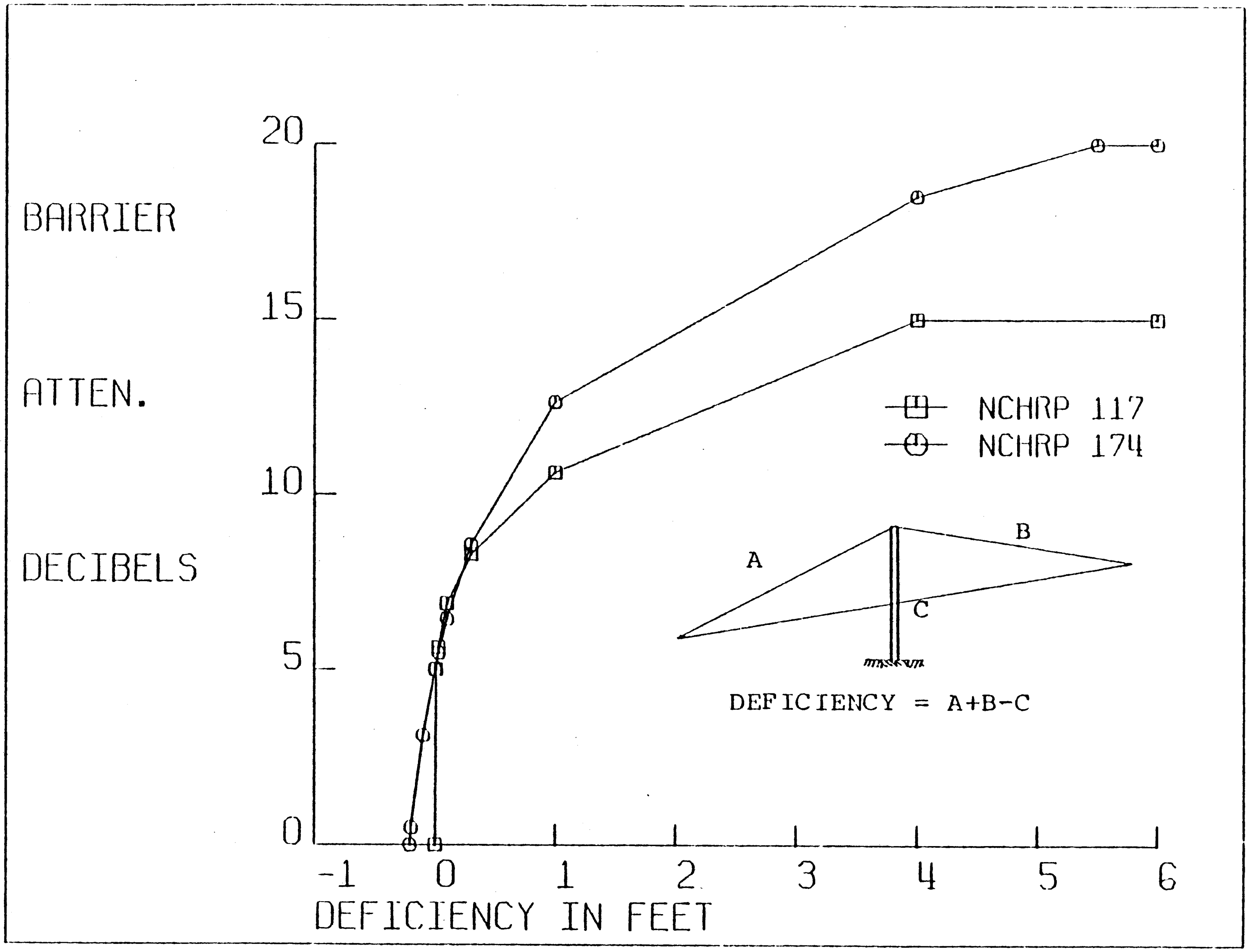

FIGURE 1. COMPARISON OF BARRIER DESIGN CURVES FROM NCHRP 117 (REF. 6) AND 174 (REF. 5).

Two sets of values are given in Appendix A. The first is based on the 4-m (13 1/2-ft) stack height and on the NCHRP 117 curve of the Virginia program. The second is based on a 2.4-m (8-ft) truck stack height and on the NCHRP 174 curve.

Essential data inputs for the MICNOISE 10 program are given in Appendix B. The traffic counts shown were obtained by direct counting during the 15-minute recording periods. All the traffic on the roadway was counted with the exception of the I-495 site, where only the traffic on the near (eastbound) lanes was counted. Traffic counts for the far lanes of I-495 were mostly inferred from near lane counts. The truck percentages (TMIX) given were for tractor trailers. Counts were also made for medium trucks; these are not shown, but were relatively high.

PRESENTATION OF RESULTS

Results of both measurements and tests are shown in Appendix A and in Figures 2-6. Note that the L_{EQ} values, although tabulated in Appendix A, are not shown in the figures. Also, that the only predicted values plotted are for L_{10}.

In each figure, the near traffic lane, the barrier, and all of the microphone locations are shown. In some cases, horizontal and vertical scales are different, as indicated. The four solid curves show measured L_1, L_{10}, L_{50}, and L_{90} values, while the broken lines bordering the shaded regions show the predicted L_{10} values obtained by the two methods. In all cases, the Virginia program with the 4-m (13 1/2-ft) truck stack heights and NCHRP 117 curves give the highest predictions. The shapes shown for the curves obtained from the Virginia program are estimated from the four points which were calculated in each case, whereas, in reality, the curves are complex, since the NCHRP 117 curve is discontinuous.

INTERPRETATION OF RESULTS

Under ideal situations, all of the curves shown in Figures 2-6 should have the same shape. Also, the predicted and measured L_{10} curves should coincide. Were this the case, there would be incontrovertible evidence that the barriers evaluated were performing exactly as the design procedures say they should.

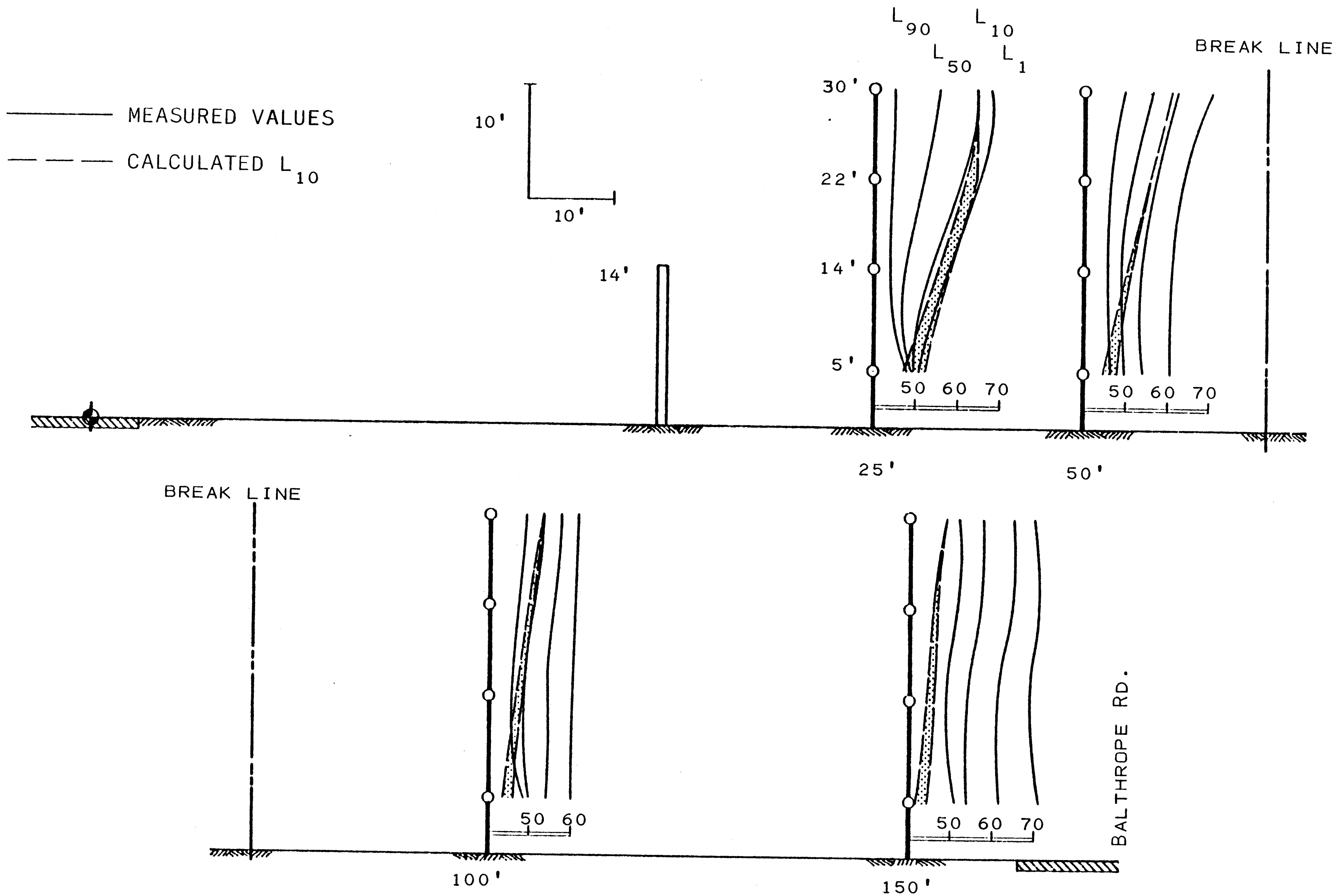

FIGURE 2. BARRIER ATTENUATION EFFECTS AT DENBIGH BLVD., NEWPORT NEWS.
NOTE: DISTANCES SHOWN FROM BARRIER. HEIGHTS SHOWN ABOVE ROADWAY.

