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Users Manual for the Highway Geometric Design Consistency Program (Metric Units)

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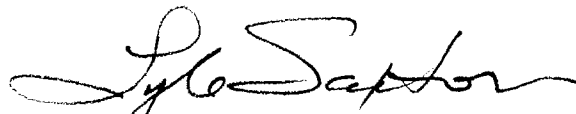
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FOREWORD

U.S. policy for designing rural horizontal alignments relies on the selection and application of design speeds to achieve consistency. However, since drivers typically select their speeds on long tangents oblivious to the design speeds on downstream horizontal curves, large speed reductions approaching and entering curves - and curve operating speeds in excess of curve design speeds - can result when the designer or design policy underestimates or disregards driver speed preferences. The resulting operating speed inconsistencies are believed to be a common cause of curve-related accidents.

Research documented in Report No. FHWA-RD-94-034 confirms that accident rates are higher at horizontal curves that experience greater tangent-to-curve speed reductions. Models and related computer software were developed in that research to assist engineers in plotting expected profiles of operating speed and driver workload as a function of horizontal alignment. This report is the user's manual for the metric-units version of that software. Report No. FHWA-RD-94-038 is a comparable manual for the English-units version.

This study was the first in a new series involving design consistency. The models developed in this and subsequent related efforts will undergo additional validation testing and will then be incorporated into the Design Consistency Module of the Interactive Highway Safety Design Model (IHSDM). The IHSDM will consist of a series of interactive computer programs enabling roadway designers and design reviewers to assess the potential safety effects of specific geometric design decisions. A conceptual plan for the development of the IHSDM was recently published as Report No. FHWA-RD-93-122.



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16. Abstract <p>The Highway Geometric Design Consistency (HGDC) program is a menu-driven microcomputer-based procedure for evaluating the geometric design consistency of rural two-lane highways in level or rolling terrain. The program estimates two measures of horizontal alignment design consistency: the decrease in 85th percentile operating speed, and the increase in driver workload, from an approach tangent to a horizontal curve. These consistency measures are estimated based on models developed under the subject contract and documented in Publication No. FHWA-RD-94-034, entitled "Horizontal Alignment Design Consistency for Rural Two-Lane Highways."</p> <p>This report is the users manual for metric-units version of the HGDC program. (There is a separate English-units version of the program.) This manual describes the capabilities and input data requirements of the program. It also describes the mechanics of using this menu-driven program, including the meaning of each option on the program menus.</p>					
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INTRODUCTION

This report is the users manual for the metric version of the Highway Geometric Design Consistency program (hereafter referred to simply as HGDC). Its purpose is to: (1) describe the program so that potential users can determine its applicability, and (2) provide users with all the information necessary to operate and use the system efficiently and effectively.

HGDC evaluates rural two-lane highway horizontal alignments using geometric design consistency models documented in a separate report.⁽¹⁾ Two measures of horizontal alignment design consistency are estimated: the decrease in 85th percentile operating speed, and the increase in driver workload, from an approach tangent to a horizontal curve. The speed model applies to alignments with horizontal curve radii greater than 58 m and vertical grades up to 5 percent. The workload model applies to horizontal curve radii greater than 145 m.

HGDC was developed for use by geometric design professionals to obtain measures of consistency for rural two-lane highways in level or rolling terrain. This is the first computer program known to be developed for this purpose. The scope of the current version is limited to the evaluation of rural two-lane highway horizontal alignments consisting of circular curves and tangents. There is no explicit treatment of transition curves in this version. The user may notice that the menu screens were designed with the capacity to be expanded; future versions may permit the evaluation of other geometric features (e.g., vertical alignment, changes in cross section, and intersections). Further enhancements to the software could include interfacing with highway design packages in order to access directly the data required for design consistency evaluation.

INPUT DATA REQUIREMENTS

The following horizontal alignment information is required as input to the HGDC (metric) program, in order to estimate both measures of geometric design consistency:

- Stationing of point of curvature and point of tangency for each horizontal curve.
- Radius of curve for each horizontal curve.
- Station equations.

It should be noted that there is a separate English-units version of HGDC. The English version requires degree of curvature instead of radius as input.

