NCHRP PROJECT 3-55(3)
CAPACITY AND QUALITY OF SERVICE
OF TWO-LANE HIGHWAYS

TASK 6

ENHANCE, CALIBRATE, AND VALIDATE
THE SELECTED SIMULATION MODEL

TWOPAS MODEL IMPROVEMENTS

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1. INTRODUCTION

The proposal for the NCHRP 3-55(3) project "Capacity and Quality of Service of Two-Lane Highways" was submitted in May 1995 and the contract was awarded to MRI in the early fall of 1995. A working plan was submitted in October 1995 and work on the project began immediately.

The project was divided into eight major tasks with the first four tasks being designated as Phase I and the last four tasks being designated as Phase II. The eight major tasks were:

- Task 1 Identify Capabilities and Deficiencies of Existing Methods
- Task 2 Develop an Improved Conceptual Framework for Capacity and Level of Service Analysis
- Task 3 Select a Suitable Simulation Model and Identify Desirable Functional Improvements
- Task 4 Prepare Interim Report
- Task 5 Collect and Analyze Data
- Task 6 Enhance, Calibrate, and Validate the Selected Simulation Model
- Task 7 Develop Revised Capacity and Quality of Service Analysis Procedures for Two-Lane Highways
- Task 8 Prepare Final Report

This report deals with Task 6 "Enhance, Calibrate, and Validate the Selected Simulation Model". The objective is to report accomplishments on TWOPAS model code upgrading and documentation and to document all TWOPAS model improvements.

The selected simulation model is expected to play a major role in complementing field study results in the development of revised capacity and quality of service procedures for two-lane highways in the HCM2000. The two-lane highway procedures contained in the HCM1985 and HCM1994 were developed exclusively using a simulation model.

The reasons for the use of a simulation model in the development of two-lane highway capacity and level of service analysis procedures are:

- Collection of field data to address all combinations of geometric, traffic control, driver, and vehicle variables of interest would be prohibitively expensive;
- Simulation models can be used to perform experiments that would be impossible in the

field, such as changing geometric variables while holding driver and vehicle factors constant; and

- In a simulation model it is possible to run exactly the same sequence of drivers and vehicles through two or more geometric alternatives and obtain a comparison which could never be performed in the field.

Task 6 has been divided into eight primary subtasks which include:

SubTask 6A	Identify and Prioritize Functional Model Improvements
SubTask 6B	Upgrade TWOPAS Model Code and Documentation
SubTask 6C	Incorporate the Highest Priority Functional Improvements
SubTask 6D	Test and Revise Individual Improvements to the Simulation Model and the Enhanced Model as a Whole
SubTask 6E	Calibrate Individual Components of the Simulation Model and the Enhanced Model as Whole
SubTask 6F	Validate and Check Reliability of the Enhanced Simulation Model
SubTask 6G	Apply the Enhanced Simulation Model to Supplement the Available Field Data
SubTask 6H	Supplementary Simulation Enhancements if Additional Funds are Available

The remaining portion of this interim report is divided into five chapters. Chapter 2 highlights the results of the four major tasks in Phase I of the project with particular emphasis on their impacts on Task 6. Chapters 3 and 4 describe the status of work on Subtasks 6A and 6B respectively. The final chapter, Chapter 5, documents all improvements made to the model during Subtasks 6C and 6D.

2. IMPACT OF PHASE I TASKS ON TASK 6

Prior to beginning work on Task 6, the four initial tasks of the project's Phase I were completed. Work on these four initial tasks provided a starting point for commencing work on Task 6 and gave direction to the effort.

The results of Task 1 "Identify Capabilities and Deficiencies of Existing Methods" was reported in the Project's Position Paper 1 prepared in March 1996. While specific reference to simulation models was not included, preliminary recommendations concerning the HCM2000 chapter 8 were made which provides some guidance as to the requirements of the simulation model. For example, candidate service measures included percent time delay, average travel speed, and delay rate, and the simulation model should provide these service measures as part of its output. It was also recognized that the scope of the chapter should consider the inclusion of the effects of: directional splits, percent no-passing zones, lane width and lateral clearance factors, heavy vehicle factors, specific grades, planning applications, passing and climbing lanes, driveway/roadside development, design speed, upgrading from two to four lanes, intersections, slow-vehicle turnouts, wide cross section to encourage shoulder driving, LOS by direction of travel, driver type factors, effects of pedestrians and bicycles, and economic analyses.

The results of Task 2 "Develop an Improved Conceptual Framework for Capacity and Level of Service Analysis" was reported in the Project's Position Paper 2 prepared in April 1996. It was proposed that a revised HCM Chapter 8 should contain procedures that are simple enough to be presented in a manual worksheet. At the same time reference is made to the planned simulation model availability for HCM users as a tool for problems that are too complex for the simple analytical procedures.

The results of Task 3 "Select a Suitable Simulation Model and Identify Desirable Functional Improvements was reported in the Project's Position Paper 3 prepared in March 1996. Based upon a comparative evaluation of the TWOPAS and TRARR simulation models, the TWOPAS simulation model was recommended for use on this project. Because of the extensiveness of the TWOPAS program code, the need for updating the program code, and the limited program documentation, it was recommended that this updating and documentation be undertaken in the early portion of Task 6. All available documentation for the TWOPAS was assembled and organized for later work on Task 6.

Task 4 was the preparation of an Interim Report which was prepared in May 1996 and covered all four tasks of the Project's Phase I effort. The Interim Report provided a summary of work completed on the first three tasks and recommended a plan for Phase II. Upgrading and documenting the program code and simulation model improvements were recommended and the work within Task 6 was defined in greater detail.

3. ESTABLISHING PRIORITIES FOR TWOPAS MODEL IMPROVEMENTS

The initial identification and prioritization of desired functional improvements in the TWOPAS model were first identified in the Project's Position Paper 3 and in the May 1996 Interim Report (Tables 36, 37, and 38). Seventy-Four (74) desired improvements to the TWOPAS model were identified which included the addition of new capabilities, improvements to existing model features, updating to incorporate changes in driver and vehicle characteristics, and interface improvements.

The candidate TWOPAS model improvements were arranged in three priority levels.

Priority 1 contained thirty-one (31) candidate model improvements that should definitely be made as part of Phase II. Priority 2 contained thirty-three (33) candidate model improvements that should be made in Phase II if time and funds permitted. Priority 3 contained ten (10) model improvements that would be desirable to be undertaken but are not recommended because of lower importance and/or lack of time and funds. In addition, an estimate of the person-weeks required, an importance priority, and a priority score was estimated for each candidate improvement.

During the following six months, with advice from the NCHRP Panel and additional efforts by the project team, candidate improvements were modified/added/deleted, estimates of person-weeks of effort/priority score were revised, and some candidate improvements were changed from one priority category to another. These modifications are covered in the June 1996 Panel Meeting minutes and in the September 1996, December 1996, and March 1997 Quarterly Reports.

Attention has been focused on the candidate improvements which had been placed in the priority one category. When this set of priority one improvements near completion, priority two and three candidate improvements will be revisited with the constraint of available funds and time.

A revised list of priority one candidate improvements was established and divided for guidance purposes into those improvements which would be expected to receive immediate attention (priority 1A) and those which would be expected to receive attention thereafter priority 1B). The priority one candidate improvements were also subdivided into two groups: those improvements for which MRI would take a leadership role and those for which UCB would take a leadership role. This revised list of priority one candidate improvements was the starting point for actual TWOPAS model improvements and is included in this report as Tables 3:1 and 3:2. It was estimated that the completion of priority one improvements would require approximately 15 to 16 person-months of effort through the combined MRI and UCB efforts.

TABLE 3:1 REVISED LIST OF PRIORITY 1A IMPROVEMENTS

CODE	PRIORITY	CANDIDATE MODEL IMPROVEMENT	LEADER	UCB TIME	MRI TIME	TOT TIME
D2-1	1A	Add Selected Range Checks	UCB	1.5	0.2	1.7
D3	1A	Increase Array Dimensions	UCB	0.6	0.0	0.6
E4	1A	RV Speed/Percent Following Problem	UCB	1.5	1.0	2.5
E10	1A	Correct Number of Passes Error	UCB	1.5	1.0	2.5
F2-1	1A	Minor Improvement to TWOSUM Output	UCB	0.5	0.0	0.5
G3	1A	Update Speed on Curves	UCB	1.5	1.5	3.0
H1	1A	Input Zone Data Approach	UCB	2.5	0.2	2.7
H4	1A	Passing Rate Profile Graph	UCB	0.6	0.0	0.6
H7	1A	Add Input Interface Variables	UCB	2.0	0.0	2.0
H8	1A	Vary Random Number Seeds	UCB	0.6	0.0	0.6
H10	1A	Coordinate Directional Coordinates	UCB	0.6	0.0	0.6
I1	1A	Additional Output Information on Graphs	UCB	0.6	0.0	0.6
J3	1A	Print Files from Interface	UCB	0.6	0.0	0.6
B1	1A	Narrow Lanes and Shoulder Effects	MRI	2.0	4.0	6.0
B4-1 *	1A	Add Intersections	MRI	6.0	8.0	14.0

* Researched but not implemented in the TWOPAS model

TABLE 3:2 REVISED LIST OF PRIORITY 1B IMPROVEMENTS

CODE	PRIORITY	CANDIDATE MODEL IMPROVEMENT	LEADER	UCB TIME	MRI TIME	TOT TIME
A1 *	1B	Input/Save Traffic Streams	UCB	1.0	0.2	1.2
B9	1B	Reduced Speed Zone Effects	UCB	3.0	0.0	3.0
E3	1B	Speed Standard Deviation by Vehicle Type	UCB	1.5	0.0	1.5
H5	1B	Automatic Sight Distance Calculation	UCB	3.5	0.5	4.0
H6	1B	Automatic Passing Zone Calculation	UCB	0.8	0.2	1.0
K5	1B	Update On-Line Help Screen	UCB	1.0	0.0	1.0
A2 *	1B	CAD Input Geometrics	MRI	2.0	2.0	4.0
C1 *	1B	Output to Other Software	MRI	0.5	0.5	1.0
E7-1 *	1B	Study Car-Following/Passing	MRI	0.5	2.5	3.0
E9-1 *	1B	Study Opposing Lane Passing Maneuvers	MRI	0.3	1.7	2.0
G1-1	1B	Study Speed/Acceleration Capabilities	MRI	1.0	2.5	3.5
G5-1 *	1B	Study Car-Following	MRI	0.5	2.0	2.5
G7-1 *	1B	Study Speed/Acceleration in Passing	MRI	0.3	1.2	1.5

***** Improvement not completed

4. UPGRADING TWOPAS MODEL CODE AND DOCUMENTATION

The requirements for upgrading the TWOPAS model coding and documenting the program was first recognized in the summary of recommendations contained in Position Paper 3 "Selection of a Suitable Simulation Model and Identification of Desirable Functional Improvements" in March 1996. It was recommended that the enhancements to the TWOPAS model be preceded by upgrading the source code of the program. The project's first Interim Report (May 1996) recommended that the first priority in Task 6 be given to modernizing the source code.

An initial plan was developed for the upgrading of the TWOPAS code in early July 1996. The ninety-nine (99) subroutines in the TWOPAS program were identified and twenty-three (23) subroutines to be upgraded were selected based upon the clarity of existing code, the extensiveness of the subroutine, and the importance of the subroutine. The work to be performed included preparing pencil and finished flow charts of the existing code, developing upgraded flow charts and upgrading the code, and extensive testing of upgraded TWOPAS program versions.

Reports on the progress of the upgrading of selected subroutines were included in the quarterly reports in September 1997, December 1997, and March 1998.

Table 4:1 identifies the subroutines selected for upgrading, assigned responsibilities, and current status of upgrading. The second column indicates with "0" the availability of old subroutine flow charts developed in previous TWOPAS projects and indicates with "R" the availability of written documentation from Ricardo Archilla's previous work at FHWA. The first step was the preparation of draft flow charts with UCB to prepare the draft flow charts for the first eleven subroutines and MRI to prepare the draft flow charts for the remaining twelve subroutines. Later the subroutine "EGAP" was transferred from MRI to UCB.

Once the draft flow chart was prepared, it was put in finished form, the upgraded flow chart prepared, the program code upgraded, and then the upgraded program version tested. UCB was responsible for all tasks except for the MRI prepared draft flow charts. The asterisks "*" indicate the tasks which have been completed.

A separate document has been prepared which provides upgrade code information for fifteen subroutines. The following information is included for each of these subroutines:

- listing of original code
- flow chart of original code
- flow chart of upgraded code
- listing of upgraded code

TABLE 4:1 STATUS OF UPGRADING TWOPAS SUBROUTINES

NAME	OLD FLOW CHART	DRAFT FLOW CHART	FINISHED FLOW CHART	UPGRADED FLOW CHART	UPGRADED PROGRAM CODE	TEST UPGRADED PROGRAM
MAIN	O	UCB*	*	*	*	*
ADV2		UCB*	*	*	*	*
AMC		UCB*	*	*	*	*
CLEN2		UCB*	*	*	*	*
ENQUE	R	UCB*	*	*	*	*
PRIM2		UCB*	*	*	*	*
PROCI	R	UCB*	*	*	*	*
SPDN	R	UCB*	*	*	*	*
ST14	R	UCB*	*	*	*	*
ST6		UCB*	*	*	*	*
ZERO2		UCB*	*	*	*	*
ALN		MRI*	*		*	*
AL21	O	MRI*	*	*	*	*
CLPRM		MRI				
CRFW2		MRI				
DRPNO		MRI				
EGAP	O,R	UCB*	*	*	*	*
FAILG	O	MRI				
GENTB		MRI				
GTRIM		MRI				
ST5		MRI*	*	*	*	*
TJCLL	O	MRI				
TRAJT	O	MRI				

In the spring of 1997 the status of this upgrading effort was re-evaluated. The upgrading work was requiring more effort than originally estimated, the subroutines which had not been upgraded were considered to be less essential for upgrading, and the urgency of turning attention to program improvements was recognized. Therefore in late February 1997 the decision was made to not expend further effort on upgrading at this time and devote all efforts toward improving the TWOPAS model. Further upgrading of the program code will be reevaluated at a later time.

5. IMPROVEMENTS TO THE TWOPAS MODEL AND THE UCBRURAL INTERFACE

Work began on improving the TWOPAS model in late February 1997 with attention being given to the previously identified priority one improvements which were discussed in the earlier Section 3 of this report. Of the twenty eight (28) original priority one improvements, twenty (20) have been completed while eight (8) have not been completed (see Tables 3:1 and 3:2).

In addition, six improvements not included in priority one have been completed. One of these, Multiple Runs, was originally a priority two improvement but was implemented because it was needed by the researchers on the project. The other five non-priority one improvements that have been implemented (labeled N1-N5) were not originally listed as possible improvements because their need was identified only while other improvements were being made. Vertical Curves on Changes of Grade were added because they were required in the automatic sight distance calculations. An error was corrected in the assignment of speeds when two or more vehicle categories are present. The method of calculating Percent Time Delay was changed to make it consistent with the HCM definition of this variable and to make it compatible with the observation station graphs for Average Percent Time Following. Two User-defined Data Intervals were added because they were needed for the analysis process. TRARR was removed from the interface because the specifications for the two models were no longer the same after several of the modifications for TWOPAS were made.

The twenty-six improvements which have been completed are each described in the following twenty-six subsections of this chapter.

5.1 B1 - Narrow Lanes and Shoulder Effects

<u>*Current Status*</u>*: partially incorporated*

Data collected by MRI for this project show that narrow shoulders reduce the speed of vehicles on two-lane rural highways. Because the data collected on narrow lanes did not show consistent results and there was insufficient data to determine the interaction between narrow lanes and narrow shoulders, no reduction due to narrow lanes is currently implemented in the interface. However, in order to minimize the effort required to implement reduced speed due to narrow lanes when such data is available, the interface includes the logic for such a reduction. The reduction in speed due to narrow lanes and shoulders is shown in Table 5.1:1.

TABLE 5.1:1 SPEED REDUCTION DUE TO NARROW LANES AND SHOULDERS

SHOULDER WIDTH ***LANE WIDTH***	**.5 FEET**	**2 FEET**	**4 FEET**	**>= 6 FEET**
<= 9 FEET	4.2 mph	2.6 mph	1.0 mph	0.0 mph
10 FEET	4.2 mph	2.6 mph	1.0 mph	0.0 mph
11 FEET	4.2 mph	2.6 mph	1.0 mph	0.0 mph
12 FEET	4.2 mph	2.6 mph	1.0 mph	0.0 mph

The interface was modified so that the user specifies the width of the lane for any subsection which has a lane width that is less than the standard of 12 feet (3.66 meters). It is assumed that each subsection will have the same lane width in both directions. The default of zero means that the subsection does not have a narrow lane. The user also specifies the width of the shoulder for each subsection where the shoulder is less that the standard of 6 feet (1.83 meters). It is assumed that each subsection will have the same shoulder width in both directions. The default of zero means that the subsection does not have a narrow shoulder. The interface calculates any reduced speed in the subsection based on both the width of the lane and the width of the shoulder by using two-dimensional interpolation between the entries in Table 5.1:1.

Until additional field data shows what effects narrow lanes have on speed, the reduced speeds in the interface will remain the same for all four lane widths as shown in Table 5.1:1. Thus, user input of narrow lanes at this time will have no effect on the simulation in TWOPAS.

In any subsection, if there is a reduced speed due to narrow lanes and/or shoulders and a reduced speed due to a reduced speed zone (see below in Section 5.2), the interface will select the *slower* of the two reduced speeds as the input mean speed . The interface then computes the ratio of the selected mean speed on the reduced speed zone to the mean desired speed on the tangent and then computes the standard deviation of speeds on the reduced speed zone by multiplying the above ratio by the standard deviation of desired speeds. The selected mean speed on the zone and computed standard deviation of speeds on the zone are then written to the TWOPAS input file

TWOPAS.INP as described in Section 5.2. These zones are the same for both directions in the TWOPAS.INP input file, but will be modeled in TWOPAS with approach zones at the beginning of each reduced-speed zone in the direction of travel.

All changes for this modification were made to the UCBRURAL interface. No changes were made to the TWOPAS source code because reduced speeds due to narrow lanes and shoulders uses the same TWOPAS code as reduced speed zone as described in Section 5.2.

5.2 B9 - Reduced Speed Zone Effects

Current Status: *incorporated*

Speed reductions due to grades, horizontal curves, and crawl regions each require their own user input and are modeled separately in TWOPAS. The purpose of this improvement is to allow the users of TWOPAS to specify zones where the speed of vehicles is reduced for some other reason such as speed limits, roadside development, or narrow lanes and shoulders. The input for reduced speed due to narrow lanes and shoulders is handled separately in the interface as described in Section 5.1. However, the modeling of reduced speed due to narrow lanes and shoulders uses the same code within TWOPAS that was developed for this modification.

Different causes for the reduced speed zone may produce different patterns of speed reduction. For example, a speed limit may affect those vehicles with a desired speed that is higher than the speed limit, but the vehicles with desired speed lower than the speed limit may be unaffected. When the speed reduction zone is caused by roadside development, all vehicles may be somewhat affected. At this point in time however the above observations are just speculative since there isn't information about these effects (we do have information about the effect of narrow lanes and shoulders which was collected by MRI).

Two different approaches for reduced speed zone effects were investigated. The first approach (which was not selected for implementation) assumed that all vehicles traveling below a threshold speed (e.g., a speed limit) were unaffected. All vehicles traveling above the threshold speed were affected in different degrees depending upon the desired speed of each vehicle. A second speed representing the maximum speed at which any driver will travel the reduced speed zone was defined. The speed reductions for vehicles with desired speeds greater than or equal to the speed threshold were then computed as follows. A driver with desired speed equal to the speed threshold continues traveling at the speed threshold (unless of course there is a curve, crawl region, or steep upgrade). A driver with the maximum speed on the tangent (i.e., a driver with desired speed equal to the mean plus three standard deviations - the maximum of the three vehicle categories) will travel at the maximum speed on the reduced speed zone. All drivers with desired speeds between the speed limit and the maximum speed on the reduced speed zone will travel the reduced speed zone with a speed:

$$V_{rs} = V_{\lim} + \frac{V_t - V_{\lim}}{V_{t_{\max}} - V_{\lim}} (V_{\max} - V_{\lim})$$

where

Vtmax = maximum speed on the tangent;
Vlim = speed threshold;
Vmax = maximum speed on the reduced speed zone; and
Vt = desired speed of vehicle in progress on the tangent.

The above equation is derived from the following two equations:

$$V_t = V_{\lim} + f\,(V_{t_{\max}} - V_{\lim})$$

$$V_c = V_{\lim} + f\,(V_{\max} - V_{\lim})$$

That is, the multiplying factor f in both equations is the same.

An approach region of length z_0 is created before the reduced speed zone. The length z_0 is determined as:

$$z_0 = \frac{V_{t_{\max}}^{\;2} - V_{\max}^{\;2}}{2\,A}$$

where A is the deceleration rate (currently 3.5 ft/sec^2 is used). On the program, the following equation for zones (whether unaffected, approach, or reduced speed zones) that start at x_0.

$$V = V_t\,[1 - c_1\,(x - x_0) - c_3] + c_1\,c_2\,(x - x_0) + c_2\,c_3$$

where

c_1,c_2,and c_3 = 0 on uninfluenced zones;
$c_1 = B/z_0$, $c_2 = V_{lim}$, and c_3 =0 for approach regions where $B = 1 - [\,(V_{max} - V_{lim})/(V_{tmax} - V_{lim})]$;
c1=0, c2=Vlim, and c3 = B for reduced speed regions (B is the same as above).

The above equation produces a constant deceleration rate on the approach regions. Though this approach had some appeal, there was no empirical evidence about its assumptions and the approach was different from the approach used to reduce the speed due to curve and crawl region effects.

Therefore the research team decided to implement a second approach which is similar to the speed reductions due to curve/crawl effects so that the handling of reduced speeds are consistent throughout the program. In this approach the speeds on the reduced speed zone are considered to have a normal distribution whose mean and standard deviation have to be specified as input to TWOPAS.

The interface was modified so that the user defines the reduced speed zones by entering the mean speed on the zone. It is assumed that each subsection will have the same mean speed in both directions. The default of zero means that there is no reduced speed. In any subsection, if there is a reduced speed due to narrow lanes and/or shoulders (see above in section 5.1) and a reduced speed due to a reduced speed zone, the interface will select the *slower* of the two reduced speeds as the input mean speed. The interface then computes the ratio of the selected mean speed on the reduced speed zone to the mean desired speed on the tangent and then computes the standard deviation of speeds on the reduced speed zone by multiplying the above ratio by the standard deviation of desired speeds.

The selected mean speed on the zone and computed standard deviation of speeds on the zone are then written to the TWOPAS input file TWOPAS.INP. These reduced speed zones are the same for both directions in the TWOPAS.INP input file, but will be modeled in TWOPAS with approach zones at the beginning of each reduced speed zone in the direction of travel. Reduced speed zone information is written in new **Optional Cards** (see Optional Cards in the TWOPAS User's Guide). These new lines have the following format:

Column	1-2	3-5	6-10	11-15	16-20	21-30	31-40	41-50	51-60
Format	A2	I3	I5	I5	I5	F10.0	F10.0	F10.0	F10.0
Content	**SR**	**JD**	**MJRS(1)**	**MJRS(2)**	**KRS**	**XRSN(KRS)**	**CRS1(KRS)**	**CRS2(KRS)**	**CRS3(KRS)**

where

SR	=	'SR' indicates a reduced speed region due to narrow lanes/narrow shoulders or a reduced speed zone.
JD	=	Direction of travel in which this reduced speed region is located, 1 or 2.
MJRS(1)	=	Total number of reduced speed regions in No. 1 direction.
MJRS(2)	=	Total number of reduced speed regions in No. 2 direction.
KRS	=	Sequence number of this reduced speed region in its particular direction of travel
XRSN(KRS)	=	beginning of the reduced speed region; the beginning of the reduced speed

region is defined in its particular direction of travel, but the location is expressed in No. 1 direction coordinates.

CRS1(KRS) = end of the reduced speed region; the end of the reduced speed region is defined in its particular direction of travel, but the location is expressed in No. 1 direction coordinates, ft.

CRS2(KRS) = Mean speed in the reduced speed region (ft/sec).

CRS3(KRS) = Standard deviation of speed in the reduced speed region (ft/sec).

A sample of the new format for the TWOPAS input file is shown in Appendix B. An example of reduced speed due to narrow lanes/narrow shoulders or reduced speed can be seen in the sample Road Input Graph in Appendix D.

The following changes were made to the TWOPAS source code:

added

```
      COMMON /RS/  MJRS(2),NJRS(2),JRSX(2),XRSN(40),RRS(40),CRS0(40),
     1             CRS1(40),CRS2(40)
```

to BLOCK DATA, ADV2, OUT, PRIME, PROCI, REED2, TINC2, AND, ZERO2

changed

```
      COMMON/DIM/ZD,ZV,ZW,ZS,ZT
```

throughout to

```
      COMMON/DIM/ZD,ZV,ZW,ZS,ZT,ZRS
```

changed

```
      COMMON/GEO/CCV0,CCV1,CCV2,CCW0,CCW1,CCW2,CUR,CWL,GD0,GD1,G,CRW,
     1 XCVT,XCWT,XGDT,XCWMN,XGDMN,XCVMN,RCVF,RCWF,
     2 ITRY,KAI,KCV,KCW,JCV,JCW,JGD
```

throughout to

```
      COMMON /GEO/CCV0,CCV1,CCV2,CCW0,CCW1,CCW2,CCRS0,CCRS1,CCRS2,
     1             CUR,CWL,CRS,GD0,GD1,G,CRW,XCVT,XCWT,XRST,XGDT,
     2             XCWMN,XGDMN,XCVMN,XRSMN,RCVF,RCWF,RRSF,
     3             ITRY,KAI,KCV,KCW,KRS,JCV,JCW,JGD,JRS
```

changed

```
      COMMON/OO/OL(9)
```

throughout to

```
      COMMON/OO/OL(10)
```

Note that the dimension of 40 in COMMON /GEO/ was later increased to 650 for modification D2 (Section 5.4).

Additional changes were made to BLOCK DATA and subroutines ADV2, OPUT, PRIM2, PROCI, REED2, SPDN, TINC2, AND ZERO2. All changes made to these TWOPAS subroutines for this modification are shown in the subroutine code with the label

C ** UCB 97 - REDUCED SPEED ZONE MODIFICATION

5.3 D2-1 - Add Selected Range Checks

Current status: incorporated

The TWOPAS model has very few if any checks on the validity of the input data. It is possible to use input values that are merely unreasonable from a transportation point of view, or more seriously to use input values that produce strange results or cause the TWOPAS model to abort or "hang". The UCBRURAL interface forces the user input for each variable to be within a given range of values. The propose of this modification was to define the minimum and maximum for each input variable in the UCBRURAL interface. Table 5.3:1 shows the type of data, the data item, the minimum and maximum values allowed, and the default value. In addition the treatment of each data item in terms of when the range check is made, the type of message that is displayed if the data item is outside the range, any additional modification that was made, and any special information is shown. Finally the last two columns in Table 5.3:1 indicate the testing that was done for this modification.

It should be noted that this modification deals with the variables that are entered by the user on UCBRURAL input screens; it does not include checks on the user-supplied TWOPAS default values that are contained in the User-supplied Default file as described in Section 5.15. In addition, all of the testing for the range checks modification were made separately for each data item (except where noted otherwise). Testing of all possible combinations of minimums and maximums was beyond the time allotted to this modification. Thus, it is still possible, but much less likely, for the user to be able to enter certain combinations of input values that could cause the TWOPAS model to "hang".

All changes made for range checking were in the UCBRURAL interface. No changes were made to the TWOPAS source code.

TABLE 5.3:1 RANGE CHECKS MADE BY UCBRURAL INTERFACE ON USER INPUT

TYPE DATA	ITEM	MIN	MAX	DEFAULT	TREATMENT	TEST MIN	TEST MAX
Traf each dir	Flow	10 vph	2000 vph	500 vph	Checked on exit from window (OK CR) Message: forced to be in range but max may be too large for particular simulation TWOPAS breaks down at capacity - produces incomplete TWOSUM.OUT **Mod: Restricted num of digits for max from 6 to 4** **Changed from old range (10-3000)**	X	na
	%Cars	0 %	100 %	85%	Checked on exit from window (OK CR) Message: forced to be in range	X	X
	%Trks	0 %	100 %	10%	Checked on exit from window (OK CR) Message: forced to be in range	X	X
	%RVs	0 %	100 %	5%	Checked on exit from window (OK CR) Message: forced to be in range	X	X
	Sum % vehs	100 %	100 %	na	Checked on exit from window (OK CR) Message: forced to be in range	X	X
	MDsSpeeds	10 mph 16 kmph	80 mph 129 kmph	62 cars; 60 trks & rvs 100 cars 97 trks & rvs	Checked on exit from window (OK CR) Message: forced to be in range	X	X
	StdDev	0.01 mph 0.016 kmph	15 mph 24.14 kmph	4.0 cars; 3.5 trks 3.0 rvs 6.44 cars;5.63 trks;4.83 rvs	Checked on exit from window (OK CR) Message: forced to be in range **Mod: Increased num digits printed** **New check: Dspd - 3*StdDev >= 0**	X	X

TYPE DATA	ITEM	MIN	MAX	DEFAULT	TREATMENT	TEST MIN	TEST MAX
	% Entering in Platoons	0 %	99 %	33%	Checked on exit from window (OK CR) Message: forced to be in range 0 or -1 for UCBRURAL to calculate **Mod: Use only 0 to calculate** **Changed from old range (-1 to 100)**	X	X
Road	Road Unit Length	52.8 ft 16.1 m	5280 ft 1609.3 m	528 feet 100 meters	Checked on exit from window (OK CR) Message: forced to be in range	X	X
	Number of Road Units	4	1200	100 using zonal method	Max Chad - exit from window (OK CR) Message: forced to be <= Max Min checked when road data used Message: forced to be >= Min **Mod: Changed from old range (3 - 1200)**	X	X
	Length of road	211.2 ft 64.37 m	30 miles 48.28 km	10 miles 10 kmeters	Calculated from Road Unit Length and Number of Road Units Checked at exit from new "zonal" road and when user tries to add or insert a road unit on road data screen Message: forced to be in range	X	X
	Sight Distance	3 feet 1 meter	2000 ft 609 m	2000 feet 609 meters	Checked when entered Message: forced to be in range	X	X
	Narrow Lanes	9 feet 2.7 meters	12 feet 3.7 m	0.0	Checked when entered Message: forced to be in range Code 0 = standard lane width (12ft) **Mod: Metric Min/Max added**	X	X

TYPE DATA	ITEM	MIN	MAX	DEFAULT	TREATMENT	TEST MIN	TEST MAX
	Narrow Shoulders	0.5 feet 0.2 meters	6 feet 1.8 meters	0.0	Checked when entered Message: forced to be in range Code 0 = stand. should. width (6ft) **Mod: Metric Min/Max added**	X	X
	Grade	-10.0 %	10.0 %	0.0 %	Checked when entered Message: forced to be in range	X	X
	Curve Radius	-9999 feet 50 feet -3048 m 15.24 m	- 50 feet 9999 feet - 15.24 m 3048 m	0	Checked when entered Message: forced to be in range |CRad| = 9999 treated as tangent |CRad| = 0 treated as tangent **Mod: Metric Min/Max added** **|CRad| < 50 ft (15.24m) but <> 0 prohibited** **Message: forced to be in range** **Reduced number of digits from 5 to 4 when positive number**	X	X
	Reduced Speed	10 mph 16 kmph	70 mph 113 kmph	0	Checked when entered Message: forced to be in range Code 0 means no reduced speed No reduced speed if RS >= Mean Des Spd for cars in direction 1 **Mod: Changed from old range (1-70 mph) (1-113 kmph)** **Fixed error when RSs for all road units are >= MDesSpd for cars dir 1**	X	X

TYPE DATA	ITEM	MIN	MAX	DEFAULT	TREATMENT	TEST MIN	TEST MAX
	Passing Lane Length	maximum of 1 road unit or 200 feet 61 meters	num road units - 2	na	First and last road units may not have passing lane Checked when run requested Message: Edit road file and resubmit; run canceled **Mod: Min length checked when run requested** **Message Edit road file and resubmit; run canceled**	X	X
ACSD	Obstruction Offset	10 ft 3 meters	100 ft 30 meters	50 feet 15.24 meters	Checked on exit from window (OK CR) Message: forced to be in range **Mod: Metric Min/Max added**	X	X
ACPZ	Min SD for Passing	500 ft 152 meters	3000 ft 914 m	1000 feet 305 meters	Checked on exit from window (OK CR) Message: forced to be in range **Mod: Metric Min/Max fixed**	X	X
	Min Length Pass Zone	400 feet 122 meters	1000 feet 305 m	400 feet 122 meters	Checked on exit from window (OK CR) Message: forced to be in range **Mod: Metric Min/Max fixed**	X	X
RUN SPECS	Simulation Time	1 min	120 mins *****	60 minutes	Checked on exit from window (OK CR) Message: forced to be in range **Mod: Changed from secs to mins** **Changed from old range (10-9999) secs** *** With high flows and long roadway, max sim time + max warmup may be too high**	X	*****

TYPE DATA	**ITEM**	**MIN**	**MAX**	**DEFAULT**	**TREATMENT**	**TEST MIN**	**TEST MAX**
	Settling Down Time	(RL mi /30mph)*60	120 mins *****	computed Minimum + 5 mins	Checked on exit from window (OK CR) Message: forced to be in range **Mod: Changed from secs to mins** **Calculate Minimum** **Changed from old range (10-9999) secs** *** With high flows and long roadway, max sim time + max warmup may be too high**	X	*
	Random Number Seed	2	999999	3	Checked on exit from window (OK CR) Message: forced to be in range **Mod: Changed from old range (0-999999)**	X	X
	User Random Num Seeds	10000000	99999999	computed from Random Number Seed above	Checked on exit from window (OK CR) Message: forced to be in range	X	X

5.4 D3 - Increase Array Dimensions

Current status: *incorporated*

The purpose of this modification was to increase the array dimensions for many of the input variables in the TWOPAS model. Such a modification allows to user to enter the input in finer detail as well as to accurately model a roadway up to 30 miles in length. Most of these increase were made to both UCBRURAL and TWOPAS; the increase in the number of road subsections had to be made only in UCBRURAL; the number of vehicles and number of headways had to be made only in the TWOPAS model.

