

A MANUAL FOR USING THE HIGHWAY NOISE ANALYSIS PROGRAM "NOISESIM"

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(The opinions, findings, and conclusions expressed in this report are those of the authors and not necessarily those of the sponsoring agencies.)

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PURPOSE

The purpose of this manual is to provide a detailed methodology for using a computer program adapted from one presented in National Cooperative Highway Research Program Report 78.^{1/} The contracting firm (with NCHRP) was Bolt, Beranek and Newman of Van Nuys, California. According to the firm, the computer program was a spin off of its basic research project on highway noise measurement and simulation. However, the authors of this present report found that after several modifications the program was a valuable tool for simulating the noise levels of proposed highway projects.

While the authors recognize that the approach described in this manual is a first step in the evaluation of highway noise, ^{2/} it is substantially better than avoiding the problem of highway noise altogether in the analysis of the environmental impact of proposed highway projects. Currently, the procedure that is followed in evaluating the noise levels of new highways or proposed improvement projects is to select a specific building location on the plans for analysis. All necessary data required as inputs to the computer program "Noisesim" are

^{1/} National Academy of Sciences — National Academy of Engineering, National Research Council, Highway Research Board, National Cooperative Highway Research Program Report 78, Highway Noise-Measurement, Simulation and Mixed Reaction, Washington, D. C., 1969.

^{2/} The techniques presently employed in measuring the noise level of a highway are under study by the Soils-Geology Section of the Virginia Highway Research Council. In the near future a revised methodology for taking noise measurements will be published.

obtained directly from the plans for the selected location. The current noise levels are also measured at the plan site locations.

The procedure given in this manual will enable the Department to compare the levels presently experienced by residents of an area to the predicted noise levels for the new highway.

IMPLEMENTATION

Noisesim has become one of the basic tools in the Department's evaluation of the environmental impact of a highway project. The Department's Environmental Quality Division develops the basic input data and the Data Processing Division runs the program through an IBM 360 model 40 computer. The initial implementation was to simply use the Noisesim program to predict the noise level of a proposed highway project. The results of this computer run are now compared to noise measurements taken in the immediate area to be affected by the proposed project. This procedure has been tested on several proposed projects and found to be of value in the evaluation of environmental impacts.

Using the Noisesim Program

The procedures described in this manual are general user input instructions, illustrated with an actual example of the use of the NCHRP Noise Simulation System 360 Electronic Computer Program. In order to ensure uniform results, the input instructions have been prepared to allow users only limited options. Should other options be desired, the user should consult the Data Processing Division before deviating from these instructions. The authors emphasize that only those individuals thoroughly familiar with the program should attempt to make modifications in the described procedures.

NOISESIM GLOSSARY

Before a discussion of the specific coding instructions, a brief review of selected terms used in the Noisesim program may be beneficial to the reader. The following glossary defines the terms used in this manual. They are presented in the sequence in which they are referred to in coding instructions.

Run Identification -- The station number for a run is entered in the upper left-hand corner of the coding sheet. Actually, any number that would enable the user to identify the individual run could be used for this purpose so long as it does not exceed 6 digits.

Number of Snapshots — This is the number of points in time that the computer program selects to estimate the noise level on the proposed highway. Each snapshot will estimate (measure) the noise level at one point in time and will include one or more vehicles. The number of vehicles actually included in the snapshot will depend upon the volume of traffic used for this computer run.

Path of Roadway — The roadway should be considered as running from left to right, as the observer faces it.

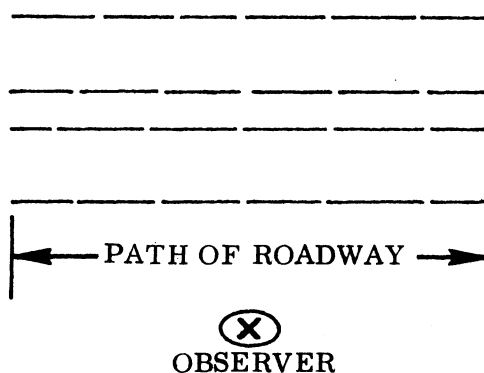


Figure 1. Observer position.

Observer Position — The observer is always considered to be facing the roadway with the traffic in the closest lane moving from his left to his right as in Figure 1. The height of the observer is always five feet above ground level. The height of the observer has been established as five feet, since this is considered to be the average height of the observer's ear.

Lane Offset — Lane offset is a term used to indicate the location of each lane from the center line of the entire roadway. This computer program uses the center line of the median as a reference point for the location of most points. The lanes closest to the observer should be indicated as a position (+) number of feet and lanes on the opposite side of the median center line are shown as a negative (-) value.

Propagation Conditions — Propagation conditions are those which can spread, increase, or decrease the noise from traffic sources.