OUTPUT

HGDC provides estimates of both measures of consistency: operating speed and driver workload. For both measures, two types of output are available: tabular and graphical. The tabular output summarizes the decrease in 85th percentile speed and increase in driver workload associated with each horizontal curve. The graphical output depicts: (1) the hori-

zontal alignment using a bar chart representing the radius, and (2) a profile of either 85th percentile speed or driver workload along the alignment.

MECHANICS OF USING THE HGDC PROGRAM

HGDC is a menu-driven interactive program designed to work on DOS-based microcomputers. The menu provides procedures for file operations including creating and editing input and output files, printing files, and deleting files. The menu also provides on-line help and utilities for executing DOS commands while running HGDC. Graphical output can be viewed on the console using the interactive menu.

HGDC can be run on IBM-compatible, DOS-based microcomputers with a minimum of 270K RAM. All files required to run the program are provided on one floppy disk. The following are the files on the HGDC system disk:

- HGDC.EXE - Executable HGDC program.
- HGDC.MSG - Contains screen information.
- HGDC.HLP - Contains information for on-line help.
- TRIP.CHR - Contains font information for graphics.
- LITT.CHR - Contains font information for graphics.

HGDC is initiated by typing "HGDC" at the DOS prompt. The introductory screen is shown in figure 1 below.

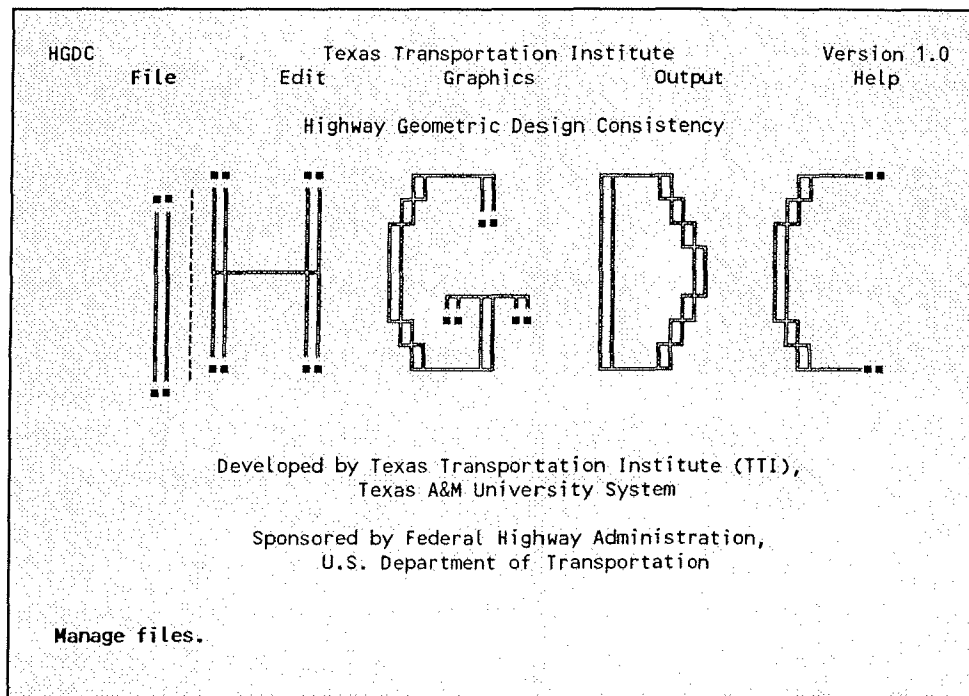


Figure 1. The introductory screen in HGDC.

Menu options can be selected using the arrow keys on the keyboard or a mouse. A brief description of the function of each menu option is displayed on the last line of the screen when a particular menu option is highlighted. Most functions available through the menu are also available through the use of function keys. The key corresponding to a particular function is displayed on the menu. This information is also available through the "Help" option.