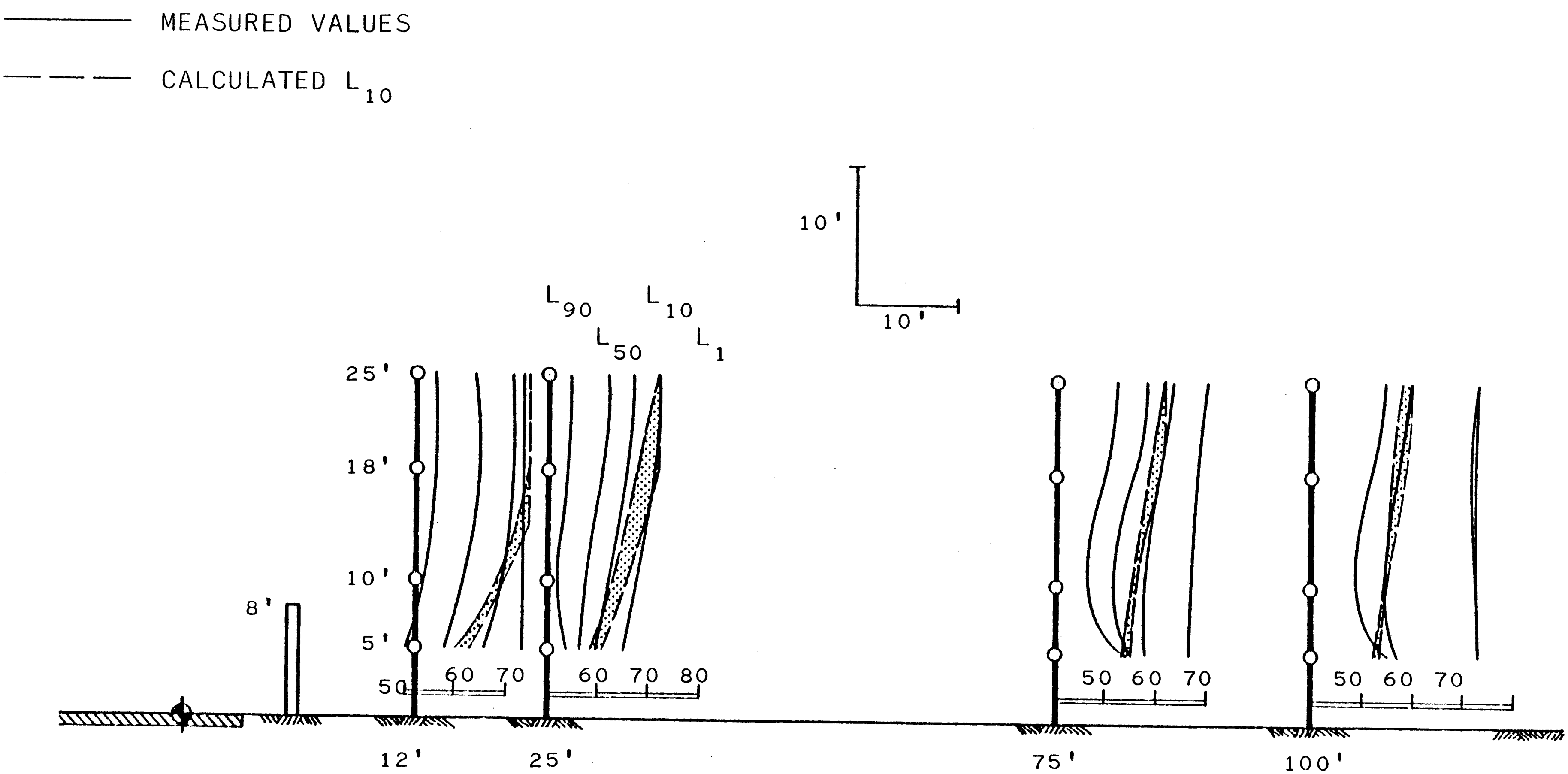

FIGURE 3. BARRIER ATTENUATION EFFECTS ON GREAT NECK RD., VIRGINIA BEACH.
NOTE: DISTANCES SHOWN FROM BARRIER. HEIGHTS SHOWN ABOVE ROADWAY.

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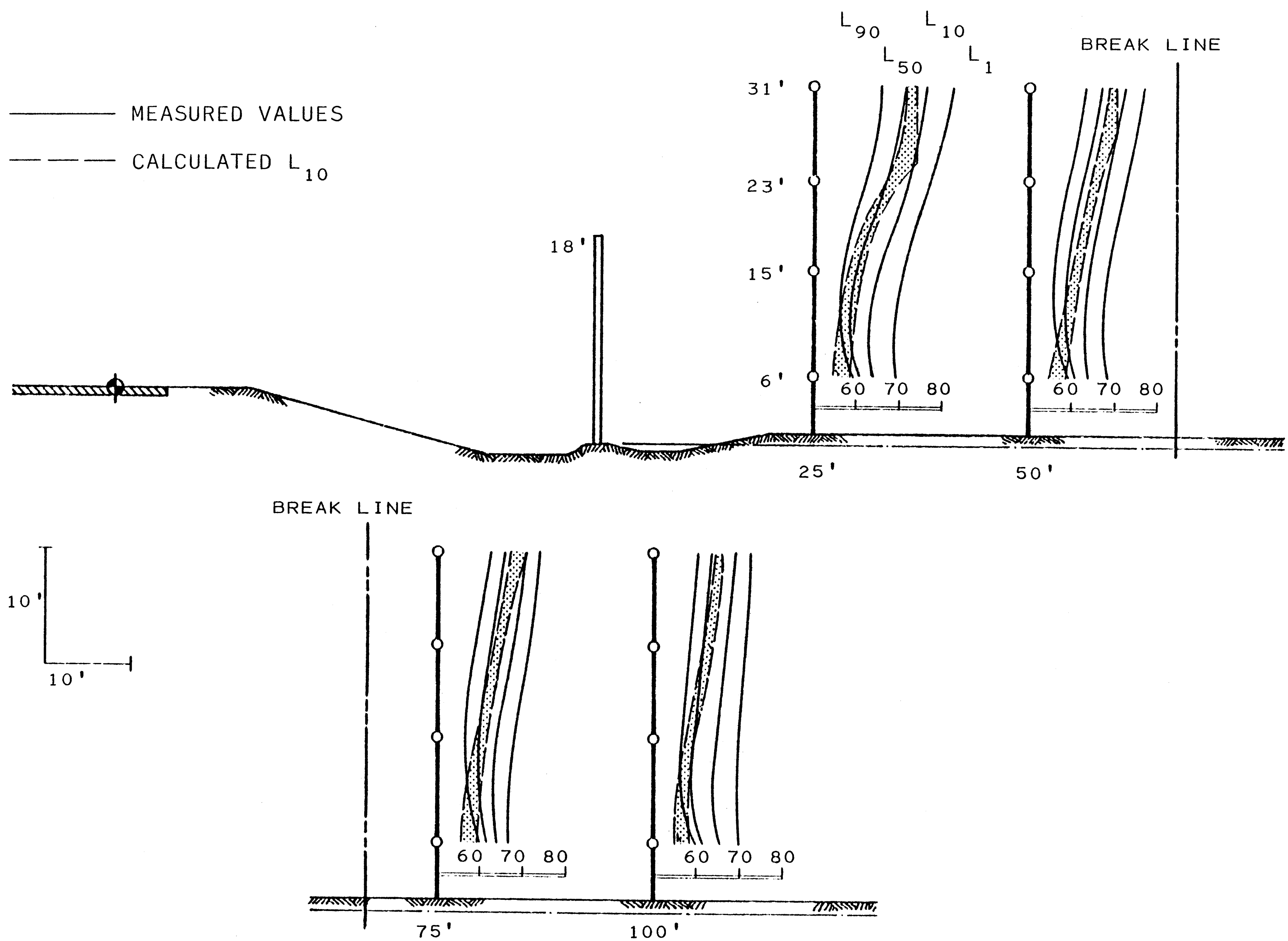

FIGURE 4. BARRIER ATTENUATION EFFECTS ON I-64, HAMPTON.
NOTE: DISTANCES SHOWN FROM BARRIER. HEIGHTS SHOWN ABOVE ROADWAY.