Table 5.4:1 displays information relevant to these increases. Each row in this table represents one input variable. One of the most complicated increases was for horizontal curves which will be used as an example in the follow description. The first column identifies the variable, horizontal curves. The second column indicates that in the original TWOPAS model 9 horizontal curves were allowed in direction 1. A modification of array dimensions made on a previous project increased the number of horizontal curves to 90 in direction 1, column 3. Researchers on this project determined that, if possible, it would be desirable to increase the number of horizontal curves to 300 in direction 1, column 4. It was determined that eight (8) arrays in the TWOPAS model would need to be increased from a dimension of 600 to a dimension of 1800, column 5. Horizontal curves need three array elements for each curve in each direction for a total of six (6). Thus, 300 curves require an array dimension of 300 times 6 for a total of 1800. During implementation it was decided that 200 horizontal curves in direction 1 would be more than sufficient for a 30 mile roadway, column 6. Thus 8 arrays in TWOPAS were increased from 600 to 1250 (allowing for a buffer of 50 elements). As this change was implemented in the UCBRURAL interface, it was discovered that the program was exceeding the memory requirements for compilation. The interface data could have been restructured to solve this problem. However, restructuring, a potentially time consuming effort, was rejected in favor of reducing the number of horizontal curves to 150 in direction 1, still an adequate number for a 30 mile roadway. This information is shown in the last column. The information for the other variables in Table 5.4:1 is more straight forward and should be easier to interpret.

Modifications to the UCBRURAL interface increased the number of road subsections to 1200. This allows the user to select a subsection length of 0.01 mile for maximum detail and still be able to analyze a roadway of 12 miles (1200 x 0.01= 12). If a longer roadway needs to be analyzed, the length of the subsection will have to be increased. Thus for 30 miles, the maximum length of road allowed, the length of the subsection has to be a minimum of 0.025 miles (1200 x 0.025 = 30).

TABLE 5.4:1 INCREASED ARRAY SIZES IN UCBRURAL AND TWOPAS

VARIABLE	ORIGINAL TWOPAS	SIZE AS OF 1/28/98	SUGGESTED INCREASE	NUMBER OF ARRAYS	IMPLEMENTED IN TWOPAS	IMPLEMENTED IN UCBRURAL
Road subsecs	NA (in UCBRURAL interface)	300	1200 - 3000	NA	NA	1200
sight distance	60 both directions combined; includes non-restricted zones	300 in each dir	600 in each direction	5 arrays of 600 -> 1200	600 in each direction	600 in each direction
grade regions	30 in direction 1	300 in dir 1	600 in dir 1	4 arrays of 600 -> 1200	600 in dir 1	600 in dir 1
horizontal curves	9 in direction 1	90 in dir 1	300 in dir 1	8 arrays of 600 -> 1800	200 in dir 1 8 arrays of 600 -> 1250	150 in dir 1
observation stations	20 each direction	300 each dir	OK - only 100 in each dir used	no change	Ok - only 100 in each dir used	OK - only 100 in each dir used
crawl regions	total of 12	OK	OK	no change	total of 12	total of 12
red spds NL&S		6 in dir 1	100 in dir 1	5 arrays of 40 -> 650	100 in dir 1	100 in dir 1
passing zones	30 each direction	no change	300 each direction	5 arrays of 60 -> 600	300 in each dir	300 each dir
number of vehs	total of 1000	total of 2000	total of 4000	13 arrays of 2000 -> 4000	total of 4000	NA
headways	total of 5000	no change	total of 10,000 - 20,000	1 array of 5000 -> 15,000	total of 15,000	NA

Additional modifications were made to the UCBRURAL interface to allow for the increased number of zones for sight distance, grade regions, horizontal curves, reduced speeds, and passing zones.

The following changes were made to the TWOPAS source code for increasing the number of sight distance regions:

changed
```
      COMMON/ST/MLS(2),NLS(2),XSGO(600),SGTO(600),RST(600),SMIN,SNOM,
     1     LS
```
throughout to
```
      COMMON /ST/  MLS(2),NLS(2),XSGO(1200),SGTO(1200),RST(1200),SMIN,
     1     SNOM,LS
```

changed
```
      COMMON /TEMP/ RCUR(600),SCUR(600),ACUR(600),SGTF(600),XSGF(600)
```
throughout to
```
      COMMON /TEMP/ RCUR(1250),SCUR(1250),ACUR(1250),SGTF(1200),
     1     XSGF(1200),SCWL(12),SP1(13)
```

Additional changes were made to BLOCK DATA and subroutines ADJ1 and ADJ2. All changes to these TWOPAS subroutines for this modification are shown in the subroutine source code with the label:

C ** UCB 98 - INCREASE NUMBER OF SIGHT DIST REGIONS FROM 30 TO 600 EACH DIR

The following changes were made to the TWOPAS source code for increasing the number of grade regions:

changed
```
      COMMON /GD/ MJGD(2),NJGD(2),JGDX(2),XGDN(600),G0(600),G1(600)
```
throughout to
```
      COMMON /GD/ MJGD(2),NJGD(2),JGDX(2),XGDN(1200),G0(1200),G1(1200)
```

Additional changes were made to BLOCK DATA and subroutines ADJ1 and ADJ2. All changes to these TWOPAS subroutines for this modification are shown in the subroutine source code with the label:

C ** UCB 98 - INCREASE NUMBER OF GRADE REGIONS FROM 30 TO 600 IN DIR 1

The following changes were made to the TWOPAS source code for increasing the number of horizontal curves:

changed
```
      COMMON /CV/ MJCV(2),NJCV(2),JCVX(2),XCVN(60),RCV(60),CV0(60),
     1     CV1(60),CV2(60)
```
throughout to
```
      COMMON /CV/ MJCV(2),NJCV(2),JCVX(2),XCVN(1250),RCV(1250),
     1     CV0(1250),CV1(1250),CV2(1250)
```

changed
```
      COMMON /TEMP/ RCUR(600),SCUR(600),ACUR(600),SGTF(600),XSGF(600)
```
throughout to
```
      COMMON /TEMP/ RCUR(1250),SCUR(1250),ACUR(1250),SGTF(1200),
     1     XSGF(1200),SCWL(12),SP1(13)
```

Additional changes were made to BLOCK DATA and subroutines ADJ1 and ADJ2. All changes to these TWOPAS subroutines for this modification are shown in the subroutine source code with the label:

C ** UCB 98 - INCREASE NUMBER OF HORIZONTAL CURVES FROM 9 TO 200 IN DIR 1

The following changes were made to the TWOPAS source code for increasing the number of reduced speed zones:

changed
```
      COMMON /RS/  MJRS(2),NJRS(2),JRSX(2),XRSN(40),RRS(40),CRS0(40),
     1           CRS1(40),CRS2(40)
```
throughout to
```
      COMMON /RS/  MJRS(2),NJRS(2),JRSX(2),XRSN(650),RRS(650),CRS0(650),
     1           CRS1(650),CRS2(650)
```

Additional changes were made to BLOCK DATA. All changes to this TWOPAS subroutine for this modification are shown in the subroutine source code with the label:

C ** UCB 98 - INCREASE NUMBER OF REDUCED SPEED ZONES FROM 6 TO 100 IN DIR 1

The following changes were made to the TWOPAS source code for increasing the number of passing zones:

changed
```
      COMMON /PS/  MLP(2),NLP(2),XPZO(60),JPS(60),LQ,LP,LFAV(60),
     1           LTMER(60),VLLER(60),XEOL
```
throughout to
```
      COMMON /PS/  MLP(2),NLP(2),XPZO(600),JPS(600),LQ,LP,LFAV(600),
     1           LTMER(600),VLLER(600),XEOL
```

Additional changes were made to BLOCK DATA. All changes to this TWOPAS subroutine for this modification are shown in the subroutine source code with the label:

C ** UCB 98 - INCREASE NUMBER OF PASSING REGIONS FROM 30 TO 300 IN EACH DIR

The following changes were made to the TWOPAS source code for increasing the number of vehicles:

changed
```
      COMMON /AKPM/ AKPM(2000)
```
throughout to
```
      COMMON /AKPM/ AKPM(4000)
```

changed
```
      COMMON /VEH/ KS(2000), KV(2000), LD(2000), LG(2000),
     1           ACL(2000), V(2000), X(2000), VDNOR(2000)
```

throughout to COMMON /VEH/ KS(**4000**), KV(**4000**), LD(**4000**), LG(**4000**),
1 ACL(**4000**), V(**4000**), X(**4000**), VDNOR(**4000**)

changed COMMON /EXT/ IOV(160),IPT(160),ISTG(160),TMRG(160),VPM(160)
throughout to COMMON /EXT/ IOV(**320**),IPT(**320**),ISTG(**320**),TMRG(**320**),VPM(**320**)

changed COMMON /IDRT/ IDRT(2000)
throughout to COMMON /IDRT/ IDRT(**4000**)

changed COMMON /IPTAR/ IPTAR(2000)
throughout to COMMON /IPTAR/ IPTAR(**4000**)

changed COMMON /TVIN/ TVIN(2000,2)
throughout to COMMON /TVIN/ TVIN(**4000**,2)

Additional changes were made to BLOCK DATA and subroutines PROCI, OUTP, AND REED2. All changes to these TWOPAS subroutines for this modification are shown in the subroutine source code with the label:

C ** UCB 98 - INCREASE NUMBER OF VEHICLES TO 4000

The following changes were made to the TWOPAS source code for increasing the number of headways:

changed COMMON /XHEAD/ XHEAD(5000)
throughout to COMMON /XHEAD/ XHEAD(**15000**)

Additional changes were made to BLOCK DATA. All changes to this TWOPAS subroutine for this modification are shown in the subroutine source code with the label:

C ** UCB 98 - INCREASE NUMBER OF VEHICLES IN TRAFFIC STREAM TO 15000

5.5 E3 - Vary Standard Deviation of Desired Speed by Vehicle Type

Current status: *incorporated*

The original TWOPAS model allowed the user to enter an overall mean desired speed and a separate bias from the overall mean desired speed for each of the three categories of vehicles: passenger cars, recreational vehicles, and trucks. However, only one standard deviation of desired speeds was permitted. Further, the three biases to the mean desired speed and the one standard deviation were used for both directions. This represented two problems. First, in most cases the standard deviation of desired speeds are different for the different vehicle categories. Second, there are situations where the mean desired speed is different for each direction for the same vehicle category, for example when most trucks travel heavily loaded in one direction and empty in the opposite direction. Therefore, the TWOPAS model has been modified so that it accepts different values of mean desired speed and standard deviation of desired speed for each vehicle category and for each direction.

The UCBRURAL interface needed only minor changes since it already allowed the input of different values for each vehicle category and direction on both mean speed and standard deviation. The interface was modified to add these additional values to the file it creates for input to the TWOPAS model.

This new information was added to "**Card No. 6**" data (see TWOPAS User's Guide) which now contains three lines and has the following format:

Column	1	2	3-8	**9-32**	33-38	39-44	45-50	51-56
Format	I1		F6.4		F6.4	F6.4	F6.4	F6.4
Content	6	Blank	VEAN	**Blank**	SIGSM	SIGBG	FP0	FP1

Column	**1**	**2**	**3-8**	**9-14**	**15-20**	**21-26**	**27-32**	**33-38**
Format	**I1**		**F6.4**	**F6.4**	**F6.4**	**F6.4**	**F6.4**	**F6.4**
Content	**6**	**Blank**	$\mathbf{VSIG_{1,1}}$	$\mathbf{VSIG_{2,1}}$	$\mathbf{VSIG_{3,1}}$	$\mathbf{VSIG_{1,2}}$	$\mathbf{VSIG_{2,2}}$	$\mathbf{VSIG_{3,2}}$

Column	**1**	**2**	**3-8**	**9-14**	**15-20**	**21-26**	**27-32**	**33-38**
Format	**I1**		**F6.4**	**F6.4**	**F6.4**	**F6.4**	**F6.4**	**F6.4**
Content	**6**	**Blank**	$\mathbf{VBI_{1,1}}$	$\mathbf{VBI_{2,1}}$	$\mathbf{VBI_{3,1}}$	$\mathbf{VBI_{1,2}}$	$\mathbf{VBI_{2,2}}$	$\mathbf{VBI_{3,2}}$

where

VSIG(1,1) = Standard deviation for Trucks in direction 1
VSIG(2,1) = Standard deviation for RVs in direction 1
VSIG(3,1) = Standard deviation for Cars in direction 1
VSIG(1,2) = Standard deviation for Trucks in direction 2
VSIG(2,2) = Standard deviation for RVs in direction 2
VSIG(3,2) = Standard deviation for Cars in direction 2
VBI(1,1) = Bias to be added algebraically to mean desired speed (VEAN) for Trucks in direction 1
VBI(2,1) = Bias to be added algebraically to mean desired speed (VEAN) for RVs in direction 1
VBI(3,1) = Bias to be added algebraically to mean desired speed (VEAN) for Cars in direction 1

VBI(1,2) = Bias to be added algebraically to mean desired speed (VEAN) for Trucks in direction 2
VBI(2,2) = Bias to be added algebraically to mean desired speed (VEAN) for RVs in direction 2
VBI(3,2) = Bias to be added algebraically to mean desired speed (VEAN) for Cars in direction 2

A sample of the new format for the TWOPAS input file is shown in Appendix B.

Default values for the speeds of the different vehicle categories and their standard deviation for both directions are as follows (Source: Archilla 1992):

TABLE 5.5:1 DEFAULT VALUES FOR MEAN DESIRED SPEED AND STANDARD DEVIATION BY VEHICLE TYPE

	Passenger cars	Recreational Vehicles	Trucks
Mean desired speed (mph)	61.5	59.5	59.5
Standard deviation (mph)	5.0	4.0	3.5

The implied biases of the mean desired speed for each vehicle category are 0, 2, and 2 mph for passenger cars, recreational vehicles and trucks respectively.

To carry out the improvement only two basic changes were needed in the TWOPAS model. First, instead of using VBI(K) as the bias for vehicle category K, a two dimensional array was used, VBI(K, JD): bias for vehicle category K and direction JD. Similarly, instead of using a single value for the standard deviation of desired speeds for all vehicle categories and for the two directions (VSIG), a two dimensional array VSIG(K, JD) was used. For both variables K=1 to 3 represents vehicle categories, cars, RV's and trucks and JD=1,2 represents the two directions.

Besides the above changes, subroutines that used VMEAN (the mean desired speed), VBI the bias for the three vehicle categories, and VSIG the standard deviation of desired speed were identified. Those subroutines were CHRMO, OPUT, PAGE2, PAGE3, PRIM2, PROCI, REED2, UPSS, and VASGN. Whenever these variables appeared a decision had to be made as to what modification to the code should be made in each of these subroutines. This decision was not always straightforward because the above variables sometimes appeared in expressions probably derived from field experiences and therefore it was not clear if a change was adequate. For example in subroutine CHRMO, which is called for vehicles in the left lane of an added passing or climbing lane and determines if the vehicle should be motivated to change to the right lane, VMEAN and VSIG are used in the expression PROB=PROB+.15*(VEAN-VIP)/VSIG. The value of PROB is further modified in the subroutine. This is an ad hoc expression, so any modification of it would be somewhat arbitrary. Further, no distinction is being made for the different vehicle categories (VMEAN is used without being adjusted by the bias.) The TWOPAS documentation states that the logic and numerical values (for subroutine CHRMO) are based on experience with a multilane highway simulation model. Thus, in this case it was decided not to make any change (i.e., the values of speed and standard deviation corresponding to the passenger car category are always used.)

For a subroutine such as VASGN, a change was clearly necessary, since this subroutine calculates the desired speed for each vehicle. Thus, the bias for each vehicle category that in the original code was the same in both directions was replaced by a directional bias for each vehicle category; the single value of the standard deviation of desired speeds was replaced by different values for each vehicle category and direction.

The following changes were made to the TWOPAS source code:

changed
```
  COMMON/VEL/VEAN,VSIG,VBI(3),SIGSM,SIGBG,SMOP,BGOP,VENTR(2,13),VLIM
 1,VDD(7),WVD(7),SDVDD(7)
```
throughout to
```
  COMMON /VEL/ VEAN,VSIG(3,2),VBI(3,2),SIGSM,SIGBG,SMOP,BGOP,
 1              VENTR(2,13),VLIM,VDD(7),WVD(7),SDVDD(7)
```

Additional changes were made to subroutines CHRMO, OPUT, PAGE2, PAGE3, PRIM2, PROCI, REED2, UPSS, and VASGN. All changes to these TWOPAS subroutines for this modification are shown in the subroutine source code with the label:

C ** UCB 97 - ADD MEAN SPEED AND STD. DEV FOR EACH VEH TYPE AND EACH DIR

5.6 E4 - RV Speed/Percent Following Problem

<u>Current status</u>: incorporated.

The RV speed/percent following problem was identified in Position Paper 3 of March 1996: “Selection of a Suitable Simulation Model and Identification of Desirable Functional Improvements.” That paper, contains a description of the simulation runs that were undertaken to determine the realism of the representation of passenger RV’s performance under low flow and ideal conditions. Simulations were performed on a 10-mi section of roadway with no barrier lines, no passing lanes, no turnouts, and sight distance of 5000 ft. The standard deviation of desired speeds was set at 0.01 mph and the entering flow rate in each direction was 40 recreational vehicles per hour. The simulation time was 3600 sec and the warm-up time was 1524 sec. Two different desired speeds were investigated, 50 and 60 mph.

The problem identified from the above simulations was that the directional average section speed for recreational vehicles was lower than the desired speed, particularly for a specified desired speed of 60 mph. It was also identified that the increase in desired speed caused an increase in the percent following value.

In order to investigate this problem, the conditions mentioned above were replicated with a mean desired speed of 60 mph[1]. As one would expect similar results were obtained. For example, mean speeds of 56.4 mph and 56.1 mph were obtained for directions 1 and 2 respectively when RV's where simulated but for passenger cars the mean speeds were 59.9 and 59.8 mph respectively.. The percent time delayed were 9.0% for direction 1 and 5.3% for direction 2 (7.1 for both directions combined) for the simulation with RV's and 1.5% and 3.9 % for the simulation with passenger cars.

An analysis of the program logic indicated that passenger cars and RV's are treated similarly. Thus, it was very strange that the speed problem manifested only for RV's and not for passengers cars. The above observations indicated that the differences could be due to differences in the vehicle performance parameters. As will be shown below, the difference from the specified mean desired speed for RV's is indeed a consequence of the vehicle performance parameters of RV's. Therefore, the apparent problem is not really a problem with the model but a problem with the input data.

The following paragraphs explain why the difference between the mean simulated speed and the mean desired speed for RV's exists (with an almost zero input standard deviation). First, it should be noted that one can specify at input whatever mean desired speed one wants. However, the model does not allow vehicles to travel faster than the vehicle performance equations allow them to travel. We now make an examination of the performance equation for RV's (and passenger cars as well) to see why the speeds of some RV types is limited to values less than 60 mph even on a zero grade.

The acceleration capability for RV's is modeled as a function of speed and local grade as:

$$AO = P0 - P1*V - G*\propto \quad (1)$$

where

AO = the maximum acceleration at current speed and grade;
P_0 = maximum acceleration at zero speed;

[1]The only difference is that the sight distance was set at 2000 ft. This should not make any difference.

P_1 = P_0/(maximum speed on zero grade);
V = current speed; and
G = acceleration of gravity;
$\propto$ = local grade in percent.

For passing and accelerating toward desired speeds, the values P_0 and P_1 are based on full available horsepower. If specified in input, values based on partial horsepower are employed in other situations. The value with partial horsepower has the same form

$$a = p_0 - p_1 \, V - G \propto \tag{2}$$

The values for p_0 and p_1 currently in used are $0.81_x P_0$ and $0.9_x P_1$. The values of the maximum acceleration at zero speed (P_0) and the maximum speed on zero grade ($1/P_1$) for the four RV types are as follows:

RV type	P_0 (ft/sec^2)	$1/P_1$ (ft/sec)	$1/P_1$ (mph)
5	8.220	78.70	53.66
6	8.640	89.70	61.16
7	8.750	96.00	65.45
8	8.760	97.50	66.48

From the above parameters, it is easy to see that a type 5 RV cannot travel faster that 53.66 mph (if equation 1 is used) even though the desired speed may have been input as 60 mph. Still, this did not justified the drop of about 4 mph in the mean speed since it was specified that only 10 % of the traffic consisted of this vehicle type (in fact only one RV type 5 was generated in the simulation for direction 1) and the other three RV types (90 % of the traffic) could *theoretically* achieve speeds slightly higher than 60 mph.

In reality, none of the RV types can achieve 60 mph. The reason is that whenever the program detects that a vehicle requires a negative acceleration as given by equation (2) for a prolonged period of time it uses that acceleration (with restricted horsepower) instead of the acceleration given by (1). It is easy to prove that with the parameters shown above the value of *a* is always negative. Thus, the vehicles enter the road at nearly 60 mph but they are decelerated until they reach a speed such that the value of *a* as given by (2) is zero. It is easy to prove by setting equation (2) equal to zero and substituting the parameter values given above that the maximum speeds that can be achieved by the four RV types are:

RV type	Max Attainable speed (mph)
5	48.31
6	55.04
7	58.91
8	59.83

Now it is apparent that the simulated speed difference should be expected given the current parameters being used. To corroborate the above finding, two more simulations were performed. In the first one, the performance parameter values for RV's were replaced by the performance parameter values for passenger cars. The average simulated speeds for directions 1 and 2 were 60.0 mph and 59.8 mph respectively. In the second simulation the performance parameters were maintained but the coefficients multiplying P_0 and P_1 in equation (2) (0.81 and 0.9 respectively) were substituted by one. This, in effect, is like assuming that vehicles use full available horsepower all the time. In this case the average simulated speeds were 59.9 mph and 59.8 mph for directions 1 and 2 respectively. Again, to make sure that the speed differences were created only by RV types 5, the performance parameters for RV type 5 were substituted by the performance parameters of RV type 6 (and of course, the multiplying factors for P_0 and P_1 in equation (2) were each set equal to 1.) In this case the simulated speeds for directions 1 and 2 were again 59.9 mph and 59.8 mph respectively.

In summary, it can be observed that the apparent problem with the speed drop is just a consequence of the performance parameter being used for RV's. The question is then if these performance parameters are adequate for current operating conditions. An analysis of field data is needed to obtain new performance parameters for RV's. However, until field data are available the following values are being used:

RV type	P_0 (ft/sec^2)	$1/P_1$ (ft/sec)	$1/P_1$ (mph)
5	8.220	102.67	70.00
6	8.640	105.92	72.22
7	8.750	110.81	75.55
8	8.760	114.07	77.78

The problem with the increment in percent following when the mean desired speed is increased from 50 mph to 60 mph is a consequence of the fact that the simulated speeds for the latter case present a greater variability than in the former case because some vehicles cannot achieve the 60 mph desired speed. However, when the parameters of the four RV types were replaced with the parameters of the passenger cars the differences were negligible. For example, for the simulation with 100% passenger cars the simulated percent following values were 1.5 % for direction 1 and 3.9 % for direction 2 (2.8 % combined) whereas for the simulation with 100% RV's the simulated percent following values were 1.5 % for direction 1 and 4.2 % for direction 2 (2.9 % combined.) This small difference is explained by the different vehicle lengths.

Changes were made to the interface so that these new values are written to the TWOPAS input file. No changes were made to the TWOPAS source code.

5.7 E10 - Correct Number of Passes Error

Current *Status*: *incorporated.*

This improvement was identified in a previous Interim report. The problem was identified as an overestimation by TWOPAS of the number of passes on sections with added or auxiliary lanes. Unfortunately the data on passing rates are very scarce. The only relatively recent reference found with passing rates in a form that could be compared (approximately) with the output from TWOPAS was the work of May (2). A very crude comparison show that the rates in the field were two to three times higher than the ones simulated with TWOPAS. However, there are many factors that are unknown and that may explain this unexpected result. First, the desired speed distribution, which has a great impact on the passing rates, is not known for the field data. Second, the field data had a mix of vehicle types with probably different desired speeds and vehicle performance but in the simulation only passenger cars were used because when this study was started, improvement N2 Correct Speeds when all Vehicle Types are Used (Section 5.23) was not solved yet. Third, the study was also started before reference [2] was known to the investigator in charge of this improvement so the passing rates on the simulations are based on a 7.8 long section whereas the field studies (on level terrain) are based on 0.3 to 0.5 mi passing lanes.

In summary, at present, a serious comparison of simulated passing rates with field data is almost impossible. Therefore, we concentrate here on the reasonableness of how TWOPAS computes the passing rates. It will also help to compare the TWOPAS results with TRARR and theoretical results.

First, let us describe how TWOPAS computes passes. In sections with an auxiliary lane TWOPAS records a pass each time a vehicle moves ahead of another. This may cause an overestimation of the number of passes. Consider the example in Figure 5.7:1. From time t_0 to t_1 vehicle 3 moves ahead of vehicle 2 and vehicle 6 moves ahead of vehicles 4 and 5 and TWOPAS records three passes. However, between times t_1 and t_2 vehicle 3 catches the slow moving vehicle 1 and it is passed by vehicle 2 and also vehicle 6 is passed by vehicle 4. TWOPAS then records 2 more passes for a total of 5 passes. However if one had taken pictures at times t_0 and t_2 only, one would have only observed that vehicle 6 had passed vehicle 5, i.e., only one passed occurred in the section.

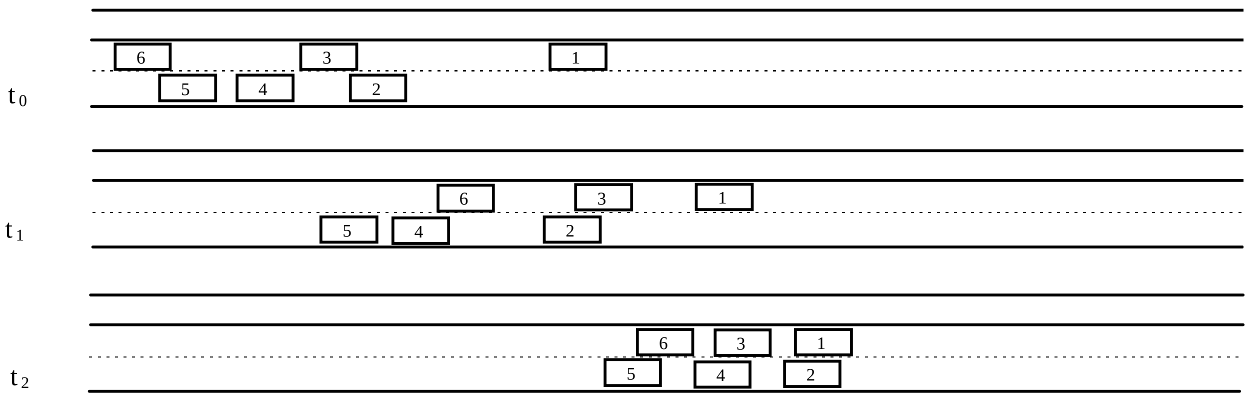

Figure 5.7:1 Three consecutive times to illustrate how passes are computed.

On normal two-lane sections (that is, sections without auxiliary lanes) TWOPAS computes a pass whenever a vehicle passes from state 5 (passing) to a state 1 to 4 (in normal lane). Interestingly, TRARR computes a pass whenever a vehicle gets ahead of another in sections with and without passing lanes. Thus, the passing rates computed by the two models under identical conditions are directly comparable on sections with passing lanes. On normal two-lane sections TRARR could give slightly higher rates than TWOPAS because in situations when a vehicle aborts a pass when it was already ahead (nose to nose) of the vehicle being passed TRARR would compute two passes whereas TWOPAS would have computed none.

In sections with passing lanes it is also interesting to compare the passing rates with a theoretical passing rate if each vehicle could maintain its desired speed. The equation developed by Wardrop is:

$$P = \frac{1}{\sqrt{\pi}} \; \frac{\sigma Q^2}{\bar{V}_s}$$

where

P = demand for passing (passes/mi/h);
Q = one directional traffic flow (vph);
V_s = mean desired speed (mph);
σ = standard deviation of desired speed (mph).

Figure 5.7:2 shows the theoretical number of passes on a 7.8 mi section along with the two simulation model results. Three replications were performed for each flow level with each model. As can be observed the number of passes predicted by TRARR is much higher than the number of passes predicted by TWOPAS and also higher than the theoretical number of passes. TWOPAS on the other hand slightly overestimates the number of passes (with respect to the theoretical results) for the lower flow rates and produces an underestimation for the higher flow rates. This is not surprising since at higher flows there is less freedom to maneuver and therefore vehicles cannot change lanes so easily to avoid slow-moving vehicles. The effect of over counting may still be present. Figure 5.7:3 shows the same results but in terms of passing rates.

In order to know what was the effect of the possible over counting due to vehicles passing each other several times on the observation section, the TWOPAS program was modified so that an effective number of passes can be obtained (this modification was performed only for this study; it has not been retained in the program code). An effective pass is counted for example when vehicle 1 enters the observation section before vehicle 2 but vehicle 2 leaves the section first. If vehicle 2 leaves the section after 1 then no pass is counted even though at some point in time vehicle 2 may have been ahead of 1.

Figure 5.7:4 and Figure 5.7:5 show the same results as Figure 5.7:2 and 5.7:3 but with the effective number of passes added. First, note that a line des. spds modified was added to verify that the number of passes was not greatly affected by improvement N2 (Section 5.23) which was already incorporated during these last simulations. As can be observed, the predictions with the unmodified version of TWOPAS and with the modifications for improvement N2 were very similar. So now a comparison of the number of passes computed by TWOPAS with the effective number of passes is possible. As would be expected the effective number of passes line is below the unmodified line. The over prediction by TWOPAS, is about 5 to 10% which is not very significant.

Finally, Figure 5.7:2 and Figure 5.7:3 show the comparison between the number of passes and the passing rates predicted by TWOPAS and TRARR. There are very important differences between the two models, so important that they do not seem to be due to the different way in which they compute the passes.

Thus in summary, from field data it was not possible to corroborate that TWOPAS overestimates the number of passes and when compared with TRARR, TWOPAS computes a lower (much lower in some cases) passing rate. Also, in the comparison with theoretical results in passing lane sections TWOPAS shows very consistent results. In conclusion, there seems to be no obvious problem with the way in which TWOPAS computes the number of passes.

No changes were made to either the UCBRURAL interface or to the TWOPAS source code.

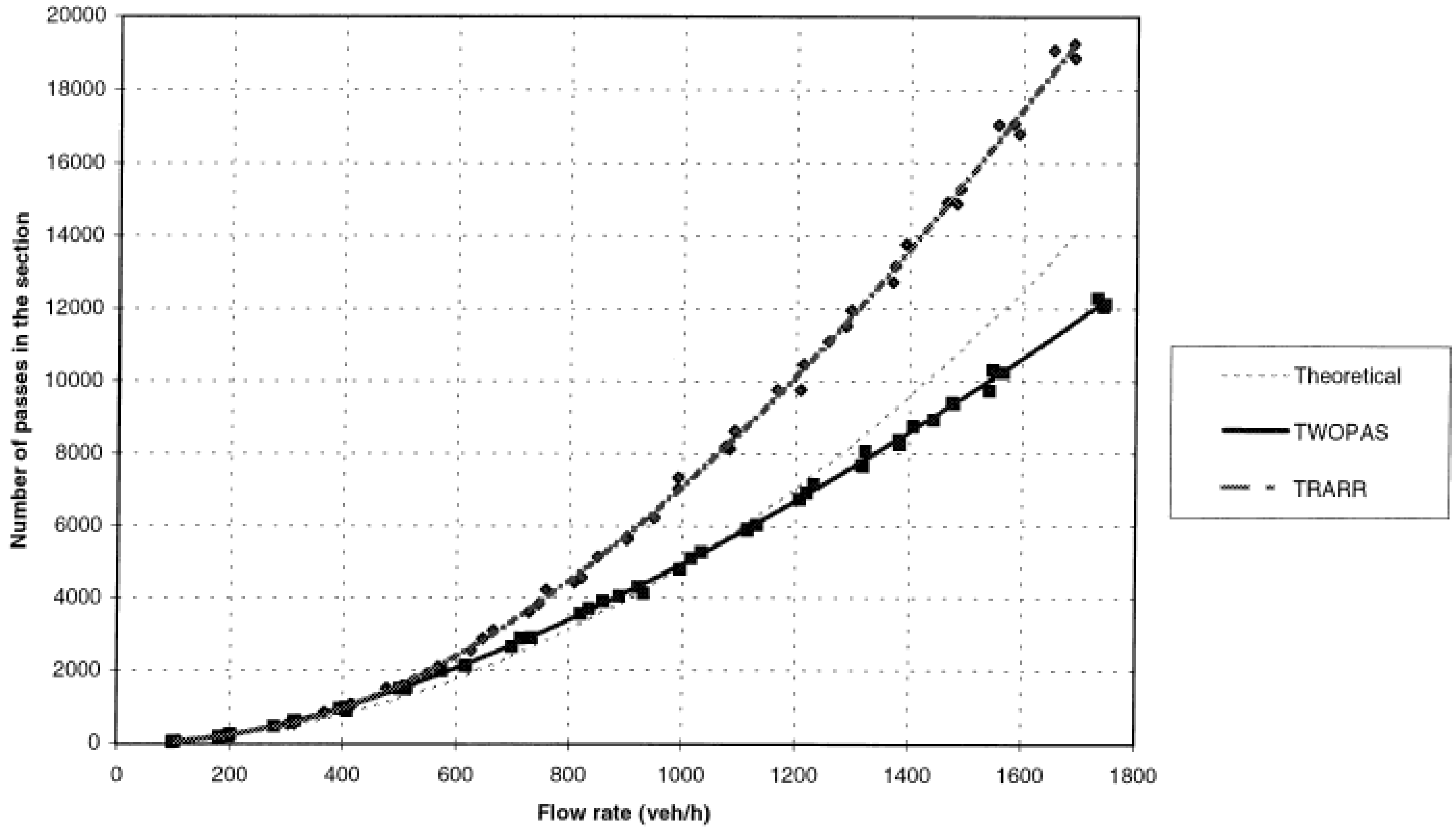

Figure 5.7:2 Number of passes vs flow rate on a 7.8 mi section with an auxiliary lane. Mean speed 60 mi/h S.D.=4 mi/h, 100 % pass cars, 50/50 dir. dist.