Air Attenuation — Air attenuation refers to factors which specify the transmission qualities of air. The program uses a factor for each of the eight octave bands (i. e. 63 to 8,000 HZ).

Shielding Attenuation — The card for this factor is used to indicate any shielding conditions that may be present. If the highway is depressed a 1 will indicate a slope cut and a 2 will indicate a vertical cut. This card is also used to indicate a wall or other noise barrier adjacent to the highway. In addition, it will specify the height of the shielding.

Traffic Characteristics — Traffic characteristics is the term employed to indicate the traffic conditions which can affect the noise levels.

Traffic Mix — This term is used to specify the percentage of each type of vehicle on the facility that can be expected under average traffic conditions. The program allows the user to identify up to four different types of vehicles. Generally, it is sufficient to distinguish between trucks and cars; but the option remains to indicate four separate noise sources.

Path Cards — These cards are designed to reference key points of the vehicle path on the roadway. They will define the length of roadway that the noise source (i. e. vehicles) will travel. In addition, they will indicate if the roadway is on a grade, level or on a curve.

Orbiting Point — This point is any convenient point on the center line of the median opposite to the observer and equidistant between the termini of the paths of the roadway. The orbiting point serves as a midpoint for vertical and horizontal measurements.

Field or Vars — Field or Vars are an established group of seven columns set aside on an IBM card to receive specific sets of data.

NOISESIM CODING INSTRUCTIONS

The coding for Noisesim is to be completed on the special coding sheet as shown in Figure 2. All input cards for the program contain an identifying number (i. e. card type code) in columns 1 and 2, with each code belonging to one of five major input groups, as shown in Table 1.

TABLE 1
MAJOR DATA INPUT GROUPS

	<u>Input Groups</u>	<u>Code</u>
I.	Control	
	Number of Snapshots	02
II.	Geometry	
	Path of Roadway	11
	Observer Position	12
	Lane Offset	13
III.	Propagation Conditions	
	Air Attenuation	21
	Shielding Attenuation	22
IV.	Vehicle Category	
	Noise Source	31
V.	Traffic Characteristics	
	Traffic Mix	41
	Traffic Volume	42
	Speed	43

Input data must be arranged as shown in Table 2. The reader should note that the card code 01 is always the last card in a given data set. It should also be noted that several data sets may be run successively; i. e., all cross sections for a given project may be combined into one computer session.

TABLE 2

ORDER OF INPUT DATA CARDS

<u>Contents of the Card</u>	<u>Code</u>	
Number of Snapshots	02	
Path Point 1	11	A minimum of three points is required to specify the path of the roadway. A separate card is required for each point.
Path Point 2	11	
Path Point 3	11	
Observer Position	12	
Offset For Lane 1	13	A separate card is required for each lane. Lane 1 is always the one closest to the observer, Lane 2 the next closest, etc. The program will handle up to eight lanes at present.
Offset for Lane 2	13	
Offset For Lane 3	13	
Offset For Lane 4	13	
Air Attenuation	21	
Shielding Attenuation	22	Used only when shielding is considered.
Noise Spectrum for Trucks	31	Up to four noise source cards could be used.
Noise Spectrum for Cars	31	
Traffic Mix For Lane 1	41	A separate card is required for each lane. The ordering of type 41 cards must be the same as the ordering of type 13 card.
Traffic Mix For Lane 2	41	
Traffic Mix For Lane 3	41	
Traffic Mix For Lane 4	41	
Etc.		
Traffic Volume For Lane 1	42	A separate card is required for each lane.
Traffic Volume For Lane 2	42	
Etc.		
Traffic Speeds for Lane 1	43	A separate card is required for each lane.
Etc.		
Empty Except For Code	01	Initiates processing of this data set.

General Instructions

Columns 1 to 8

The identification code (i.e. card type) for each input card is preprinted in columns 1 and 2 on the coding sheet. The only exception to this is card type 22, shielding attenuation, which is used only when shielding is a consideration. Therefore, the user must code 22 in columns 1 and 2 when this variable is to be considered.

An identification number, usually the cross section number, is coded in the upper left-hand corner of the coding sheet. It will be punched in columns 3 to 8 on each card.

The project charge number is entered in the block in the upper right-hand corner of the coding sheet.

Column 9

It should be noted that since Column 9 is not used in this computer program it is not shown on the coding sheet.

Columns 10 Through 79

Columns 10 through 79 contain ten fields of seven columns each. On the coding sheet these fields are entitled VARS (1) through VARS (10). Any number, up to 10, of these fields may be used to input the necessary data for an individual run. Numbers must not extend across field boundaries and only one number (up to six digits and a decimal) may be coded per field. The boundaries of these fields are indicated on the coding sheet by vertical solid lines enclosing columns 10 through 16, 17 through 23, 24 through 30, 31 through 37, 38 through 44, 45 through 51, 52 through 58, 59 through 65, 66 through 72 and 73 through 79.