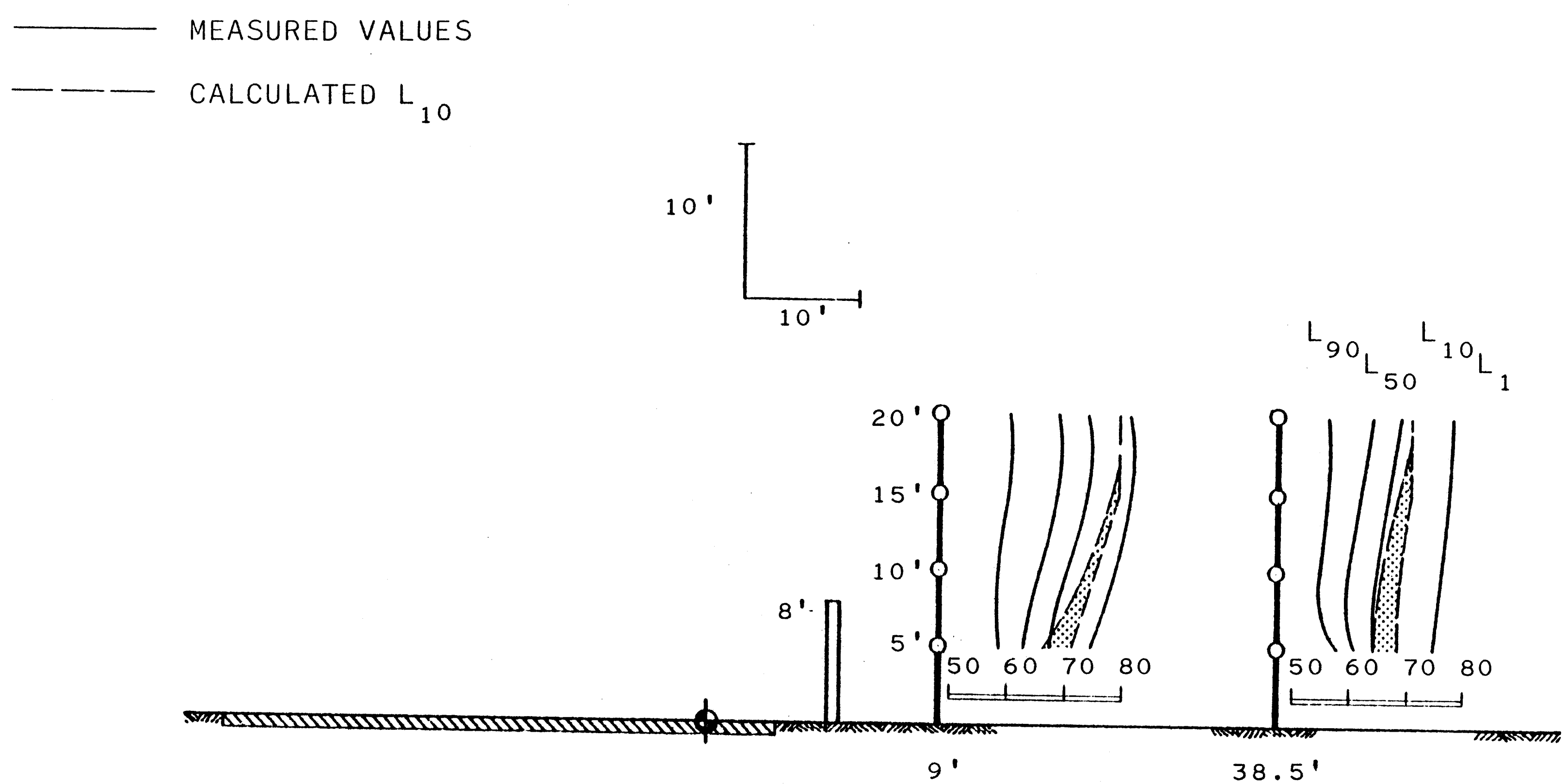

FIGURE 5. BARRIER ATTENUATION EFFECTS AT CHURCHLAND BRIDGE SITE, PORTSMOUTH.
NOTE: DISTANCES SHOWN FROM BARRIER. HEIGHTS SHOWN ABOVE ROADWAY.

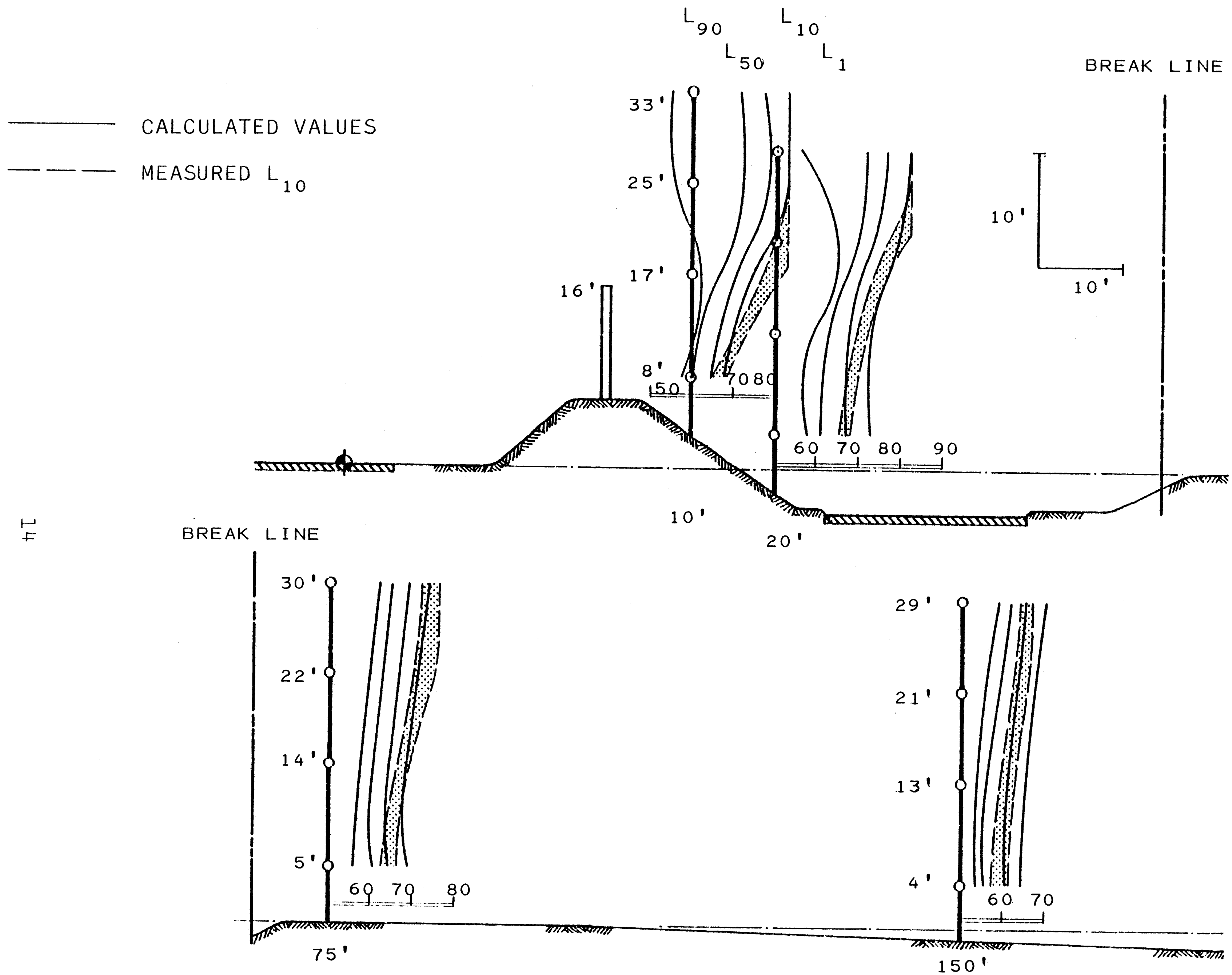

FIGURE 6. BARRIER ATTENUATION EFFECTS AT I-495, SPRINGFIELD.
NOTE: DISTANCES SHOWN FROM BARRIER. HEIGHTS SHOWN ABOVE ROADWAY.

It is apparent from an examination of the figures that the above conditions were not met, except in an approximate way. Thus, in order to demonstrate that the barriers do function, one must take into account the various factors which evidently influenced the results. These factors are discussed below.

1. Performance of all-weather microphone. From a cursory inspection of the curves, as one compares noise levels measured by the four microphones he sees that the lower the microphone, the more its reading is attenuated by the barrier. However, the lowest microphone, i.e., the all-weather microphone, shows a sharp increase in most cases. This is consistent with a higher electronic background noise level, which has since been traced to a noisy heater power supply. Thus, in effect, readings of the lowest microphone must be noted with care.

2. Overall Noise Level Prediction. Consider the comparison between the predicted and measured L_{10} levels at the top three microphones. Although the shapes of the curves compare reasonably, overall level predictions are off in most cases. This discrepancy seems to be partly due to the effect of light trucks. Analyses treating all trucks as heavy trucks (not shown) tended to lead to overprediction, whereas the present analyses, in which light trucks were treated as automobiles, tended to underprediction. Although this seems to confirm the newer practice of treating light trucks as intermediate noise sources, it was not considered a proper topic to pursue in this investigation.

3. Effect of Aircraft Overflights. Aircraft overhead contributed significantly to some of the measured values, especially when the road traffic was relatively light.