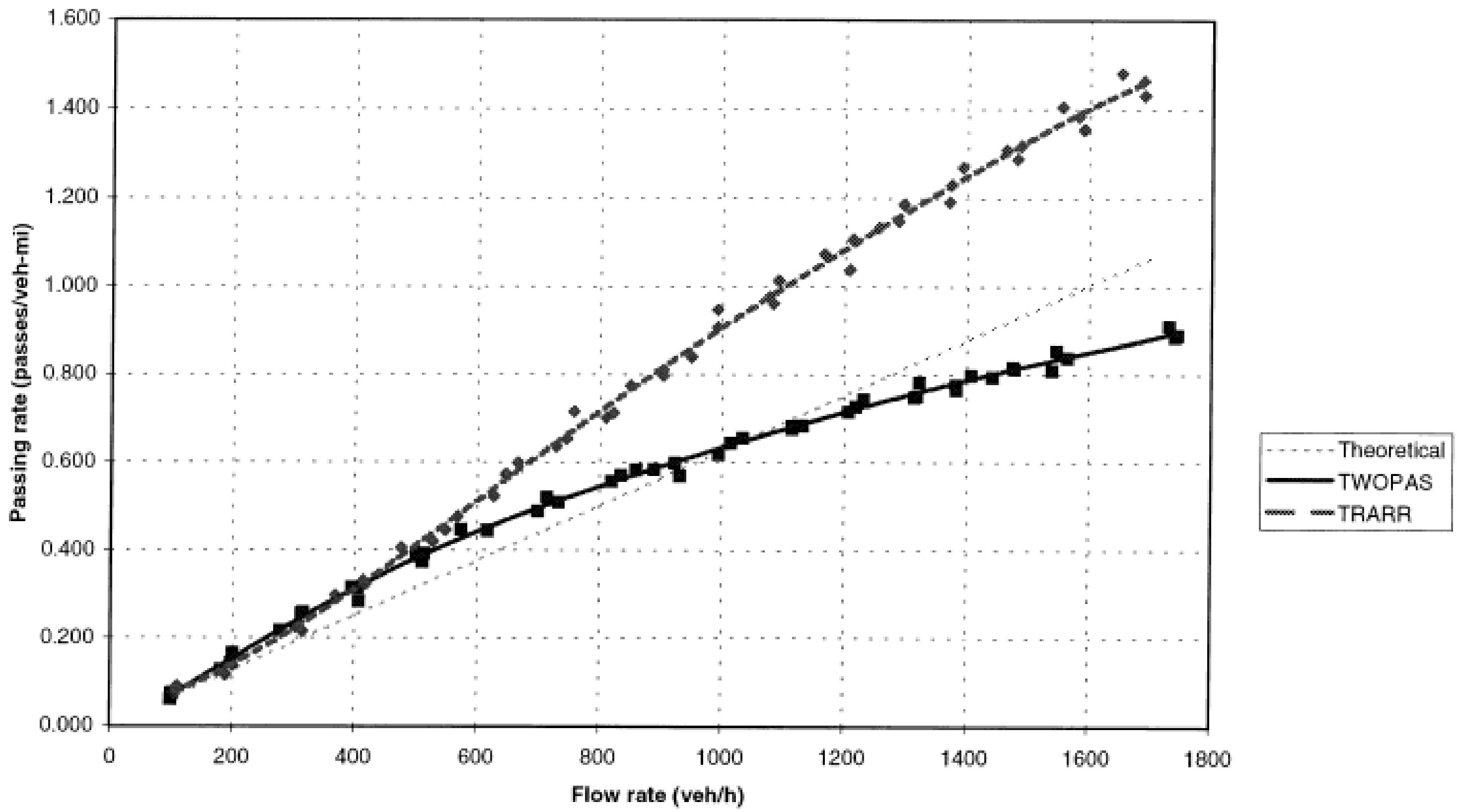

Figure 5.7:3 Passing rate vs flow rate on a 7.8 mi section with an auxiliary lane. Mean speed 60 mi/h S.D.=4 mi/h, 100 % pass cars, 50/50 dir. dist.

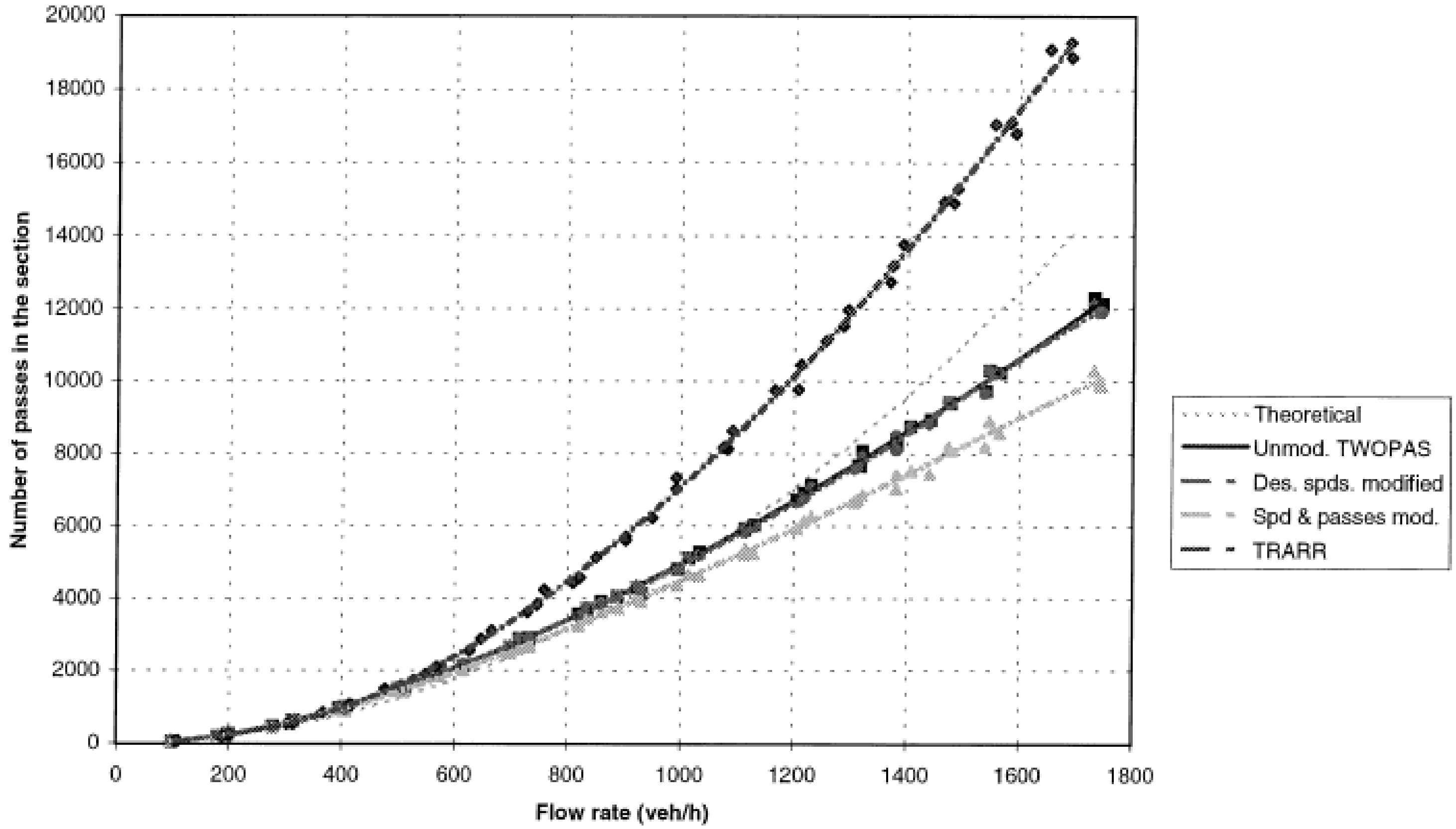

Figure 5.7:4 Number of passes vs flow rate on a 7.8 mi section with an auxiliary lane. Mean speed 60 mi/h S.D.=4 mi/h, 100 % pass cars, 50/50 dir. dist.

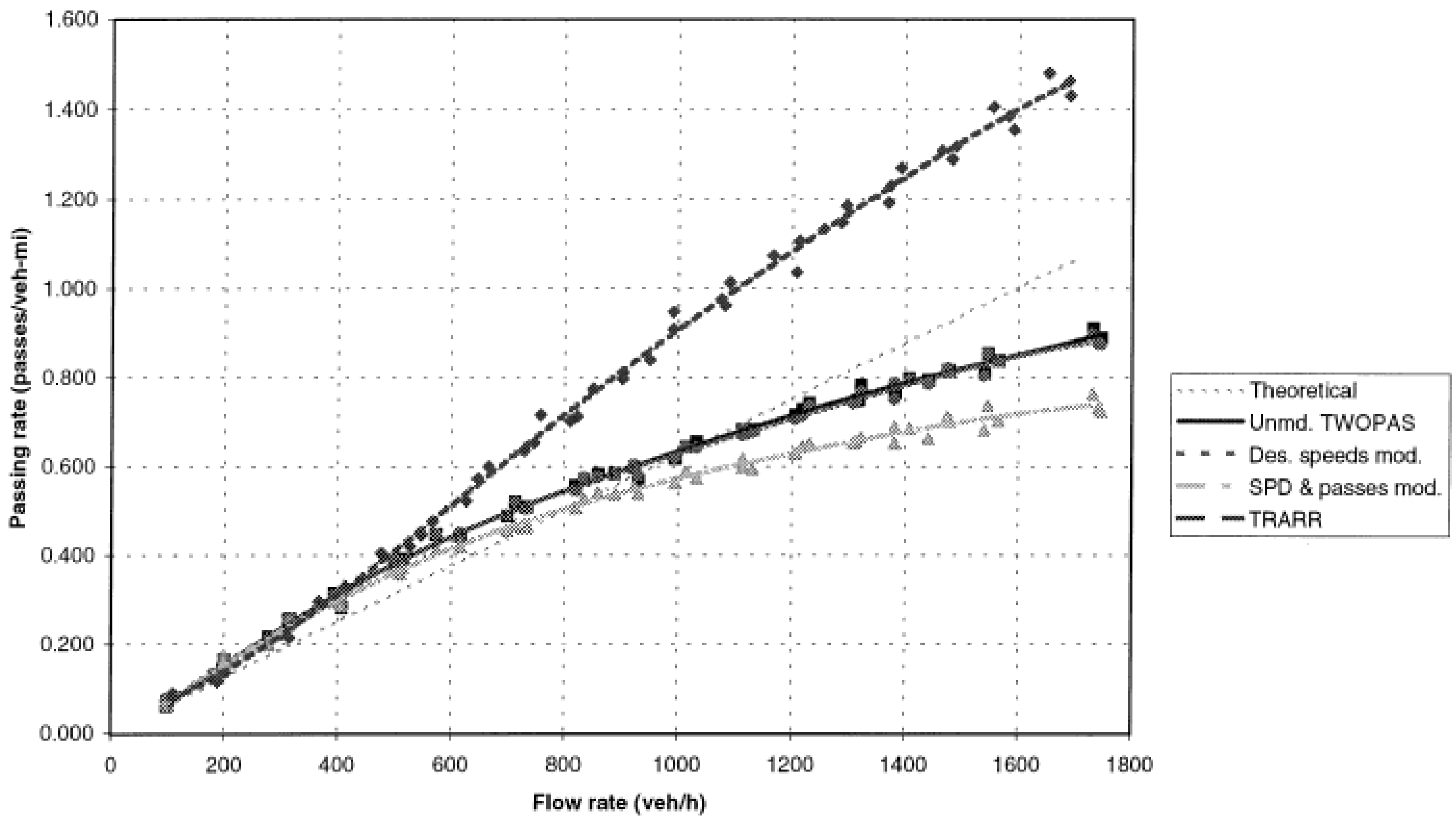

Figure 5.7:5 Passing rate vs flow rate on a 7.8 mi section with an auxiliary lane. Mean speed 60 mi/h S.D.=4 mi/h, 100 % pass cars, 50/50 dir. dist.

5.8 F2 - Improvements to TWOSUM Output

Current Status: incorporated.

The TWOPAS model produces an extensive output file. A post-processing program called TWOSUM extracts information from the TWOPAS output file and writes this selected information to a file called TWOSUM.OUT. This TWOSUM output consists of three parts: some general information about the run, spot information at the individual observation stations, and information collected over intervals. The UCBRURAL interface reads the TWOSUM output file after a run has been made and uses that data to produce profile graphs of Percent Following, Mean Speed, and Number of Passes (see Section 5.12). The appropriate data collected over the interval from the first to the last observation station in each direction is printed above each graph. The user is also able to print the TWOSUM.OUT file by selecting this action from Output on the Main Menu (section 5.19). Researchers on the project felt that output from TWOSUM would be much more useful if additional information were added and if it were split into two parts: a summary table and a detailed listing of the observation station spot information.

After making a TWOPAS run, the user can print a one page output summary by selecting Summary under Output on the Main Menu. The Summary output consists of three tables;

The first table includes the specifications for the run such as Simulation Time, Settling Down Time, and the Random Number Seeds; the name of the user input files; Length of Simulation, and the Length of Warm-up Sections.

The second table consists of Input Data such as Flowrate, Distribution of Traffic, Desired Speed, Standard Deviation of Speed, and Percent Platooning of Entering Vehicles.

The third table consist of output for the Simulation Length and the User Supplied Intervals. This output displays Simulated Flowrate, Average Percent Time Following, Average Speed, Trip Time, Trip Delay due to traffic, Trip Delay due to the geometry, Total Trip Time, Number of Passes, Vehicle-miles, and Vehicle-hours.

After making a TWOPAS run, the user can print directional detailed output that has been collected for each observation station by selecting Detail under Output on the Main Menu.

For each of these output options, the printer should be set to condensed printing (line printer - 132 columns and the IBM character set). The user will have to check their printer manual for instructions on how to change their printer settings.

All changes for this improvement were made to the UCBRURAL interface. No modifications were made to the TWOPAS code. A sample of the Summary output table and the Detail output at observation stations are shown in Appendix C.

5.9 G1-1 - Study: Speed/Acceleration Capabilities

Current Status: incorporated

New vehicle performance characteristics provided by MRI were incorporated into TWOPAS. There are thirteen vehicle types modeled in TWOPAS. Table 5.9:1 shows the vehicle characteristics for the four trucks types; table 5.9:2 shows the vehicle characteristics for the four types of recreational vehicles; and table 5.9:3 shows the vehicle characteristics for five types of passenger cars. Note that both the original values and the new values are listed in order to indicate the magnitude and direction of the changes that have been made.

TABLE 5.9:1 SUMMARY OF UPDATED TRUCK PERFORMANCE CHARACTERISTICS

TWOPAS Vehicle Type	Percent of Truck Population	Original Weight to Net Horsepower (lb\hp)	Updated Weight to Net Horsepower (lb\hp)	Original Weight to Projected Frontal Area (lb/ft^2)	Updated Weight to Projected Frontal Area (lb/ft^2)
1	12.0	266.0	228.0	620.0	682.0
2	25.6	196.0	176.0	420.0	462.0
3	34.0	128.0	140.0	284.0	340.0
4	28.4	72.0	76.0	158.0	174.0

TABLE 5.9:2 SUMMARY OF UPDATED RV PERFORMANCE CHARACTERISTICS

TWOPAS Vehicle Type	Percent of RV Population	Original Maximum Acceleration (ft/sec^2)	Updated Maximum Acceleration (ft/sec^2)	Original Maximum Speed (ft/sec)	Updated Maximum Speed (ft/sec)
5	10.0	8.22	9.0	102.67	110.0
6	40.0	8.64	11.0	105.42	115.0
7	40.0	8.75	12.5	110.81	120.0
8	10.0	8.66	14.0	114.07	125.0

TABLE 5.9:3 SUMMARY OF UPDATED PASSENGER CAR PERFORMANCE CHARACTERISTICS

TWOPAS Vehicle Type	Percent of Passenger Car Population	Original Maximum Acceleration (ft/sec^2)	Updated Maximum Acceleration (ft/sec^2)	Original Maximum Speed (ft/sec)	Updated Maximum Speed (ft/sec)
9	10.0	9.277	11.17	109.14	112.8
10	15.0	9.766	11.99	114.89	117.8
11	20.0	10.089	12.77	118.69	121.1
12	25.0	10.429	13.22	122.69	127.0
13	30.0	11.281	14.10	131.78	142.7

Note that vehicle type 9 is the lowest performance passenger car, while vehicle type 13 is the highest performance passenger car.

Two changes were made to the UCBRURAL interface for this modification. First the defaults for vehicle characteristics that are written to the TWOPAS.INP file in the interface were changed to the updated values. Secondly, the default values as listed in the user-supplied default file (see Section 5.15) were changed to the updated vehicle characteristics values.

No changes were made to the TWOPAS source code because vehicle characteristics are input variables provided to the TWOPAS model in the TWOPAS.INP file.

5.10 G3 - Correct Speed on Curves

Current Status: *incorporated*

The reason for working on this improvement was that it was observed that TWOPAS did not reduce the speed of vehicles on curves adequately. For a very wide range of curve radii the speeds were completely unaffected until a relatively sharp radius was specified at which the curve effect seemed to be triggered. In order to explain the problem the handling of curve effects in TWOPAS will be explained.

TWOPAS considers that the distribution of desired speeds in a horizontal curve is essentially normal in the cumulative range 1 percent to 99 percent. The calculated distribution for a specific curve in the simulation is based on a maximum speed and a minimum speed for the curve. Both the maximum and minimum, Umax and Umin, are based on the lateral acceleration. The equations for Umax and Umin are given elsewhere (1)

In the simulation, an individual vehicle on a curve has a curve desired speed proportional to its normal desired speed. The normal desired speed is the algebraic sum of a mean speed and a deviation from the mean which is a factor multiplied by the standard deviation (that is des. speed= mean + factor * standard deviation). In the curve the same factor is applied to the standard deviation of speeds on the curve and the result is added to the mean speed on the curve to obtain the speed of the vehicle on the curve.

Figure 5.10:1 illustrates the distribution of speeds on the curve for a 500 ft radius curve. The figure also illustrates the desired speed distribution on the tangent for different standard deviations of desired speed. The speed on curves problem arises because the program only applies the curve speed distribution when the calculated maximum speed on the curve is less than the maximum speed on the tangent. So for example, in Figure 5.10:1 the speed on curve distribution would be applied for the standard deviations of desired speeds of 2, 3 and 6 mph but not for standard deviations of 0.01 and 1 mph.

The problem was solved as follows. Whenever a curve is specified, the speed on curve distribution is applied. However, the upper limit of the distribution is different in some cases. If Umax is less than the maximum desired speed on the tangent then the curve speed distribution is the same as before but if Umax is greater than the maximum speed on curve then Umax is assigned the value of the maximum speed on the tangent and the distribution on the curve is considered a truncated normal distribution where Umin and Umax are the truncation points and $U_{min}=V_{meancurve}$ -

$3\ \sigma_{curve}$ and $U_{max} = V_{meancurve} + 3\ \sigma_{curve.}$ A test was also included for very unlikely cases in which the minimum speed on the curve is greater than the minimum speed on the tangent. If so, the minimum speed on the curve is made equal to the minimum speed on the tangent since no vehicle would accelerate because it enters a curve.

Figure 5.10:2 and Figure 5.10:3 show the simulated speeds on a 0.2 mi long curve of varying radii for standard deviations of desired speed of 0.01 mph and 4 mph. As can be observed, the effect for the 0.01 mph standard deviation is greater than for the 4 mph standard deviation especially for the larger radii. This is to be expected after the modification of the algorithm. Figure 5.10:4 shows how the mean desired speed on the curve changes with radius for the two standard deviations. For the lower radii, the curve equation for Umax is governing so the standard deviation of desired speed has no effect. However, for the larger radii the maximum desired speed is smaller than the computed value of Umax and therefore the former, which is obviously smaller for the smaller standard deviation, is used as the maximum value of the distribution.

No changes were made to the UCBRURAL interface. Changes were made to the TWOPAS source code for subroutine PROCI. All changes to this TWOPAS subroutine for this modification are shown in the source code with the label:

C ** UCB 97 - CORRECT SPEED ON CURVES

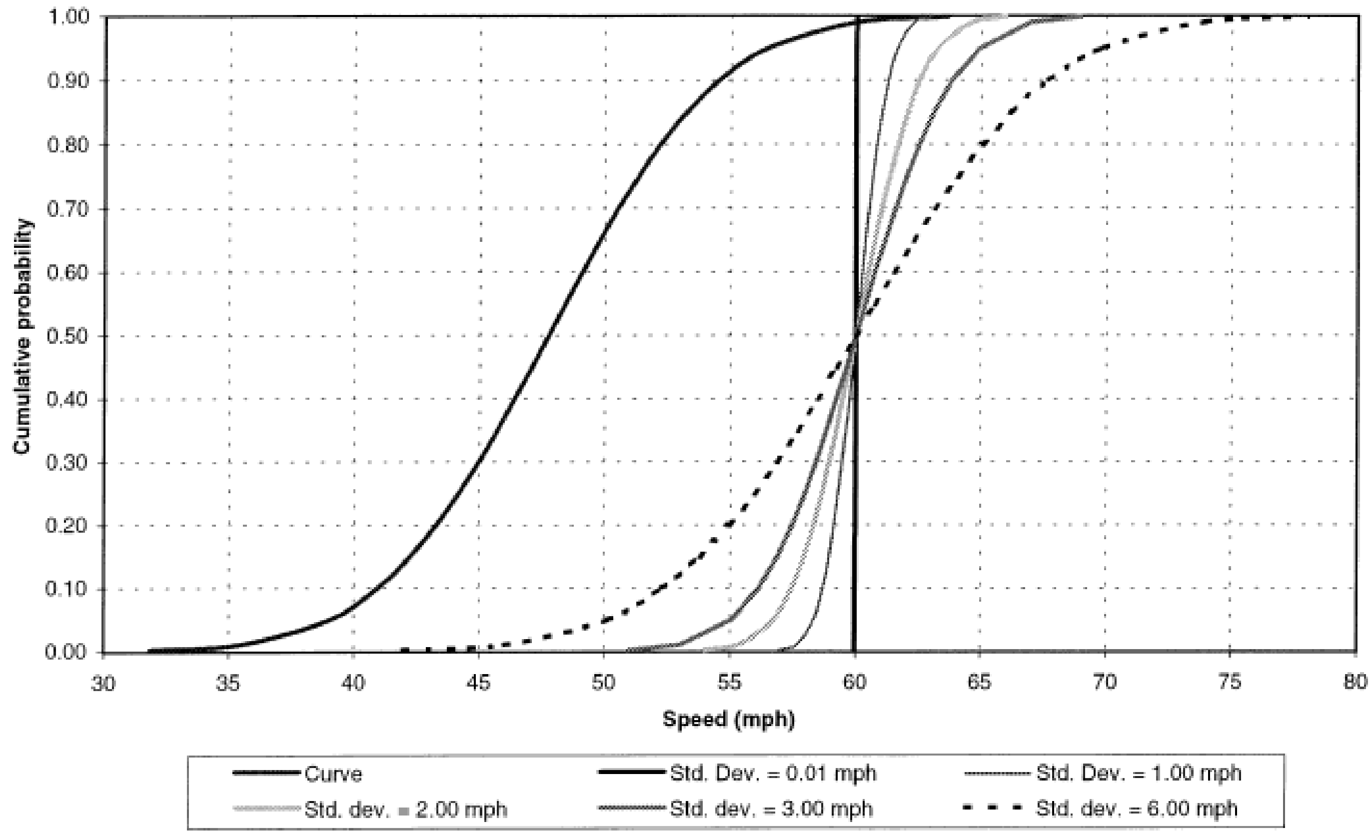

Figure 5.10:1 Curve and tangent speed cdfs for std devs of speed from 0.01 to 6 mph. R = 500 ft, s=0.08

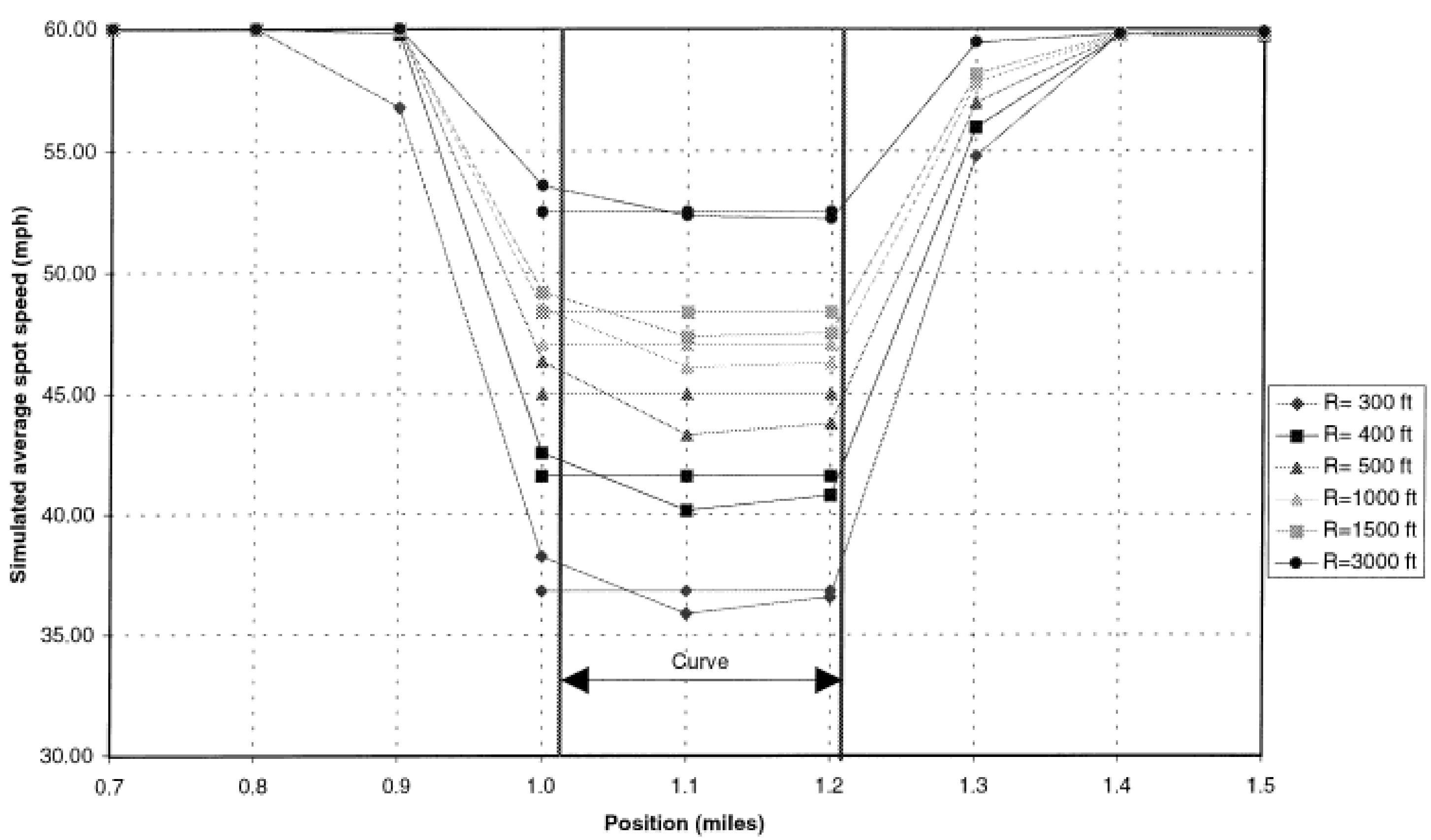

Figure 5.10:2 Simulated average spot speed vs. position. Flow rate 100 vph per direction 100 % passenger cars. Curve length =0.2 mi. Mean des. spd.=60 mph. SD=0.01 mph. The horizontal lines on the curve are the desired average speed on the curve.

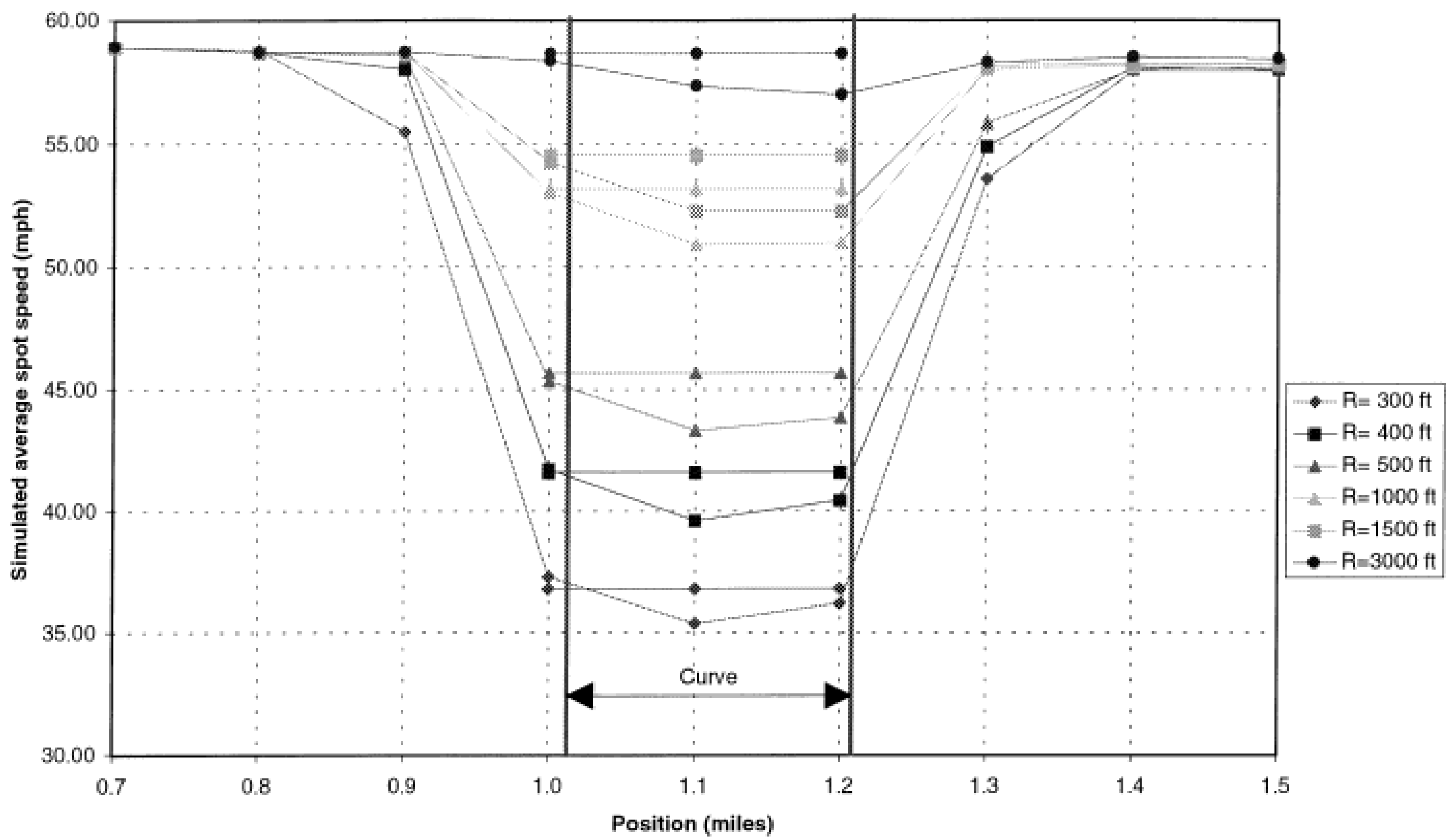

Figure 5.10:3 Simulated average spot speed vs. position. Flow rate 100 vph per dir 100 % passenger cars. Curve length =0.2 mi. Mean des. spd.=60 mph. SD=4 mph. The horizontal lines on the curve are the desired average speed on the curve.

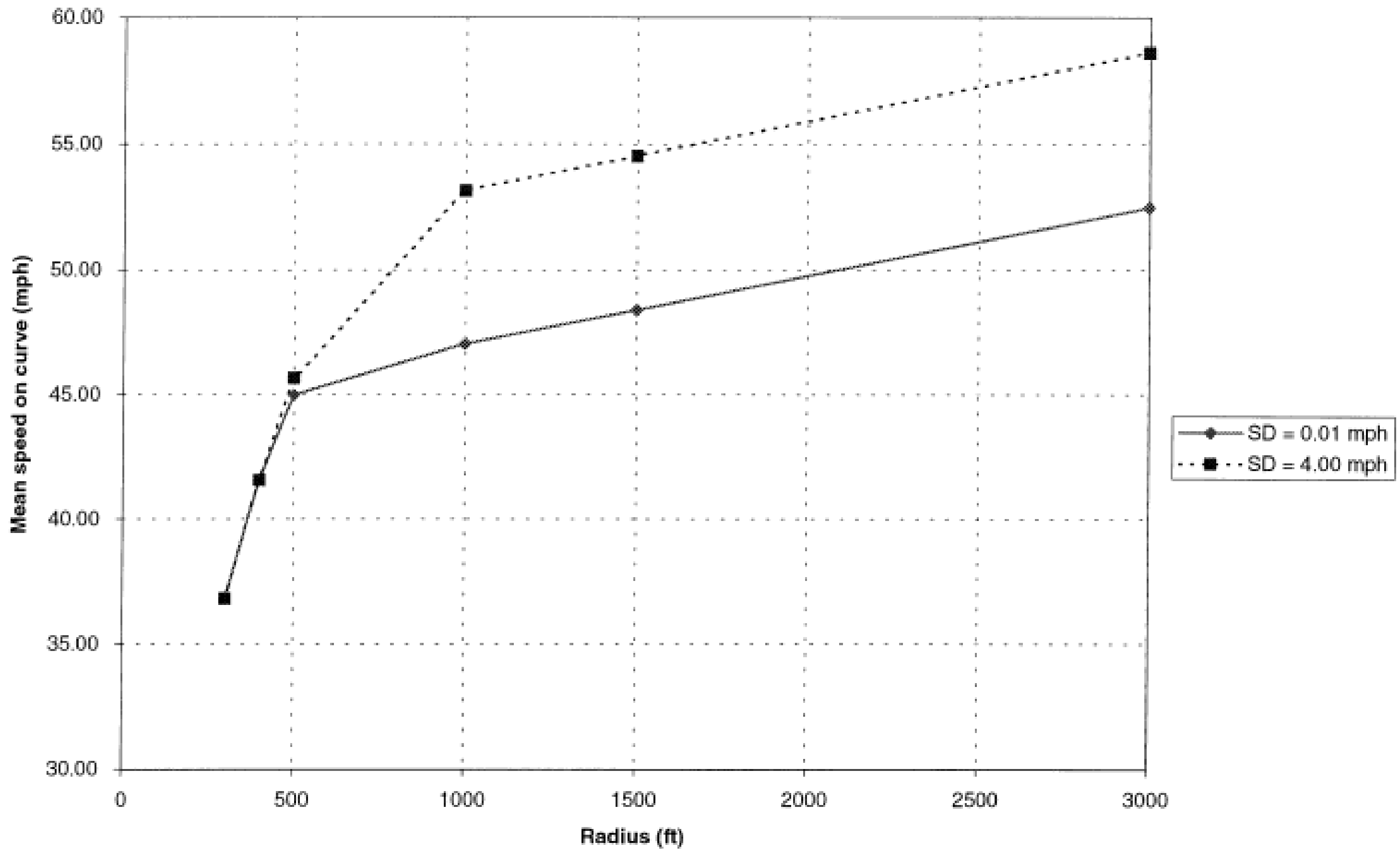

Figure 5.10:4 Average spot speed on the curve vs. radius.