In the following sections, options on the menu are described in detail. The options include:

- File
- Edit
- Graphics
- Output
- Help

File

Figure 2 shows the pop-up menu that appears when the File option of the main menu is selected. The pop-up menu contains 9 options as shown in the figure. Each option is explained below:

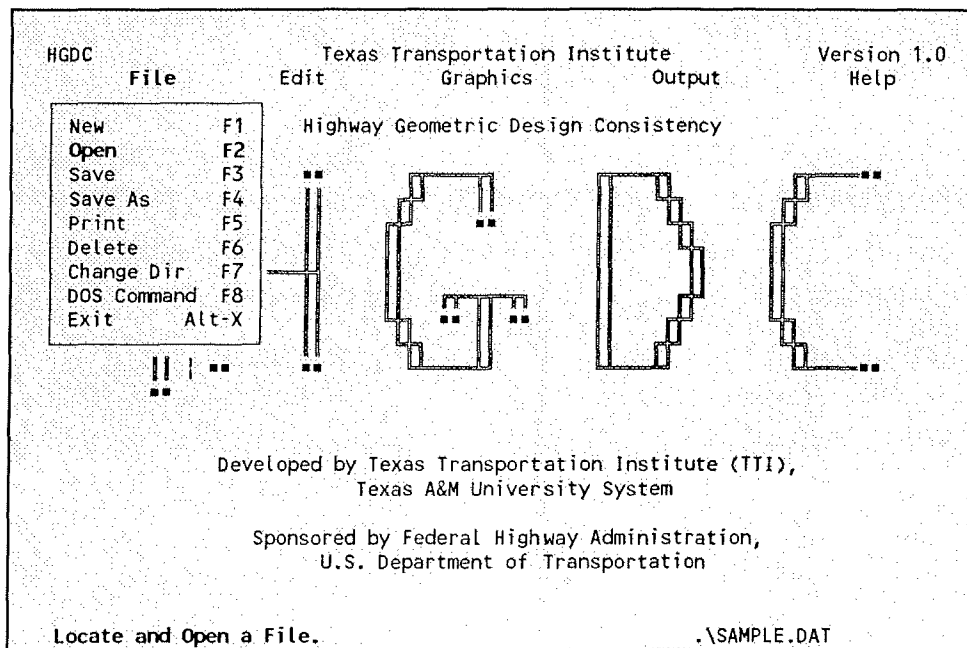


Figure 2. Functions available under the file option.

- New* This option prompts for a new file name and then creates a blank file and activates the alignment data entry screen.
- Open* This option opens an existing file for editing or viewing the output. When this option is selected, another menu appears with the names of all files existing in the current directory with a ".DAT" extension. After a file is selected, the alignment data entry screen is automatically activated.
- Save* This option saves the currently open file on disk.
- Save As* This option saves the currently open file under a new name. If the new file entered by the user already exists, the program overwrites the file after confirmation by the user.
- Print* This option prints any text file including the input and output files. When this option is selected, the program prompts for a file name to print. The file is printed to the parallel port LPT1 only. If the printer is connected to a serial port, LPT1 should be appropriately rerouted. An error message is displayed if the print request cannot be fulfilled.
- Delete* This option deletes HGDC data and output files from the disk. When selected, a submenu pops up with the list of ".DAT" and ".OUT" files. The files to be deleted can be selected by using the arrow keys or mouse.
- Change Dir* This option is used to change the current working directory. Data and output files are saved in the current working directory.
- DOS Command* This option allows the execution of a DOS command from within the program. The program prompts for a command to be executed. After executing the command the control returns to HGDC.
- Exit* This option terminates HGDC. Before termination the program checks whether the current file is saved. If the current file was edited and not saved, the menu prompts the user to determine if it should be saved.

Edit

Currently, the Edit function contains only the alignment data entry option. (There is capacity to accommodate additional options if the scope of the program is expanded.) The alignment data entry screen is shown in figure 3. The same screen appears for editing an existing input file or entering data into a new input file. The program checks the validity of the data as it is entered or modified.

HGDC		Texas Transportation Institute				Version 1.0	
File		Edit		Graphics		Output	
				ALIGNMENT DATA			
Curve No	PC Station	PT Station	Station Equation	Radius (m)	85 %-ile Speed (km/h)	Driver Workload	
1	0.00	350.00		145.00	73.59	0.39	
2	900.00	1+200.00		75.00	46.03	0.57	
3	2+000.00	2+700.00		100.00	42.64	0.48	
4	3+200.00	4+200.00		200.00	71.68	0.34	
5	4+500.00	5+700.00		400.00	92.61	0.26	
6	6+700.00	7+300.00		250.00	84.68	0.31	
7	7+700.00	8+300.00		100.00	47.23	0.48	
8	9+000.00	9+200.00		140.00	76.81	0.40	
9	9+500.00	9+800.00		75.00	46.03	0.57	
10							
11							
12							
13							
14							
15							

F1:Ins Rec F2:Del Rec Esc:Exit

Edit current data. .\SAMPLE.DAT

Figure 3. The alignment data entry screen.