Plus and minus signs (plus signs are optional) must be punched as the first character in a field. Every field that is used must contain an explicit decimal point; e.g., the integer -199 could be coded in seven columns as -199.00 or -199., while the decimal fraction 1.2 could be coded as 1.200000, etc. The exact location of the decimal point within the field is immaterial — it simply must be present and must of course, make sense (one would not try to code 19 as 190000.)

The 02 coded card will be the first data card of each individual run; e.g. each cross section is considered a separate run. This card should contain, under the data field headed VARS (1), columns 10 through 16, the number of snapshots required for this particular run. The number of snapshots should be at least 21, since statistical reliability increases as the number of snapshots increases. In addition, the number of snapshots must always be the same as the number of actual readings taken in field to be compared to the projected noise levels from the computer run. A sample coding of the 02 type card is shown in Figure 3.

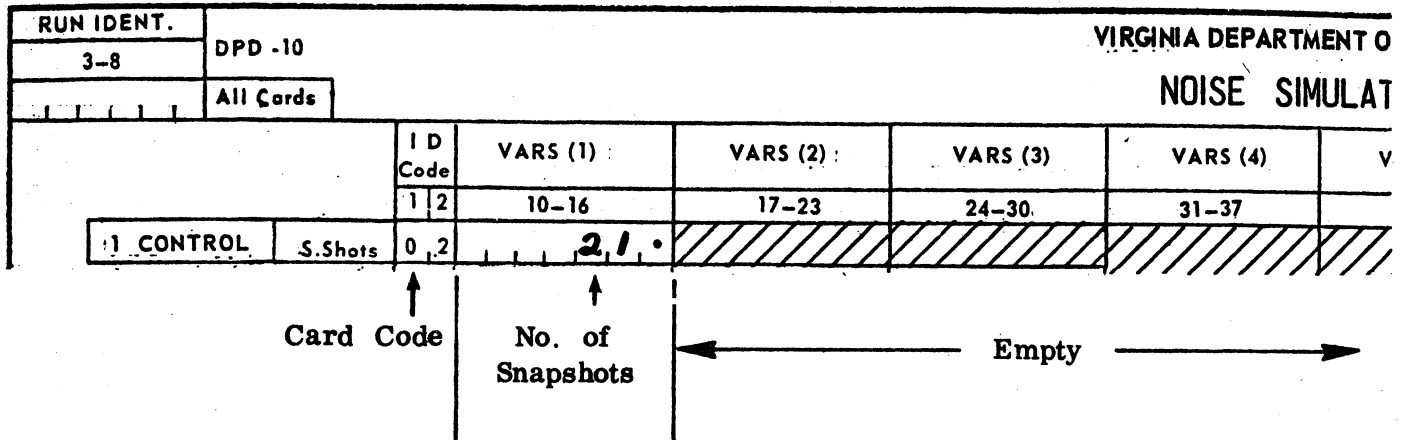


Figure 3. Coding of 02 type card.

Geometry Cards

Path Cards

Path cards, coded 11, define the center line of the roadway in a three-dimensional coordinate space. The origin of this space may be fixed at any point convenient for the user. Some point on the center line of the roadway would be a good choice. All three-dimensional coordinates on the path cards and on all following cards must be taken with respect to this origin.

All coordinate points are given as triples — X, Y, and Z — where the X and Y dimensions define the surface of the earth.

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Each path card contains one triple, i.e., one point. The X, Y, Z coordinates should be expressed in feet. It is suggested that the length of roadway, i.e., the X points to the left and right of the orbiting point in the roadway, should be at least 10,000 feet. However, if the total traffic volume is less than 500 vehicles the roadway length should be shown as 25,000 feet. If an insufficient roadway length is selected, the computer program will increment in 5,000 feet intervals until sufficient roadway length is obtained.

Path cards are punched by placing the X coordinate in columns 10 through 16, the Y coordinate in columns 17 through 23, and the Z coordinate in columns 24 through 30.

The X point to the left of the orbiting point should be shown as a minus figure, and the one to the right as a plus value.

The Y coordinate is intended to indicate any horizontal offsets from the center line of the roadway. This field would be used to indicate a curve section of highway. A point on the observer's side (i.e., the area between the observer and the center line of the roadway) would be coded as a plus value. Points on the side opposite the observer would be coded as negative values.

The Z coordinate is designed to indicate the grade or elevation of the roadway, the actual elevation (above sea level) of two convenient points on the roadway. One would be to the left of the orbiting point and the other to the right of the orbiting point.

A sample coding for a straight level roadway, with the X axis running down the center line of the roadway, is shown in Figure 4.