5.11 H1 - Input Zone Data Approach

Current status: *incorporated*

The Road Data Set defines the geometry of the roadway. With implementation of D3 - Increase Array Dimension (Section 5.4) specifications for up to 1200 equal-length road sections may be provided by the user. Although the TWOPAS model does not require that this information be entered for equal-length road sections, the incorporation of TWOPAS into the UCBRURAL interface was simplified by deciding that this requirement would be applied to TWOPAS as well as to TRARR for which the interface was originally developed. Entering road data in the interface for TWOPAS by road section was adequate for an original research tool. However, as work with TWOPAS increased, it became apparent that the interface should reduce the effort required by the user to enter road data by implementing the zone method of the TWOPAS model.

The road variables that currently need to be entered for each road section are the location of passing lanes, the grade, and curves. Sight distance and passing zone data may be entered for each road section or may be calculated automatically by the new modifications to the interface (see sections 5.13 and 5.14).

The goal for modifying the interface to accept zonal data was to devise a simple procedure that could be incorporated into the general logic of the existing road data screen. There were several reasons for this decision. First, developing a whole new procedure for entering road data would be unnecessarily expensive and time consuming. Secondly, the various displays on the current road data screen are very helpful in visualizing the roadway as data is being entered and in may cases will alert the user to data entry errors.

There are two pictures of the roadway visible at the top of the originally implemented road data screen, one showing a plan view, and one showing a profile view. The current subsection is always displayed in the center of these two figures, and is highlighted in a different color. These views are automatically updated any time a change is made to any of the relevant roadway data. The geometric data corresponding to the displayed roadway is contained in the large table below these figures. The current subsection always occupies the center of this table, and as before, is highlighted.

A method for allowing the user to enter road data in a zonal or regional method within the current road data screen has been developed and is in the process of being implemented. The general procedure for beginning a new study will be to have the user specify not only the length of the equal-length road section but also the total length of the road. The interface will then generate all the road sections with default values. (Previously the user added each road section separately.) Beginning at the top of the road file, the user will enter all the data for one variable for the entire roadway. Each time a value is entered, it will be automatically repeat for the remaining road sections to the end of the roadway. In this way the user need enter values only where they change. When the road data is being edited after the data has been entered by this method a similar procedure will take place. In this case, each time the user enters a value for the given variable, it will automatically be stored in all the following road sections if they have the same value as the one that was replaced by the user. For example, if there are 25 road sections with a grade of 3% and the first one is changed by the user to 3.5%, then the grade for the remaining 24 road sections will also be changed to 3.5%.

This procedure, while quite simple, allows the TWOPAS user to think of the road data as zonal data and enter it in that fashion. At the same time, the user benefits from the graphic depiction of the road data as it is entered on the existing road data screen , and also can see the interaction of the various variables as displayed section by section.

Some users may still prefer to edit road data for each road section after the initial data is entered. In order to allow for this possibility, the user will be able to set a flag in the Environment Option from the Main Menu bar which will specify whether road data is to be entered by this new zonal technique or for each individual section. This option can be toggled back and forth to accommodate changing needs during data entry.

Note that the shorter the road section length the more detail can be provided. However, the maximum number of road sections remains constant , so that the length of the roadway may have to be reduced. At the present time the interface handles 1200 equal-length road units.

When the user requests that a TWOPAS run be made, either a single run or a run that is part of a multiple run (see Section 5.20), the interface processes all of the current data and produces an input file for TWOPAS. Included in that input file will be the road data that the interface has converted to zonal form as expected by the TWOPAS model. At the present time, the TWOPAS model has a limit of 600 sight distance zones in each direction, 600 grade regions in direction 1, 300 passing zones in each direction, 150 horizontal curves direction 1, and 100 reduced speed zones in direction 1. The limits on these regions were increased for another modification, D3 (Section 5.4).

All changes made for this improvement were made in the UCBRURAL interface. There were no modifications made to the TWOPAS code.

5.12 H4 - Add Profile Graph of Number of Passes

Current Status: incorporated

The number of passes or the passing rate along the road is a potentially important measure of effectiveness (MOE) of the quality of service on two-lane highways. Unfortunately TWOPAS yields this information only for the specified intervals which are only two per direction. This improvement was performed so that a graph of the number of passes along the road (or the passing rate along the road) could be computed.

Obviously, the number of passes and the passing rates cannot be computed at a point; they have to be computed over an interval. For this case the obvious choice of the intervals were the intervals defined by consecutive observation stations. The concept used for this improvement was essentially the same used for improvement N4-Allow Two User-defined Data Collection Intervals (Section 5.25). For N4 a second column was added to the SL cards in the TWOPAS input file so that overlapping intervals could be specified. Here, instead of adding a third column to the file, a third column was virtually created inside the program and the limit of intervals instead of being 10 was redefined as 100 per direction (maximum number of observation station per direction). The limit was redefined only for this third virtual column. The program automatically assigns observation station 1 to subinterval 1, observation station 2 to subinterval 2, and so on.

Though the collection of data is essentially the same as for the user specified intervals, only the number of passes and the passing rates were needed. Therefore some new simplified subroutines had to be created to obtain only the passing information on the subintervals. Further, although the information corresponds to subintervals they are displayed together with the station information on both the TWOPAS and the TWOSUM output files (see for example the last column on the modified TWOSUM output file shown in Appendix E. The number of passes reported for station 1 were computed between stations 1 and 2, the number reported for station 2 were computed between stations 2 and 3, etc. Thus, the number of passes and the passing rate reported for a given observation station are the number of passes and the passing rate observed between that observation station and the *next* observation station. Therefore the reported numbers for the last observation station in each direction will always be equal to zero.

Modifications to the UCBRURAL were minor, since the interface already produced a graph for Number of Passes; there was just no data to graph. Now that the data is available, the interface produces a completed graph for Number of Passes, both on the screen and in printed form (see Appendix D).

The following changes were made to the TWOPAS source code:

added	**COMMON /PPROF/ KPASS(600), FTTVLS(600)**
to subroutines	ERASE AND POUT
changed	COMMON /STAT/ MSTA(2),JCDA(300,2,2),XSTA(300,2),PTDES(300,2,10)
throughout to	COMMON /STAT/ MSTA(2),**JCDA(300,2,3)**,XSTA(300,2),PTDES(300,2,10)

Note that COMMON /STAT/ had already been changed for improvement N4 Allow Two User-defined Data Collection Intervals as described in section 5.25.

A new subroutine DBSPT2 was added to the TWOPAS source code. Additional changes were made to subroutines CXSTA, ERASE2, POUT, AND REED2. All changes made to these TWOPAS subroutines for this improvement are shown in the source code with the label:

C ** UCB 97 - PASSING PROFILE

5.13 H5 - Automatic Sight Distance Calculation

<u>Current status</u>: *incorporated.*

This was a major effort improvement whose purpose was to relieve users of the TWOPAS model from computing the sight distance either from plans and profiles or in the field. These calculations are very time consuming and expensive and therefore practitioners often use approximations. Thus, the UCBRURAL interface was modified to allow the automatic calculation of the sight distance along the road. The calculations performed by the algorithm are also approximate because, as it is explained below, several simplifications were needed to make it relatively simple and fast. The simplifications are nonetheless considered adequate for several reasons. First, the algorithm computes the sight distance as is usually done by most practitioners. Second, it requires the input of just a few parameters. Although a more comprehensive algorithm could be designed, this would require too many inputs, thus making its application unfeasible. Third, the TWOPAS simulation model needs only an approximation to the sight distance profile in order to assess the feasibility of passing maneuvers. Fourth, if deemed necessary, the user can still alter the computed values.

The following paragraphs succinctly describe the major features of the algorithm.

The algorithm that automatically computes the sight distance needs as input the horizontal and vertical alignment of the road, the drivers eye height (h_1), the height of the object (h_2), and the distances from the centerline to the obstructions to both sides of the road (from now on called offsets.) Although the user can input different values of the offsets for each side of the road, these need to be constant along the road, i.e., the obstructions are modeled as continuous lines parallel to the centerline. This assumption greatly simplifies the algorithm and the interface. Further, as mentioned before, practitioners do not usually measure these distances in the field, and they usually make the same assumption. Again, there is always the possibility of making the calculations several times with different offset values and then selecting the appropriate values. This, however, has not been automated.

Other important assumptions of the algorithm are the following. Only circular curves are modeled. This is a restriction in the TWOPAS model that has been carried over to this algorithm. In TWOPAS the modeling of spirals is not important from an operational point of view. For the automatic sight distance calculation spirals are not important either because there are other assumptions that have greater implications. For example, the assumption that the obstruction follows a parallel line to the alignment is a much stronger one. In fact, even if the alignment had spirals, it is unlikely that the offsets would be parallel to the alignment in the spiral section. Therefore, this simplification is also reasonable.

Only daylight conditions are modeled. Nighttime conditions and the restrictions posed by overpasses are not modeled. The sight distance is computed from a position on the centerline of the road to another position on the centerline, i.e., the vehicle evaluating a pass and the opposing vehicle are both assumed to be on the centerline. This is again a simplification, but the practical consequences are negligible (remember that constant offsets have been assumed along the road, which is a more restrictive assumption.)

The algorithm computes the horizontal and vertical sight distances independently for points located on the centerline of the road a constant interval apart and for each point chooses the minimum of the two as the available sight distance. Again, this procedure is approximate since no account is made for the effects of superelevation or for how the offset changes when the offset distance is determined by a back slope (the offset distance cannot be constant when a vertical and a horizontal curve are superimposed and the offset is determined by the back slope unless the back slope is vertical.) However, this is what is usually done in practice and is recommended by AASHTO.

The conceptual basis for the procedures that compute the horizontal and vertical sight distances are explained in the following two subsections. Then subsection 5.13.3 briefly explains how the information passed to TWOPAS is obtained. Appendix A contains the mathematical derivation of the most fundamental equations needed for the procedures. The material in that appendix together with the following subsections and the algorithm source code, which contains extensive comments, should suffice for researches to understand the whole procedure.

5.13.1 Horizontal Sight Distance

The assumption that the objects obstructing the sight line are located on both sides of the road at constant distances (offsets) measured in the perpendicular direction to the centerline makes the determination of the sight distance relatively straightforward (note that the offsets at each side of the road can be different.) The only elements that can obstruct the sight line are arcs of circumference parallel to the curves of the centerline and located on the inside of the curve a distance equal to the offset corresponding to that side of the curve. This is illustrated in Figure 5.13:1. Note that the inside of the curve is the side where the center of the arc is located.

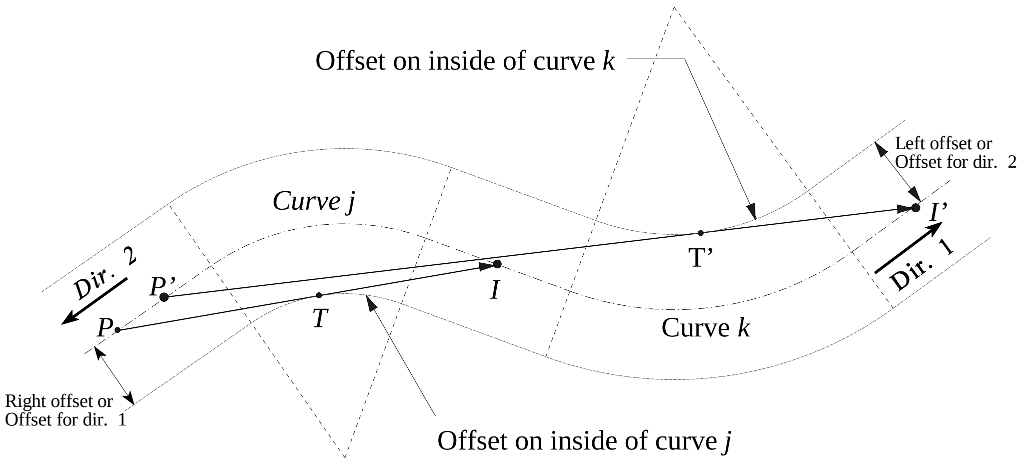

Figure 5.13:1 Only the inside of the curves can obstruct the sight distance

Based on this simple observation the algorithm proceeds as follows. For each point (lets call it P) the algorithm first find its coordinates x_p and y_p. Different procedures are used depending upon the point P being located on an tangent element or in a curve element *I* of the alignment. After that, the following computations are performed first in direction 1 and then in direction 2. First, the sight distance, HorSD, is initialized with a value of MAXSD. MAXSD represents a value beyond which passing maneuvers are not affected. Then the algorithm finds the first curve *I* on the alignment (centerline) that may obstruct the sight distance. If P is on a curve then that curve is selected and labeled *j*, if not then the first curve after P (in the direction being considered) is selected. The algorithm then proceeds to find the equation of a straight line that is tangent to a curve parallel to curve *j* at a distance equal to the offset corresponding to the inside of the curve. Note that such a tangent may not exists. If the tangent does exist the algorithm finds the station corresponding to the tangent point. A provision is made for cases such as the one shown in Figure 5.13:2 in which the direction of the tangent line selected is opposite to the direction being considered. In such cases, the algorithm selects the other tangent line if it exists or sets a flag to indicate that a tangent was not found. If a tangent is not found the algorithm continues with the curves located downstream until a tangent is found or the curves are located at distances greater than MAXSD. In the latter case, the sight distance is assumed to be MAXSD, i.e., for all practical purposes there are no obstructions to the sight line. Such a case is illustrated in Figure 5.13:3 in which the actual sight distance is given by the segment PI whereas MAXSD reaches up to point Q located upstream of A.

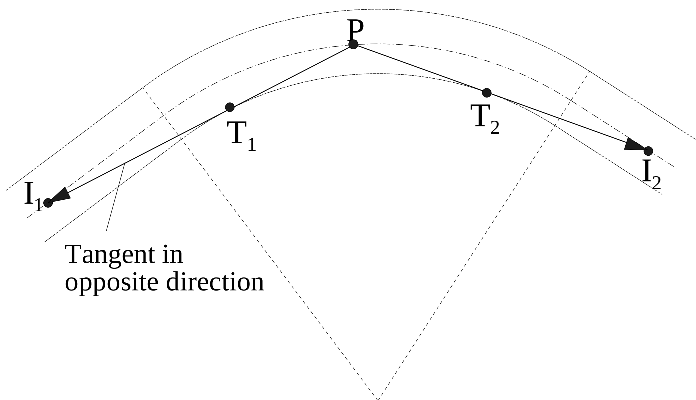

Figure 5.13:2 It must be checked that the tangent obtained is in the direction of interest

Once a tangent to an offset curve has been found, the algorithm proceeds to find the first intersection of the tangent line with the centerline in the direction being analyzed. For this, each

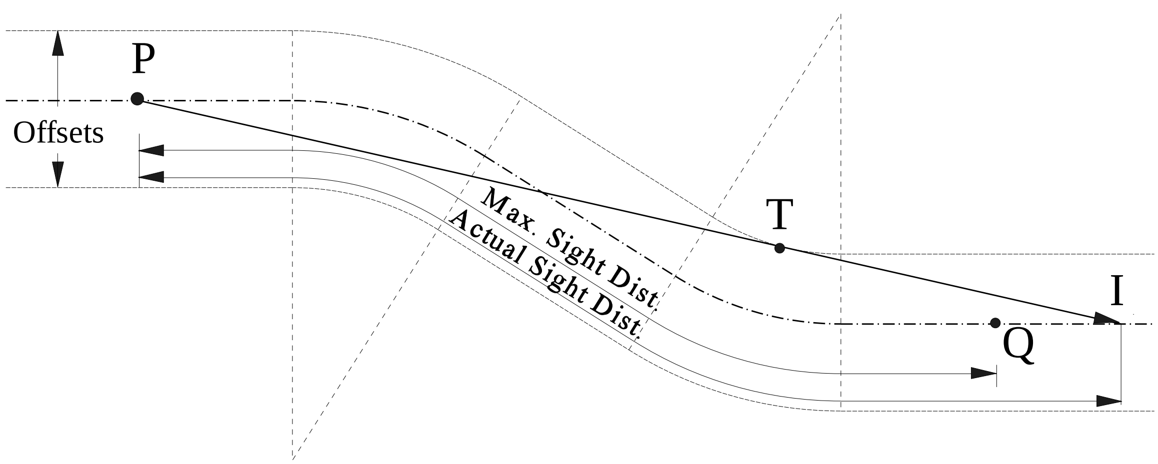

Figure 5.13:3 A case where the actual sight distance is greater than MAXSD

alignment element *k* (starting with element *j*) is inspected to see if intersects the tangent line. Once

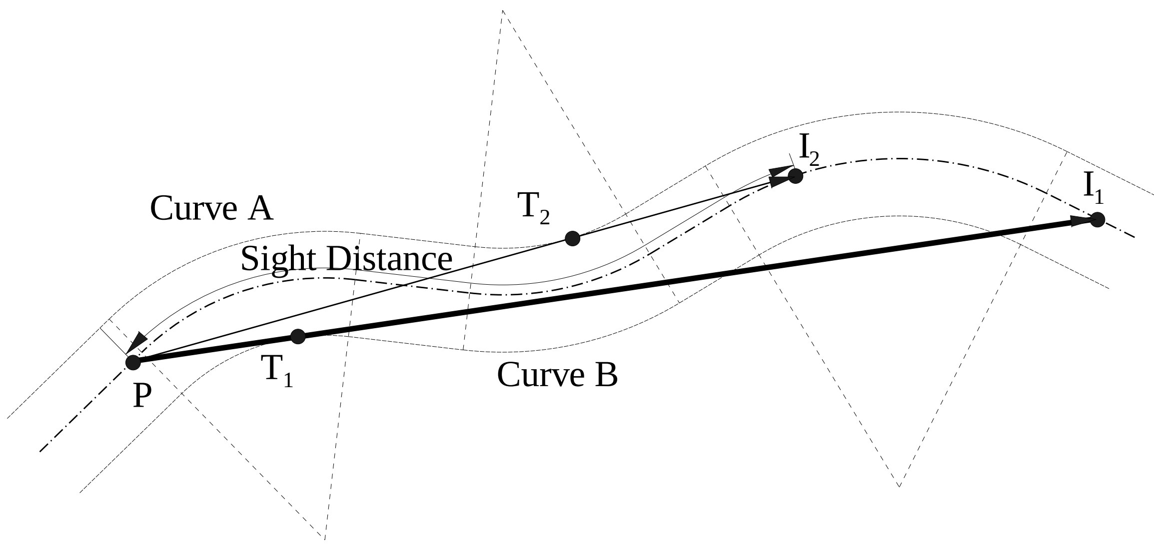

Figure 5.13:4 A curve located further away from P can be more restrictive than one closer to P.

an intersection *I* is found, the sight distance from *P* to *I* is computed. If the computed sight distance is less than the horizontal sight distance HorSD then the value of HorSD is updated. Notice that different procedures are used to find the intersection of the tangent line with curves and straight segments.

At this point even if a sight distance value less than MAXSD has been found the algorithm still continues analyzing other curves located further downstream. The reason for this is evident from Figure 5.13:4. As shown in the figure, curve A is located closer to P than curve B. However, curve B is more restrictive than curve A. Further, in other situations curve A may not restrict the sight line at all whereas a curve like B, located downstream of A may restrict the sight line. Therefore the algorithm keeps analyzing curves until a curve whose starting point is located a distance (measured along the alignment) greater than MAXSD is found. Clearly, a curve that is beyond MAXSD cannot restrict the sight distance to values less than MAXSD.

5.13.2 Vertical Sight Distance

The algorithm for the determination of the vertical sight distance proceeds in a similar fashion as the one for the horizontal sight distance. In this case the only vertical alignment elements that can obstruct the sight line are the convex vertical curves. The point at which the sight is lost however, can be located in any kind of element. The algorithm starts by identifying the vertical alignment element *I* (either straight segment, a concave vertical curve or a convex vertical curve) that

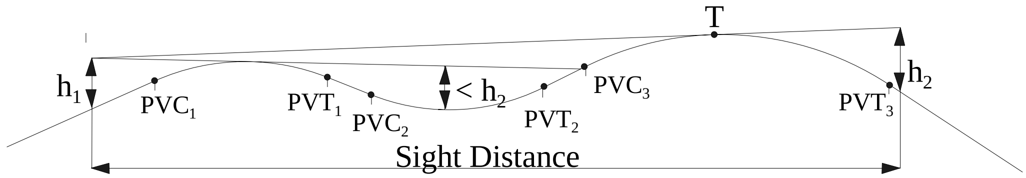

Figure 5.13:5 The first crest vertical curve does not restrict the sight.

contains the point *P* at which the sight distance is to be determined. Then the following computations are performed first in direction 1 and then in direction 2. First, the sight distance, VertSD, is initialized with a value of MAXSD. Again MAXSD represents a value beyond which passing maneuvers are not affected. Then the algorithm finds the first crest vertical curve *j* which may constrain the sight distance (crest vertical curves are characterized by a negative algebraic difference of grades $A=G_2-G_1$, where G_1 is the grade at the start of the curve and G_2 is the grade at the end.) Notice that in some special situations as the one shown in Figure 5.13:5 the first crest vertical curve may not restrict the sight distance at all. If a crest vertical curve is found downstream of P the algorithm tries to find a tangent to that curve and the point of tangent *T*. A tangent may not always exists. In such a case, the procedure continues with the elements located downstream (in the direction being analyzed) until a crest vertical curve for which a tangent equation can be obtained is found.

Having found a crest vertical curve for which it can be obtained the equation for a tangent line to it that pass through a point a distance h_1 (the drivers eye height) above *P* and if the point of tangent *T* is a distance (measured on a horizontal plane) smaller than MAXSD from *P* then the algorithm proceeds to find the point at which the sight is lost. The sight is lost when the vertical separation between the sight line and the road profile becomes greater than h_2 (the height of the object) for the first time downstream of the point of tangent *T*. As mentioned above the point at which the sight is lost may be located in any kind of vertical element. The paragraphs that follow explain the several tests needed to locate where the sight is lost.

First, the difference in elevation (DeltaY) between the sight line and the alignment at the end of the crest vertical curve constraining the sight is computed. If this difference is greater than h_2 then there is a point between *T* and the end of the curve at which the difference in elevation between the sight line and the alignment is h_2, i.e., the sight is lost in the crest vertical curve constraining the sight. Thus the procedure **SightDistOnCrest** is called to obtain the sight distance. As its name implies this procedure computes the sight distance when the point where the sight is lost is located on a crest vertical curve. However, if DeltaY at the end of the crest vertical curve is smaller than h_2 then the sight is lost somewhere downstream, so in order to find where the sight is lost the algorithm proceeds to analyze the elements *k* located downstream of the crest vertical curve that constrains the sight. Depending on the type of vertical alignment element different procedures are used to test if the sight is lost on the element. The details the procedures are explained in the comment lines of the source code and the basic equations for them are derived in Appendix A. It is worth noting that when element *k* is a crest vertical curve, a test has to be performed to see if it is more restrictive than the crest vertical curve *j* (the current crest considered as restricting the sight). The test simply consists on finding the slope of a tangent line to curve *k* that pass through a point a distance h_2 above P and then comparing this slope with the slope of the tangent to curve *j*. If the tangent to curve *k* is more restrictive than the tangent to curve *j* then the slope of the tangent to *k* is steeper than the slope of the tangent to *j*. When a more restrictive crest vertical curve is found the parameters of the sight line (the tangent to the crest vertical curve) have to be updated. Once the procedure finds the station of the point at which the sight is lost (x_{SD}), the vertical sight distance is computed simply as the difference x_{SD} - x_P, where x_P is the station of P.

5.13.3 Sight Distance Profile passed to TWOPAS

In the interface, the user activates the automatic calculation of sight distance by clicking on the **acSD** button from within the **Road Data** entry screen. A window will be displayed requesting the user supplied offset values for each direction. The sight distance is then calculated at specific points along the road section. These points are spaced evenly over the road section such that there is a maximum of 10 points for each road section and the points are a minimum of 10 ft apart. The final sight distance for each road section is taken as the minimum of the sight distances that are calculated along its length and is displayed on the **Road Data** screen. The user may change the sight distance for individual road sections as needed. Note that if the sight distances are recalculated any user entered sight distances will be lost.

The procedure to calculate the sight distance requires that vertical curves occur between every change of grade. If the user does not explicitly enter vertical curves, the interface will calculate vertical curves whenever a brake in the grade profile is detected. The vertical curves are calculated based on the equation

$$L = K A$$

where

L = length of the vertical curve (ft)
A = percent change in the grade,
K = rate of vertical curvature (horizontal distance require to effect 1 % change in slope)

The value of K used in UCBRURAL is set at 50 ft.

When the UCBRURAL interface creates the sight distance regions for input to TWOPAS, the sight distances for each road section are rounded to the nearest hundreds. All contiguous road sections with the same sight distance are placed in the same sight distance region.

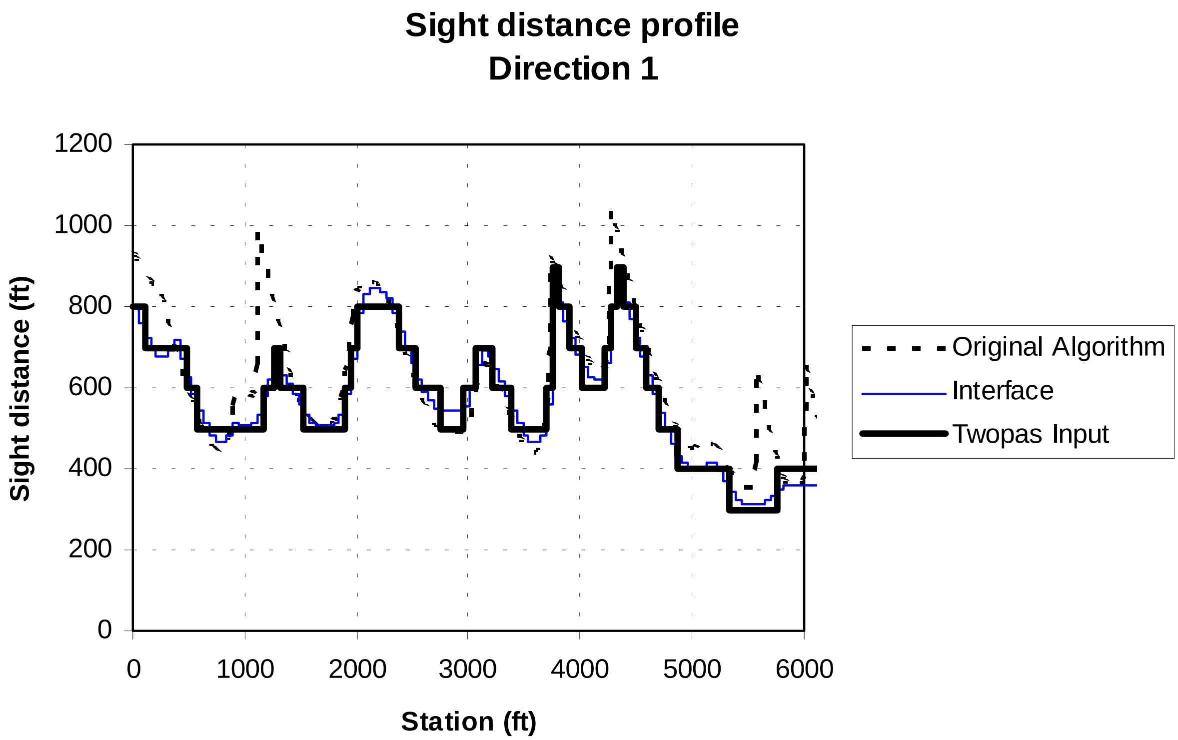

Figure 5.13:6 Example of sight distance profiles.

Figure 5.13:6 shows an example with three sight distance profiles computed for a very restrictive alignment that was used for testing purposes. The line labeled Original Algorithm was obtained by computing the sight distance at points 10 ft apart with the algorithm programmed outside the interface. The line labeled interface was obtained from the interface. The differences between the two lines are because of two reasons. First, the alignment entered into the interface is an approximation of the real alignment used to obtain the line labeled Original Algorithm. The approximation results from entering the alignment as road sections. Thus, for example, if the start of a curve is in the middle of a section then one is forced to either locate the start of the curve upstream of the real start by half a section length or locate it downstream also by half a section length. Second, the line labeled interface is formed by the minimum of the values found on each section. The third line labeled TWOPAS Input represents the information that the interface gives to TWOPAS. This line is simply the line labeled Interface but with the values rounded off to the nearest hundreds. As can be observed for this example the three lines are in close agreement. This is because a small road section was used (0.05 mi.). As the length of the section is increased, greater differences are expected to occur.

All changes for this improvement were made in the UCBRURAL interface. There were no modifications to the TWOPAS source code.

5.14 H6 - Automatic Passing Zone Calculation

Current status: incorporated

This improvement has the purpose making the data input process less intensive. By creating the passing/no passing zones automatically, the user needs to change the barrier line codes only for the sections in which the computed barrier line code disagrees with the field marking. Further, though many two lane road have pavement markings indicating passing/no passing zones, some low category roads may not have these markings. In such cases the automatic calculation of passing zones becomes a very useful and time-saving tool. Finally, even though the purpose of this improvement is just to help the TWOPAS user, it can also help to identify sections with poor or deficient pavement marking (provided the road units are small enough that the sight distance is relatively accurate if computed automatically.)

In order to obtain passing/no passing zones automatically, the sight distance for each road section is needed. This information either has to be entered by the user or calculated automatically as explained in the previous section. The following paragraphs explain the rationale for the determination of the passing/no passing zones and its implementation.

No passing zones should be established on sections with inadequate sight distance. The UCBRURAL interface allows the user to input the minimum sight distance required for safe passing to occur. The valid range for this variable is 500 - 3000 ft (152-914 meters). It is noted that the range recommended by the MUTED is between 500 ft for an off-peak 85th percentile speed or posted speed limit (whichever is higher) of 30 mph and 1200 ft for 70 mph. In addition no passing zones should also be established in sections with adequate sight distance for passing but located between no passing sections separated by a small distance, this in effect limits the minimum length of a passing zone. MUTED recommends a minimum distance between consecutive no passing zones of 400 ft which is the default value used in the UCBRURAL interface. This value can also be changed by the user but is restricted to the range between 400-1000 ft..

In summary, two conditions have to be met to create a passing zone. First, the sight distance on the zone has to be adequate for passing (user specified) and the length of the zone has to be at least 400 ft (or any other value specified by the user.)

It is standard in many states and other countries to introduce no passing marking on sections with auxiliary lanes in the direction that has the auxiliary lane. In the opposite direction however, marking decisions are sometimes based on traffic volumes or other agencies' policies (and of course on sight distance availability). The UCBRURAL interface was modified to allow the user to control the treatment of the barrier line in the opposite direction to a passing zone during the automatic calculation of passing zones. The user first selects Program Environment from Options on the Main Menu. The user can then can select between two treatments of the barrier line under ACPZ Barr Opp Pass Lane. If the user selects "Forced no passing", then during the automatic calculation of passing zones a barrier line will be added to the opposing lane for the entire length of the passing lane, including a taper in and a taper out of the passing lane. If the user selects "Based on sight dist", then during the automatic calculation of passing zones the barrier line in the opposite direction to a passing zone will be determined only by the sight distance and the user supplied minimum sight distance required for passing and minimum length of a passing zone. The selected option will be in effect until they are changed. UCBRURAL records these options in a permanent file on the hard drive, so they will remain in effect between UCBRURAL sessions.

Passing is also restricted in both directions along a 300 ft (91 meter) diverge taper at the beginning of each auxiliary lane and along a 600 ft (182 meter) merge taper at the end of each auxiliary lane. The actual number of road units that will be treated as a taper is the length of the taper divided by the length of the road unit. This number is then rounded to the nearest whole number. Thus if the road unit is twice the length of the taper, no road units will be used for the taper; if the road unit is half the length of the taper, two road units will be used for the taper. Again the decision of using double barrier lines on both types of taper may be considered too conservative by some users. If so, the users can change from barrier to no barriers on the tapers manually (the number of tapers will be small in most applications so this should not be a major problem.)

The algorithm creates the zones by analyzing the road features in several passes. During the first pass, the available sight distance at each road section is analyzed (first in direction 1 and then in direction 2). Whenever the sight distance is inadequate for passing the road section is assigned a barrier line. If the sight distance is adequate for passing, however, the road section is not immediately assigned a no barrier line code. First, the algorithm keeps track of the adjacent road sections with adequate sight distance for passing and when a section with inadequate sight is found, the sum of the lengths of the adjacent sections with adequate sight distance, i.e., the length of the prospective passing zone, is analyzed for adequacy. If the length of the prospective passing zone is adequate then the algorithm assigns a no barrier code to the road sections comprising the passing zone; otherwise it assigns barrier codes. In the second pass the algorithm identifies the road sections with auxiliary lanes and merge and diverge tapers and convert them to no passing (if they were not no passing zones already). Notice that since in the second pass some sections may be changed from pass to no pass, some passing sections of road that before had an adequate length to be labeled as passing zones may have been shortened to inadequate lengths. Thus, a third pass is needed to see if that has happened. During the third pass, any passing zones found to have an inadequate length are converted to no passing zones.

The user can always change the barrier line setting for individual road sections. It should be noted that all such settings will be lost if the user asks for the interface to recalculated the passing zones.