   At the first site, on Denbigh Blvd., only very light traffic was encountered so that aircraft contributed considerably. Typical of this effect are the curves shown in Figure 2 for the 30.5-m (100-ft) and 45.7-m (150-ft) locations. Here the measured L_{10} curves are higher than predicted, and all of the measured values tend to be aligned vertically, because the barrier provides no attenuation of noise from overhead.

   At the second site, on Great Neck Road, there were many low-flying aircraft during the reading at the 30.5-m (100-ft) location. The effect was not only to make the L_1 and L_{10} curves of Figure 3 almost vertical, but also to make them merge, indicating that an aircraft was overhead at least 10% of the time.

   Although aircraft were overhead during the measurements on I-64, they were higher, and the relatively heavy road traffic reduced their effect somewhat, as shown in Figure 4.

4. Ground Effect. It had been expected that some of the attenuation at the lower microphones might be attributable to ground effects. For this reason, measurements were made at the seventh site on U.S. 29 north of Charlottesville where there is no barrier. The results, shown in Figure 7, indicate almost no effect; thus, most of the attenuation seen in the other curves must be attributed to the barriers. This lack of height effect is confirmed by an analysis reported in reference 4. It appears that lush vegetation does increase attenuation due to distance, but that the same attenuation with distance is seen to an appreciable height above ground.

5. Effect of Analysis Parameters. The figures show calculations for L_{10} made with two extreme sets of assumptions. The higher values follow the analysis method presently used by the Department. In these, truck stacks are assumed to be at 4 m (13 1/2 ft) and the NCHRP 117 (ref. 6) curves are used. The lower values are based on the standard 2.4-m (8-ft) stack heights and on the lower NCHRP 174 (ref. 5) attenuation curves.

   Taking into account some of the other factors mentioned, the measured data do appear to favor the lower stack height and the newer barrier attenuation curves. In fact, it was as a result of similar measurements reported in NCHRP 144 (ref. 3) that the NCHRP 173 attenuation curves were developed.

The most completely documented investigation of barriers appears to be that reported in NCHRP 144 (ref. 3). However, the major difference between the present study and that in NCHRP 144 is that whereas readings were taken simultaneously at different heights but at the same location in the present study, they were taken simultaneously at different locations but at the same height in the NCHRP 144 study. Thus the present study gives the barrier attenuation effects directly, whereas NCHRP 144 gives distance effects directly and barrier attenuation only through a statistical analysis.

However, in order to support whatever comparison can be made, one set of curves from NCHRP 144 is given in Figure 8. The range of L_{50} attenuation values is shown in shaded blocks, while the broken curves show predicted attenuations. Thus these curves differ from those shown in Figures 2-7 in that the latter show absolute values whilst Figure 8 shows relative levels. The predicted attenuations of Figure 8 are based on the NCHRP 117 methods.

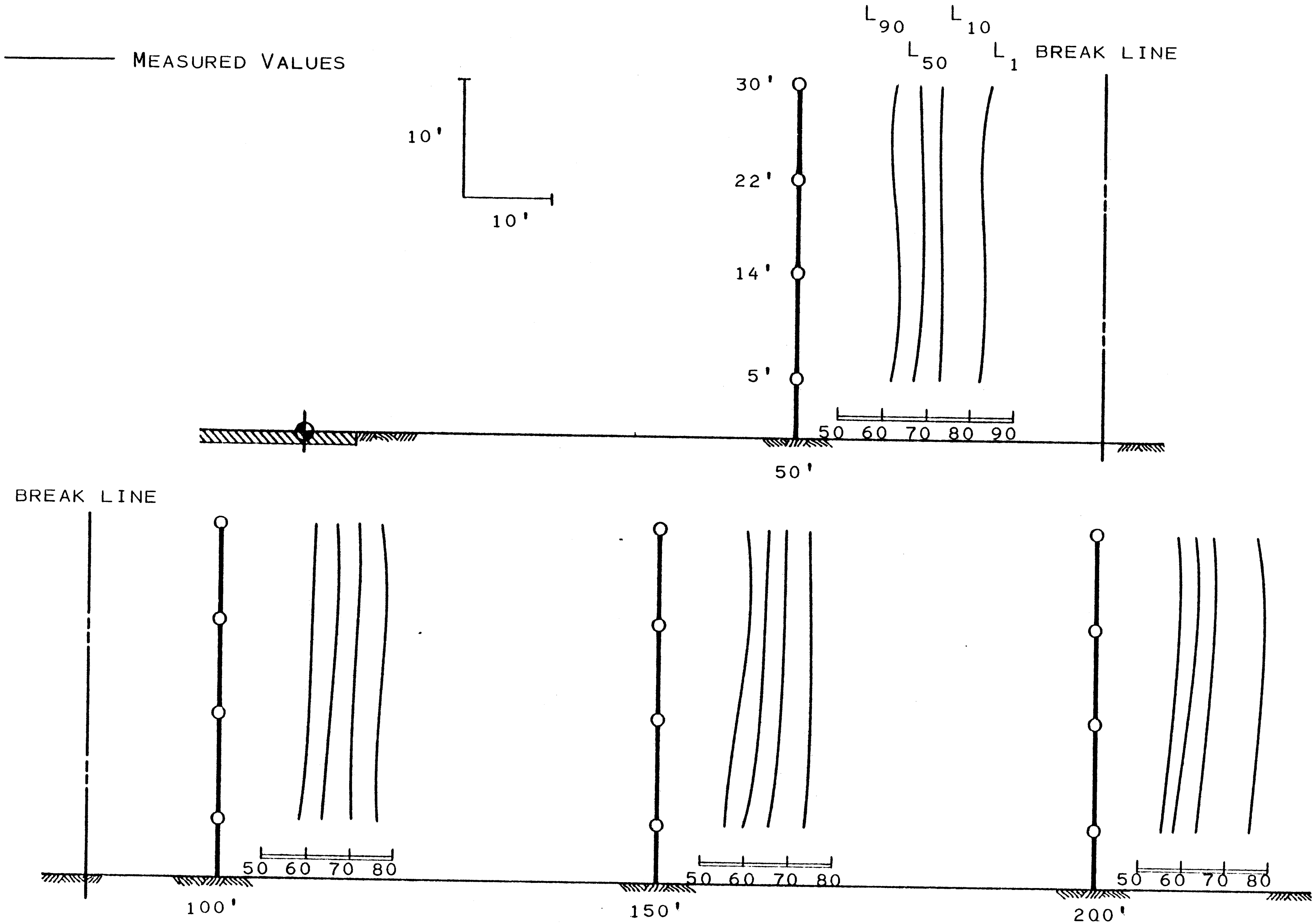

FIGURE 7. ATTENUATION OVER LEVEL GROUND. 29N, CHARLOTTESVILLE, (SPERRY MARINE SYSTEMS PLANT)