RUN IDENT.		VIRGINIA DEPAR				
3-8		NOISE S				
DPD-10						
All Cards						
ID Code		VARS (1)	VARS (2)	VARS (3)	VARS (4)	
1 2		10-16	17-23	24-30	31-37	
1 CONTROL	S.Shots	0, 2				
CS	* Rd.Way	XYZ, Coord	1 1	-1,000.0	0.0	1,380.0
			1 1	0.0	0.0	1,380.0
			1 1	1,000.0	0.0	1,380.0
	.Obs.	1 2				
		Code	X	Y	Z	Empty

Figure 4. Sample coding of path card for straight level roadway.

At least three path cards must be used, but as many as are necessary to define the center line of the roadway may be used.

The length of the path, described by the X coordinate, is determined by the sum of the distances between the path points and must be greater than four times the maximum vehicle gap for any lane. It is generally advisable to use a roadway length of at least 10,000 feet in both directions.

The Observer Card

The card coded 12, the observer card, defines the location of the observer in the chosen coordinate system. The X coordinate for the observer is generally shown as 0.0 since usually the observer is opposite the orbiting point.

The Y coordinate of the observer is the horizontal distance that the observer is located from the center line of the roadway. It should be noted that in computing the Z coordinate of the observer the ears of the observer are generally assumed to be five feet above the ground elevation of where he is assumed to be standing. A sample coding for the observer is shown in Figure 5.

RUN IDENT.		VIRGINIA DEPART				
3-8		NOISE SI				
All Cards						
		ID Code	VARs (1)	VARs (2)	VARs (3)	VARs (4)
		1 2	10-16	17-23	24-30	31-37
1 CONTROL	S.Shots	0,2				
CS	* Rd.Way	XYZ,Coord	1,1			
		1,1				
		1,1				
	.Obs.	1,2	0.0	141.0	1385.0	
		Code	X	Y	Z	Empty

Figure 5. Sample coding for observer card.

The Lane Location Card

Cards coded 13, lane location cards, are used to specify the location of the lanes relative to the center line of the roadway. There must be one lane location card for each lane of the roadway. The first lane location card is for the lane closest to the observer, and the last card is for the lane farthest from the observer. All intermediate lanes are numbered accordingly.

The lane location cards contain, in columns 10 through 16, the distance in feet that a lane is offset horizontally from the center line and, in columns 17 through 23, the distance in feet that a lane is offset vertically from the center line.

Horizontal offsets are specified as positive (+) numbers for all lanes between the observer and the center line and as negative (-) numbers for all lanes beyond the center line. Vertical offsets are specified as positive for all lanes that are elevated with respect to the center line and as negative for all lanes that are depressed. A sample coding for a level, symmetric, eight-lane roadway is shown in Figure 6.

RUN IDENT.		DPD-10		VIRGINIA DEPAR			
3-8		All Cards		NOISE S			
		ID Code	VAR5 (1)	VAR5 (2)	VAR5 (3)	VAR5 (4)	
		1 2	10-16	17-23	24-30	31-37	
entries in VARS fields. joined use another code sheet.	1 CONTROL	5.Shots	0 2				
		* Rd.Way	1 1				
	2 GEOMETRICS	* Lane Offset (one card per lane)	XYZ, Coord	1 1			
			Obs.	1 1			
			1 2				
			1 3	54.0	0.0		
			1 3	42.0	0.0		
			1 3	30.0	0.0		
			1 3	18.0	0.0		
			1 3	-18.0	0.0		
	1 3	-30.0	0.0				
	1 3	-42.0	0.0				
	1 3	-54.0	0.0				

Code
Horizontal
Vertical
Empty

Figure 6. Sample lane location card.

Air Attenuation Card

The card coded 21, the air attenuation card, is used to specify the transmission qualities of the air. This card uses eight fields, one for each of the eight octave bands on 63 to 8,000 HZ, to specify the air attenuation. The numbers of the air attenuation card are applicable to many situations and may be used unless specific data are available for the individual area. A sample coding of the air attenuation card, is shown in Figure 7.

Shielding Attenuation Card

The 22 card, shielding attenuation card, contains two fields, i.e., Vars (1) and Vars (2). The first field, Vars (1) indicates the geometrics of the shielding. Vars (1) will contain a one if there is a sloped cut, i.e., if the cut makes an obtuse angle with the terrain. If the shielding is vertical Vars (1) should be coded with a two i.e., if the shielding makes a 90° angle with the terrain.

Vars (2) is used to indicate the height of the shielding expressed in feet. The 22 card is omitted from the input deck when there is no shielding, i.e., when the terrain is level with the roadway. If this card is used a 22 must be entered in the appropriate columns, i.e. columns 1-2.

A sample of the shielding attenuation card is shown in Figure 8. This sample card assumes a vertical cut or vertical shielding of twenty feet.