All changes made for this improvement were made in the UCBRURAL interface. There were no modifications made to the TWOPAS source code

5.15 H7 - Add Input Interface Variables

<u>Current status</u>: *incorporated.*

When the TWOPAS model was first incorporated into the UCBRURAL interface during a previous project, the researchers determined which of the many TWOPAS input variables should be brought into the interface as variables that the user could change and which TWOPAS input variables were sufficiently complex that they should be treated as defaults by the interface. The purpose of this modification was to identify those variables that were treated as defaults that the more advanced transportation researcher might wish to change. These variables, both required and optional input to the TWOPAS model have been brought into a user-supplied text input file that can be edited by the user. In addition, data and constants imbedded in the TWOPAS model that more advanced researchers might want to changed were identified and made into variables that could be entered from the same user-supplied text input file.

In order to use this modification, the user must first edit the user-supplied text input file, TWPSUSER.TDF, from **OUTSIDE** the UCBRURAL interface. **WARNING: The format of this file must be maintained**. **This means that the position of each number and character in TWPSUSER.TDF must be maintained and that the TWPSUSER.TDF must not be edited with software that changes the format or adds any extraneous characters. If errors are made in this input file, the interface or TWOPAS model may abort or "hang" with no useful error messages. Only the more experienced user should modify these defaults**.

The user implements the user-supplied defaults from within the UCBRURAL interface by first selecting File from the Main Menu, then selecting File Manager, TWOPAS Defaults, and finally selecting User-supplied defaults. If user-supplied defaults are selected, they will be used for all TWOPAS runs during the current session, until the user selects Program defaults from the same sequence of menus. Selecting Program Defaults returns all variables listed in the user-supplied text input file to their program defined values. When the user begins a new UCBRURAL session, the Program defaults will always be the TWOPAS default setting. All output from a given run indicates if user-supplied defaults have been used.

Table 5.15:1 is a copy of the user-supplied text input file, TWPSUSER.TDF. **The user may change the defaults values in columns 19-26. No other value should be changed**.

The UCBRURAL interface was modified to allow the user to selected User-Supplied or Program-Supplied default values. If User-Supplied defaults are selected, the interface will now read in the User-Supplied default values that are either used by the interface for calculations, or written by the interface to the TWOPAS.INP file. If User-Supplied defaults are selected, the interface will now reset all of the defaults in the interface to the standard program defaults.

The interface was also modified to add the variable IDEFLT to the file it creates for input to the TWOPAS model. If IDEFLT = 0, then program defaults are being transferred from the interface to TWOPAS and in addition, TWOPAS should use the program defaults that are defined within the TWOPAS model. If IDEFLT = 1, then user-supplied defaults are being transferred from the interface to TWOPAS and in addition, TWOPAS should read the remaining user-supplied defaults from the TWPSUSER.TDF file. This variable is also used to label the output as either using program or user-supplied default values.

This new variable, IDEFLT, was added to "**Card No. 2**" data (see TWOPAS User's Guide) which now has the following format:

Column	1	**2-5**	**6**	11-20	21-30	31-40	41-50	51-60	61-70
Format	I1		**I1**	F10.0	F10.0	F10.0	F10.0	F10.0	F10.0
Content	2	**Blank**	**IDEFLT**	RL	XMS1	XMS2	SMIN	SNOM	PREC

A sample of the new format for the TWOPAS input file is shown in Appendix B.

TABLE 5.15:1 USER-SUPPLIED TEXT INPUT FILE: TWPSUSER.TDF

```
THIS FILE ENABLES USERS OF UCBRURAL TO MODIFY DEFAULTS THAT ARE USED FOR
1) REQUIRED INPUT TO TWOPAS MODEL (READ BY UCBRURAL, WRITTEN TO TWOPAS.INP)
2) OPTIONAL INPUT TO TWOPAS MODEL (READ BY UCBRURAL, WRITTEN TO TWOPAS.INP)
3) DATA IMBEDDED IN THE TWOPAS CODE (READ BY TWOPAS MODEL)
4) CONSTANTS IMBEDDED IN THE TWOPAS CODE (READ BY TWOPAS MODEL)
-----------------------------------------------------------------------------
WARNING: ONLY EDIT VALUES IN "USER" COLUMN, KEEP ALL OTHER CHARACTERS IN
         ORIGINAL LOCATIONS (USE SCROLL LOCK OR TYPEOVER KEYBOARD OPTIONS)
=============================================================================
REQUIRED INPUT FOR TWOPAS MODEL: LINE NUMBERS CORRESPOND TO INPUT LINE
                                    NUMBERS IN THE TWOPAS USER'S GUIDE
                                 PROGRAM DEFAULTS COLS 10-17 RIGHT JUSTIFIED
                                 USER SUPPLIED    COLS 19-26 RIGHT JUSTIFIED
                           NOTE: FRC DEFINED DIFFERENTLY FROM USER'S GUIDE
                                 SUM OF FRC OVER TRKS (1-4)   MUST = 100.%
                                 SUM OF FRC OVER RCS (5-8)    MUST = 100.%
                                 SUM OF FRC OVER CARS (10-13) MUST = 100.%

LINE  DEFAULT     USER    NAME        DESCRIPTION
-----------------------------------------------------------------------------
  2       800      800    SMIN        minimum passing sight distance
         2000     2000    SNOM        nominal sight distance
          0.2      0.2    PREC        prob. pass reconsider next review per.
-----------------------------------------------------------------------------
  3         1        1    NUPG(1)     upstream alignment for dir1
            1        1    NUPG(2)     upstream alignment for dir2
-----------------------------------------------------------------------------
  4      12.0     12.0    FRC(1,1)    frac. of trks that are v.type 1 in d1
         25.6     25.6    FRC(1,2)    frac. of trks that are v.type 2 in d1
         34.0     34.0    FRC(1,3)    frac. of trks that are v.type 3 in d1
         28.4     28.4    FRC(1,4)    frac. of trks that are v.type 4 in d1
         10.0     10.0    FRC(1,5)    frac. of rvs  that are v.type 5 in d1
         40.0     40.0    FRC(1,6)    frac. of rvs  that are v.type 6 in d1
         40.0     40.0    FRC(1,7)    frac. of rvs  that are v.type 7 in d1
         10.0     10.0    FRC(1,8)    frac. of rvs  that are v.type 8 in d1
         10.0     10.0    FRC(1,9)    frac. of cars that are v.type 9 in d1
         15.0     15.0    FRC(1,10)   frac. of cars that are v.type 10 in d1
         20.0     20.0    FRC(1,11)   frac. of cars that are v.type 11 in d1
         25.0     25.0    FRC(1,12)   frac. of cars that are v.type 12 in d1
         30.0     30.0    FRC(1,13)   frac. of cars that are v.type 13 in d1
-----------------------------------------------------------------------------
  5      12.0     12.0    FRC(2,1)    frac. of trks that are v.type 1 in d2
         25.6     25.6    FRC(2,2)    frac. of trks that are v.type 2 in d2
         34.0     34.0    FRC(2,3)    frac. of trks that are v.type 3 in d2
         28.4     28.4    FRC(2,4)    frac. of trks that are v.type 4 in d2
         10.0     10.0    FRC(2,5)    frac. of rvs  that are v.type 5 in d2
         40.0     40.0    FRC(2,6)    frac. of rvs  that are v.type 6 in d2
         40.0     40.0    FRC(2,7)    frac. of rvs  that are v.type 7 in d2
         10.0     10.0    FRC(2,8)    frac. of rvs  that are v.type 8 in d2
         10.0     10.0    FRC(2,9)    frac. of cars that are v.type 9 in d2
         15.0     15.0    FRC(2,10)   frac. of cars that are v.type 10 in d2
         20.0     20.0    FRC(2,11)   frac. of cars that are v.type 11 in d2
         25.0     25.0    FRC(2,12)   frac. of cars that are v.type 12 in d2
         30.0     30.0    FRC(2,13)   frac. of cars that are v.type 13 in d2
 ----------------------------------------------------------------------------
 10       0.8      0.8    ZKCOR       car-following sensitivity factor
         0.43     0.43    BKPM(1)     stoch. driver type fact.- dr. type 1
         0.51     0.51    BKPM(2)     stoch. driver type fact.- dr. type 2
         0.57     0.57    BKPM(3)     stoch. driver type fact.- dr. type 3
         0.65     0.65    BKPM(4)     stoch. driver type fact.- dr. type 4
         0.76     0.76    BKPM(5)     stoch. driver type fact.- dr. type 5
         0.91     0.91    BKPM(6)     stoch. driver type fact.- dr. type 6
         1.13     1.13    BKPM(7)     stoch. driver type fact.- dr. type 7
         1.34     1.34    BKPM(8)     stoch. driver type fact.- dr. type 8
         1.58     1.58    BKPM(9)     stoch. driver type fact.- dr. type 9
         2.12     2.12    BKPM(10)    stoch. driver type fact.- dr. type 10
============================================================================
OPTIONAL INPUT FOR TWOPAS MODEL: TYPE CODES ARE
                                  PL: CHARACTERISTICS FOR ALL PASSING LANES
                                 VCT: VEHICLE CHARACTERISTICS FOR TRUCKS
```

```
 71                               VCC&R: VEH. CHARACTERISTICS FOR CARS AND RVS
 72                                  CW: CRAWL REGIONS
 73                                 PROGRAM DEFAULTS COLS 10-17 RIGHT JUSTIFIED
 74                                 USER SUPPLIED    COLS 19-26 RIGHT JUSTIFIED
 75                           NOTE: CRAWL REGIONS
 76                                 REPEAT LINES 136-140 FOR EACH CRAWL REGION
 77                                 IF NO CRAWL REGION, LEAVE 1 BLANK SET
 78
 79 TYPE  DEFAULT     USER    NAME        DESCRIPTION
 80 ---------------------------------------------------------------------------
 81 PL          2        2    JPS         2=right (3=left) lane drop at DS end
 82             2        2    LFAV        2=no (1=lt 3=rt) lane favored UPS end
 83 ---------------------------------------------------------------------------
 84 VCT     228.0    228.0    WOHP(1)     weight/nethp ratio for vehicle type 1
 85         176.0    176.0    WOHP(2)     weight/nethp ratio for vehicle type 2
 86         140.0    140.0    WOHP(3)     weight/nethp ratio for vehicle type 3
 87          76.0     76.0    WOHP(4)     weight/nethp ratio for vehicle type 4
 88         682.0    682.0    WOA(1)      weight/p.front.area ratio - v.type 1
 89         462.0    462.0    WOA(2)      weight/p.front.area ratio - v.type 2
 90         340.0    340.0    WOA(3)      weight/p.front.area ratio - v.type 3
 91         174.0    174.0    WOA(4)      weight/p.front.area ratio - v.type 4
 92          65.0     65.0    FLG(1)      overall length for vehicle type 1
 93          65.0     65.0    FLG(2)      overall length for vehicle type 2
 94          65.0     65.0    FLG(3)      overall length for vehicle type 3
 95          30.0     30.0    FLG(4)      overall length for vehicle type 4
 96           1.0      1.0    CPE(1)      hp factor -> local el for veh type 1
 97           1.0      1.0    CPE(2)      hp factor -> local el for veh type 2
 98           1.0      1.0    CPE(3)      hp factor -> local el for veh type 3
 99           1.0      1.0    CPE(4)      hp factor -> local el for veh type 4
100         0.957    0.957    CDE         aerod. drag fact.-> local el v.type 1
101         0.957    0.957    CDE         aerod. drag fact.-> local el v.type 2
102         0.957    0.957    CDE         aerod. drag fact.-> local el v.type 3
103         0.957    0.957    CDE         aerod. drag fact.-> local el v.type 4
104 ---------------------------------------------------------------------------
105 VCC&R       4        4    KCWLF       >4, v.types <= KCWLF use crawl regions
106         9.000    9.000    P0(5)       max acc. using max avail.hp -v.type 5
107        11.000   11.000    P0(6)       max acc. using max avail.hp -v.type 6
108        12.500   12.500    P0(7)       max acc. using max avail.hp -v.type 7
109        14.000   14.000    P0(8)       max acc. using max avail.hp -v.type 8
110        11.170   11.170    P0(9)       max acc. using max avail.hp -v.type 9
111        11.990   11.990    P0(10)      max acc. using max avail.hp -v.type 10
112        12.770   12.770    P0(11)      max acc. using max avail.hp -v.type 11
113        13.220   13.220    P0(12)      max acc. using max avail.hp -v.type 12
114        14.100   14.100    P0(13)      max acc. using max avail.hp -v.type 13
115        110.00   110.00    SP1(5)      max spd on 0 grade, max hp - v.type 5
116        115.00   115.00    SP1(6)      max spd on 0 grade, max hp - v.type 6
117        120.00   120.00    SP1(7)      max spd on 0 grade, max hp - v.type 7
118        125.00   125.00    SP1(8)      max spd on 0 grade, max hp - v.type 8
119        112.80   112.80    SP1(9)      max spd on 0 grade, max hp - v.type 9
120        117.80   117.80    SP1(10)     max spd on 0 grade, max hp - v.type 10
121        121.10   121.10    SP1(11)     max spd on 0 grade, max hp - v.type 11
122        127.00   127.00    SP1(12)     max spd on 0 grade, max hp - v.type 12
123        142.70   142.70    SP1(13)     max spd on 0 grade, max hp - v.type 13
124          36.0     36.0    FLG(5)      overall length for vehicle type 5
125          28.0     28.0    FLG(6)      overall length for vehicle type 6
126          21.0     21.0    FLG(7)      overall length for vehicle type 7
127          32.0     32.0    FLG(8)      overall length for vehicle type 8
128          13.0     13.0    FLG(9)      overall length for vehicle type 9
129          14.0     14.0    FLG(10)     overall length for vehicle type 10
130          16.0     16.0    FLG(11)     overall length for vehicle type 11
131          17.0     17.0    FLG(12)     overall length for vehicle type 12
132          18.0     18.0    FLG(13)     overall length for vehicle type 13
133 ---------------------------------------------------------------------------
134 CW   NOTE: REPEAT LINES 131-135 FOR EACH REGION/IF TOTCWL=0, LEAVE 1 SET
135             0        0    TOTCWL      total number of crawl regs both dirs
136             0        0    JD          direction of travel for this crawl reg
137           0.0      0.0   XCWN(KCW)    location at start of crawl region
138           0.0      0.0   CW2(KCW)     location at end of crawl region
139           0.0      0.0   CS0(KCW)     mean crawl speed
140           0.0      0.0   SCWL(KCW)    std deviation of mean crawl speed
141 ===========================================================================
142 DATA IMBEDDED IN TWOPAS CODE: BLK IS COMMON BLOCK WHERE DATA IS STORED
143                               NEW BLKS /DFT1/ AND /DFT2/FOR LOCAL VARS
144                               SUBROUTINES CONTAINING THESE LOCAL VARIABLES
145                                    LISTED AT END OF DESCRIPTION
146                               PROGRAM DEFAULTS COLS 10-17 RIGHT JUSTIFIED
147                               USER SUPPLIED    COLS 19-26 RIGHT JUSTIFIED
148
```

```
149 BLK   DEFAULT     USER    NAME        DESCRIPTION
150 ---------------------------------------------------------------------------------
151 CAR          4          4    KT          largest v.type using trk perf. eq.
152 DRPL     150.0      150.0    DEOL        test - change modivation from lane drop
153 DRPL     750.0      750.0    DSGN        test - change modivation from lane drop
154 DRPL      15.0       15.0    TEOLHI      test - change modivation from lane drop
155 DRPL      10.0       10.0    TEOLLO      test - change modivation from lane drop
156 DFT1      10.0       10.0    ACRIT       decel - chng follower's excess spd GAPC
157 DFT1       5.0        5.0    AED         typical pos acceleration CRFW2
158 DFT1      15.0       15.0    REE         max pos. deceleration  CRFW2 & GENTB
159 DFT1       5.0        5.0    RJERK       max pos rate of change of accel. CRFW2
160 DFT1       4.0        4.0    THP         max time hdwy for platoon members  DSTA
161 DFT1         4          4    MXPT        max time hdwy for platoon members EPLAT
162 PLHDWY     4.0        4.0    PLHDWY      max time headway for platoon members
163 RE       -15.0      -15.0    RE          extreme/emergency accel. rate (ft/sec)
164 REUB3      0.1        0.1    RB          non-linear term coef. in Pitt-KLD model
165 REUB3      0.3        0.3    RC          driver response delay in Pitt-KLD model
166 RVMAX    120.0      120.0    RVMAX       maximum speed (car-following)
167 TRK        3.5        3.5    AD          decel. for approach spds to crvs & cwls
168 VC           4          4    KC          largest v.type using downgrade cw.spds.
169 VC     -0.2445    -0.2445    C0          const. in trk accel. during gear shifts
170 VC     -0.0004    -0.0004    C1          spd coef. - trk accel.during gear shfts
171 ZKF       20.0       20.0    ZKF         free-flow density (car-following)
172 ZKJ      210.0      210.0    ZKJ         jam density (veh/mile) (car-following)
173 ZL         2.2        2.2    ZL          calibration factor (car-following)
174 ZM         0.6        0.6    ZM          calibration factor (car-following)
175 ZUF       55.0       55.0    ZUF         speed at free-flow den. (car-following)
176 ---------------------------------------------------------------------------------
177 DFT2   -0.1907    -0.1907    P41(1)      coefs. to compute pass acceptance prob.
178 DFT2   -0.1430    -0.1430    P41(2)      coefs. to compute pass acceptance prob.
179 DFT2   -0.0953    -0.0953    P41(3)      coefs. to compute pass acceptance prob.
180 DFT2   -0.0477    -0.0477    P41(4)      coefs. to compute pass acceptance prob.
181 DFT2    0.0000     0.0000    P41(5)      coefs. to compute pass acceptance prob.
182 DFT2    0.0477     0.0477    P41(6)      coefs. to compute pass acceptance prob.
183 DFT2    0.0953     0.0953    P41(7)      coefs. to compute pass acceptance prob.
184 DFT2    0.1430     0.1430    P41(8)      coefs. to compute pass acceptance prob.
185 DFT2    0.2009     0.2009    P41(9)      coefs. to compute pass acceptance prob.
186 DFT2    0.2587     0.2587    P41(10)     coefs. to compute pass acceptance prob.
187 DFT2    0.3166     0.3166    P41(11)     coefs. to compute pass acceptance prob.
188 DFT2    0.3744     0.3744    P41(12)     coefs. to compute pass acceptance prob.
189 DFT2    0.4323     0.4323    P41(13)     coefs. to compute pass acceptance prob.
190 DFT2    0.4901     0.4901    P41(14)     coefs. to compute pass acceptance prob.
191 DFT2    0.5480     0.5480    P41(15)     coefs. to compute pass acceptance prob.
192 DFT2    0.5837     0.5837    P41(16)     coefs. to compute pass acceptance prob.
193 DFT2    0.6194     0.6194    P41(17)     coefs. to compute pass acceptance prob.
194 DFT2    0.6551     0.6551    P41(18)     coefs. to compute pass acceptance prob.
195 DFT2    0.6908     0.6908    P41(19)     coefs. to compute pass acceptance prob.
196 DFT2    0.7265     0.7265    P41(20)     coefs. to compute pass acceptance prob.
197 DFT2    0.7622     0.7622    P41(21)     coefs. to compute pass acceptance prob.
198 DFT2    0.7979     0.7979    P41(22)     coefs. to compute pass acceptance prob.
199 DFT2    0.8336     0.8336    P41(23)     coefs. to compute pass acceptance prob.
200 DFT2    0.8693     0.8693    P41(24)     coefs. to compute pass acceptance prob.
201 DFT2    0.9050     0.9050    P41(25)     coefs. to compute pass acceptance prob.
202 DFT2    0.9169     0.9169    P41(26)     coefs. to compute pass acceptance prob.
203 DFT2    0.9288     0.9288    P41(27)     coefs. to compute pass acceptance prob.
204 DFT2    0.9406     0.9406    P41(28)     coefs. to compute pass acceptance prob.
205 DFT2    0.9525     0.9525    P41(29)     coefs. to compute pass acceptance prob.
206 DFT2    0.9644     0.9644    P41(30)     coefs. to compute pass acceptance prob.
207 DFT2    0.9763     0.9763    P41(31)     coefs. to compute pass acceptance prob.
208 DFT2    0.9881     0.9881    P41(32)     coefs. to compute pass acceptance prob.
209 DFT2    1.0000     1.0000    P41(33)     coefs. to compute pass acceptance prob.
210 DFT2    1.0000     1.0000    P41(34)     coefs. to compute pass acceptance prob.
211 DFT2    1.0000     1.0000    P41(35)     coefs. to compute pass acceptance prob.
212 DFT2    1.0000     1.0000    P41(36)     coefs. to compute pass acceptance prob.
213 DFT2    1.0000     1.0000    P41(37)     coefs. to compute pass acceptance prob.
214 DFT2    1.0000     1.0000    P41(38)     coefs. to compute pass acceptance prob.
215 DFT2 -.005591   -.005591     SON(1)      coefs. to compute pass acceptance prob.
216 DFT2 -.005591   -.005591     SON(2)      coefs. to compute pass acceptance prob.
217 DFT2 -.005591   -.005591     SON(3)      coefs. to compute pass acceptance prob.
218 DFT2 -.005591   -.005591     SON(4)      coefs. to compute pass acceptance prob.
219 DFT2 -.005591   -.005591     SON(5)      coefs. to compute pass acceptance prob.
220 DFT2 -.005591   -.005591     SON(6)      coefs. to compute pass acceptance prob.
221 DFT2 -.005591   -.005591     SON(7)      coefs. to compute pass acceptance prob.
122 DFT2 -.005591   -.005591     SON(8)      coefs. to compute pass acceptance prob.
223 DFT2 -.005591   -.005591     SON(9)      coefs. to compute pass acceptance prob.
224 DFT2 -.005591   -.005591     SON(10)     coefs. to compute pass acceptance prob.
225 DFT2 -.007773   -.007773     SON(11)     coefs. to compute pass acceptance prob.
226 DFT2 -.009955   -.009955     SON(12)     coefs. to compute pass acceptance prob.
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227 DFT2 -.012136 -.012136   SON(13)      coefs. to compute pass acceptance prob.
228 DFT2 -.014318 -.014318   SON(14)      coefs. to compute pass acceptance prob.
229 DFT2 -.019432 -.019432   SON(15)      coefs. to compute pass acceptance prob.
230 DFT2 -.024546 -.024546   SON(16)      coefs. to compute pass acceptance prob.
231 DFT2 -.029659 -.029659   SON(17)      coefs. to compute pass acceptance prob.
232 DFT2 -.034773 -.034773   SON(18)      coefs. to compute pass acceptance prob.
233 DFT2 -.030938 -.030938   SON(19)      coefs. to compute pass acceptance prob.
234 DFT2 -.027103 -.027103   SON(20)      coefs. to compute pass acceptance prob.
235 DFT2 -.023267 -.023267   SON(21)      coefs. to compute pass acceptance prob.
236 DFT2 -.019432 -.019432   SON(22)      coefs. to compute pass acceptance prob.
237 DFT2 -.016398 -.016398   SON(23)      coefs. to compute pass acceptance prob.
238 DFT2 -.013364 -.013364   SON(24)      coefs. to compute pass acceptance prob.
239 DFT2 -.010329 -.010329   SON(25)      coefs. to compute pass acceptance prob.
240 DFT2 -.007295 -.007295   SON(26)      coefs. to compute pass acceptance prob.
241 DFT2 -.006869 -.006869   SON(27)      coefs. to compute pass acceptance prob.
242 DFT2 -.006443 -.006443   SON(28)      coefs. to compute pass acceptance prob.
243 DFT2 -.006017 -.006017   SON(29)      coefs. to compute pass acceptance prob.
244 DFT2 -.005591 -.005591   SON(30)      coefs. to compute pass acceptance prob.
245 DFT2 -.005591 -.005591   SON(31)      coefs. to compute pass acceptance prob.
246 DFT2 -.005591 -.005591   SON(32)      coefs. to compute pass acceptance prob.
247 DFT2 -.005591 -.005591   SON(33)      coefs. to compute pass acceptance prob.
248 DFT2 -.005591 -.005591   SON(34)      coefs. to compute pass acceptance prob.
249 DFT2 -.005591 -.005591   SON(35)      coefs. to compute pass acceptance prob.
250 DFT2 -.005591 -.005591   SON(36)      coefs. to compute pass acceptance prob.
251 DFT2 -.005591 -.005591   SON(37)      coefs. to compute pass acceptance prob.
252 DFT2 -.005591 -.005591   SON(38)      coefs. to compute pass acceptance prob.
253 DFT2 -.004500 -.004500   SOP(1)       coefs. to compute pass acceptance prob.
254 DFT2 -.004500 -.004500   SOP(2)       coefs. to compute pass acceptance prob.
255 DFT2 -.004500 -.004500   SOP(3)       coefs. to compute pass acceptance prob.
256 DFT2 -.004500 -.004500   SOP(4)       coefs. to compute pass acceptance prob.
257 DFT2 -.004500 -.004500   SOP(5)       coefs. to compute pass acceptance prob.
258 DFT2 -.004500 -.004500   SOP(6)       coefs. to compute pass acceptance prob.
259 DFT2 -.004500 -.004500   SOP(7)       coefs. to compute pass acceptance prob.
260 DFT2 -.004500 -.004500   SOP(8)       coefs. to compute pass acceptance prob.
261 DFT2 -.004500 -.004500   SOP(9)       coefs. to compute pass acceptance prob.
262 DFT2 -.004500 -.004500   SOP(10)      coefs. to compute pass acceptance prob.
263 DFT2 -.004142 -.004142   SOP(11)      coefs. to compute pass acceptance prob.
264 DFT2 -.003784 -.003784   SOP(12)      coefs. to compute pass acceptance prob.
265 DFT2 -.003426 -.003426   SOP(13)      coefs. to compute pass acceptance prob.
266 DFT2 -.003068 -.003068   SOP(14)      coefs. to compute pass acceptance prob.
267 DFT2 -.003324 -.003324   SOP(15)      coefs. to compute pass acceptance prob.
268 DFT2 -.003580 -.003580   SOP(16)      coefs. to compute pass acceptance prob.
269 DFT2 -.003835 -.003835   SOP(17)      coefs. to compute pass acceptance prob.
270 DFT2 -.004441 -.004441   SOP(18)      coefs. to compute pass acceptance prob.
271 DFT2 -.005727 -.005727   SOP(19)      coefs. to compute pass acceptance prob.
272 DFT2 -.007364 -.007364   SOP(20)      coefs. to compute pass acceptance prob.
273 DFT2 -.009000 -.009000   SOP(21)      coefs. to compute pass acceptance prob.
274 DFT2 -.010306 -.010306   SOP(22)      coefs. to compute pass acceptance prob.
275 DFT2 -.010875 -.010875   SOP(23)      coefs. to compute pass acceptance prob.
276 DFT2 -.011114 -.011114   SOP(24)      coefs. to compute pass acceptance prob.
277 DFT2 -.011352 -.011352   SOP(25)      coefs. to compute pass acceptance prob.
278 DFT2 -.011591 -.011591   SOP(26)      coefs. to compute pass acceptance prob.
279 DFT2 -.010909 -.010909   SOP(27)      coefs. to compute pass acceptance prob.
280 DFT2 -.010228 -.010228   SOP(28)      coefs. to compute pass acceptance prob.
281 DFT2 -.009546 -.009546   SOP(29)      coefs. to compute pass acceptance prob.
282 DFT2 -.008864 -.008864   SOP(30)      coefs. to compute pass acceptance prob.
283 DFT2 -.008455 -.008455   SOP(31)      coefs. to compute pass acceptance prob.
284 DFT2 -.008045 -.008045   SOP(32)      coefs. to compute pass acceptance prob.
285 DFT2 -.007636 -.007636   SOP(33)      coefs. to compute pass acceptance prob.
286 DFT2 -.007227 -.007227   SOP(34)      coefs. to compute pass acceptance prob.
287 DFT2 -.007074 -.007074   SOP(35)      coefs. to compute pass acceptance prob.
288 DFT2 -.006921 -.006921   SOP(36)      coefs. to compute pass acceptance prob.
289 DFT2 -.006767 -.006767   SOP(37)      coefs. to compute pass acceptance prob.
290 DFT2 -.006614 -.006614   SOP(38)      coefs. to compute pass acceptance prob.
291 DFT2  0.00000  0.00000   SSN(1)       coefs. to compute pass acceptance prob.
292 DFT2  -.00635  -.00635   SSN(2)       coefs. to compute pass acceptance prob.
293 DFT2  -.01318  -.01318   SSN(3)       coefs. to compute pass acceptance prob.
294 DFT2  -.02068  -.02068   SSN(4)       coefs. to compute pass acceptance prob.
295 DFT2  -.02818  -.02818   SSN(5)       coefs. to compute pass acceptance prob.
296 DFT2  -.03477  -.03477   SSN(6)       coefs. to compute pass acceptance prob.
297 DFT2  -.04136  -.04136   SSN(7)       coefs. to compute pass acceptance prob.
298 DFT2  -.04757  -.04757   SSN(8)       coefs. to compute pass acceptance prob.
299 DFT2  -.05379  -.05379   SSN(9)       coefs. to compute pass acceptance prob.
300 DFT2  -.06000  -.06000   SSN(10)      coefs. to compute pass acceptance prob.
301 DFT2  -.06000  -.06000   SSN(11)      coefs. to compute pass acceptance prob.
302 DFT2  -.06000  -.06000   SSN(12)      coefs. to compute pass acceptance prob.
303 DFT2  -.06000  -.06000   SSN(13)      coefs. to compute pass acceptance prob.
304 DFT2  -.06000  -.06000   SSN(14)      coefs. to compute pass acceptance prob.
```

```
DFT2  -.06000  -.06000   SSN(15)     coefs. to compute pass acceptance prob.
DFT2  -.06000  -.06000   SSN(16)     coefs. to compute pass acceptance prob.
DFT2  -.06000  -.06000   SSN(17)     coefs. to compute pass acceptance prob.
DFT2  -.06000  -.06000   SSN(18)     coefs. to compute pass acceptance prob.
DFT2  -.06000  -.06000   SSN(19)     coefs. to compute pass acceptance prob.
DFT2  -.06000  -.06000   SSN(20)     coefs. to compute pass acceptance prob.
DFT2  -.06000  -.06000   SSN(21)     coefs. to compute pass acceptance prob.
DFT2  -.06000  -.06000   SSN(22)     coefs. to compute pass acceptance prob.
DFT2  -.06000  -.06000   SSN(23)     coefs. to compute pass acceptance prob.
DFT2  -.06000  -.06000   SSN(24)     coefs. to compute pass acceptance prob.
DFT2  -.06000  -.06000   SSN(25)     coefs. to compute pass acceptance prob.
DFT2  -.06000  -.06000   SSN(26)     coefs. to compute pass acceptance prob.
DFT2  -.06000  -.06000   SSN(27)     coefs. to compute pass acceptance prob.
DFT2  -.06000  -.06000   SSN(28)     coefs. to compute pass acceptance prob.
DFT2  -.06000  -.06000   SSN(29)     coefs. to compute pass acceptance prob.
DFT2  -.06000  -.06000   SSN(30)     coefs. to compute pass acceptance prob.
DFT2  -.06000  -.06000   SSN(31)     coefs. to compute pass acceptance prob.
DFT2  -.06000  -.06000   SSN(32)     coefs. to compute pass acceptance prob.
DFT2  -.06000  -.06000   SSN(33)     coefs. to compute pass acceptance prob.
DFT2  -.06000  -.06000   SSN(34)     coefs. to compute pass acceptance prob.
DFT2  -.06000  -.06000   SSN(35)     coefs. to compute pass acceptance prob.
DFT2  -.06000  -.06000   SSN(36)     coefs. to compute pass acceptance prob.
DFT2  -.06000  -.06000   SSN(37)     coefs. to compute pass acceptance prob.
DFT2  -.06000  -.06000   SSN(38)     coefs. to compute pass acceptance prob.
DFT2 0.000000 0.000000   SSP(1)      coefs. to compute pass acceptance prob.
DFT2 0.000000 0.000000   SSP(2)      coefs. to compute pass acceptance prob.
DFT2 0.000000 0.000000   SSP(3)      coefs. to compute pass acceptance prob.
DFT2 0.000000 0.000000   SSP(4)      coefs. to compute pass acceptance prob.
DFT2 -.000000 -.000000   SSP(5)      coefs. to compute pass acceptance prob.
DFT2 -.001735 -.001735   SSP(6)      coefs. to compute pass acceptance prob.
DFT2 -.003468 -.003468   SSP(7)      coefs. to compute pass acceptance prob.
DFT2 -.005201 -.005201   SSP(8)      coefs. to compute pass acceptance prob.
DFT2 -.006934 -.006934   SSP(9)      coefs. to compute pass acceptance prob.
DFT2 -.008667 -.008667   SSP(10)     coefs. to compute pass acceptance prob.
DFT2 -.010587 -.010587   SSP(11)     coefs. to compute pass acceptance prob.
DFT2 -.012507 -.012507   SSP(12)     coefs. to compute pass acceptance prob.
DFT2 -.014427 -.014427   SSP(13)     coefs. to compute pass acceptance prob.
DFT2 -.016347 -.016347   SSP(14)     coefs. to compute pass acceptance prob.
DFT2 -.018267 -.018267   SSP(15)     coefs. to compute pass acceptance prob.
DFT2 -.018267 -.018267   SSP(16      coefs. to compute pass acceptance prob.
DFT2 -.018267 -.018267   SSP(1)      coefs. to compute pass acceptance prob.
DFT2 -.018267 -.018267   SSP(8)      coefs. to compute pass acceptance prob.
DFT2 -.018267 -.018267   SSP19)      coefs. to compute pass acceptance prob.
DFT2 -.018267 -.018267   SSP(20)     coefs. to compute pass acceptance prob.
DFT2 -.017732 -.017732   SSP(21)     coefs. to compute pass acceptance prob.
DFT2 -.017199 -.017199   SSP(22)     coefs. to compute pass acceptance prob.
DFT2 -.016667 -.016667   SSP(23)     coefs. to compute pass acceptance prob.
DFT2 -.016135 -.016135   SSP(24)     coefs. to compute pass acceptance prob.
DFT2 -.015603 -.015603   SSP(25)     coefs. to compute pass acceptance prob.
DFT2 -.015452 -.015452   SSP(26)     coefs. to compute pass acceptance prob.
DFT2 -.015301 -.015301   SSP(27)     coefs. to compute pass acceptance prob.
DFT2 -.015150 -.015150   SSP(28)     coefs. to compute pass acceptance prob.
DFT2 -.014997 -.014997   SSP(29)     coefs. to compute pass acceptance prob.
DFT2 -.014844 -.014844   SSP(30)     coefs. to compute pass acceptance prob.
DFT2 -.014692 -.014692   SSP(31)     coefs. to compute pass acceptance prob.
DFT2 -.014540 -.014540   SSP(32)     coefs. to compute pass acceptance prob.
DFT2 -.014388 -.014388   SSP(33)     coefs. to compute pass acceptance prob.
DFT2 -.013948 -.013948   SSP(34)     coefs. to compute pass acceptance prob.
DFT2 -.013511 -.013511   SSP(35)     coefs. to compute pass acceptance prob.
DFT2 -.013074 -.013074   SSP(36)     coefs. to compute pass acceptance prob.
DFT2 -.012637 -.012637   SSP(37)     coefs. to compute pass acceptance prob.
DFT2 -.012200 -.012200   SSP(38)     coefs. to compute pass acceptance prob.
============================================================================
CONSTANTS IMBEDDED IN TWOPAS CODE: NEW BLK /DFT3/ FOR CONSTANTS CONVERTED
                                     TO VARIABLES
                                   SUBROUTINES THAT USE THESE LOCAL CONSTANTS
                                     LISTED AT END OF DESCRIPTION
                                   PROGRAM DEFAULTS COLS 10-17 RIGHT JUSTIFIED
                                   USER SUPPLIED    COLS 19-26 RIGHT JUSTIFIED

      DEFAULT     USER   NAME        DESCRIPTION
----------------------------------------------------------------------------
DFT3    1.167    1.167   FSPDP(1)    spd inc. fact. of pass.vehs.SPDN & ST14
DFT3     15.0     15.0   FSPDP(2)    spd inc. fact. of pass.vehs.SPDN & ST14
============================================================================
```

The TWOPAS source code was modified to read the new variable, IDEFLT, which has been added to the TWOPAS.INP file. The TWOPAS source code was also modified so that if IDEFLT=1, the TWOPAS model will read the user-supplied defaults for TWOPAS imbedded data and constants which are not transferred to TWOPAS using the TWOPAS.INP input file. In addition all such values were converted to variables in the TWOPAS source code.