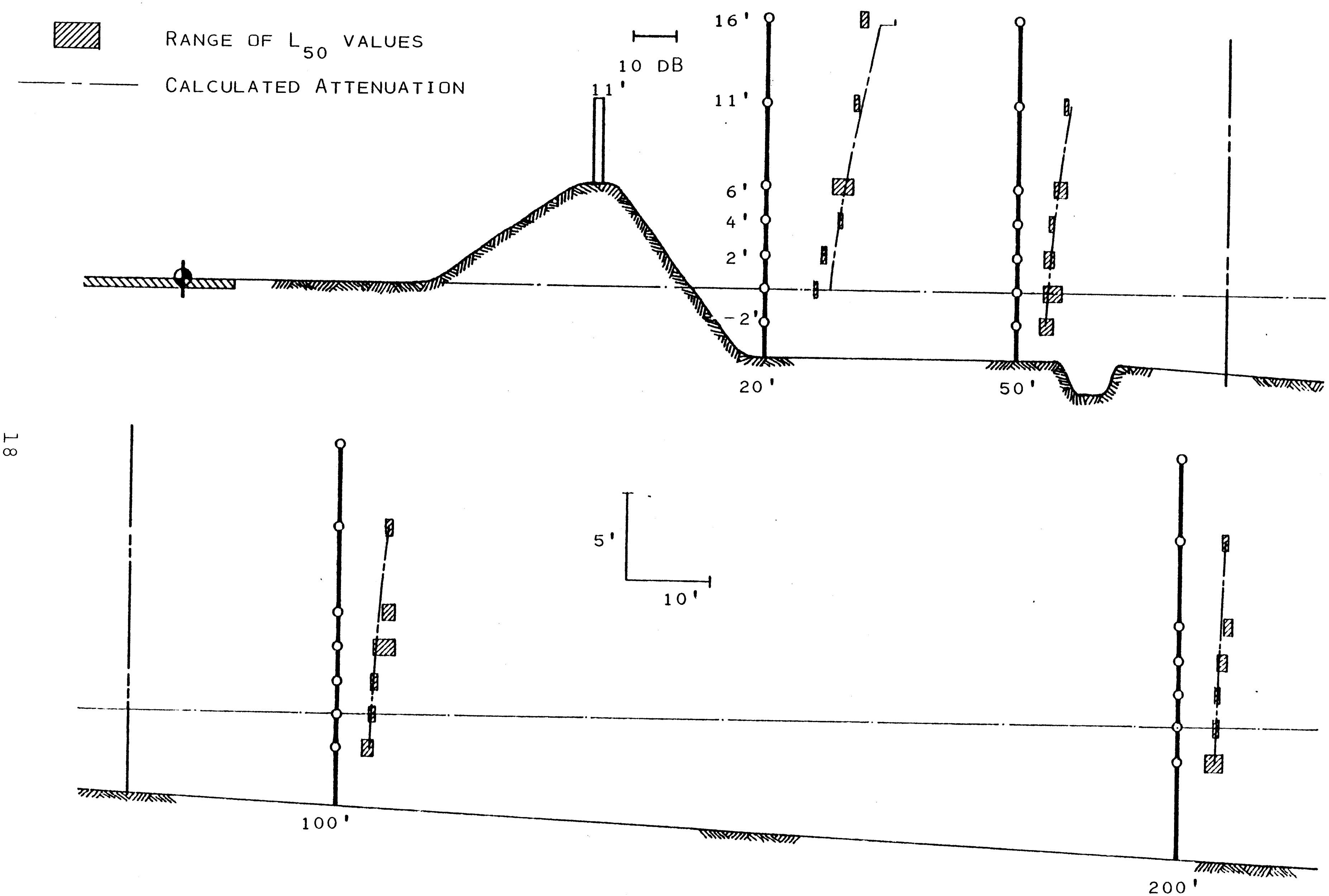

FIGURE 8. BARRIER ATTENUATION EFFECTS ON I-680, MILPITAS CA., FROM NCHRP 144 AND 173.

As a further aid in interpreting these results, Table 2 shows a comparison between measured and calculated barrier effects. The latter were obtained by the Department method with truck stacks at 4.m (13.5 ft). These effects are expressed in terms of the differences between the L_{10} levels at the upper and those at the second from lowest microphones. (Not the lowest microphone because of difficulties already mentioned.) If the upper microphone were always clearly in the line of sight, the values given would be the insertion losses. However, such conditions were met in only a few cases, as noted in the table, so that the remaining values must be viewed as differential insertion losses. Comparing the measured and computed values given, it is seen that differences are mostly within 2 dB, and that neither measured nor computed values are favored. One exception is the reading at 30.5 m (100 ft) from the barrier at Great Neck Road, where aircraft flyovers reduced the measured differential loss to zero. Another is the calculated value at 3.1 m (10 ft) from the barrier on I-495. Here, the NCHRP 174 method predicted a differential of 5.7 dB, which is much closer to the measured 6.7 dB value.

CONCLUSIONS

Based on a comparison between predicted and measured noise levels behind the barrier, and taking into account the factors already mentioned, the weight of evidence indicates that the barriers are performing as they should be expected to. That is to say that if a barrier is designed according to present criteria, and if one of the methods of construction (wood panels, metal panels, or concrete) used on the sample barriers is adhered to, then the barrier will meet the designed objectives.

Table 2

Summary of Results

Site	Distance from Barrier, Ft.	Measured Insertion Loss Differential,(a) dB	Calculated Insertion Loss Differential,(b) dB
Denbigh	25	10.7 (c)	7.5
	50	8.2	9.4
	100	3.3	4.7
	150	3.6	2.8
Great Neck	12	2.0	5.8
	25	4.7	6.1
	75	5.8	5.2
	100	- .1 (d)	5.3
I-64	25	11.6 (c)	12.0
	50	8.1	8.5
	75	6.5	8.4
	100	4.2 (d)	9.2
Churchland Bridge	9	3.4 (c)	3.6
	38.5	4.3	2.2
I-495	10	6.7 (c)	1.0 (e)
	20	9.0	9.2
	75	10.4	6.9
	150	5.0	6.8

CONVERSION: 0.305 m = 1 ft.
(a) Determined from L_{10} values measured over 15 minutes at highest and third highest microphone positions.
(b) Calculated for 13.5 ft stack heights.
(c) These values are clearly true insertion losses.
(d) Results heavily affected by aircraft flyovers.
(e) In this case, the NCHRP 174 method gave a calculated value of 5.7 dB.

RECOMMENDATIONS

The measurements reported here were made on the understanding that they would be treated as preliminary, and that if the methodology to be used proved feasible, then there would be an opportunity to rectify any apparent discrepancies and to make more accurate measurements. Therefore, these recommendations address the question of whether more measurements should be made so as to provide additional input for the decision-making process.

1. Based on the somewhat limited study reported here, it is recommended that no policy decisions be made at present which would eliminate the use of any material or construction technique on the basis of performance. This assumes, of course, that the proper design technique is used in each case.

2. It is recommended that a second series of barrier measurements be planned to accomplish the following.

    a. Add to the variety of barrier types tested.

    b. Provide verification of the performance of barriers.

    c. Support a recommendation on whether changes should be made in Virginia's design methodology.

3. It is further recommended that the following discrepancies in available test equipment be rectified.

    a. Procure three 12.7 mm (1/2-in) quartz-coated microphones with rain covers and dessicators.

    b. Build a pole that will satisfactorily hold all four microphones so as to free the all-weather microphone for installation near the highway.

    c. Build a calibration system to drive four activators simultaneously.

    d. Add a push-button cutoff to stop measurement while aircraft are overhead.

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LIST OF ABBREVIATIONS

L_E — E - percent exceedance sound level, the A-weighted sound level equaled or exceeded E% of the time.

L_{EQ} — Equivalent A-weighted sound level over a 24-hour period.

L_{NP} — Noise Pollution Level - computed from:

$$L_{NP} = L_{50} + (L_{10} - L_{90}) + \frac{(L_{10} - L_{90})^2}{60}$$

NPL — Noise pollution level.

TNI — Traffic noise index - computed from

$$TNI = 4(L_{10} - L_{50}) + L_{90} - 30$$

L_{SIG} — Standard deviation expressed in decibels, based on assuming that L_E is derived from a normal distribution.

L_{EPS} — Standard deviation expressed in decibels, based on readings on a specific channel.

APPENDIX A

RESULTS OF BARRIER EVALUATION
(Noise Levels In dBA)

Site No.	Location	Ht. (Ft)	Dist. (Ft)	Measured Levels					Calculated for 13.5' trucks			Calculated for 8.0' trucks and NCHRP 174 barrier method		
				L_{90}	L_{50}	L_{10}	L_1	L_{EQ}	L_{50}	L_{10}	L_{EQ}	L_{50}	L_{10}	L_{EQ}
2	Denbigh	5	25	48.3	49.0	49.8	50.9	49.3	42.7	50.3	48.6	39.6	47.0	45.0
		14	25	43.4	47.4	53.3	57.3	51.0	48.9	56.0	58.8	47.8	55.3	53.1
		22	25	44.5	51.6	60.7	65.0	56.4	56.5	63.5	60.7	54.5	61.9	60.0
		30	25	44.8	54.2	64.0	67.5	59.3	56.5	63.5	60.7	56.5	63.5	60.7
		5	50	46.3	49.7	54.0	60.3	51.8	42.0	47.8	42.6	39.3	45.1	39.9
		14	50	45.1	48.9	53.8	60.7	51.4	45.5	51.3	46.1	44.6	50.4	45.2
		22	50	46.4	51.4	56.9	63.4	53.9	49.7	55.6	50.3	49.7	55.5	50.3
		30	50	49.5	56.0	62.0	70.3	59.2	54.9	60.7	55.5	54.9	60.7	55.5
		5	100	48.3	49.9	53.3	59.6	51.4	40.8	45.5	41.2	38.3	43.0	38.7
		14	100	45.1	48.2	53.6	59.8	50.7	43.0	47.6	43.3	41.5	46.1	41.9
		22	100	46.9	50.7	55.6	60.3	52.6	45.0	49.6	45.4	45.0	50.0	45.3
		30	100	48.5	52.5	56.9	60.6	53.9	47.7	52.3	48.1	47.8	52.4	48.1
		5	150	50.5	53.2	61.0	70.6	58.4	39.4	43.7	39.9	37.0	41.3	37.5
		14	150	48.4	53.5	60.7	68.3	57.6	41.0	45.3	41.5	39.2	43.5	39.8
		22	150	51.1	56.7	64.4	70.7	60.7	42.3	46.6	42.8	41.6	45.9	42.1
		30	150	51.8	57.3	64.3	69.5	60.6	43.9	48.1	44.4	44.2	48.4	44.7
3	Great Neck	5	12	50.1	57.3	65.5	72.9	62.9	53.7	62.8	54.2	51.7	60.6	52.3
		10	12	52.7	61.3	68.3	72.8	64.6	60.2	68.4	60.7	58.7	67.7	59.2
		18	12	54.6	64.3	71.0	72.2	66.5	65.0	74.2	65.5	65.0	74.2	65.5
		25	12	54.8	63.8	70.3	72.5	66.1	65.0	74.2	65.5	65.0	74.2	65.5
		5	25	53.9	56.0	59.4	64.6	57.2	52.3	60.3	52.9	50.6	58.4	51.2
		10	25	51.5	57.1	61.6	67.5	58.8	58.1	65.2	58.7	55.0	62.7	55.6
		18	25	53.7	60.5	65.5	70.6	62.3	63.1	71.3	63.7	59.8	67.5	60.4
		25	25	54.0	61.4	66.3	71.8	63.1	63.1	71.3	63.7	63.1	71.3	63.7
		5	75	53.1	54.8	57.1	66.0	56.6	49.1	54.5	49.4	47.8	53.1	48.1
		10	75	46.0	51.0	57.0	66.3	55.3	50.5	55.9	50.9	50.1	55.3	50.4
		18	75	49.3	55.0	60.1	67.6	57.7	55.5	60.5	55.9	52.3	57.6	52.6
		25	75	51.3	57.8	62.8	69.9	60.2	55.9	61.1	56.3	56.0	61.2	56.4
		5	100	55.0	56.7	72.6	72.9	64.7	48.8	53.4	49.0	47.6	52.1	47.8
		10	100	48.9	54.1	72.7	72.8	64.6	49.9	54.6	50.2	49.4	53.9	49.7