VIRGINIA DEPARTMENT OF HIGHWAYS										PROJECT CHARGE N			
NOISE SIMULATION										Co.	Route	City Co.	Sec
ID Code	VARs (1)	VARs (2)	VARs (3)	VARs (4)	VARs (5)	VARs (6)	VARs (7)	VARs (8)	VARs (9)				
1 2	10-16	17-23	24-30	31-37	38-44	45-51	52-58	59-65	65-72				
Shots	0 2												
XYZ, Coord													
(one card per lane)													
Air	0.0	0.0	-0.3	-0.6	-0.6	-1.2	-2.4	-5.2					
Card Code	First	Second	Third	Fourth	Fifth	Sixth	Seventh	Eighth	Empty				
	Octave Bands												

Figure 7. Sample coding of air attenuation card.

RUN IDENT.		DFD-10		VIRGINIA DEPART.			
3-8		All Cards		NOISE SI			
		ID Code	VARS (1)	VARS (2)	VARS (3)	VARS (4)	
		1 2	10-16	17-23	24-30	31-37	
1 CONTROL		S. Shots	0, 2				
2 GEOMETRICS * Lane Offset (one card per lane)	* Rd. Way	XYZ, Coord	1 1				
			1 1				
			1 1				
	.Obs.		1 2				
			1 3				
			1 3				
			1 3				
			1 3				
			1 3				
			1 3				
			1 3				
			1 3				
	3	Propg.	Air	2 1			
		Shldg.	2 2	2.	20.	0	

Card Code* Type of Cut Height Empty

Cards with entries in VARS fields. be required use another code sheet.

*Note: If this card is used a 22 must be entered by the user in columns 1 and 2. The card code is not preprinted on the coding sheet for this card.

Figure 8. Sample shielding attenuation card.

Vehicle Category Cards

Noise Source Cards

The cards coded 31, the noise source cards, contain ten fields. The first eight fields (Vars 1-8) specify the source-noise spectrum by octave band. The ninth and tenth fields contain the reference distance, in feet, and the reference speed, in mph respectively. The first noise source card defines the noise generated by trucks, while the second defines the noise contribution from cars.

The data shown for the noise source cards are applicable to many situations and may be used if more specific data are not available. It should be noted that NCHRP Report 78 (Figure B14 on page 42) provides data for motorcycles and sports cars if desired. However, if a noise source card is used for either or both a traffic mix estimate must be available.

A sample coding of the noise source card is shown in Figure 9.

Traffic Characteristic Cards

The cards coded 41, the traffic mix cards, specify the percent of trucks and the percent of cars for a given lane. There must be a traffic mix card for each lane. The first traffic mix card should reference the lane closest to the observer. Traffic mix cards should be ordered by lane just as the lane offset cards were.

Traffic mix cards use two fields. The first field specifies the percent of trucks in the lane and the second specifies the percent of cars. The sum of Vars (1) and Vars (2) must equal 100% for each lane.

A sample coding for the traffic mix cards for an eight-lane roadway is shown in Figure 10.

Traffic Volume Card

The card coded 42, the traffic volume card, specifies the volume for the individual lanes. The card uses as many fields as there are lanes of roadway. The first field references the lane closest to the observer. The fields are ordered in the same manner as the lanes. Volumes are given in vehicles per hour. It is generally advisable to use the DHV (Design Hour Volume) since this will simulate the noise levels under the worst possible conditions. Usually the traffic volume projections will indicate the percent of traffic moving in each direction (i. e. 60% eastbound and 40% westbound). However, if the direction is not given the traffic would be assumed to be equally divided between all lanes.

A sample coding for the traffic volume card for an eight-lane roadway is shown in Figure 11.

Traffic Speed Card

The card coded 43, the traffic speed card, specifies the average vehicle speed for the individual lanes of the roadway. The card uses as many fields as there are lanes with the fields being ordered as on the traffic volume card. Speeds are given in miles per hour. Generally it is advisable to use the maximum speed limits since they will simulate the noise levels under the worst possible conditions.

A sample coding for the traffic speed card for an eight-lane roadway is shown in Figure 12.

RUN IDENT.		VIRGINIA DEPART														
3-8		NOISE SI														
All Cards																
		ID Code	VARS (1)			VARS (2)			VARS (3)			VARS (4)				
		1	2		10-16			17-23			24-30			31-37		
1 CONTROL		S.Shots	0	2	/			/			/					
2 GEOMETRICS		* Rd.Way	1	1												
			1	1												
			1	1												
		Obs.	1	2												
			1	3												
			1	3												
			1	3												
			1	3												
			1	3												
			1	3												
3		Propg.	2	1												
		Air Shldg.														
4 VEH.CAT.		* Noise Source Spectrum	3	1												
			3	1												
			3	1												
			3	1												
FFIC CHARACTERISTICS		* Vehicle Type (one card per lane)	4	1	10.0			90.0								
			4	1	2.0			98.0								
			4	1	2.0			98.0								
			4	1	2.0			98.0								
			4	1	2.0			98.0								
			4	1	2.0			98.0								
			4	1	2.0			98.0								
			4	1	2.0			98.0								
			4	1	10.0			90.0								

Card Code →

Percent of Trucks	Percent of Cars	Empty
-------------------	-----------------	-------

Figure 10. Sample traffic characteristics card.