Either a mouse or the keyboard can be used to move around the screen. The functions of the cursor movement keys on the keyboard are described below:

- Left and right arrow keys - move the cursor to the adjacent column horizontally, within a field (or line of data). When the cursor is on the first or last column in a field, the appropriate arrow key moves the cursor to the adjacent field.
- Up and down arrow keys - move the cursor vertically, keeping it in the same column.
- Tab and Shift-Tab keys - move the cursor to the next and previous fields, respectively.
- Esc key - moves control to the main menu at any time.

Special keys, as displayed at the bottom of the screen, allow the user to insert and delete records. It should be noted that only one blank line can be inserted. To insert more lines the existing blank line should be filled or deleted. The station values are displayed with a "+" at the thousands position according to the metric-units convention. The program computes and reports the driver workload and 85th percentile operating speed on the curve automatically after the data are entered or modified and the cursor moved to the next line. The workload and operating speed values cannot be directly modified by the user. When the data entry or modification is complete, the Edit function can be terminated by pressing the

Esc key. Upon exiting the Edit function, the program automatically determines whether changes were made and computes values for plotting graphs.

Graphics

HGDC generates graphical output for both the operating speed and driver workload measures of consistency. The graphical output of operating speeds depicts the profile of 85th percentile speeds along the length of the highway. The screen is divided into two parts: (1) the upper portion displays a bar chart depicting the radius of curve, and (2) the lower portion depicts the corresponding profile of estimated 85th percentile speeds. An example operating speed profile is shown in figure 4.