The following changes were made to the TWOPAS source code:

added	**COMMON /DFLTS/ IDEFLT**
to	REED2
added	**COMMON /DFT1/ ACRIT,AED,REE,RJERK,THP,MXPT**
to	CRFW2, DSTA, EPLAT, GAPC, and GENTB
added	**COMMON /DFT2/ P41(38),SON(38),SOP(38),SSN(38),SSP(38)**
to	PASP
added	**COMMON /DFT3/ FSPDP(2)**
to	SPDN and ST14

A new subroutine SETDFT was added to the TWOPAS source code. Additional changes were made to the MAIN program, BLOCK DATA, and subroutines FILEOP, CRFW2, DSTA, EPLAT, GENTB, PASP, REED2, SPDN, and ST14. All changes to these TWOPAS routines for this modification are shown in the source code with the label:

C ** UCB 97 - ADD USER SUPPLIED DEFAULTS

5.16 H8 - Vary Random Number Seeds

<u>Current status</u>: *incorporated.*

TWOPAS uses five 8-digit random number seeds as follows:

Seed 1 - used to select entering headways and vehicle types in direction 1.

Seed 2 - used to select entering headways and vehicle types in direction 2.

Seed 3 - used to select desired speeds for entering vehicles in direction 1.

Seed 4 - used during priming to select desired speeds, and then used subsequently (without reset) to make stochastic decisions on pass initiation and pass extension during simulation.

Seed 5 - used to select desired speeds for entering vehicles in direction 2.

If the same random number seeds are used in two runs with the same traffic inputs but different geometrics, then identical traffic streams will be simulated for each geometric condition. On the other hand, if the random number seed is varied without changing the geometric or traffic inputs, then replicate runs can be made with random variations in traffic stream composition while maintaining approximately the same flow rate and vehicle mix.

The UCBRURAL interface allowed the user to enter only one random number seed from which the interface generated the five 8-digit random number seeds. It must be noted that the whole sequence of generated pseudo random numbers (for one of the seeds) depends on the random number seed. Although the generation routine is designed to generate numbers as if they were random, for some seeds the sequence of numbers may not show enough randomness. When that happened, the user did not have control over the five seeds. Thus, a modification was needed to allow the user to input all five random number seeds directly.

The interface has been modified so that the user now has two options for specifying the random number seeds. The first option, is as before, i.e., the user can direct the interface to generate the five random number seeds that are used by TWOPAS. The numbers are generated from the one user supplied random number seed that is entered on the Run Specs screen when a run is initiated. To use this option the user has to select "Generated by UCBRURAL" under Environment from the Options Menu. The second option allows the user to enter all five random number seeds when a run is initiated. To use this option the user has to select "Entered by user" under Environment from the Options Menu.

When making a Multiple TWOPAS Run (see section 5.20), the Run Specs screen where the random number seed(s) are entered is displayed each time a run is added to the multiple run. This process occurs within the Traffic Data Screen every time the MultiRunTWPS button is clicked. Thus the user can change the random number be seeds for each of the runs within the multiple run.

All changes for this improvement were made in the UCBRURAL interface. The were no modifications made to the TWOPAS source code.

5.17 H 10 - Have D2 Locations be Specified in D1 Coordinates

Current Status: incorporated

During the simulation process, TWOPAS collects information at observation stations and over intervals. The user specifies the location of the observation stations and two intervals (see section 5.25) on the Observation Data Screen in the UCBRURAL interface. The interface, as it was originally developed for TRARR, displayed the schematic of the roadway on the screen with Direction 1 going from left to right with the left most coordinate labeled as zero; it displayed Direction 2 from right to left with the right most coordinate labeled as zero. The locations of the observation information in Direction 1 were specified by the user in Direction 1 coordinates and the locations of the observation information in Direction 2 were given in Direction 2 coordinates. However, this two coordinate system was not appropriate for TWOPAS which expects all locations to be entered in Direction 1 coordinates. Although the interface converted the Direction 2 coordinates to Direction 1 coordinates before writing them to the TWOPAS input file, its requirement that Direction 2 locations be entered in Direction 2 coordinates proved confusing to many users of the program. The UCBRURAL interface has been modified so that all locations are entered in Direction 1 coordinates.

The Observation Data Screen has been modified so that Direction 2 which still goes from right to left now has its left most coordinate labeled as zero. The locations for the first observation point in Direction 2 is a "warm-up" distance in from the beginning of the roadway for Direction 2 (right side of the screen). The coordinate for this location is now expected in Direction 1 coordinates. The same is true for the last observation point in Direction 2 which is in from the end of the roadway for Direction 2 (left side of the screen). The user also can specify the location of two data collection intervals. The end points of the interval in Direction 2 must now be given in Direction 1 coordinates.

All changes for this improvement were made in the UCBRURAL interface. The were no modifications made to the TWOPAS source code.

5.18 I1 - Additional Output Information on Graphs

Current status: incorporated

The purpose of this modification was to review the various graphs produced by the UCBRURAL interface, identify those graphs which were the most important to update, and make the necessary modifications.

The graph of the Road Input Data contained four graphs of data associated with the road geometry: Sight Distance, 85th Percentile Speed, Curve Radius, and Relative Grade. The 85th Percentile Speed graph was specific to the TRARR model and needed to be removed. It was replaced with a Reduced Speed graph which displays the reduced speed that is transferred to TWOPAS through the TWOPAS.INP input file. When present, this reduced speed represents the slower of the speeds due to a reduced speed zone and/or a reduced speed due to narrow lanes and shoulders. The Relative Grade graph was hard to interpret. It was replaced by a graph of the actual grades which proves much more relevant. The schematic of the roadway, including possible automatically calculated striping, is drawn at the bottom of the graph. This schematic was not changed.

The printed graph of the TWOPAS output contained four graphs: Percent Following, Number of Passes, Mean Speed, and Relative Grade. Although grades are an input, not an output, the Grade graph is particularly useful in analyzing the three output graphs and thus was retained on the printed output graph. However, the Relative Grade graph was replace by a graph of the actual grades. In addition, a schematic of the roadway is drawn at the bottom of the graph. This schematic was not changed.

The graphs of the output which could be viewed on the screen were Percent Following, Number of Passes, Mean Speed, and Relative Grade. Because a graph of the Relative Grade was not very useful while viewing the output on the screen and modifying a screen graph was fairly time consuming, the Relative Grade graph was not converted to actual grades, but was merely removed from this option. The user can select any two of remaining three variables which will then be graphed over the length of the roadway. Limits on the size of the screen does not allow displaying graphs of all three variables at the same time. The screen output also includes a schematic of the roadway with passing lanes and striping.

Comparison graphs from two runs can be printed for one user-specified variable chosen from the three output variables: Percent Following, Number of Passes, and Mean Speed. The schematic of the roadway is drawn at the bottom of the comparison graphs. No changes were made to this graphical output.

Samples of the Road Input Data graph, the printed output graph, and the comparison graph can be seen in Appendix D.

All changes for this modification were made in the UCBRURAL interface. No changes were made to the TWOPAS source code.

5.19 J3 - Print Files from Interface

Current status: *incorporated.*

The TWOPAS model produces an output file which consists of an echo of the user-supplied input and a detailed tabular output of the results, including information at all the user-specified station locations. The output from TWOPAS is then read by a short post-processor program named TWOSUM. TWOSUM produces an output file which consists of a summary table of results at each station location, a summary over the user-specified data collection intervals, and a few of the input variables. With the exception of the graph of the data associated with the road geometry, all graphical output produced by the interface is based on the TWOSUM output.

The UCBRURAL interface for TWOPAS was originally developed to produce graphical output on the screen and graphical printed output. There was no provision to print either the long TWOPAS output or the one to two page TWOSUM output from within the interface. The user would have to save the current data files and exit the UCBRURAL interface each time there was a need to print one of these files. Then after printing the output files, the user would re-enter the interface and re-load the data files back into the program. An option to allow the user to print output files from within the interface became a high priority request from the researchers on the team who were using the TWOPAS model extensively.

A method for printing a text file from within the interface has been developed and has been implemented for printing the TWOSUM output. The user selects this option from Output on the Main menu. A sample TWOSUM output file printed from within the interface can be found in Appendix E.

At a later time, it may be useful to implement this print option for other currently exiting text files such as the TWOPAS input file and the TWOPAS multiple run batch file which are both created by the interface, and even perhaps implement it for the complete TWOPAS output file.

All changes for this improvement were made in the UCBRURAL interface. The were no modifications made to the TWOPAS source code.

5.20 K1 - Multiple Runs

The UCBRURAL interface has been modified so that the user can create multiple runs with the same road and observation files. Only the traffic specifications are changed from run to run. Though this improvement was classified as priority 2, it was implemented at this point because it was needed by the research team to test the updated TWOPAS code in the calibration and validation of the model as well as on the capacity investigations. Being able to make multiple runs is extremely helpful for testing some of the modifications to TWOPAS and will be essential during the capacity investigation phase where hundreds of runs have to be performed and analyzed. This modification was split into two parts: Making Multiple Runs and Output from Multiple Runs. Each part of this modification was implemented as it was needed by the researchers.

5.20.1 K1-1 - Making Multiple Runs

Current status: *incorporated*

In order to make a Multiple TWOPAS Run, the user must first create TWOPAS input files from the Traffic Data Screen. This is done by editing the traffic data for the current run and then pressing the MultiRunTWPS button.

The first time the MultiRunTWPS button is pressed, the user will be asked to enter a beginning number. This number must be between 1 and 9999. It will be used in creating file names for the sequence of TWOPAS runs. If the user enters 1, the first run will be RUN0001 and the first TWOPAS input file will be TWPS0001.INP. The associated output files will be TWPS0001.OUT and TWSM0001.OUT. Each additional run will be numbered sequentially from the beginning number that was entered. The maximum number for a run is 9999, so the user has to make sure to pick a beginning number that will allow for the number of runs he/she wishes to make in a multiple run.

Each time the MultiRunTWPS button is pressed to create a TWOPAS input file the user will be asked for the Run Specifications for that run. It is important that the user enter a unique descriptive run title. The run number will be automatically inserted at the beginning of this title. The user will also be asked for the random number seed(s). The number of random number seeds that the user enters depends on weather the user has selected “Generated by UCBRURAL” or “Entered by user” under Environment from the Options Menu (Section 5.16 - Vary Random Number Seeds.)

When all the input files for a Multiple TWOPAS Run have been created, the user exits the Traffic Data Screen ans selects TWOPAS Multiple Run from the Run Menu. The TWOPAS Multiple Run will then begin to execute. The user can follow the progress of a TWOPAS Multiple Run on the screen in a one-line window that displays the run number and the simulation time of that run.

When the TWOPAS Multiple Run is completed the graphic results of the last run can be viewed on the screen or printed. The results of the other runs can be seen by printing the corresponding TWOSUM output files from outside the interface.

All changes for this improvement were made in the UCBRURAL interface. The were no changes made to the TWOPAS source code.

5.20.2 K1-2 - Output from Multiple Runs

<u>Current status</u>: *partially incorporated*

Users have many options for reviewing the output from single TWOPAS runs. These options include viewing the graphic results on the screen, printing the graphic output, printing detail and summary tables of the output, and printing the actual TWOSUM .OUT summary output file. All of these options would be desirable for reviewing the output from each run made during a multiple run. In addition, a new feature needed to be developed which would allow the user to request a text file consisting of a summary table of results from all the runs within a multiple run. After they had left the UCBRURAL interface, users could import this text file of the multiple run summary table into spreadsheet software in order to print the table or do statistical analysis on the data.

Because of time and funding constraints only the option to produce a text file of the multiple run summary table has been implemented. Allowing the user access to the same output options for multiple run as for single runs, especially the graphs, is still considered important, but cannot be implemented under the current project.

After making a TWOPAS Multiple Run, the user can request that a Spreadsheet be created and written to a file on the harddrive. The user provides Spreadsheet File Specifications which include the name for the spreadsheet file and which multiruns should be included in the spreadsheet. After leaving the UCBRURAL program, the user can read the spreadsheet file into any standard spreadsheet software such as EXCEL, manipulate the data, and create reports.

The SpreadSheet contains one row (88 columns) of information from each run including

- Run Number
- Date of run
- Computer run time
- Road and Observation file names
- 35 input items associated with
  - Length of Road
  - Simulation Time
  - Flows
  - Distribution by Vehicle Category
  - Desired Mean Speeds
  - Standard. Deviations of Mean Speeds
  - Entering Platooning Percentages
  - Random Number Seeds
- Source of defaults (program or user)

47 output items associated with
- Simulated Flows
- Average Percent Time Following
- Average Time Delay (Not in State 1)
- Average Speed
- Trip Time
- Trip Delays (Traffic and Geometric Delays listed separately)
- Number of Passes
- Vehicle-miles (-kms)
- Vehicle-hours
- User Supplied Intervals
  - Location
  - Simulated Flows
  - Avg Percent Time Following
  - Avg Time Delay (Not in State 1)
  - Average Speed
  - Number of Passes

A sample of an Excel report produced from the UCBRURAL/TWOPAS multiple run spreadsheet text file is shown in Appendix F. It is printed in Landscape, at 60% size, and with gridlines. All data written to the UCBRURAL spreadsheet is included in this sample report.

All changes for this improvement were made in the UCBRURAL interface. There were no changes made to the TWOPAS source code.

5.21 K5 - Update On-Line Help

Current status: *incorporated.*

UCBRURAL provides extensive on-line help. Much of this on-line help is specific to any currently highlighted menu item or to any current window (context-sensitive). As modifications were made to UCBRURAL, the context-sensitive on-line help was updated to give the user the information needed to use the interface appropriately. In some cases the on-line help is quite extensive. For example, the on-line help for automatic calculation of sight distance includes a description of input values requested from the user and an explanation of the procedure, assumptions, and imbedded constants. In other cases such as printing the TWOSUM output file from the interface, the on-line help is quite short because it merely explains the existence of the option and how to select it. In addition to the context-sensitive help, there is general help on using the UCBRURAL interface.

Updating the on-line help was a modification that was in progress until all modifications were completed. The on-line help has been updated for all of the modifications that have been implemented.

The Help Menu on the Main Menu bar provides the user with access to directions on using the Context-Sensitive Help that is provided by UCBRURAL. The Help Menu also provides access to General Help on using the UCBRURAL interface. The following comments describe the use and versatility of the on-line help.

The user can activate the Context Sensitive Help for a menu item by highlighting the desired item and then pressing the F1 key. If using a mouse the user needs to keep the mouse button down while pressing the F1 key so that the item itself is not selected. The user can activate the Context Sensitive Help on the data entry windows by either selecting the Help Button with the mouse or pressing the F1 key.

Users may view additional related information by clicking on any highlighted item in the text of a help window. At any point, users can retrace their steps by clicking on any help item that is listed at the bottom of the help window. In this way users can browse through the entire on-line context help that is provided by UCBRURAL.

The help window can be zoomed to full screen size by clicking on the arrow in the upper right hand corner of the help window. A subsequent click on the same arrow will return the Help window to normal size. The help window can be moved around on the screen by dragging anywhere on the top boundary of the window (except the close button and the zoom arrow). The help window can be resized by dragging the lower right corner of the window. The help window also has vertical and horizontal scroll bars.

The help screen must be closed before UCBRURAL can continue. Pressing ESC or clicking on the small green square in the upper left corner of any help window will close it.

The on-line help as been updated for each new modification. All changes for this improvement were made in the UCBRURAL interface. The were no modifications made to the TWOPAS source code.

5.22 N 1 - Added Improvement - Vertical Curves on Changes of Grade

Current status: *incorporated.*

When TWOPAS was incorporated into the UCBRURAL interface it was decided that because TWOPAS handles discrepancies in the grade, the TWOPAS model capability of handling vertical curves need not be implemented in the interface. However, vertical curves were needed for the automatic sight distance calculation since the algorithm that computes the sight distance automatically requires that each change of grade in the vertical alignment be achieved by a vertical curve

In section 5.13.2 it was pointed out that crest vertical curves were the only vertical alignment elements that could restrict the sight distance. Although not mentioned in section 5.13.2, it is obvious that a break in the alignment (corresponding to a crest but without a curve) could also obstruct the sight distance. The reason why breaks were not considered in section 5.13.2 are as follows. First, if a break does exists on a real alignment, it will necessarily have to be very small (AASHTO allows a break without the introduction of a vertical curve for a maximum change of grade of 0.5 %.) Second, even if a small break is contemplated in the design of a highway, some rounding of the alignment will be done during construction which can be model with a small vertical curve Third, though for traffic modeling purposes it could be acceptable to replace vertical curves by straight segments, this is not acceptable to obtain the sight distance, especially if the change of grade is important. Thus, it was decided to model the vertical alignment with curves on all changes of grade.

Therefore the interface was adapted to handle vertical curves. The vertical alignment of the road is specified by entering the grade over each road section for direction 1. But for road sections that are on vertical curves the user should enter a “code” 99 instead. When computing the sight distance automatically the interface automatically calculates the vertical curves. This is possible since the grades at the start and end of the curves are known as well as the length of each curve. Of course, the accuracy of the curve calculations depend on the road unit length used. As already explained in section 5.13.3, vertical curves are calculated based on the equation

$$L = K A$$

where

L = length of the vertical curve (ft)
A = percent change in the grade,
K = rate of vertical curvature (horizontal distance require to effect 1 % change in slope)

The value of K used in UCBRURAL is set at 50 ft.

All changes for this improvement were made in the UCBRURAL interface. There were no modifications made to the TWOPAS source code.

5.23 N2 - Added Improvement - Correct Speeds when all Vehicle Categories are Present (or when more than one vehicle category is present).

Current Status: incorporated

This improvement was not in the list of improvements for this project. However, while working on the other improvements, it was found that when two or more vehicle categories with different specified desired speed distributions were used, the program did not generate desired speed distributions consistent with the values specified at input. This problem was not apparent when only one vehicle category was specified or if two or more vehicle categories were used but with the same desired speed distribution.

To illustrate the problem, consider the portion of the TWOPAS output file shown in Table 5.23:1 for a simulation with 30% trucks, 30% RV's and 40% passenger cars and with mean desired speeds of 55 mph (80.7 ft/sec), 50 mph (73.3 ft/sec), and 60 mph (88 ft/sec) respectively. The specified standard deviation of desired speeds was 0.01 mph for the three vehicle categories. As can be observed, under the column heading "AVERAGE DESIRED - MEAS.", the simulated (measured) mean desired speeds were completely unrelated to the input values. This is not logical since the input standard deviation of desired speeds were 0.01 mph and therefore for a level straight section of road one could expect a difference between the specified and input values of at most 0.03 mph (0.043 ft/sec) (the simulated speed range is -3 to +3 standard deviations from the mean desired speed), and zero differences on average.

Table 5.23:2 illustrates that for a simulation with 100% passenger cars with mean desired speed of 60 mph and standard deviation of 0.01 mph, the simulated desired speeds were in much better agreement with the input values. Similar results were obtained with 100% trucks and 100% RV's. Note however, that there still are some problems since the differences are greater than they should be. This is discussed later.

A review did not indicate any problem with the logic. It turned out that the problem was caused because common block CAR was missing from subroutine EPLAT. This common block has the variable KVT which specifies the vehicle type. When EPLAT was executed a local variable was correctly computed. Subroutine EPLAT calls subroutine VASGN which correctly computed the desired speed for a vehicle of type KVT. However, the new value of KVT computed in subroutine EPLAT was never passed to subroutine VASGN. The end result was that in subroutine VASGN a desired speed corresponding to the vehicle type that was previously stored in the KVT variable in common block /CAR/ was being used instead of the desired speed corresponding to the vehicle type KVT as determined in subroutine EPLAT.

TABLE 5.23:1 Portion of the TWOPAS output file illustrating the problem with the generation of desired speeds. Flow rates = 500 vph in each direction with 40% cars, 30% trucks and 30 % RV's.

1RUN NO. 1 UCBRURAL RUN 60.00 MIN. PAGE 2
0SPEEDS, OVERALL AND DESIRED (FT/SEC)

DIRECTION ONE
0

VEH TYPE CAT.	SAMPLE SIZE SPECIFIED	SAMPLE SIZE MEAS.	**AVE. DESIRED SPEC.**	**AVE. DESIRED MEAS.**	**DIFF.**	REFERENCE AVERAGES IDEAL GEOM.	REFERENCE AVERAGES ZERO TRAFFIC	MEASURED OVERALL AVERAGE	MEASURED OVERALL STD. DEVIATION	MAX.	MIN.
1	18.00	12.00	**80.70**	**79.82**	**-0.88**	80.70	80.70	75.15	3.05	80.38	71.30
2	38.40	49.00	**80.70**	**80.08**	**-0.62**	80.70	80.70	74.74	2.81	80.38	70.98
3	51.00	52.00	**80.70**	**79.60**	**-1.10**	80.70	80.70	75.52	3.38	83.80	70.84
4	42.60	59.00	**80.70**	**79.63**	**-1.07**	80.70	80.70	75.62	3.52	80.53	70.67
TRUCKS	150.00	172.00	**80.70**	**79.76**	**-0.94**	80.70	80.70	75.31	3.25	83.80	70.67
5	15.00	19.00	**73.30**	**77.78**	**4.48**	70.83	70.83	70.82	0.01	70.83	70.77
6	60.00	64.00	**73.30**	**80.57**	**7.27**	73.30	73.30	74.89	2.78	80.72	70.76
7	60.00	59.00	**73.30**	**80.67**	**7.37**	73.30	73.30	75.58	3.09	80.50	71.05
8	15.00	13.00	**73.30**	**81.99**	**8.69**	73.30	73.30	78.30	3.83	84.64	72.72
REC.V.	150.00	155.00	**73.30**	**80.39**	**7.09**	73.05	73.05	74.94	3.33	84.64	70.76
9	20.00	18.00	**88.00**	**81.35**	**-6.65**	88.00	88.00	76.78	3.19	80.66	72.92
10	30.00	41.00	**88.00**	**82.28**	**-5.72**	88.00	88.00	75.51	3.22	81.28	70.83
11	40.00	33.00	**88.00**	**80.67**	**-7.33**	88.00	88.00	75.24	2.88	80.38	71.04
12	50.00	50.00	**88.00**	**79.65**	**-8.35**	88.00	88.00	76.17	3.46	81.78	71.21
13	60.00	52.00	**88.00**	**80.18**	**-7.82**	88.00	88.00	75.74	3.25	84.57	70.70
PASS.	200.00	194.00	**88.00**	**80.68**	**-7.32**	88.00	88.00	75.81	3.23	84.57	70.70
ALL	500.00	521.00	**81.40**	**80.29**	**-1.11**	81.33	81.33	75.39	3.28	84.64	70.67

TABLE 5.23:2 Portion of the TWOPAS output file for 100% passenger car. illustrating the problem with the generation of desired speeds. Flow rates = 500 vph in each direction. Note that the differences between specified and measured desired speeds are all less 1 mph (1.47 ft/sec).

1RUN NO. 1 UCBRURAL RUN 60.00 MIN. PAGE 2
0SPEEDS, OVERALL AND DESIRED (FT/SEC)

DIRECTION ONE

0 VEH	SAMPLE SIZE		**AVE. DESIRED**			REFERENCE AVERAGES		MEASURED OVERALL			
TYPE						IDEAL	ZERO		STD.		
CAT.	SPECIFIED	MEAS.	**SPEC.**	**MEAS.**	**DIFF.**	GEOM.	TRAFFIC	AVERAGE	DEVIATION	MAX.	MIN.
1	0.00	0.00	**0.00**	**0.00**	**0.00**	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	**0.00**	**0.00**	**0.00**	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	**0.00**	**0.00**	**0.00**	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	**0.00**	**0.00**	**0.00**	0.00	0.00	0.00	0.00	0.00	0.00
TRUCKS	0.00	0.00	**0.00**	**0.00**	**0.00**	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	**0.00**	**0.00**	**0.00**	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	**0.00**	**0.00**	**0.00**	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	**0.00**	**0.00**	**0.00**	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	**0.00**	**0.00**	**0.00**	0.00	0.00	0.00	0.00	0.00	0.00
REC.V.	0.00	0.00	**0.00**	**0.00**	**0.00**	0.00	0.00	0.00	0.00	0.00	0.00
9	50.00	52.00	**88.00**	**87.68**	**-0.32**	88.00	88.00	87.42	0.33	88.39	87.01
10	75.00	91.00	**88.00**	**87.76**	**-0.24**	88.00	88.00	87.46	0.33	88.40	87.11
11	100.00	108.00	**88.00**	**87.79**	**-0.21**	88.00	88.00	87.49	0.38	88.40	87.09
12	125.00	128.00	**88.00**	**87.81**	**-0.19**	88.00	88.00	87.54	0.41	88.64	87.10
13	150.00	132.00	**88.00**	**87.82**	**-0.18**	88.00	88.00	87.51	0.40	88.59	87.10
PASS.	500.00	511.00	**88.00**	**87.79**	**-0.21**	88.00	88.00	87.49	0.38	88.64	87.01
ALL	500.00	511.00	**88.00**	**87.79**	**-0.21**	88.00	88.00	87.49	0.38	88.64	87.01

In summary, the program logic was correct but because of the missing common block, the desired speed was not necessarily assigned from the distribution of the vehicle category. Instead the program selected the vehicle categories almost at random and therefore the generated desired speeds were incorrect.

To solve the problem the following change was made to the TWOPAS source code:

added
```
      COMMON /CAR/  IP,KSIP,KVT,IDEX,NRR1,NRR2,NRS1,NRS2,NRDX1,NRDX2,
     1              KSN,NAGE,KT,IOL,IAGE,IDR, XIP,VIP,VDNR,COMPL,XN,VN,
     2              GRD,GAIN
```
to
```
EPLAT
```

As can be observed in Table 5.23:3 the agreement between the specified desired speeds and the simulated (measured) desired speeds after the above correction is much better than the one in Table 5.23:1. Note however, that even though the differences were significantly reduced the generated desired speeds were still incorrect since as mentioned before the speeds should differ at most in three standard deviations (0.043 ft/sec). The fact that all the differences were less than 1 ft/sec hinted that the problem could be caused by some rounding of numbers. Indeed, the small differences were found to be caused by a truncation of the desired speed values and the addition of a decimal value (variable TIN) that represents the time at which the vehicle crosses the first observation station. The storage of that time on the desired speed of each vehicle was really unnecessary because the crossing times were already stored in another variable (TVIN).

As can be observed in Table 5.23:4, the simulated average desired speeds for each vehicle type agreed exactly with the specified mean desired speeds after this last correction was made. The perfect coincidence was to be expected since the standard deviation of desired speeds was only 0.043 ft/sec (0.01 mph) and several vehicles were simulated for each vehicle type (a minimum of 10 for veh. type 9). The difference of 0.10 for all vehicle types arises because 37.3 % pass. cars, 29.8% RV's, and 32.9% trucks were simulated instead of the specified 40%, 30%, and 30% respectively.

The changes to the TWOPAS code in subroutines SLIN2 and subroutine ZERO2 which were necessary to solve this last problem are shown in the source code with the label:

```
C **  UCB 97 - FIX PROBLEM WITH DESIRED SPEEDS
```

TABLE 5.23:3 Portion of the TWOPAS output file illustrating the partial solution to the problem with the generation of desired speeds. Flow rates = 500 vph in each direction with 40% cars, 30% trucks and 30% RV's. Note that the differences between specified and measured desired speeds are all << 1 mph (1.47 ft/sec).

1RUN NO. 1 UCBRURAL RUN 60.00 MIN. PAGE 2
0SPEEDS, OVERALL AND DESIRED (FT/SEC)

DIRECTION ONE

0 VEH TYPE CAT.	SAMPLE SIZE SPECIFIED	SAMPLE SIZE MEAS.	**AVE. DESIRED SPEC.**	**AVE. DESIRED MEAS.**	**DIFF.**	REFERENCE AVERAGES IDEAL GEOM.	REFERENCE AVERAGES ZERO TRAFFIC	MEASURED OVERALL AVERAGE	MEASURED OVERALL STD. DEVIATION	MAX.	MIN.
1	18.00	12.00	**80.70**	**80.32**	**-0.38**	80.70	80.70	74.69	2.76	80.30	71.08
2	38.40	48.00	**80.70**	**80.29**	**-0.41**	80.70	80.70	74.54	2.58	80.44	70.39
3	51.00	52.00	**80.70**	**80.29**	**-0.41**	80.70	80.70	74.48	2.69	80.37	70.81
4	42.60	59.00	**80.70**	**80.31**	**-0.39**	80.70	80.70	74.67	3.03	80.37	70.51
TRUCKS	150.00	171.00	**80.70**	**80.30**	**-0.40**	80.70	80.70	74.58	2.76	80.44	70.39
5	15.00	19.00	**73.30**	**73.31**	**0.01**	70.83	70.83	70.80	0.09	70.83	70.48
6	60.00	64.00	**73.30**	**73.28**	**-0.02**	73.30	73.30	73.07	0.55	73.44	70.94
7	60.00	59.00	**73.30**	**73.27**	**-0.03**	73.30	73.30	73.06	0.60	73.69	70.98
8	15.00	13.00	**73.30**	**73.29**	**-0.01**	73.30	73.30	72.77	0.98	73.43	70.82
REC.V.	150.00	155.00	**73.30**	**73.28**	**-0.02**	73.05	73.05	72.77	0.94	73.69	70.48
9	20.00	18.00	**88.00**	**88.07**	**0.07**	88.00	88.00	75.97	2.54	80.37	73.29
10	30.00	41.00	**88.00**	**87.84**	**-0.16**	88.00	88.00	75.87	3.29	85.32	71.43
11	40.00	33.00	**88.00**	**87.73**	**-0.27**	88.00	88.00	75.60	3.22	84.63	70.84
12	50.00	50.00	**88.00**	**87.85**	**-0.15**	88.00	88.00	76.33	3.74	84.97	70.82
13	60.00	52.00	**88.00**	**87.84**	**-0.16**	88.00	88.00	75.64	3.71	87.63	70.79
PASS.	200.00	194.00	**88.00**	**87.85**	**-0.15**	88.00	88.00	75.89	3.43	87.63	70.79
ALL	500.00	520.00	**81.40**	**81.02**	**-0.38**	81.33	81.33	74.53	2.96	87.63	70.39

TABLE 5.23:4 Portion of the TWOPAS output file illustrating the complete solution to the problem with the generation of desired speeds. Flow rates = 500 vph in each direction with 40% cars, 30% trucks and 30% RV's.

```
1RUN NO.   1   UCBRURAL RUN                                                                   60.00 MIN.       PAGE 2
0SPEEDS, OVERALL AND DESIRED  (FT/SEC)
 ------------------------------------
      DIRECTION  ONE
```

0 VEH TYPE CAT.	SAMPLE SIZE SPECIFIED	MEAS.	AVE. DESIRED SPEC.	MEAS.	DIFF.	REFERENCE AVERAGES IDEAL GEOM.	ZERO TRAFFIC	MEASURED OVERALL AVERAGE	STD. DEVIATION	MAX.	MIN.
1	18.00	12.00	**80.70**	**80.70**	**0.00**	80.70	80.70	74.65	2.81	80.67	70.77
2	38.40	48.00	**80.70**	**80.70**	**0.00**	80.70	80.70	74.55	2.65	80.69	70.38
3	51.00	52.00	**80.70**	**80.70**	**0.00**	80.70	80.70	74.40	2.79	80.69	70.81
4	42.60	59.00	**80.70**	**80.70**	**0.00**	80.70	80.70	74.50	3.02	80.78	70.38
TRUCKS	150.00	171.00	**80.70**	**80.70**	**0.00**	80.70	80.70	74.49	2.81	80.78	70.38
5	15.00	19.00	**73.30**	**73.30**	**0.00**	70.83	70.83	70.81	0.06	70.83	70.59
6	60.00	64.00	**73.30**	**73.30**	**0.00**	73.30	73.30	73.07	0.62	73.31	70.84
7	60.00	59.00	**73.30**	**73.30**	**0.00**	73.30	73.30	73.09	0.64	73.61	70.79
8	15.00	13.00	**73.30**	**73.30**	**0.00**	73.30	73.30	72.76	1.02	73.30	70.81
REC.V.	150.00	155.00	**73.30**	**73.30**	**0.00**	73.05	73.05	72.77	0.97	73.61	70.59
9	20.00	18.00	**88.00**	**88.00**	**0.00**	88.00	88.00	75.93	2.56	80.68	73.29
10	30.00	41.00	**88.00**	**88.00**	**0.00**	88.00	88.00	75.54	2.82	81.37	70.77
11	40.00	33.00	**88.00**	**88.00**	**0.00**	88.00	88.00	75.45	3.06	83.60	70.88
12	50.00	50.00	**88.00**	**88.00**	**0.00**	88.00	88.00	76.19	3.68	84.60	70.81
13	60.00	52.00	**88.00**	**88.00**	**0.00**	88.00	88.00	75.39	3.41	87.08	70.80
PASS.	200.00	194.00	**88.00**	**88.00**	**0.00**	88.00	88.00	75.69	3.22	87.08	70.77
ALL	500.00	520.00	**81.40**	**81.22**	**-0.18**	81.33	81.33	74.43	2.85	87.08	70.38

5.24 N3 - Added Improvement - Correct Percent Time Delay Compatibility on Graphs.

Current Status: incorporated

The TWOSUM output file contains several variables related to vehicles following other vehicles. Because of this there was confusion about the meaning of these variables and, in addition, there was no interval output in TWOSUM that was compatible with the point and space measurements displayed on the graphs for Percent Following. In fact, this confusion seems to have been around at least since the development of Chapter 8 of the 1985 HCM. In that reference, Percent Time Delay is defined as the percent of time vehicles spent traveling at headways less than 5 secs, yet at that time, the TWOPAS program output (which was used in the development of that Chapter) did not give any output matching that definition!