Terminal Control Card

The card coded 01, the run card, is placed at the end of each complete data set. The run card tells the computer to process the data. The only entry on this card will be 01 in column 1 and 2 respectively. All other columns are empty.

Sample Input and Output Data

For the convenience of the reader a sample of the input data coding sheet, using the information from the examples shown in this report, is included as Appendix A. In addition a copy of the computer printout, actually run from the data cards shown in Appendix A, is included as Appendix B of this report.

APPENDIX B

SAMPLE COMPUTER PRINTOUT

HIGHWAY TRAFFIC NOISE SIMULATION

SNAPSHOTS = 21

PATH POINT (X,Y,Z) = -10000. 0. 1380.

PATH POINT (X,Y,Z) = 0. 0. 1380.

PATH POINT (X,Y,Z) = 10000. 0. 1380.

OBS. POINT (X,Y,Z) = 0. 141. 1385.

LANE OFFSET (H,V) = 54. 0.

LANE OFFSET (H,V) = 42. 0.

LANE OFFSET (H,V) = 30. 0.

LANE OFFSET (H,V) = 18. 0.

LANE OFFSET (H,V) = -18. 0.

LANE OFFSET (H,V) = -30. 0.

LANE OFFSET (H,V) = -42. 0.

LANE OFFSET (H,V) = -54. 0.

AIR ATTEN., 63-8000HZ

0.0 0.0 -0.30 -0.60 -0.60 -1.20 -2.40 -5.20

SHIELDING ATTEN., VERTICAL CUT 2

CUT (FT.) = 20.00

VEHICLE CATEGORY 1 SPECTRUM, 63-8000 HZ

78.00 82.00 85.00 80.00 75.00 71.00 65.00 54.00

REF. DIST. (FT) = 50.

REF. SPEED (MPH) = 0.0

VEHICLE CATEGORY 2 SPECTRUM, 63-8000 HZ

68.00 69.00 65.00 63.00 63.00 59.00 50.00 42.00

REF. DIST. (FT) = 50.

REF. SPEED (MPH) = 50.00

MIX FOR LANE 1 10.00 90.00

MIX FOR LANE 2 2.00 98.00

MIX FOR LANE 3 2.00 98.00

MIX FOR LANE 4 2.00 98.00

MIX FOR LANE 5 2.00 98.00

MIX FOR LANE 6 2.00 98.00

MIX FOR LANE 7 2.00 98.00

MIX FOR LANE 8 10.00 90.00

FLOW IN VPH FOR LANES 1- 8

1034.0 1034.0 1034.0 1034.0 1551.0 1551.0 1551.0 1551.0

SPEED IN MPH FOR LANES 1- 8

65.0 65.0 65.0 65.0 65.0 65.0 65.0 65.0

RUN = SAMPLE

APPENDIX B continued

DBA	DBC	BANDS 63 - 8000 HZ							
73.62	80.32	74.86	75.86	71.82	69.78	69.78	65.70	56.54	48.19

VEHICLE POPULATION FOR LANES 1 - 8

1	0.	0.	0.	0.	0.	0.	0.	0.	0.
2	8.	8.	8.	4.	8.	4.	4.	4.	4.

TRAFFIC SPAN (FT) FOR LANES 1 - 8

2692.	2441.	2219.	1350.	806.	513.	707.	423.		
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DBA	DBC	BANDS 63 - 8000 HZ							
73.92	80.63	75.03	76.10	72.56	70.20	69.99	65.90	56.83	48.38

VEHICLE POPULATION FOR LANES 1 - 8

1	0.	0.	0.	0.	0.	0.	0.	1.	0.
2	8.	8.	8.	8.	8.	4.	4.	3.	3.

TRAFFIC SPAN (FT) FOR LANES 1 - 8

3806.	2427.	1966.	1418.	1595.	816.	925.	744.		
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DBA	DBC	BANDS 63 - 8000 HZ							
75.88	82.39	75.79	77.38	76.39	72.69	71.04	66.94	58.58	49.29

VEHICLE POPULATION FOR LANES 1 - 8

1	0.	1.	0.	0.	0.	0.	1.	0.	0.
2	12.	11.	8.	12.	12.	3.	7.	4.	4.

TRAFFIC SPAN (FT) FOR LANES 1 - 8

3119.	1716.	2106.	2563.	2032.	638.	1324.	408.		
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DBA	DBC	BANDS 63 - 5000 HZ							
74.14	80.85	75.35	76.37	72.50	70.34	70.27	66.18	57.03	48.61

VEHICLE POPULATION FOR LANES 1 - 8

1	0.	0.	1.	0.	0.	0.	0.	0.	0.
2	8.	12.	7.	8.	8.	4.	8.	4.	4.