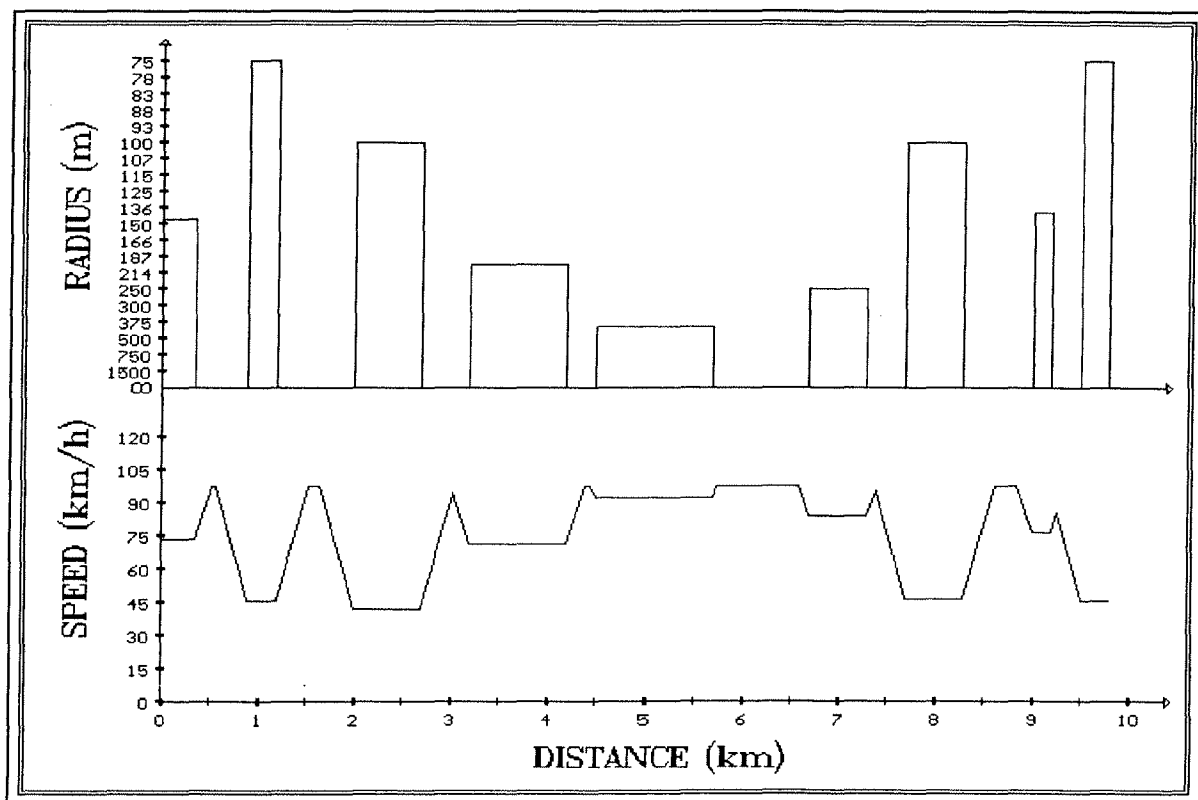


Figure 4. Operating speed profile.

The graphical output for driver workload also includes two parts. The upper portion is a bar chart depicting the sharpness of the curves along the highway. The lower portion illustrates the increase in workload on each curve.

It should be noted that the values displayed on the vertical axis of the upper portion of the graph correspond to the curve radius, while the bars represent the sharpness of the curve. The sharpness of a curve is inversely proportional to its radius. Hence, the bars for the shorter radii are longer. It should also be noted that the vertical axis is not linear. The curve

radius is shown on the vertical axis instead of a value representative of the sharpness, because it is easier to perceive and identify curves based on radius than some measure of sharpness.

The graphs are displayed on the computer monitor. A print-screen or a screen-capture utility can be used to print a hard copy of the graph.

When the graphics option is selected, a pop-up menu appears for the user to select between the operating speed and driver workload outputs. The appropriate graph is displayed on the screen when the user selects one of these two options.

When one of the two options for a graphics display is selected, a submenu (figure 5) appears prompting for a starting and ending record. This submenu enables the user to specify a portion of the alignment to be viewed on the screen instead of viewing the entire alignment, which is the default. The starting and ending records are the numbers of the first and the last curve elements to be plotted. Specifying these records enables the user to scale the graphics output. The portion of the roadway between and including the specified curves is displayed on the screen. This submenu also allows the user to indicate if a grid should be displayed. The grid may make it easier for some users to read values from the graph.

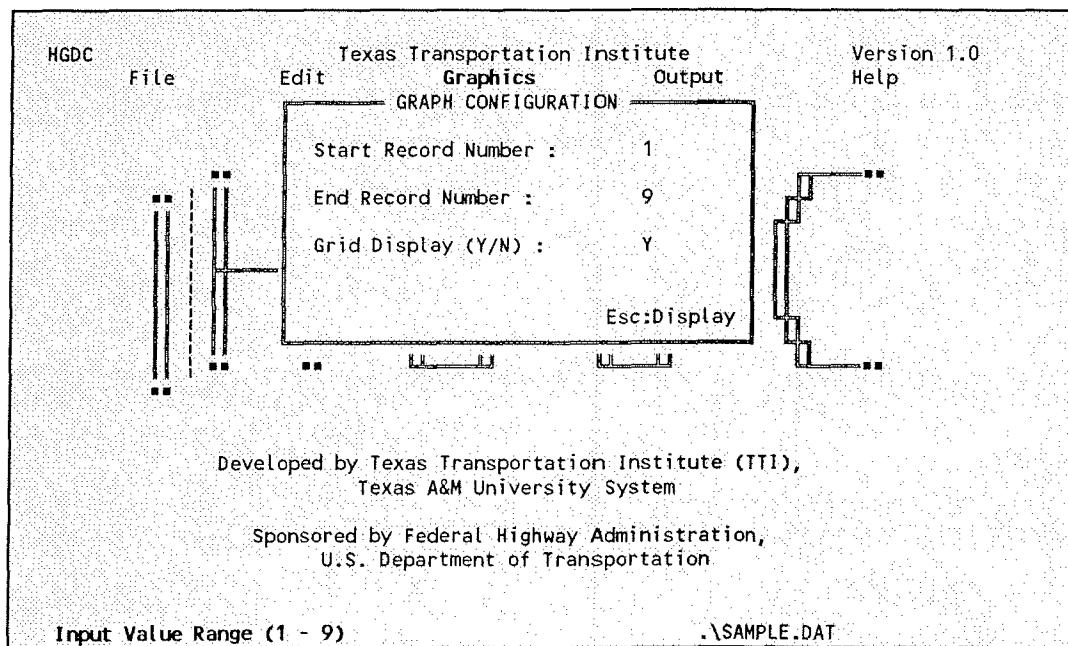


Figure 5. Graphics submenu to display segments of the alignment.