APPENDIX A (continued)

Site No.	Location	Ht. (Ft)	Dist. (Ft)	Measured Levels					Calculated for 13.5' trucks			Calculated for 8.0' trucks and NCHRP 174 barrier method		
				L_{90}	L_{50}	L_{10}	L_{1}	L_{EQ}	L_{50}	L_{10}	L_{EQ}	L_{50}	L_{10}	L_{EQ}
3	Great Neck	18	100	51.6	56.9	71.4	72.2	64.6	55.2	59.6	55.5	51.3	55.8	51.5
		25	100	54.1	59.7	72.6	72.6	65.3	55.5	59.9	55.7	53.8	58.3	54.0
4	I-64	6	25	59.4	60.9	64.3	69.1	62.1	52.2	58.7	54.8	47.6	54.1	50.2
		15	25	56.3	59.8	65.0	70.9	62.0	54.5	61.6	58.2	52.2	58.9	55.6
		23	25	62.4	67.0	72.1	77.6	69.0	61.9	68.4	65.2	59.0	66.1	63.0
		31	25	65.9	71.1	76.6	82.6	73.3	67.1	73.6	69.6	64.1	71.4	68.0
		6	50	59.3	60.7	63.6	68.2	61.7	52.5	58.7	55.4	48.5	54.6	51.4
		15	50	55.9	58.8	64.0	68.3	60.8	55.0	61.6	58.5	53.0	59.5	56.3
		23	50	59.0	62.4	68.0	72.4	64.6	59.3	66.8	63.8	58.0	64.1	60.9
		31	50	63.1	66.8	72.1	76.6	68.8	63.4	70.1	67.2	63.1	68.9	65.7
		6	75	59.6	61.2	63.8	66.5	61.8	52.5	59.4	56.1	49.0	55.5	52.2
		15	75	56.2	59.6	63.8	67.8	60.9	54.7	61.9	58.6	52.7	59.3	56.1
		23	75	58.9	62.4	67.2	71.1	64.0	58.1	66.1	63.1	56.8	63.1	60.0
		31	75	62.1	65.2	70.3	73.4	67.0	63.1	70.3	67.0	59.7	66.9	63.8
		6	100	59.8	61.3	65.1	69.9	62.8	51.8	58.4	55.6	48.6	54.9	52.1
		15	100	56.3	59.4	64.8	69.5	61.6	53.2	59.4	56.6	51.0	57.3	54.6
		23	100	58.3	61.6	66.9	71.1	63.6	57.4	65.4	62.7	55.2	61.6	58.9
		31	100	60.3	63.8	69.0	72.5	65.6	61.8	68.6	65.9	57.5	64.1	61.3
5	Churchland	5	9	58.6	62.4	67.2	74.3	64.9	61.2	71.8	70.7	57.2	66.1	63.5
		10	9	58.0	65.3	70.3	78.2	67.9	67.2	75.4	72.6	64.9	73.6	70.7
		15	9	59.9	68.7	73.8	81.2	71.1	71.0	79.0	74.1	69.7	77.7	73.5
		20	9	60.0	68.5	73.7	80.8	70.9	71.0	79.0	74.1	71.0	79.0	74.1
		5	38.5	57.6	60.1	63.8	74.5	63.1	58.0	68.3	67.5	64.9	63.5	62.2
		10	38.5	54.6	59.4	64.1	75.4	63.4	59.3	68.7	67.7	57.7	65.3	63.6
		15	38.5	55.7	61.3	66.4	76.6	65.3	63.7	70.6	68.7	60.5	68.8	67.5
		20	38.5	57.5	63.3	68.4	77.2	66.6	64.1	70.9	68.8	63.2	70.4	68.5
6	I-495	8	10	57.6	60.5	64.2	68.0	61.4	59.6	68.4	62.3	55.4	64.3	58.6
		17	10	62.4	66.2	70.3	74.8	67.6	70.7	81.3	74.5	67.6	76.6	70.3
		25	10	55.9	72.0	77.9	82.6	74.3	74.1	82.3	76.2	74.1	82.3	76.2
		33	10	55.0	71.6	77.0	82.6	73.6	74.1	82.3	76.2	74.1	82.3	76.2

APPENDIX A (continued)

Site No.	Location	Ht. (Ft)	Dist. (Ft)	Measured Levels					Calculated for 13.5' trucks			Calculated for 8.0' trucks and NCHRP 174 barrier method		
				L_{90}	L_{50}	L_{10}	L_1	L_{EQ}	L_{50}	L_{10}	L_{EQ}	L_{50}	L_{10}	L_{EQ}
6	I-495	3	20	57.5	60.6	66.5	72.5	63.3	58.5	67.9	62.5	54.6	65.1	60.2
		12	20	58.8	62.2	67.0	72.4	64.4	62.0	71.7	65.7	59.3	69.1	63.5
		20	20	64.6	69.1	72.7	78.9	70.5	70.3	80.2	73.9	67.2	76.0	70.1
		28	20	55.7	71.0	76.0	81.7	72.7	72.7	80.9	75.1	72.7	80.9	75.1
		5	75	54.9	58.2	62.5	66.7	59.5	58.7	66.4	61.8	55.0	62.7	58.3
		14	75	57.6	60.2	64.2	68.0	61.3	61.4	69.1	64.4	58.7	66.2	61.7
		22	75	64.7	67.5	71.4	75.3	68.7	67.6	75.7	71.0	62.7	70.0	65.6
		30	75	61.2	70.4	74.6	79.5	71.7	68.6	76.0	71.5	65.1	72.0	67.8
		4	150	55.8	60.3	63.9	68.4	61.2	54.6	61.2	58.2	51.0	57.2	54.3
		13	150	57.1	60.2	63.7	68.1	61.1	56.2	62.8	59.8	53.2	59.5	56.6
		21	150	59.0	62.5	66.2	70.7	63.7	60.9	68.6	65.4	55.5	61.9	59.0
		29	150	61.2	64.6	68.7	73.0	65.9	62.2	69.6	66.7	58.0	64.2	61.4
7	Sperry	5	50	60.2	68.2	72.7	81.5	70.5	---	---	---	---	---	---
		14	50	58.7	66.8	72.3	82.7	70.5	---	---	---	---	---	---
		22	50	61.6	68.5	72.9	81.5	70.9	---	---	---	---	---	---
		30	50	61.3	67.7	72.5	84.0	71.3	---	---	---	---	---	---
		5	100	60.2	65.7	70.8	76.0	67.7	---	---	---	---	---	---
		14	100	58.6	63.9	70.4	76.6	67.2	---	---	---	---	---	---
		22	100	61.7	66.9	71.8	77.7	69.0	---	---	---	---	---	---
		30	100	61.3	66.4	71.6	76.7	68.6	---	---	---	---	---	---
		5	150	55.4	59.6	65.3	73.7	62.9	---	---	---	---	---	---
		14	150	57.8	63.0	67.9	74.3	65.2	---	---	---	---	---	---
		22	150	60.1	64.7	68.7	74.3	66.1	---	---	---	---	---	---
		30	150	59.7	64.5	68.4	74.0	65.9	---	---	---	---	---	---
		5	200	55.5	58.0	63.1	75.1	63.7	---	---	---	---	---	---
		14	200	57.7	60.9	65.6	77.0	65.2	---	---	---	---	---	---
		22	200	59.5	63.1	67.2	78.7	66.5	---	---	---	---	---	---
		30	200	58.7	62.4	66.7	76.9	65.5	---	---	---	---	---	---

APPENDIX B

EXPERIMENTAL PARAMETERS

Sym.	Height/Dist. (ft)	5/25	14/25	22/25	30/25	5/50	14/50	22/50	30/50	5/100	14/100	22/100	30/100
	Road Element No.	1	1	1	1	1	1	1	1	1	1	1	1
	Item	Denbigh											
REN	No. of Road Els.	1	1	1	1	1	1	1	1	1	1	1	1
NLG	No. of Lane Grps.	1	1	1	1	1	1	1	1	1	1	1	1
DHV	Design Hourly Vol.	428	428	428	428	428	428	428	428	480	480	480	480
TMIX	Percent Trucks	1.9	1.9	1.9	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ST	Truck Sp. (mph)	38.0	38.0	38.0	38.0	37.7	37.7	37.7	37.7	36.3	36.3	36.3	36.3
SA	Auto Sp. (mph)	38.0	38.0	38.0	38.0	37.7	37.7	37.7	37.7	36.3	36.3	36.3	36.3
HE	Road Elev. (ft)	0	0	0	0	0	0	0	0	0	0	0	0
DN	Obs. to Road (ft)	93	93	93	93	118	118	118	118	168	168	168	168
RL	Road Length Type	1	1	1	1	1	1	1	1	1	1	1	1
BL	Barr. Length Type	1	1	1	1	1	1	1	1	1	1	1	1
P	No. of Lanes	2	2	2	2	2	2	2	2	2	2	2	2
MED	Median Width (ft)	---	---	---	---	---	---	---	---	---	---	---	---
HO	Observer Ht. (ft)	5	14	22	30	5	14	22	30	5	14	22	30
DS	Obs.-Shldr. (ft)	---	---	---	---	---	---	---	---	---	---	---	---
H	Barrier Ht. (ft)	14	14	14	14	14	14	14	14	14	14	14	14
DB	Obs. - Barr. (ft)	25	25	25	25	50	50	50	50	100	100	100	100