TRAFFIC SPAN (FT) FOR LANES 1 - 8

3594.	3186.	2843.	2328.	1116.	542.	522.	277.		
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DBA	DBC	BANDS 63 - 2000 HZ							
74.37	81.09	75.41	76.52	73.27	70.73	70.38	66.28	57.23	48.63

VEHICLE POPULATION FOR LANES 1 - 8

1	4.	0.	0.	0.	0.	0.	0.	0.	0.
2	12.	8.	8.	8.	8.	4.	8.	4.	4.

TRAFFIC SPAN (FT) FOR LANES 1 - 8

4989.	2834.	2104.	3125.	989.	562.	1729.	1040.		
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DBA	DBC	BANDS 63 - 8000 HZ							
78.50	85.17	76.98	79.50	80.75	76.23	72.88	68.83	61.60	51.47

VEHICLE POPULATION FOR LANES 1 - 8

1	2.	0.	0.	0.	1.	0.	0.	0.	0.
2	6.	8.	4.	4.	3.	4.	4.	4.	4.

TRAFFIC SPAN (FT) FOR LANES 1 - 8

1561.	834.	834.	1148.	463.	908.	121.	2035.		
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DBA	DBC	BANDS 63 - 8000 HZ							
73.61	80.32	74.82	75.85	71.98	69.81	69.74	65.64	56.48	48.95

VEHICLE POPULATION FOR LANES 1 - 8

1	2.	0.	0.	0.	0.	0.	0.	0.	0.
2	10.	8.	8.	8.	8.	4.	8.	3.	3.

TRAFFIC SPAN (FT) FOR LANES 1 - 8

4327.	3810.	1811.	3398.	816.	891.	1431.	1430.		
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DBA DBC BANDS 63 - 8000 HZ
 75.05 81.77 75.15 76.76 75.80 72.03 70.41 66.30 57.31 48.62

VEHICLE POPULATION FOR LANES 1 - 8
 3. 0. 1. 0. 0. 0. 0. 2.
 13. 8. 7. 2. 3. 8. 8. 5.

TRAFFIC SPAN (FT) FOR LANES 1 - 8
 5075. 1357. 2416. 2571. 1124. 1254. 1284. 2176.

DBA DBC BANDS 63 - 8000 HZ
 79.19 85.86 77.45 80.11 81.60 76.99 73.45 69.40 62.31 52.08

VEHICLE POPULATION FOR LANES 1 - 8
 3. 0. 0. 0. 0. 0. 0. 0.
 9. 4. 4. 4. 4. 4. 4. 4.

TRAFFIC SPAN (FT) FOR LANES 1 - 8
 3174. 524. 2506. 1206. 532. 820. 705. 1099.

DBA DBC BANDS 63 - 8000 HZ
 77.46 84.15 77.45 79.09 78.23 74.52 72.76 68.68 60.41 51.15

VEHICLE POPULATION FOR LANES 1 - 8
 0. 0. 0. 0. 0. 0. 0. 3.
 16. 3. 4. 3. 8. 4. 4. 5.

TRAFFIC SPAN (FT) FOR LANES 1 - 8
 2874. 1049. 1238. 2615. 919. 315. 437. 1674.

DBA DBC BANDS 63 - 8000 HZ
 74.55 81.26 74.63 76.24 75.30 71.52 69.90 65.80 57.43 48.20

VEHICLE POPULATION FOR LANES 1 - 8
 0. 0. 0. 0. 1. 0. 0. 1.
 8. 3. 3. 4. 7. 4. 4. 7.

TRAFFIC SPAN (FT) FOR LANES 1 - 8
 2528. 3357. 1514. 1838. 2086. 1311. 707. 1077.

DBA DBC BANDS 63 - 8000 HZ
 71.71 78.44 73.00 74.00 69.94 67.83 67.88 63.75 54.52 46.00

VEHICLE POPULATION FOR LANES 1 - 8
 0. 0. 0. 0. 0. 0. 0. 0.
 8. 2. 8. 4. 8. 8. 8. 3.

TRAFFIC SPAN (FT) FOR LANES 1 - 8
 3196. 3737. 3033. 2209. 1973. 1929. 925. 1120.

DBA DBC BANDS 63 - 8000 HZ
 73.66 80.36 74.90 75.90 71.85 69.82 69.82 65.73 56.55 48.19

VEHICLE POPULATION FOR LANES 1 - 8
 0. 0. 0. 0. 0. 0. 0. 0.
 8. 8. 8. 8. 3. 3. 3. 4.

TRAFFIC SPAN (FT) FOR LANES 1 - 8
 3094. 2414. 2638. 2395. 1481. 1604. 1647. 448.