The following paragraphs clarify the meaning of the variables in the TWOSUM file. The structure of the unmodified TWOSUM output is illustrated below:

```
1                    ***** PROGRAM TWOPAS:  RURAL TRAFFIC SIMULATION;  OUTPUT SUMMARY *****

 1RUN NO.    1      TEST RUN FOR REPORT  DEMO.*
                   -----------
 0      WARM TIME= 12.000 MINUTES        TEST TIME= 60.000 MINUTES        TOTAL TIME= 72.000 MINUTES
 OVERALL TRAVEL TIME=   76.8 SEC, S.D.=  12.3 SEC
 OVERALL % TIME DELAYED:  DIR1=  43.3 DIR2=  38.1 COMB=  41.8

                              *** SUMMARY SPOT CHARACTERISTICS ***
 STN         LOCATION          DIRN  NL   FLOW  %UNIMP  %DESSP  PSIZE  NFOLL  SPTRK   SPRV  SPCAR  SPALL   %IMP  PFOLL
  1  MILEPOST   0.04              1   1  400.0   83.0   76.0    2.7  125.0   57.7    0.0   57.3   57.3   17.0   31.3
  2  MILEPOST   0.11              1   1  400.0   76.0   78.0    2.7  129.0   57.1    0.0   57.2   57.1   24.0   32.3

                                    .       .       .       .       .
                                    .       .       .       .       .

                                 *** SUMMARY INTERVAL INFORMATION ***
     DIRN  FROM  TO   DIST  SPEED   TTIME    MTIME DELAY  %UNIMP  %NDS   PR1   PR2   VTIME   NVEH   PASS1L  PASS2L
        1     1  47  18400.  46.6  106957.   76.8    9.1   56.8   25.2  0.23  0.00   267.6    400.     313       0
        2     1  47  18400.  51.1   41575.   70.5    5.5   62.0   28.5  0.05  0.00   245.7    169.      28       0

      COMPUTER TIME FOR THIS RUN WAS:     3.46 SEC.
```

As can be observed, the output consists of three parts. The top part gives general information about the run, the second part gives information for selected points (spots), and the last part gives interval information.

OVERALL % TIME DELAY appears in the top part for each direction and for both directions combined. OVERALL % TIME DELAY in TWOSUM is the complement to 100 of the **PERCENT OF TIME UNIMPEDED** in the TWOPAS output. That is, OVERALL % TIME DELAY = 100 - PERCENT OF TIME UNIMPEDED. PERCENT OF TIME UNIMPEDED in turn is computed as the percentage of vehicles that are in **STATE 1** one between the first and the last observation station and during the test time. STATE 1 defines free vehicles, unimpeded by other vehicles in the same lane. It must be stressed out that the criteria to define free vehicles in TWOPAS is different from the 5 sec criteria used to defined **Percent Time Delay** in the HCM 1985 (and also in the HCM 1994).

In the second part of the TWOSUM output under the heading SUMMARY SPOT CHARACTERISTICS, appear the variables %UNIMP, %IMP, and %FOLL. **%IMP** is computed simply as 100-%UNIMP. **%UNIMP** is obtained from the TWOPAS output file under the heading PERCENT UNIMPEDED for each user-selected station. TWOPAS computes **PERCENT UNIMPEDED** as the percentage of all vehicles that crossed the station that were in STATE 1. Again, this is different from the percent following (percentage of vehicles traveling at headways less than 5 sec at an observation station) usually used as a proxy for percent time delay .

%FOLL is computed as:

$$\frac{\text{No. of members in platoon}}{\text{Flow rate}} \; \frac{60 \times 100}{\text{Simulated Time (min)}} = \frac{\text{Flow of following vehic}}{\text{Flow rate}}$$

The number of members in platoon is taken from NFOLL also in the TWOSUM output. TWOPAS considers that a vehicle is a platoon member when the vehicle is traveling at a headway less than four seconds from its leader when it crosses the observation station. This is more in the spirit of the 1994 HCM but instead of 5 sec the program is using 4 sec. A modification to use 5 sec as the criterion is trivial and is under consideration.

Finally, in the third part, SUMMARY INTERVAL INFORMATION, there is again a heading **%UNIMP**. This is computed as the percentage of vehicles in the interval that during the test period were traveling in STATE 1. Since, the UCBRURAL interface is defining the interval from the first observation station to the last for each direction, the values of %UNIMP should be equal to 100-OVERALL % TIME DELAY where OVERALL % TIME DELAY was defined for the first part of the TWOSUM output.

%NDS appears in the TWOPAS output file under the heading PERCENT OF TIME NEAR DESIRED SPEED. This is simply the percentage of vehicles in the interval that were traveling at a speed greater than their desired speed - 2 ft/sec.

As mention at the beginning of this section the point and space measurements displayed on the graphs produced by the UCBRURAL interface were incompatible. The reason was that the variable OVERALL % TIME DELAY in the first section of TWOSUM was selected as the space measurement variable whereas for the point observations the variable PFOLL in the second section was selected. As mentioned before, the former was based on the states of vehicles whereas the latter was based on a simple headway criterion. Obviously, there were occasions (particularly were passing lanes were simulated) in which the two variables were inconsistent.

The following modification have been performed on the TWOSUM output so as to make it more understandable and compatible with the project requirements (the reader may notice other differences between the old and new versions of TWOSUM, but these are explained in other sections). The modifications are highlighted in the following extract from a new TWOSUM output file.

```
1                    ***** PROGRAM TWOPAS:  RURAL TRAFFIC SIMULATION;  OUTPUT SUMMARY *****

 1RUN NO.    1      TEST RUN FOR REPORT  DEMO.*
   ROAD:DEMO      TRAF:DEMO      OBS:DEMO      DATE:10/29/97  TIME:13:16 NB SB
   RANDOM NUMBERS:  55652279  22751215  56740816  35918417  88756749
 0      WARM TIME= 12.000 MINUTES        TEST TIME= 60.000 MINUTES        TOTAL TIME= 72.000 MINUTES
 OVERALL TRAVEL TIME=   76.9 SEC, S.D.=  13.5 SEC
 OVERALL % TIME IN STATE 1:  DIR1=  42.9 DIR2=  35.5 COMB=  40.9
        .       .       .       .       .
        .       .       .       .       .

                              *** SUMMARY SPOT CHARACTERISTICS ***
 STN         LOCATION              DIRN  NL  FLOW  %UNIMP  %DESSP  PSIZE  NFOLL  SPTRK   SPRV  SPCAR  SPALL   %IMP  PFOLL
#PASS
  1  MILEPOST   0.04                 1   1  400.0   83.0   73.0    2.7  125.0   49.5    0.0   57.3   56.9   17.0   31.3
0.0
  2  MILEPOST   0.11                 1   1  401.0   74.0   19.0    2.6  126.0   47.3    0.0   56.3   55.7   26.0   31.4
5.0
        .       .       .       .
        .       .       .       .

                              *** SUMMARY INTERVAL INFORMATION ***
 DIRN  FROM  TO   DIST  SPEED   TTIME   MTIME  TFDLY    PTD   %NDS   PR1   PR2   VTIME    VPH   PASS1L  PASS2L VEH-MILES
GEDLY
    1    1   47  18400.  46.6  107032.   76.9    8.9   50.8   20.8  0.23  0.00   267.8    400.     319       0   1386.95
  6.3
    2    1   47  18400.  51.6   41097.   69.7    4.5   39.3   25.5  0.06  0.00   242.9    169.      38       0    589.65
  3.5

  COMPUTER TIME FOR THIS RUN WAS:     3.95 SEC.
```

First, in the first output section, the label OVERALL % TIME DELAY has been changed to **OVERALL % TIME IN STATE 1.** This new label accurately represents the numerical value written by the program. Second, %UNIMP in the third section was changed to **PTD** where PTD is percent time delay as defined in the HCM (though at present a 4 sec definition is in use).

The point observations in the Percent Following graph which represents the percent of vehicles following as they pass the observation station is still represented by PFOLL (based on a 4 sec. Headway criterion). However, the space measurements are now taken from PTD in the overall interval in the third section (the interface always creates an overall observation interval from the first to the last observation station for each direction; for more information on this see section 5.19). Since PTD is also based on a 4 seconds headway criterion the two variables are now compatible.

The following changes were made to the TWOPAS source code:

added to DBSPT

```
      COMMON /PLHDWY/ PLHDWY
```

changed

```
      COMMON/BSPOT/ KFNL(3,20),AOTT(3,20),AMSP(3,2,20),AMSP2(3,2,20),
     1 SSMN(3,2,20),KREV(3,2,20),KREUN(3,2,20),KDSPD(3,2,20),
     2 LCBYM(3,3,20),LCPTD(7,20),LCDIS(5,20),FTTVL(3,2,20),
     3 KPAS1(3,20),KPAS2(3,20)
```

throughout to

```
      COMMON /BSPOT/ KFNL(3,20),AOTT(3,20),AMSP(3,2,20),AMSP2(3,2,20),
     1                SSMN(3,2,20),KREV(3,2,20),KREUN(3,2,20),
     2                KPTD(3,2,20),KDSPD(3,2,20),LCBYM(3,3,20),
     3                LCPTD(7,20),LCDIS(5,20),FTTVL(3,2,20),
     4                KPAS1(3,20),KPAS2(3,20)
```

Additional changes were made to subroutines DBSBT, ERASE2, AND SOUT. All changes made to these TWOPAS subroutines for this improvement are shown in the source code with the label:

```
C    UCB 97  PERCENT TIME DELAY
```

5.25 N4 - Added Improvement - Allow Two User-defined Data Collection Intervals

Current Status: incorporated

The original TWOPAS code allowed the user to define up to 10 **non-overlapping** data collection intervals per direction. However, the UCBRURAL interface allowed the user to define only one interval per direction. It is the output data from this interval that the interface uses to produce the profile graphs of Percent Following and Mean Speed. (Profile graph of Number of Passes added Improvement described in Section 5.12). Aggregate values over the interval for the variable graphed is printed at the top of each graph. In order to display graphs of the entire simulated roadway, the user would need to specify the start and end of that interval as the first and last observation stations respectively. Researchers on the project were certainly interested in the overall (from the first to the last observation station) interval information, but also needed aggregate data over other subintervals in order to see, for example, what happens around passing lanes. Thus, the ability to collect data over user-defined intervals which **overlap** the overall interval improvement was added to the improvement list. The implementation of this improvement also greatly simplified the implementation of Improvement H4 - Add Profile Graph of Number of Passes (Section 5.12).

It was decided to have the interface automatically generate an overall interval from the first observation to the last observation station. The spot output data for this interval would be used for the graphs and the aggregate data for this interval would be displayed at the top of the graphs. The user-supplied intervals in the interface could then be used to get aggregate information over a shorter distance (one in each direction). The reason for using an interval to get overall output data and not using the general output information generated by TWOPAS was because the general output calculated Percent Time Delay as Percent of Time in State 1 which is not compatible with the HCM definition of this variable. It would have been possible to modify the TWOPAS code to compute PTD for the overall interval in the same manner the program computes the Percent of Time in State 1 for the overall interval. This, however, would have demanded a much greater research and programming effort and some small discrepancies in the PTD could have resulted (different subroutines are called in the two options).

Since the 10 intervals allowed in the original TWOPAS code had to be non-overlapping and the only interval allowed by the interface covered from the first to the last observation station, no other interval could be defined.

The solution was in concept very simple (though not so simple to program). In the observation station cards of the TWOPAS input data file there is a column in which the user specifies the interval to which the road length downstream from the station location belongs. So by simply adding another column the user could now specify that a the road length downstream from the station location (until the next observation station) belongs to two different intervals (or just one or none). Therefore, a new column was added to the SL data cards in the TWOPAS input file.

The format of the Station Locations (SL) optional data cards had to be changed as follows:

Columns	1-2	**3-4**	**5-8**	**9-12**	**13-16**	**17-20**	21-30	41-80
Format	A2		**I4**	**I4**	**I4**	**I4**	F10.0	10A4
Content	SL	Empty	ISTA	JDD	JCDA(KTAB,**1**)	JCDA(KTAB,**2**)	XSTA(KTAB)	PTDES(I,KTAB)

where:

ISTA = The sequence number of the station in the specified direction of travel; station sequence numbers are consecutive integers that increase in the order they are encountered by vehicles in each direction of travel (i.e., in order of increasing coordinates for the No. 1 Direction and in order of descending coordinates for the No. 2 Direction); the maximum number of stations that can be specified in either directions of travel is 20.

JDD = The specified direction of travel for the station, 1 or 2.

JCDA(KTAB,**I**) = The sequence number of the specified interval of which the road length downstream from the station location (up to the next station) is part; use 0 if the road length downstream of the station location is not part of any subsection. **The index I is 1 for the data in columns 13-16 and 2 for data in columns 17-20. The overall interval is entered in JCDA(KTAB,1) as interval 1 and the user-specified interval is entered in JCDA(KTAB,2) as interval 2.**

XSTA(KTAB) = The location of the station specified in feet in Direction 1 coordinates.

PTDES(I,KTAB)= Text description of the station location; maximum of 40 characters.

It must be noted that at present the interface limits the number of observation intervals per direction to two. Modifying the interface to allow more intervals per direction was outside the scope of this work (especially considering that this improvement was not initially defined). The modified TWOPAS program still allows the definition of up to 10 observation intervals per direction. The 10 observation intervals could be specified all in the first JCDA column or all in the second JCDA column or 1 in the first column (the overall interval) and nine in the second column or any other combination as long as the number of intervals is less than or equal to 10. This allows the user of TWOPAS to define overlapping intervals as long as there is no overlapping with a column. Future versions of the interface or new interfaces could make use of the addition number of intervals which exit in the new TWOPAS version.

The UCBRURAL interface now allows the user to define one interval in each direction and automatically defines an additional overall interval in each direction. The UCBRURAL interface was modified to write this information to the TWOPAS input file. A sample TWOPAS.INP file is shown in Appendix B. Output for a user supplied interval is shown in Appendix C.

The following changes were made to the TWOPAS source code:

change COMMON /STAT/ MSTA(2),JCDA(300,2),XSTA(300,2),PTDES(300,2,10)
throughout to COMMON /STAT/ MSTA(2),JCDA(300,2**,2**),XSTA(300,2),PTDES(300,2,10)

Note that COMMON /STAT/ was modified again for improvement H4 - Add Profile Graph of Number of Passes (section 5.12) so that the final form is

COMMON /STAT/ MSTA(2),JCDA(300,2**,3**),XSTA(300,2),PTDES(300,2,10)

change COMMON /TVIN/ TVIN(2000)
throughout to COMMON /TVIN/ TVIN(2000**,2**)

Additional changes were made to subroutines CXSTA, FLIN2, FPUT2, FSTA, REED2, SLIN2, SOUT, SSTA, VGEN, AND ZERO2. All changes made to these TWOPAS subroutines for this improvement are shown in the source code with the label:

C ** UCB 97 - USER SPECIFIED INTERVAL - OVERLAPPING INTERVALS

5.26 N5 - Remove TRARR from Interface

Current Status: incorporated

The UCBRURAL interface was originally developed for the TRARR two-lane rural highway simulation model. The TWOPAS simulation model was later incorporated into the same interface. With this version of the UCBRURAL interface, the user was able to enter data and then run either the TRARR or TWOPAS model. An interface from which either model could be run proved to be a very useful research tool and was used extensively during the beginning phase of the current project in evaluating and comparing the two models before a final model selection was made. After the TWOPAS model was selected and work began on modifications, an effort was made to retain the TRARR model in the interface. However, with the inclusion of several of the modifications, the specifications for the two models were no longer compatible. Because the modifications needed to maintain the TRARR model were not part of the current project, researchers reluctantly concluded that the TRARR model had be removed from the current UCBRURAL interface.

The option for making a TRARR run was removed from the Run menu. All other references to TRARR within the menus and screens in the UCBRURAL interface were also removed. In addition, all on-line help for the TRARR model was removed.

The TRARR variable "distance upstream with no passing" was removed from the TRAF DATA Screen and thus also removed from the Traf Data Set. This variable has no equivalent in TWOPAS and is confusing to the user. TRARR vehicle types (U.S. or Australian) were removed from the choices in Environment and thus also from the Environment data. This is a choice that has no meaning in TWOPAS. Unfortunately time did not permit removing the name TRARR from all UCBRURAL program file names. However, since the user does not actually see the names of these files , changing them did not have much importance.

All of the data in UCBRURAL was stored in metric because the interface was originally developed for TRARR which is an Australian model. Each time a data set (e.g. Road Data) was used by a section of the interface (e.g. Edit Road Data), the data set was converted to the units the user had selected in the Environment Option. Each time this conversion was made from metric to English units and then back to metric, some accuracy was lost. Thus the user might enter 2000 ft for sight distance, and the next time the user edited the road file the value appeared as 1998 ft. The UCBRURAL interface was modified so that the data files are stored in the units which were selected by the user under Environment at the time that the data was entered. However, the user can still change the Environment setting to view the data or output in a different unit. Because the data set is converted back and forth, a warning is displayed if the user tries to save a data set.

All changes for this modification were made to the UCBRURAL interface. No changes were made to the TWOPAS source code.

6. REFERENCES

1. AASHTO (1994), *"A policy on Geometric Design of Highways and Streets"*, American Association of State Highway and Transportation Officials.

2. Archilla A. R. (1992), "*Effect of long, steep downgrades on two-lane highway traffic operations"*. M.Sc. Thesis, Department of Civil Engineering, The University of Calgary.

3. Federal Highway Administration (1988), *"Manual on Uniform Traffic Control Devices for Streets and Highways"*, U.S. Government Printing Office, Washington D.C.

APPENDIX A

BUILDING BLOCKS FOR THE ALGORITHMS USED IN THE AUTOMATIC CALCULATION OF SIGHT DISTANCE

The following geometric derivations form the basis of the algorithms.

A.1 Tangent to a circular curve (an arc of circumference).

This subsection explains the fundamental concepts used in the development of the procedure FindTangent necessary for the horizontal sight distance calculation.

Figure A.1 shows the three cases one may find when trying to compute the parameters of the tangent line from a point P of coordinates (x_P,y_P) to an arc of circumference defined by the starting point 1, the center 0, and the ending point 2 with coordinates (x_1,y_1), (x_0,y_0), and (x_2,y_2) respectively. In (a) no tangent can be found. This case is characterized by an angles α_1<90º and α_2<90º, where α_1 is the angle between the positive directions of the vectors from P to 1 and from 1 to 0 and α_2 is the angle formed by the positive directions of the vectors from P to 2 and from 2 to 0. In (b) a tangent can be found. Notice that for that case if the angle α_1 is less than 90 degrees (or > 90º), then the angle α_2 must be greater than 90 degrees (< 90º). Equivalently the cosines of α_1 and α_2 must have different signs. This yields a simple test to find if there is only one point of tangency. For the above to be valid however the central angle of the arc must be less than 180 degrees. In case © two tangent lines can be found. This case is identified because both α_1 and α_2 are greater than 90 degrees, i.e., their cosines are negative.

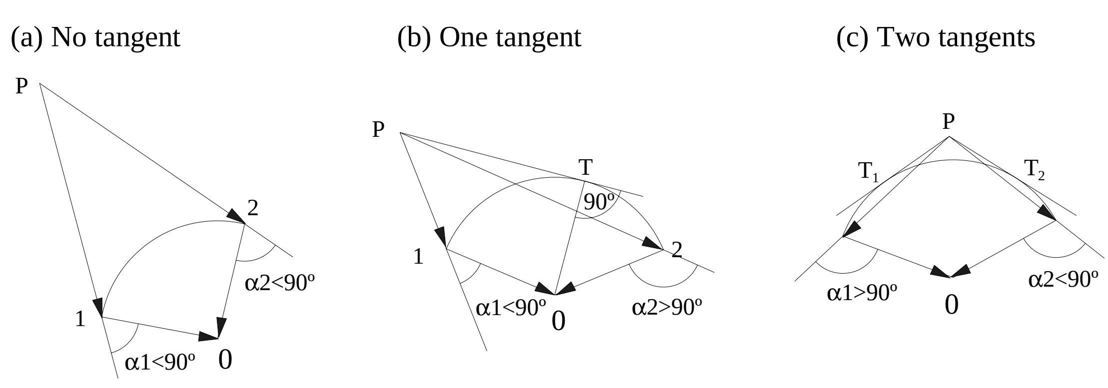

Figure 1 **Figure A.1** Depending on the configuration there may be no tangent, one tangent or, two tangents that pass through point P.

The parameters of the tangent line and the coordinates of the tangent point are found by an iterative procedure. The procedure simply consists on taking points along the curve separated by a given initial arc interval as tentative tangent points until the cos α changes sign, where the angle α is shown in Figure A.2. The change in sign means that α moved from a value less (greater) than 90 degrees to a value greater (less) than 90 degrees, i.e., the tangent point is located between the two last tentative points of tangent. The procedure then goes back one point, it reduces the search interval and continues in the same fashion until the desired precision is achieved, that is, until α is close enough to 90 degrees.

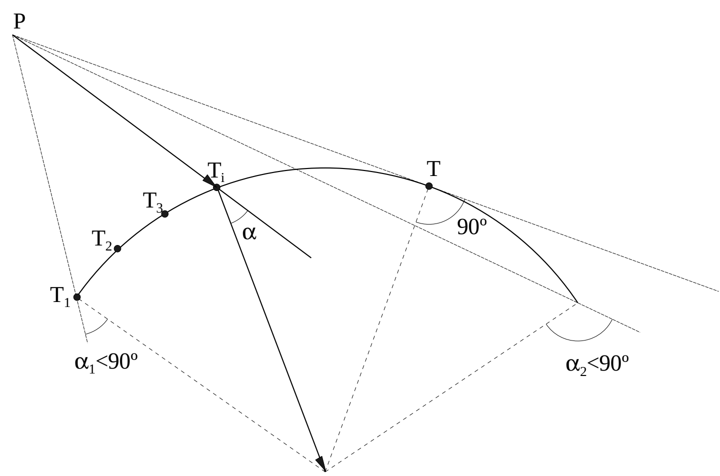

Figure 2Figure A.2 Determination of the tangent point T.

In the case where two tangents exists, one has to choose the tangent line that coincides with the positive direction of the direction in process. This is accomplished by a careful selection of the initial search angle and the sign of the increment which depends on the curve turning left or right. Also in the case with two tangents the algorithm only computes a tangent line when the station of P is actually between the stations of the start and end of the curve since this is the only case with two tangents that is relevant.

A.2 Intersection of a line and an arc of circumference.

This subsection explains the fundamental concepts used in the development of the procedure FindCurveInt used in the horizontal sight distance calculation. This procedure determines if the sight line intersects a given arc of circumference of the horizontal alignment (i.e., one of the circular curves.)

The point on the circular curve satisfy the following equation

$$(x-x_0)^2 + (y-y_0)^2 = R^2 \quad \text{(A.1)}$$

where

x_0 = x coordinate of the center of the arc of circumference,
y_0 = y coordinate of the center of the arc of circumference, and
R = radius of the curve.

Using the following transformation of coordinates

$X = x - x_0$, and

$Y = y - y_0$

equation A.1 is rewritten as

$$X^2 + Y^2 = R^2 \quad \text{(A.2)}$$

The equation of the sight line that passes through point P can be expressed as

$$y = y_P + m\,(x - x_P) \quad \text{(A.3)}$$

where

x_P and y_P = coordinates of P, and
m = slope of the sight line.

In transformed coordinates, equation A.3 is expressed as

$$Y = m\,X + h \quad \text{(A.4)}$$

where

$$h = -\,y_0 + y_P + m\,x_0 - m\,x_P \quad \text{(A.5)}$$

Doing some algebra manipulations with equations A.2 and A.4, it can be shown that the X (transformed) coordinates of the intersection points (if any) are given by

$$X_1 = \frac{-mh + \sqrt{(1+m^2)R^2 - h^2}}{(1+m^2)} \tag{A.6}$$

and

$$X_2 = \frac{-mh - \sqrt{(1+m^2)R^2 - h^2}}{(1+m^2)} \tag{A.7}$$

Having obtained the X coordinates, the Y coordinates are obtained from equation A.4 and then the x and y coordinates are obtained as $x = X + x_0$ and $y = Y + y_0$.

Clearly, for the intersection to exists, $(1+m^2)\,R^2 - h^2$ has to be greater than zero. Note also that even if $(1+m^2)\,R^2 - h^2 > 0$, there may be no intersection with the *arc of circumference* that represents the circular curve. This is illustrated in Figure A.3, where the two intersection points whose X coordinates are given by equations A.6 and A.7 lie outside the arc of circumference. Figure A.4 illustrates the case when one of the points lies inside the arc. Note that a necessary condition for the intersection point to be inside the curve is that the angle β be greater than 90 degrees or equivalently that its cosine be negative. (Note than this is only true if the central angle of the curve is less than 180 degrees). This gives a simple test to see if the intersection points are inside or outside the arc of circumference. When the two points are inside the curve the procedure selects the closest to the point P (the location at which the sight distance is being computed) as the intersection point.

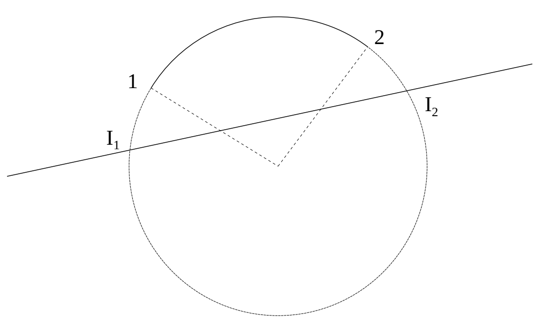

Figure 5Figure A.3 The intersections of the line with the circumference (I_1 and I_2) are located outside the circular curve (arc 12)

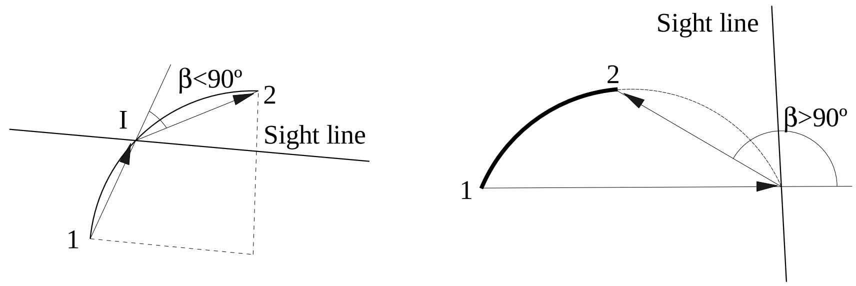

Figure 6Figure A.4 The angle b is <90º if I is inside the curve and >90º otherwise.

Equations A.6 and A.7 cannot be used when the sight line is vertical since m is infinity. Even when m is not infinity but is very large the precision of the results will not be very good. This problem can be solved by solving the system of equations consisting of equation A.2 and A.8 (see below)

$$X = m' Y + h' \qquad \text{(A.8)}$$

where

$m' = 1/m$, and

$h' = -x_0 + x_P + m' y_0 - m' y_P$

Note that equation A.8 represents the same sight line as the one represented by equation A.4. Considering only the first quadrant, whenever the sight line is steeper than 45º the algorithm uses equation A.8, otherwise it uses equation A.4. Equivalent choices are made in the other quadrants. By selecting the equations to use as explained above, we are making certain that an overflow error will never occur.

A.3 Equation of the tangent line to a vertical curve and coordinates of the tangent point

As explained in section 5.9.2, to determine the vertical sight distance a procedure is needed to obtain the parameters of a line passing through a point and is tangent to a crest vertical curve. The procedure that performs such calculations is called TangentToVC. The basic equations used in that procedure are explained in this subsection.

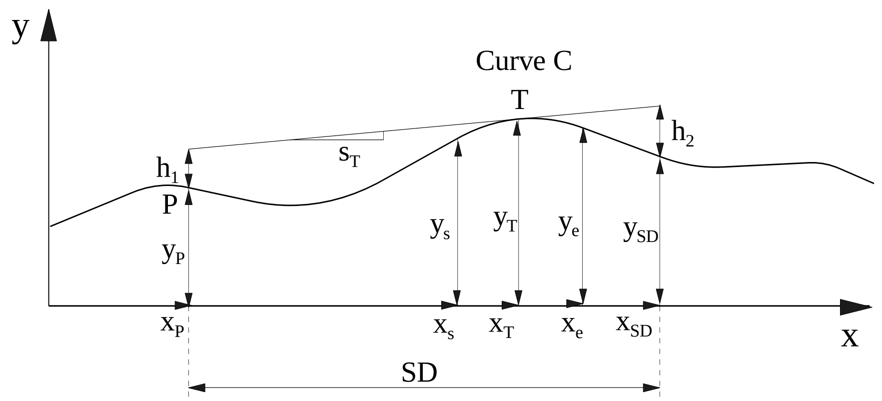

Figure 7Figure A.5 Determination of vertical sight distance

Assume the scenario shown in Figure A.5. The vertical sight distance is needed for point P with station x_P and located a distance h_1 above the alignment (P has coordinates x_P,y_P.) Further curve C is constraining the sight. The equation of the tangent line can be expressed as

$$[y - (y_P + h_1)] = s_T (x - x_P) \tag{A.9}$$

On the other hand, the equation of the crest vertical curve can be expressed as

$$y=y_s+G_1(x-x_s)+\frac{(G_2-G_1)}{2L}(x-x_s)^2 \tag{A.10}$$

where

y_s = y coordinate of the start of the vertical curve,
x_s = x coordinate of the start of the vertical curve,
G_1 = grade at the start of the vertical curve, and
G_2 = grade at the end of the vertical curve.

At the tangent point, the two following conditions have to be satisfied

$$y_T=y_P+h_1+s_T(x_T-x_P)=y_s+G_1(x_T-x_s)+2a(x_T-x_s)^2 \tag{A.11}$$

$$s_T = G_1 + 2\,a\,(x_T - x_s) \qquad (A.12)$$

where $a = (G_2 - G_1)/(2\,L)$.

Equation A.11 says that the y coordinates are equal for the curve and the sight line. Equation A.12 says that the slopes are equal. Solving equations A.11 and A.12 yields the following quadratic expression on x_T

$$a\,x_T^2 - (2\,a\,x_P)\,x_T + C = 0 \qquad (A.13)$$

where

$$C = G_1\,(x_b - x_P) - a\,x_b^2 + y_P + h_1 - y_b + 2\,a\,x_b\,x_P \qquad (A.14)$$

After obtaining x_T from A.13, s_T can be obtained from A.12, and y_T from A.11.

A.4 Determination of the position where the sight is lost on a crest vertical curve.

Once the equation of the sight line is known, the position where the sight is first lost needs to be determined. This section explains the derivation of the equations necessary to determine the station of the point where the sight is lost when that point is located on a crest vertical curve.

Figures A.6a and A.6b show the two possible cases in which the sight is lost on a crest vertical curve. At the station x_{SD}, where the sight is lost, the difference between the elevation on the sight line (equation A.9) and the elevation on the crest vertical curve (equation A.10) must be equal to h_2, the height of the object, i.e.

$$\Delta y = h_2 = y_P + h_1 + s_T\,(x_{SD} - x_P) - a\,(x_{SD} - x_s)^2 - G_1\,(x_{SD} - x_s) - y_s \qquad (A.15)$$

Expanding terms and rearranging yields the following quadratic equation on x_{SD}

$$a\,x_{SD}^2 + b\,x_{SD} + c = 0 \qquad (A.16)$$

where

$a = (G_1 - G_2)/(2\,L)$,
$b = G_1 - s_T - 2\,a\,x_s$, and
$c = a\,x_s^2 + s_T\,x_P - G_1\,x_s + y_s - y_P + h_2 - h_1$

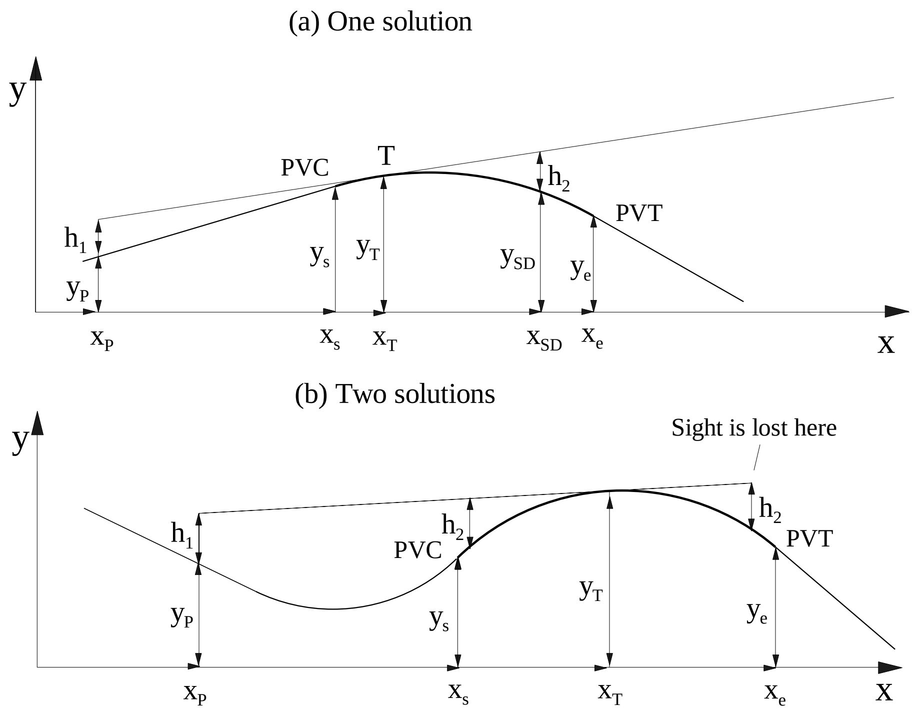

Figure 10Figure A.6 Sight is lost on a crest vertical curve.