APPENDIX B

EXPERIMENTAL PARAMETERS

	Height/Dist.(ft)	5/150	14/150	22/150	30/150	5/12	10/12	18/12	25/12	5/25	10/25	18/25	25/25
	Road Element No.	1	1	1	1	1	1	1	1	1	1	1	1
Sym.	Item	Denbigh				Great Neck							
REN	No. of Road Els.	1	1	1	1	1	1	1	1	1	1	1	1
NLG	No. of Lane Grps.	1	1	1	1	2	2	2	2	2	2	2	2
DHV	Design Hourly Vol.	452	452	452	452	944	944	944	944	912	912	912	912
TMIX	Percent Trucks	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ST	Truck Sp. (mph)	37.9	37.9	37.9	37.9	39.8	39.8	39.8	39.8	40.6	40.6	40.6	40.6
SA	Auto Sp. (mph)	37.9	37.9	37.9	37.9	39.8	39.8	39.8	39.8	40.6	40.6	40.6	40.6
HE	Road Elev. (ft)	0	0	0	0	0	0	0	0	0	0	0	0
DN	Obs. to Road (ft)	218	218	218	218	29	29	29	29	42	42	42	42
RL	Road Length Type	1	1	1	1	1	1	1	1	1	1	1	1
BL	Barr. Length Type	1	1	1	1	1	1	1	1	1	1	1	1
P	No. of Lanes	2	2	2	2	2	2	2	2	2	2	2	2
MED	Median Width (ft)	---	---	---	---	40	40	40	40	40	40	40	40
HO	Observer Ht. (ft)	5	14	22	30	5	10	18	25	5	10	18	25
DS	Obs.-Shldr. (ft)	---	---	---	---	---	---	---	---	---	---	---	---
H	Barrier Ht. (ft)	14	14	14	14	8	8	8	8	8	8	8	8
DB	Obs. - Barr. (ft)	150	150	150	150	12	12	12	12	25	25	25	25

APPENDIX B

EXPERIMENTAL PARAMETERS

Sym.	Item	5/75	10/75	18/75	25/75	5/100	10/100	18/100	25/100	6/25	6/25	15/25	15/25
	Height/Dist.(ft)	5/75	10/75	18/75	25/75	5/100	10/100	18/100	25/100	6/25	6/25	15/25	15/25
	Road Element No.	1	1	1	1	1	1	1	1	1	2	1	2
		Great Neck								I-64 Hampton			
REN	No. of Road Els.	1	1	1	1	1	1	1	1	2	-	2	-
NLG	No. of Lane Grps.	2	2	2	2	2	2	2	2	1	1	1	1
DHV	Design Hourly Vol.	1032	1032	1032	1032	1192	1192	1192	1192	1176	1004	1176	1004
TMIX	Percent Trucks	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.7	3.6	3.7	3.6
ST	Truck Sp. (mph)	38.8	38.8	38.8	38.8	39.6	39.6	39.6	39.6	55.2	55.2	55.2	55.2
SA	Auto Sp. (mph)	38.8	38.8	38.8	38.8	39.6	39.6	39.6	39.6	55.2	55.2	55.2	55.2
HE	Road Elev. (ft)	0	0	0	0	0	0	0	0	4.5	0	4.5	0
DN	Obs. to Road (ft)	92	92	92	92	117	117	117	117	75	164	75	164
RL	Road Length Type	1	1	1	1	1	1	1	1	1	1	1	1
BL	Barr. Length Type	1	1	1	1	1	1	1	1	1	1	1	1
P	No. of Lanes	2	2	2	2	2	2	2	2	2	2	2	2
MED	Median Width (ft)	40	40	40	40	40	40	40	40	----	----	----	----
HO	Observer Ht. (ft)	5	10	18	25	5	10	18	25	6	6	15	15
DS	Obs.-Shldr. (ft)	----	----	----	----	----	----	----	----	25	----	25	----
H	Barrier Ht. (ft)	8	8	8	8	8	8	8	8	18	18	18	18
DB	Obs. - Barr. (ft)	75	75	75	75	100	100	100	100	25	25	25	25

APPENDIX B

EXPERIMENTAL PARAMETERS

	Height/Dist.(ft)	23/25	23/25	31/25	31/25	6/50	6/50	15/50	15/50	23/50	23/50	31/50	31/50
	Road Element No.	1	2	1	2	1	2	1	2	1	2	1	2
Sym.	Item	I-64 Hampton											
REN	No. of Road Els.	2	-	2	-	2	-	2	-	2	-	2	-
NLG	No. of Lane Grps.	1	1	1	1	1	1	1	1	1	1	1	1
DHV	Design Hourly Vol.	1176	1004	1176	1004	1380	1428	1380	1428	1380	1428	1380	1428
TMIX	Percent Trucks	3.7	3.6	3.7	3.6	2.9	4.5	2.9	4.5	2.9	4.5	2.9	4.5
ST	Truck Sp. (mph)	55.2	55.2	55.2	55.2	55.1	59.2	55.1	59.2	55.1	59.2	55.1	59.2
SA	Auto Sp. (mph)	55.2	55.2	55.2	55.2	55.1	59.2	55.1	59.2	55.1	59.2	55.1	59.2
HE	Road Elev. (ft)	4.5	0	4.5	0	4.5	0	4.5	0	4.5	0	4.5	0
DN	Obs. to Road (ft)	75	164	75	164	100	189	100	189	100	189	100	189
RL	Road Length Type	1	1	1	1	1	1	1	1	1	1	1	1
BL	Barr. Length Type	1	1	1	1	1	1	1	1	1	1	1	1
P	No. of Lanes	2	2	2	2	2	2	2	2	2	2	2	2
MED	Median Width (ft)	----	----	----	----	----	----	----	----	----	----	----	----
HO	Observer Ht. (ft)	23	23	31	31	6	6	15	15	23	23	31	31
DS	Obs.-Shldr. (ft)	25	----	25	----	50	-	50	-	50	-	50	-
H	Barrier Ht. (ft)	18	18	18	18	18	18	18	18	18	18	18	18
DB	Obs. - Barr. (ft)	25	25	25	25	50	50	50	50	50	50	50	50

APPENDIX B

EXPERIMENTAL PARAMETERS

Sym.	Height/Dist.(ft)	6/75	6/75	15/75	15/75	23/75	23/75	31/75	31/75	6/100	6/100	15/100	15/100
	Road Element No.	1	2	1	2	1	2	1	2	1	2	1	2
	Item	I-64 Hampton											
REN	No. of Road Els.	2	-	2	-	2	-	2	-	2	-	2	-
NLG	No. of Lane Grps.	1	1	1	1	1	1	1	1	1	1	1	1
DHV	Design Hourly Vol.	1444	1708	1444	1708	1444	1708	1444	1708	1540	1600	1540	1600
TMIX	Percent Trucks	4.4	3.8	4.4	3.8	4.4	3.8	4.4	3.8	3.1	5.5	3.1	5.5
ST	Truck Sp. (mph)	55.9	57.4	55.9	57.4	55.9	57.4	55.9	57.4	54.0	56.0	54.0	56.0
SA	Auto Sp. (mph)	55.9	57.4	55.9	57.4	55.9	57.4	55.9	57.4	54.0	56.0	54.0	56.0
HE	Road Elev. (ft)	4.5	0	4.5	0	4.5	0	4.5	0	4.5	0	4.5	0
DN	Obs. to Road (ft)	125	214	125	214	125	214	125	214	150	239	150	239
RL	Road Length Type	1	1	1	1	1	1	1	1	1	1	1	1
BL	Barr. Length Type	1	1	1	1	1	1	1	1	1	1	1	1
P	No. of Lanes	2	2	2	2	2	2	2	2	2	2	2	2
MED	Median Width (ft)	---	---	---	---	---	---	---	---	---	---	---	---
HO	Observer Ht. (ft)	6	6	15	15	23	23	31	31	6	6	15	15
DS	Obs.-Shldr. (ft)	75	-	75	-	75	-	75	-	100	-	100	-
H	Barrier Ht. (ft)	18	18	18	18	18	18	18	18	18	18	18	18
DB	Obs. - Barr. (ft)	75	75	75	75	75	75	75	75	100	100	100	100