Output

The output function of the main menu is used to view the tabular output generated by HGDC. The output display screen is shown in figure 6. The output function also provides other functions, as can be seen from figure 6, that allow the user to traverse through the output file using keyboard or mouse. These functions are self explanatory.

Curve No	PC Station	Radius (m)	85 %-ile Speed Reduction (km/h)	Workload Increase
1	0.00	145.00	0.00	0.21
2	900.00	75.00	51.80	0.39
3	2+000.00	100.00	55.19	0.30
4	3+200.00	200.00	23.23	0.16
5	4+500.00	400.00	5.22	0.08
6	6+700.00	250.00	13.15	0.13
7	7+700.00	100.00	48.29	0.30
8	9+000.00	140.00	21.02	0.22
9	9+500.00	75.00	39.57	0.39

Figure 6. Consistency measures in tabular format.

Help

The Help function provides general information about HGDC and the functions performed by various keys and combinations of keys. Figure 7 shows the options available under the Help function.

Getting Started This option provides a brief description of HGDC for a new user.

HGDC Files This option provides a list of files required to use HGDC.

Menus & Keys This option provides a list of all the special keys used in HGDC and their functions. These keys may be used instead of the menus.

Rights This option provides general information about the program.

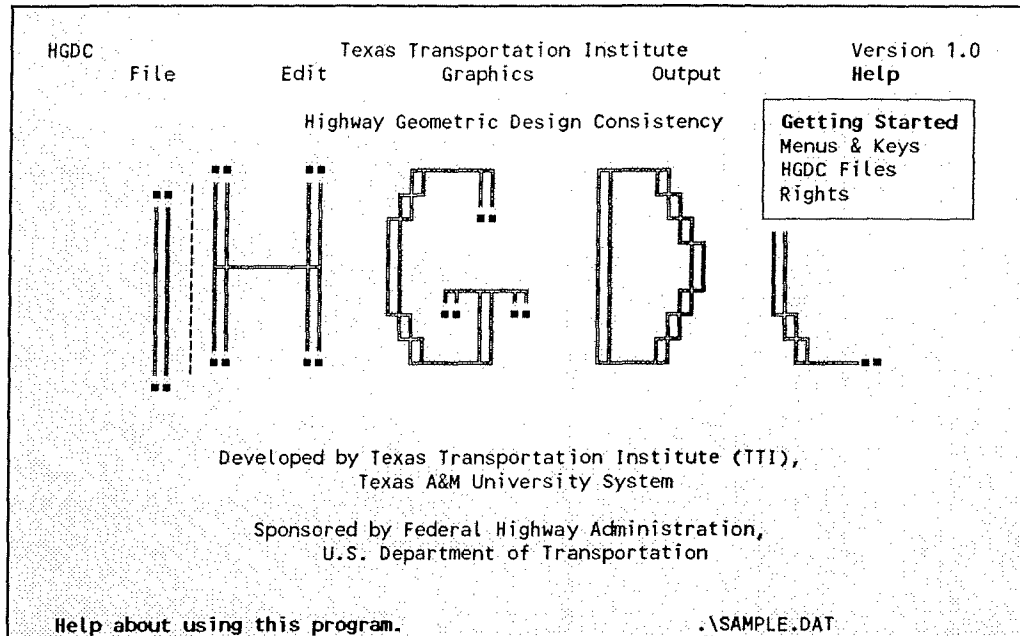


Figure 7. Options available under help.

REFERENCE

1. R. A. Krammes, R.Q. Brackett, M.A. Shafer, J.L. Ottesen, I.B. Anderson, K.L. Fink, K.M. Collins, O.J. Pendleton, C.J. Messer, "Horizontal Alignment Design Consistency for Rural Two-Lane Highways," Publication No. FHWA-RD-94-034, Federal Highway Administration, Washington, DC, 1994.