DBA DBC BANDS 63 - 8000 HZ
 75.05 81.74 76.25 77.27 73.28 71.21 71.20 67.13 58.00 49.69

VEHICLE POPULATION FOR LANES 1 - 8
 1. 0. 0. 0. 0. 0. 0. 0.
 7. 3. 6. 4. 3. 4. 4. 4.

TRAFFIC SPAN (FT) FOR LANES 1 - 8
 5002. 2335. 1633. 1274. 806. 601. 367. 546.

APPENDIX B continued

.....									
DBA	DBC		BANDS 63 - 8000 HZ						
77.37	84.06	76.50	78.64	79.16	74.86	72.13	68.05	60.36	50.52
VEHICLE POPULATION FOR LANES 1 - 8									
1	1.	1.	0.	0.	1.	0.	0.	0.	0.
2	11.	7.	4.	8.	7.	4.	4.	4.	4.
TRAFFIC SPAN (FT) FOR LANES 1 - 8									
1771.	2844.	2591.	1502.	718.	322.	170.	631.		
.....									
DBA	DBC		BANDS 63 - 8000 HZ						
74.07	80.78	75.15	76.24	72.83	70.39	70.11	66.02	56.95	48.46
VEHICLE POPULATION FOR LANES 1 - 8									
1	2.	0.	0.	0.	0.	0.	0.	0.	0.
2	10.	8.	8.	8.	4.	4.	4.	4.	4.
TRAFFIC SPAN (FT) FOR LANES 1 - 8									
3409.	2464.	1397.	3167.	946.	483.	550.	468.		
.....									
DBA	DBC		BANDS 63 - 8000 HZ						
75.12	81.84	75.33	76.38	75.71	72.08	70.55	66.45	57.99	48.77
VEHICLE POPULATION FOR LANES 1 - 8									
1	0.	0.	0.	0.	2.	0.	0.	1.	1.
2	8.	8.	8.	8.	10.	4.	4.	7.	7.
TRAFFIC SPAN (FT) FOR LANES 1 - 8									
2354.	2920.	2231.	1670.	1681.	496.	380.	1373.		
.....									
DBA	DBC		BANDS 63 - 8000 HZ						
74.86	81.57	75.57	76.85	74.52	71.47	70.64	66.55	57.73	48.96
VEHICLE POPULATION FOR LANES 1 - 8									
1	1.	0.	0.	0.	0.	0.	1.	1.	1.
2	11.	8.	8.	8.	4.	4.	7.	7.	7.
TRAFFIC SPAN (FT) FOR LANES 1 - 8									
2473.	1610.	2077.	3384.	640.	1024.	1461.	1527.		
.....									
DBA	DBC		BANDS 63 - 8000 HZ						
73.97	80.67	75.20	76.21	72.22	70.14	70.12	66.04	56.88	48.51
VEHICLE POPULATION FOR LANES 1 - 8									
1	0.	0.	0.	0.	0.	0.	0.	1.	1.
2	8.	8.	8.	4.	8.	3.	8.	3.	3.
TRAFFIC SPAN (FT) FOR LANES 1 - 8									
1878.	1882.	3208.	1142.	1136.	1615.	680.	1738.		
.....									
DBA	DBC		BANDS 63 - 8000 HZ						
74.32	81.04	75.15	76.37	73.74	70.86	70.18	65.09	57.20	48.45
VEHICLE POPULATION FOR LANES 1 - 8									
1	1.	0.	0.	0.	0.	0.	0.	0.	0.
2	15.	8.	8.	8.	8.	8.	4.	4.	4.
TRAFFIC SPAN (FT) FOR LANES 1 - 8									
2968.	2986.	2311.	2034.	1298.	1217.	1157.	336.		
.....									
DBA	DBC		BANDS 63 - 8000 HZ						
74.25	80.96	75.39	76.45	72.81	70.51	70.34	65.25	57.14	48.70
VEHICLE POPULATION FOR LANES 1 - 8									
1	0.	0.	0.	1.	0.	0.	0.	1.	1.
2	8.	8.	8.	7.	8.	8.	4.	7.	7.
TRAFFIC SPAN (FT) FOR LANES 1 - 8									
1927.	3428.	1595.	1808.	1873.	1755.	605.	1009.		

EAN= 67.34 74.05

EV= 1.79 1.77

IN= 64.07 70.81

AX= 71.56 78.22

EAN SPECTRUM FOR SNAPSHOTS

75.5 76.9 74.6 71.6 70.6 66.6 57.9 49.0

DISTRIBUTION OF SNAPSHOT DBA VALUES

4	1	4.76
5	2	9.52
6	9	42.86
7	4	19.05
8	1	4.76
9	2	9.52
0	1	4.76
1	1	4.76
2	0	0.0