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APPENDIX B

EXPERIMENTAL PARAMETERS

Sym.	Height/Dist.(ft)	23/100	23/100	31/100	31/100	5/9	10/9	15/9	20/9	5/38½	10/38½	15/38½	20/38½
	Road Element No.	1	2	1	2	1	1	1	1	1	2	1	2
	Item	I-64 Hampton				Churchland Bridge							
REN	No. of Road Els.	2	-	2	-	1	1	1	1	1	1	1	1
NLG	No. of Lane Grps.	1	1	1	1	2	2	2	2	2	2	2	2
DHV	Design Hourly Vol.	1540	1600	1540	1600	2092	2092	2092	2092	2360	2360	2360	2360
TMIX	Percent Trucks	3.1	5.5	3.1	5.5	1.5	1.5	1.5	1.5	1.4	1.4	1.4	1.4
ST	Truck Sp. (mph)	54.0	56.0	54.0	56.0	37.5	37.5	37.5	37.5	37.2	37.2	37.2	37.2
SA	Auto Sp. (mph)	54.0	56.0	54.0	56.0	37.5	37.5	37.5	37.5	37.2	37.2	37.2	37.2
HE	Road Elev. (ft)	4.5	0	4.5	0	0	0	0	0	0	0	0	0
DN	Obs. to Road (ft)	150	239	150	239	20	20	20	20	49.5	49.5	49.5	49.5
RL	Road Length Type	1	1	1	1	1	1	1	1	1	1	1	1
BL	Barr. Length Type	1	1	1	1	1	1	1	1	1	1	1	1
P	No. of Lanes	2	2	2	2	2	2	2	2	2	2	2	2
MED	Median Width (ft)	---	---	---	---	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7
HO	Observer Ht. (ft)	23	23	31	31	5	10	15	20	5	10	15	20
DS	Obs.-Shldr. (ft)	100	-	100	-	-	-	-	-	-	-	-	-
H	Barrier Ht. (ft)	18	18	18	18	8	8	8	8	8	8	8	8
DB	Obs. - Barr. (ft)	100	100	100	100	9	9	9	9	38.5	38.5	38.5	38.5

APPENDIX B

EXPERIMENTAL PARAMETERS

Sym.	Height/Dist. (ft)	8/10	8/10	8/10	17/10	17/10	17/10	25/10	25/10	25/10	33/10	33/10	33/10
	Road Element No.	1	2	3	1	2	3	1	2	3	1	2	3
	Item	I-495 Springfield											
REN	No. of Road Els.	3	-	-	3	-	-	3	-	-	3	-	-
NLG	No. of Lane Grps.	1	1	1	1	1	1	1	1	1	1	1	1
DHV	Design Hourly Vol.	3232	3232	16	3232	3232	16	3232	3232	16	3232	3232	16
TMIX	Percent Trucks	4.7	4.7	0	4.7	4.7	0	4.7	4.7	0	4.7	4.7	0
ST	Truck Sp. (mph)	51	51	30	51	51	30	51	51	30	51	51	30
SA	Auto Sp. (mph)	51	51	30	51	51	30	51	51	30	51	51	30
HE	Road Elev. (ft)	0	-13	- 4	0	-13	-4	0	-13	- 4	0	-13	- 4
DN	Obs. to Road (ft)	35	175	16	35	175	16	35	175	16	35	175	16
RL	Road Length Type	1	1	1	1	1	1	1	1	1	1	1	1
BL	Barr. Length Type	1	1	0	1	1	0	1	1	0	1	1	0
P	No. of Lanes	6	4	2	6	4	2	6	4	2	6	4	2
MED	Median Width (ft)	---	---	---	---	---	---	---	---	---	---	---	---
HO	Observer Ht. (ft)	8	8	8	17	17	17	25	25	25	33	33	33
DS	Obs.-Shldr. (ft)	-	1	1	-	1	1	-	1	1	-	1	1
H	Barrier Ht. (ft)	16	16	-	16	16	-	16	16	-	16	16	-
DB	Obs. - Barr. (ft)	10	10	-	10	10	-	10	10	-	10	10	-

APPENDIX B

EXPERIMENTAL PARAMETERS

	Height/Dist.(ft)	3/20	3/20	3/20	12/20	12/20	12/20	20/20	20/20	20/20	28/20	28/20	28/20
	Road Element No.	1	2	3	1	2	3	1	2	3	1	2	3
Sym.	Item	I-495 Springfield											
REN	No. of Road Els.	3	-	-	3	-	-	3	-	-	3	-	-
NLG	No. of Lane Grps.	1	1	1	1	1	1	1	1	1	1	1	1
DHV	Design Hourly Vol.	3272	3272	32	3272	3272	32	3272	3272	32	3272	3272	32
TMIX	Percent Trucks	4.3	4.3	0	4.3	4.3	0	4.3	4.3	0	4.3	4.3	0
ST	Truck Sp. (mph)	47	47	30	47	47	30	47	47	30	47	47	30
SA	Auto Sp. (mph)	47	47	30	47	47	30	47	47	30	47	47	30
HE	Road Elev. (ft)	0	-13	- 4	0	-13	- 4	0	-13	- 4	0	-13	- 4
DN	Obs. to Road (ft)	45	185	6	45	185	6	45	185	6	45	185	6
RL	Road Length Type	1	1	1	1	1	1	1	1	1	1	1	1
BL	Barr. Length Type	1	1	0	1	1	0	1	1	0	1	1	0
P	No. of Lanes	6	4	2	6	4	2	6	4	2	6	4	2
MED	Median Width (ft)	---	---	---	---	---	---	---	---	---	---	---	---
HO	Observer Ht. (ft)	3	3	3	12	12	12	20	20	20	28	28	28
DS	Obs.-Shldr. (ft)	-	1	1	-	1	1	-	1	1	-	1	1
H	Barrier Ht. (ft)	16	16	-	16	16	-	16	16	-	16	16	-
DB	Obs. - Barr. (ft)	20	20	-	20	20	-	20	20	-	20	20	-

EXPERIMENTAL PARAMETERS

	Height/Dist.(ft)	5/75	5/75	5/75	14/75	14/75	14/75	22/75	22/75	22/75	30/75	30/75	30/75
	Road Element No.	1	2	3	1	2	3	1	2	3	1	2	3
Sym.	Item	I-495 Springfield											
REN	No. of Road Els.	3	-	-	3	-	-	3	-	-	3	-	-
NLG	No. of Lane Grps.	1	1	1	1	1	1	1	1	1	1	1	1
DHV	Design Hourly Vol.	3308	3308	28	3308	3308	28	3308	3308	28	3308	3308	28
TMIX	Percent Trucks	5.9	5.9	0	5.9	5.9	0	5.9	5.9	0	5.9	5.9	0
ST	Truck Sp. (mph)	50	50	30	50	50	30	50	50	30	50	50	30
SA	Auto Sp. (mph)	50	50	30	50	50	30	50	50	30	50	50	30
HE	Road Elev. (ft)	0	-13	- 4	0	-13	- 4	0	-13	- 4	0	-13	- 4
DN	Obs. to Road (ft)	100	240	25	100	240	25	100	240	25	100	240	25
RL	Road Length Type	1	1	1	1	1	1	1	1	1	1	1	1
BL	Barr. Length Type	1	1	0	1	1	0	1	1	0	1	1	0
P	No. of Lanes	6	4	2	6	4	2	6	4	2	6	4	2
MED	Median Width (ft)	---	---	---	---	---	---	---	---	---	-	-	-
HO	Observer Ht. (ft)	5	5	5	14	14	14	22	22	22	30	30	30
DS	Obs.-Shldr. (ft)	-	1	1	-	1	1	-	1	1	-	1	1
H	Barrier Ht. (ft)	16	16	-	16	16	-	16	16	-	16	16	-
DB	Obs. - Barr. (ft)	75	75	-	75	75	-	75	75	-	75	75	-

APPENDIX B

EXPERIMENTAL PARAMETERS

Sym.	Height/Dist.(ft)	4/150	4/150	13/150	13/150	21/150	21/150	29/150	29/150				
	Road Element No.	1	2	1	2	1	2	1	2				
	Item	I-495 Springfield											
REN	No. of Road Els.	2	-	2	-	2	-	2	-				
NLG	No. of Lane Grps.	1	1	1	1		1	1	1				
DHV	Design Hourly Vol.	3088	3088	3088	3088	3088	3088	3088	3088				
TMIX	Percent Trucks	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3				
ST	Truck Sp. (mph)	50	50	50	50	50	50	50	50				
SA	Auto Sp. (mph)	50	50	50	50	50	50	50	50				
HE	Road Elev. (ft)	0	-13	0	-13	0	-13	0	-13				
DN	Obs. to Road (ft)	175	315	175	315	175	315	175	315				
RL	Road Length Type	1	1	1	1	1	1	1	1				
BL	Barr. Length Type	1	1	1	1	1	1	1	1				
P	No. of Lanes	6	4	6	4	6	4	6	4				
MED	Median Width (ft)	----	----	----	----	----	----	----	----				
HO	Observer Ht. (ft)	4	4	13	13	21	21	29	29				
DS	Obs.-Shldr. (ft)	-	1	-	1	-	1	-	1				
H	Barrier Ht. (ft)	16	16	16	16	16	16	16	16				
DB	Obs. - Barr. (ft)	150	150	150	150	150	150	150	150				