If equation A.16 has real roots it will yield two solutions. If only one of the solutions lies inside the curve then that is the point at which the sight is lost. This is the case represented in figure A.6a. If the two points lie inside the curve then the point that is furthest away from P is the point at which the sight is lost. As illustrated in Figure A.6b the other point is in fact upstream of P. If none of the solutions lie inside the curve then the sight is not lost on this element.

A.5 Determination of the position where the sight is lost on a sag vertical curve.

This section explains the derivation of the equations necessary to determine the station of the point where the sight is lost when that point is located on a sag vertical curve.

The equations that determine the two possible solutions are the same as the ones derived in the previous subsection. The interpretation of the results, however, are somewhat different. As with crest vertical curves, when only one solution lies inside the curve that solution gives the point at which the sight is lost. Figure A.7a gives an example. However, unlike for crest vertical curves, when there are two solutions the one that yields the point closest to P has to be chosen as illustrated in Figure A.7b

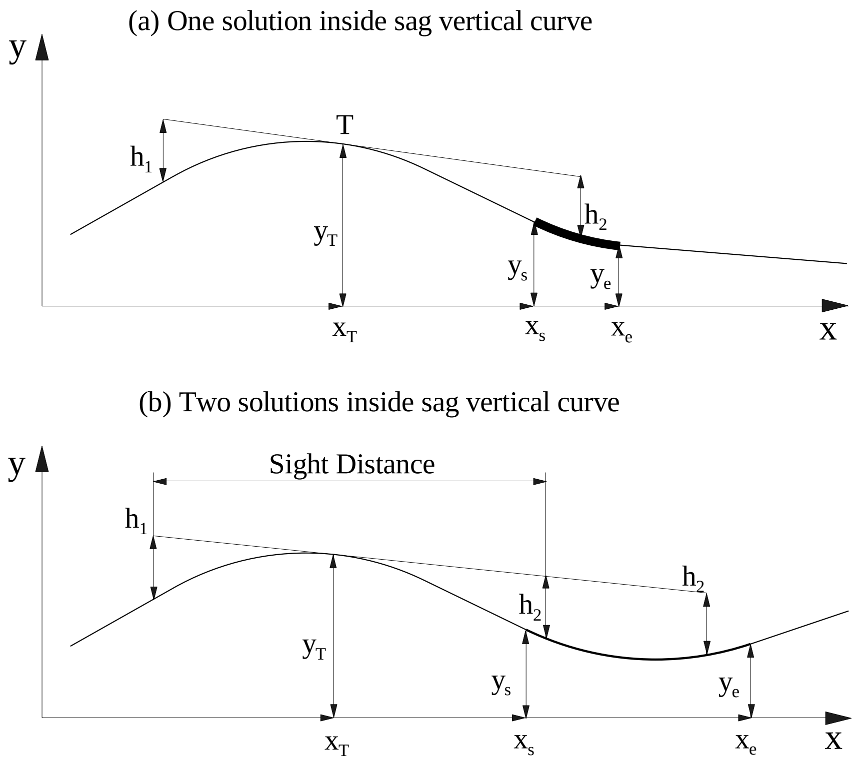

Figure 11
Figure A.7 Sight is lost on a sag vertical curve

APPENDIX B

SAMPLE TWOPAS INPUT FILE

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520.01200.02560.03400.02840.00500.02000.02000.00500.08500.12750.17000.21250.2550
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82  150.  150.  150.  150.  150.  150.  150.  150.  150.  150.  150.  150.  150.
9
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ST  2   59   55   54    1600.     800.     800.    1200.
ST  2   59   55   55    1200.    1000.    1000.       0.
VC  1                 228.000   682.00      65.      1.0       0.957
VC  2                 176.000   462.00      65.      1.0       0.957
VC  3                 140.000   340.00      65.      1.0       0.957
VC  4                  76.000   174.00      30.      1.0       0.957
VC  5                   9.000   110.00      36.
VC  6                  11.000   115.00      28.
VC  7                  12.500   120.00      21.
VC  8                  14.000   125.00      32.
VC  9                  11.170   112.80      13.
VC 10                  11.990   117.80      14.
VC 11                  12.770   121.10      16.
VC 12                  13.220   127.00      17.
VC 13                  14.100   142.70      18.
SL      1    1    1    0     200.         MILEPOST   0.038
SL      2    1    1    0     800.         MILEPOST   0.152
SL      3    1    1    0    1400.         MILEPOST   0.265
SL      4    1    1    0    2000.         MILEPOST   0.379
SL      5    1    1    0    2600.         MILEPOST   0.492
SL      6    1    1    0    3200.         MILEPOST   0.606
SL      7    1    1    0    3800.         MILEPOST   0.720
SL      8    1    1    0    4400.         MILEPOST   0.833
SL      9    1    1    0    5000.         MILEPOST   0.947
SL     10    1    1    0    5600.         MILEPOST   1.061
SL     11    1    1    2    6200.         MILEPOST   1.174
```

SL	12	1	1	**2**	6800.	MILEPOST	1.288
SL	13	1	1	**2**	7400.	MILEPOST	1.402
SL	14	1	1	**2**	8000.	MILEPOST	1.515
SL	15	1	1	**2**	8600.	MILEPOST	1.629
SL	16	1	1	0	9200.	MILEPOST	1.742
SL	17	1	1	0	9800.	MILEPOST	1.856
SL	18	1	1	0	10400.	MILEPOST	1.970
SL	19	1	1	0	11000.	MILEPOST	2.083
SL	20	1	1	0	11600.	MILEPOST	2.197
SL	21	1	1	0	12200.	MILEPOST	2.311
SL	22	1	1	0	12800.	MILEPOST	2.424
SL	23	1	1	0	13400.	MILEPOST	2.538
SL	24	1	1	0	14000.	MILEPOST	2.652
SL	25	1	1	0	14600.	MILEPOST	2.765
SL	26	1	1	0	15200.	MILEPOST	2.879
SL	27	1	1	0	15800.	MILEPOST	2.992
SL	28	1	1	0	16400.	MILEPOST	3.106
SL	29	1	1	0	17000.	MILEPOST	3.220
SL	30	1	1	0	17600.	MILEPOST	3.333
SL	31	1	0	0	18600.	MILEPOST	3.523
SL	1	2	1	0	18600.	OPPOSING DIR - MP	3.523
SL	2	2	1	0	17600.	OPPOSING DIR - MP	3.333
SL	3	2	1	0	17000.	OPPOSING DIR - MP	3.220
SL	4	2	1	0	16400.	OPPOSING DIR - MP	3.106
SL	5	2	1	0	15800.	OPPOSING DIR - MP	2.992
SL	6	2	1	0	15200.	OPPOSING DIR - MP	2.879
SL	7	2	1	0	14600.	OPPOSING DIR - MP	2.765
SL	8	2	1	0	14000.	OPPOSING DIR - MP	2.652
SL	9	2	1	0	13400.	OPPOSING DIR - MP	2.538
SL	10	2	1	**2**	12800.	OPPOSING DIR - MP	2.424
SL	11	2	1	**2**	12200.	OPPOSING DIR - MP	2.311
SL	12	2	1	**2**	11600.	OPPOSING DIR - MP	2.197
SL	13	2	1	**2**	11000.	OPPOSING DIR - MP	2.083
SL	14	2	1	**2**	10400.	OPPOSING DIR - MP	1.970
SL	15	2	1	0	9800.	OPPOSING DIR - MP	1.856
SL	16	2	1	0	9200.	OPPOSING DIR - MP	1.742
SL	17	2	1	0	8600.	OPPOSING DIR - MP	1.629
SL	18	2	1	0	8000.	OPPOSING DIR - MP	1.515
SL	19	2	1	0	7400.	OPPOSING DIR - MP	1.402
SL	20	2	1	0	6800.	OPPOSING DIR - MP	1.288
SL	21	2	1	0	6200.	OPPOSING DIR - MP	1.174
SL	22	2	1	0	5600.	OPPOSING DIR - MP	1.061
SL	23	2	1	0	5000.	OPPOSING DIR - MP	0.947
SL	24	2	1	0	4400.	OPPOSING DIR - MP	0.833
SL	25	2	1	0	3800.	OPPOSING DIR - MP	0.720
SL	26	2	1	0	3200.	OPPOSING DIR - MP	0.606
SL	27	2	1	0	2600.	OPPOSING DIR - MP	0.492
SL	28	2	1	0	2000.	OPPOSING DIR - MP	0.379
SL	29	2	1	0	1400.	OPPOSING DIR - MP	0.265
SL	30	2	1	0	800.	OPPOSING DIR - MP	0.152
SL	31	2	0	0	200.	OPPOSING DIR - MP	0.038
-1							

APPENDIX C

SAMPLE SUMMARY AND DETAIL OUTPUT

TITLE: Sample run TWOPAS improvements report July 1998
ROAD:JULY98 TRAF:JULY98 OBS:JULY98 DATE: 7/21/98 TIME: 9:22
RANDOM NUMBERS: 18827963 95922895 22870807 82720374 93824144 USER DEFAULTS

SIMULALTION DATA	VALUE	SIMULATION DATA	VALUE
SIMULATION TIME (min)	60.00	TEST LENGTH (km)	5.61
SETTLING TIME (min)	12.00	WARM-UP LENGTH D1 (km)	0.06
TOTAL TIME (min)	72.00	WARM-UP LENGTH D2 (km)	0.06
COMPUTER TIME (sec)	4.12	TOTAL LENGTH (km)	5.73

INPUT DATA GROUP	ITEM	DIR 1 NB	DIR 2 SB
FLOW RATE (vph)	FLOW RATE	390.00	175.00
DISTRIBUTION (%)	PASSENGER CARS	85.00	85.00
	TRUCKS	10.00	10.00
	RECREATIONAL VEHS	5.00	5.00
DESIRED SPEED (kph)	PASSENGER CARS	100.00	100.00
	TRUCKS	97.00	97.00
	RECREATIONAL VEHS	97.00	97.00
SPEED DEVIATION (kph)	PASSENGER CARS	6.44	6.44
	TRUCKS	5.63	5.63
	RECREATIONAL VEHS	4.83	4.83
PLATOONING (%)	ENTERING TRAFFIC	33.00	33.00

OUTPUT PERFORMANCE MEASURE	TEST LENGTH INTERVAL			USER INT D1 1.89 - 2.80 (kmeters)	USER INT D2 3.90 - 2.99 (kmeters)
	DIR 1 NB	DIR 2 SB	COMBINED		
SIM FLOW RATE (vph)	380.00	170.00	550.00	381.00	169.00
AVG % TIME FOLLOWING	45.60	31.70	39.92	29.60	24.70
AVG % TIME DELAY (ST1)	43.40	26.50	38.18	23.80	19.80
AVERAGE SPEED (kph)	72.58	84.81	76.36	76.61	81.75
TRIP TIME (min)	4.65	3.99	4.45	0.72	0.67
TRIP TRAF DELAY (min)	0.70	0.19	0.54	0.05	0.03
TRIP GEOM DELAY (min)	0.55	0.39	0.50	0.11	0.09
TRIP TOTAL DELAY (min)	1.25	0.58	1.04	0.16	0.12
NUMBER OF PASSES	434.00	43.00	477.00	193.00	43.00
VEHICLE-KMS	2139.73	957.72	3097.45	348.05	154.69
VEHICLE-HOURS	29.46	11.30	40.76	4.54	1.90

TITLE: Sample run TWOPAS Improvements report July 1998
ROAD:JULY98 TRAF:JULY98 OBS:JULY98 DATE: 7/21/98 TIME: 9:22 USER DEFAULTS

DIRECTION 1 (NB) DETAILED INFORMATION AT OBSERVATION STATIONS

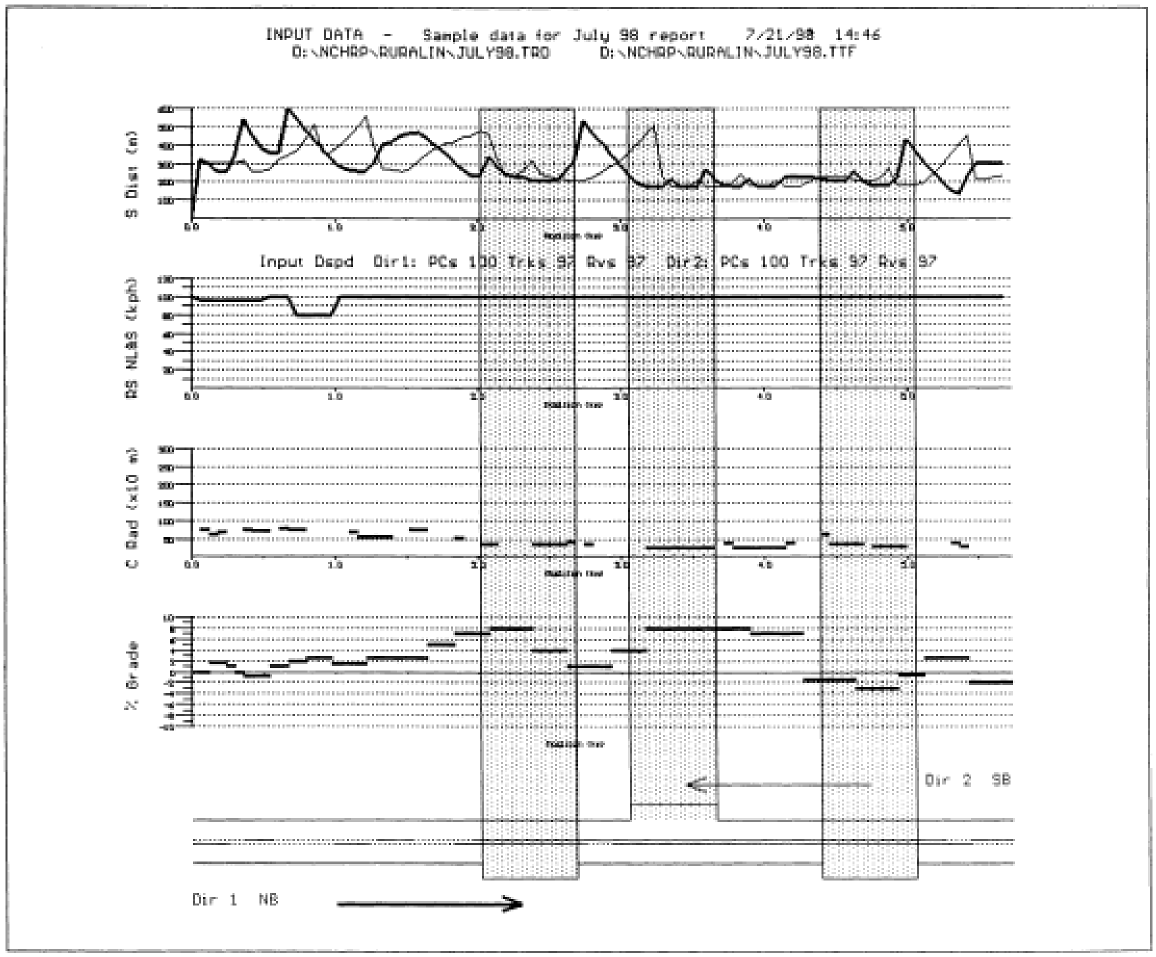
STN		LOCATION km	DIRN	NL	FLOW	%UNIMP	%DESSP	PSIZE	NFOLL	SPTRK kmph	SPRV kmph	SPCAR kmph	SPALL kmph	%IMP	PFOLL	#PASS
1	MILEPOST	0.058	1	1	381.0	86.0	0.0	2.4	95.0	87.1	92.1	93.0	92.4	14.0	24.9	0.0
2	MILEPOST	0.242	1	1	381.0	79.0	0.0	2.4	107.0	82.7	89.2	89.8	89.0	21.0	28.1	0.0
3	MILEPOST	0.425	1	1	382.0	74.0	0.0	2.5	106.0	85.0	90.9	90.1	89.6	26.0	27.7	0.0
4	MILEPOST	0.609	1	1	381.0	71.0	0.0	2.4	110.0	85.0	89.5	88.8	88.5	29.0	28.9	0.0
5	MILEPOST	0.792	1	1	379.0	70.0	0.0	2.4	110.0	74.4	77.9	77.7	77.4	30.0	29.0	0.0
6	MILEPOST	0.976	1	1	379.0	77.0	0.0	2.5	124.0	73.7	78.4	78.1	77.7	23.0	32.7	0.0
7	MILEPOST	1.160	1	1	379.0	68.0	0.0	2.4	122.0	77.6	87.5	86.4	85.6	32.0	32.2	0.0
8	MILEPOST	1.343	1	1	382.0	64.0	0.0	2.5	129.0	76.4	84.7	83.2	82.6	36.0	33.8	0.0
9	MILEPOST	1.517	1	1	380.0	63.0	5.0	2.5	137.0	77.4	90.4	88.5	87.5	37.0	36.1	0.0
10	MILEPOST	1.711	1	1	380.0	64.0	16.0	2.5	142.0	75.6	91.9	90.0	88.7	36.0	37.4	0.0
11	MILEPOST	1.884	1	1	381.0	62.0	0.0	2.6	154.0	66.8	82.7	81.3	79.8	38.0	40.4	0.0
12	MILEPOST	2.068	1	2	381.0	79.0	0.0	2.5	82.0	56.0	80.1	81.3	79.0	21.0	21.5	5.0
13	MILEPOST	2.252	1	2	380.0	89.0	0.0	2.3	81.0	47.2	82.2	85.6	81.3	11.0	21.3	79.0
14	MILEPOST	2.435	1	2	382.0	80.0	0.0	2.3	78.0	48.3	80.1	83.4	79.0	20.0	20.4	55.0
15	MILEPOST	2.619	1	2	380.0	69.0	0.0	2.8	152.0	54.9	80.1	81.3	77.9	31.0	40.0	41.0
16	MILEPOST	2.802	1	1	380.0	64.0	0.0	3.0	152.0	62.9	81.9	80.8	79.2	36.0	40.0	13.0
17	MILEPOST	2.986	1	1	380.0	59.0	47.0	2.9	155.0	68.6	92.2	90.4	88.4	41.0	40.8	0.0
18	MILEPOST	3.170	1	1	381.0	60.0	0.0	3.0	162.0	63.7	79.5	77.4	76.1	40.0	42.5	0.0
19	MILEPOST	3.353	1	1	378.0	51.0	0.0	3.0	162.0	47.8	73.1	68.1	66.1	49.0	42.9	0.0
20	MILEPOST	3.527	1	1	378.0	45.0	0.0	3.0	176.0	41.0	65.2	63.2	61.0	55.0	46.6	0.0
21	MILEPOST	3.721	1	1	378.0	43.0	0.0	3.2	177.0	38.8	67.3	63.6	61.2	57.0	46.8	0.0
22	MILEPOST	3.894	1	1	386.0	38.0	0.0	3.4	189.0	37.8	61.2	58.1	56.3	62.0	49.0	0.0
23	MILEPOST	4.078	1	1	385.0	35.0	0.0	3.5	202.0	39.1	61.0	56.5	55.0	65.0	52.5	0.0
24	MILEPOST	4.262	1	1	385.0	44.0	0.0	4.5	229.0	41.8	71.9	69.2	66.5	56.0	59.5	0.0
25	MILEPOST	4.445	1	2	385.0	73.0	0.0	2.9	137.0	65.8	85.4	84.5	83.4	27.0	35.4	0.0
26	MILEPOST	4.629	1	2	384.0	76.0	0.0	2.7	147.0	74.7	82.2	84.5	83.4	24.0	38.3	62.0
27	MILEPOST	4.812	1	2	383.0	68.0	0.0	3.1	159.0	74.7	79.0	81.3	80.1	32.0	41.5	61.0
28	MILEPOST	4.996	1	2	383.0	55.0	0.0	4.2	225.0	69.2	74.7	75.6	74.7	45.0	58.7	69.0
29	MILEPOST	5.180	1	1	381.0	47.0	36.0	4.6	235.0	71.3	88.5	84.8	83.7	53.0	61.7	49.0
30	MILEPOST	5.363	1	1	381.0	45.0	0.0	4.4	233.0	71.1	77.2	76.3	75.8	55.0	61.2	0.0
31	MILEPOST	5.663	1	1	380.0	55.0	38.0	4.6	234.0	87.4	90.4	92.2	91.6	45.0	61.6	0.0

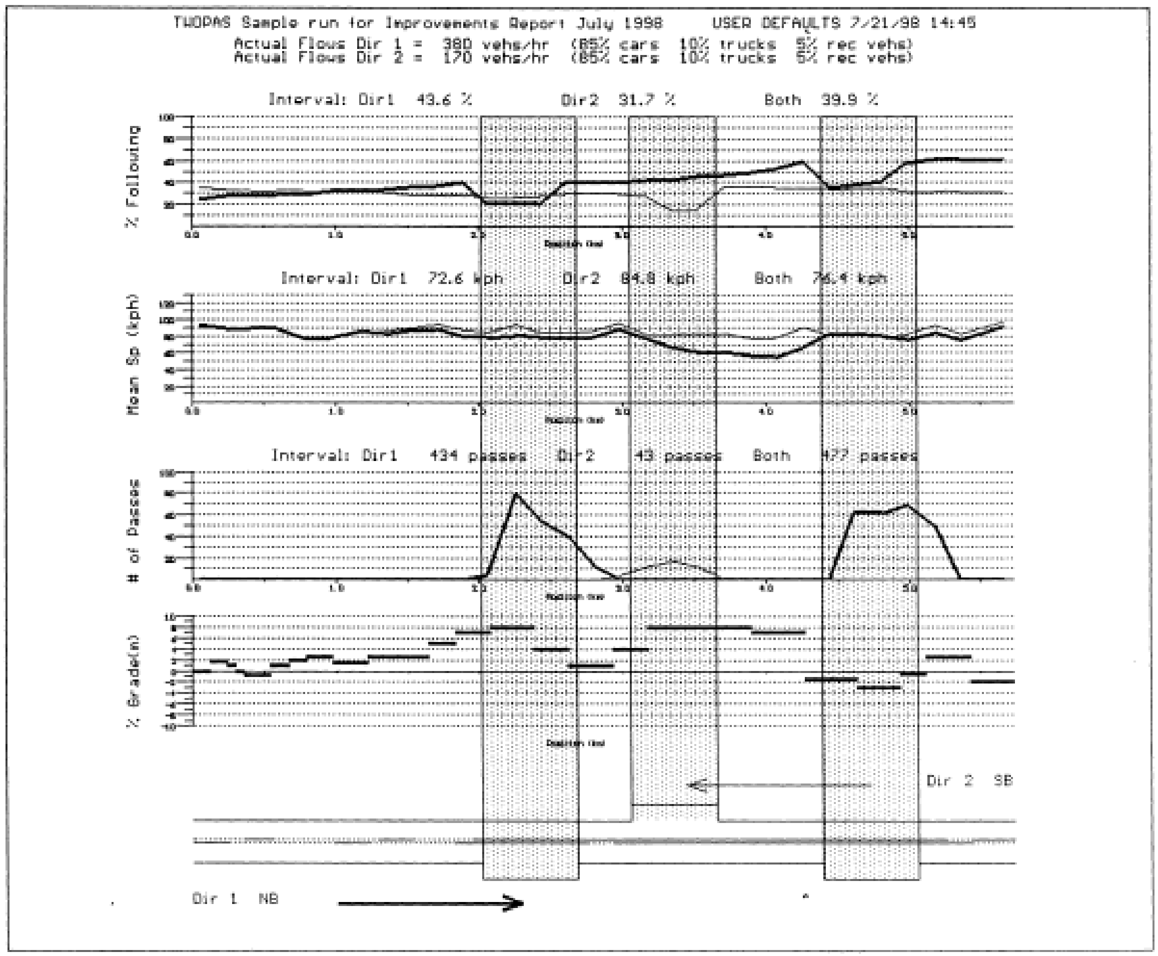
DIRECTION 2 (SB) DETAILED INFORMATION AT OBSERVATION STATIONS

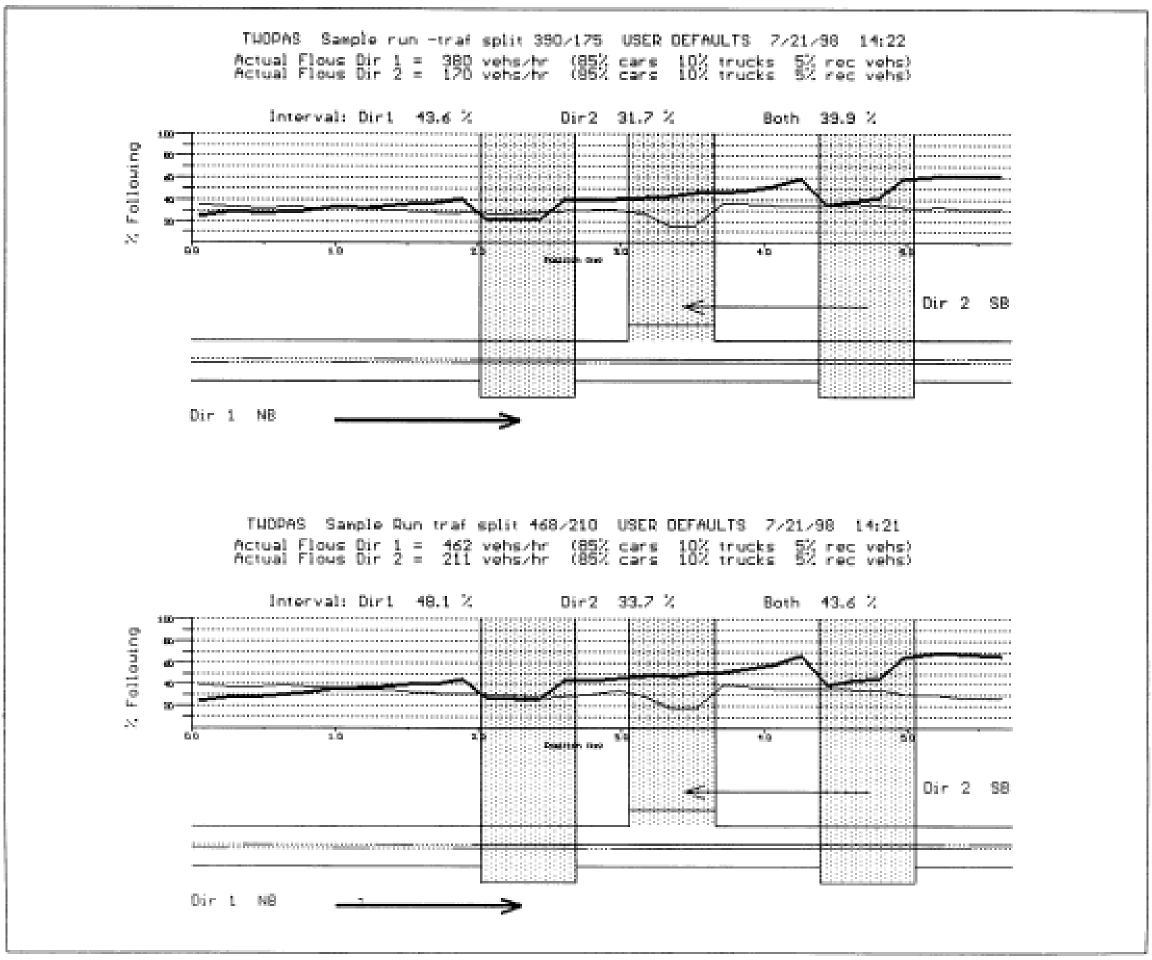
STN	* LOCATION km		DIRN	NL	FLOW	%UNIMP	%DESSP	PSIZE	NFOLL	SPTRK kmph	SPRV kmph	SPCAR kmph	SPALL kmph	%IMP	PFOLL	#PASS
301	OPPOSING DIR - MP	5.663	2	1	178.0	89.0	79.0	2.8	56.0	93.2	96.1	98.7	97.8	11.0	31.5	0.0
302	OPPOSING DIR - MP	5.363	2	1	178.0	76.0	0.0	2.4	55.0	78.5	78.5	83.7	82.7	24.0	30.9	0.0
303	OPPOSING DIR - MP	5.180	2	1	177.0	73.0	37.0	2.8	58.0	88.7	91.6	94.8	93.7	27.0	32.8	0.0
304	OPPOSING DIR - MP	4.996	2	1	175.0	74.0	0.0	2.8	56.0	78.5	79.8	84.0	82.9	26.0	32.0	0.0
305	OPPOSING DIR - MP	4.812	2	1	172.0	70.0	0.0	3.0	59.0	73.5	76.3	80.1	79.0	30.0	34.3	0.0
306	OPPOSING DIR - MP	4.629	2	1	172.0	71.0	0.0	3.0	60.0	74.0	79.5	82.4	81.1	29.0	34.9	0.0
307	OPPOSING DIR - MP	4.445	2	1	172.0	70.0	0.0	3.1	58.0	76.1	80.1	83.4	81.9	30.0	33.7	0.0
308	OPPOSING DIR - MP	4.262	2	1	172.0	69.0	34.0	3.1	59.0	80.1	90.8	91.9	90.1	31.0	34.3	0.0
309	OPPOSING DIR - MP	4.078	2	1	171.0	65.0	0.0	3.1	59.0	75.2	76.4	79.3	78.5	35.0	34.5	0.0
310	OPPOSING DIR - MP	3.894	2	1	171.0	65.0	0.0	3.1	61.0	73.1	75.3	77.9	77.1	35.0	35.7	0.0
311	OPPOSING DIR - MP	3.721	2	1	170.0	72.0	0.0	3.2	62.0	77.9	80.5	84.0	82.9	28.0	36.5	0.0
312	OPPOSING DIR - MP	3.527	2	2	167.0	93.0	0.0	2.3	27.0	77.9	77.9	83.4	82.2	7.0	16.2	11.0
313	OPPOSING DIR - MP	3.353	2	2	166.0	92.0	0.0	2.3	25.0	77.9	77.9	83.4	82.2	8.0	15.1	17.0
314	OPPOSING DIR - MP	3.170	2	2	172.0	80.0	0.0	2.8	46.0	75.6	77.9	82.2	81.3	20.0	26.7	12.0
315	OPPOSING DIR - MP	2.986	2	1	173.0	80.0	74.0	3.0	51.0	92.2	94.6	96.6	95.9	20.0	29.5	3.0
316	OPPOSING DIR - MP	2.802	2	1	173.0	80.0	2.0	3.2	53.0	83.8	83.8	87.5	86.7	20.0	30.6	0.0
317	OPPOSING DIR - MP	2.619	2	1	173.0	76.0	0.0	3.2	52.0	81.6	81.6	85.0	84.3	24.0	30.1	0.0
318	OPPOSING DIR - MP	2.435	2	1	172.0	76.0	0.0	2.9	49.0	81.1	81.4	84.5	83.8	24.0	28.5	0.0
319	OPPOSING DIR - MP	2.252	2	1	168.0	79.0	44.0	2.8	45.0	92.9	92.9	95.3	94.8	21.0	26.8	0.0
320	OPPOSING DIR - MP	2.068	2	1	167.0	78.0	0.0	2.8	44.0	82.1	81.9	85.6	84.8	22.0	26.3	0.0
321	OPPOSING DIR - MP	1.884	2	1	166.0	77.0	2.0	2.7	47.0	85.0	85.3	88.2	87.5	23.0	28.3	0.0
322	OPPOSING DIR - MP	1.711	2	1	166.0	77.0	59.0	2.8	46.0	92.9	93.7	95.4	95.0	23.0	27.7	0.0
323	OPPOSING DIR - MP	1.517	2	1	166.0	75.0	1.0	2.7	47.0	88.4	88.7	91.3	90.8	25.0	28.3	0.0
324	OPPOSING DIR - MP	1.343	2	1	168.0	73.0	1.0	2.7	50.0	85.7	84.2	87.1	86.4	27.0	29.8	0.0
325	OPPOSING DIR - MP	1.160	2	1	170.0	72.0	1.0	2.9	53.0	82.4	83.7	86.1	85.3	28.0	31.2	0.0
326	OPPOSING DIR - MP	0.976	2	1	169.0	78.0	0.0	2.9	54.0	78.1	78.9	80.5	80.1	22.0	32.0	0.0
327	OPPOSING DIR - MP	0.792	2	1	168.0	71.0	0.0	2.9	53.0	74.3	77.1	77.6	77.4	29.0	31.5	0.0
328	OPPOSING DIR - MP	0.609	2	1	169.0	75.0	0.0	2.9	55.0	80.6	87.1	89.2	87.7	25.0	32.5	0.0
329	OPPOSING DIR - MP	0.425	2	1	169.0	71.0	0.0	2.9	53.0	84.2	88.5	89.8	89.0	29.0	31.4	0.0
330	OPPOSING DIR - MP	0.242	2	1	169.0	69.0	0.0	3.0	55.0	87.1	89.2	90.3	89.8	31.0	32.5	0.0
331	OPPOSING DIR - MP	0.058	2	1	168.0	78.0	0.0	2.9	59.0	87.2	88.5	90.8	90.1	22.0	35.1	0.0

APPENDIX D

SAMPLE ROAD DATA INPUT GRAPH AND OUTPUT GRAPHS




TWOPAS Sample run for Improvements Report July 1998 USER DEFAULTS 7/21/98 14:45
Actual Flows Dir 1 = 380 vehs/hr (85% cars 10% trucks 5% rec vehs)
Actual Flows Dir 2 = 170 vehs/hr (85% cars 10% trucks 5% rec vehs)
Interval: Dir1 43.6 % Dir2 31.7 % Both 39.9 %
% Following
Interval: Dir1 72.6 kph Dir2 84.8 kph Both 76.4 kph
Mean Sp (kph)
Interval: Dir1 434 passes Dir2 43 passes Both 477 passes
# of Passes
% Grade(m)
Dir 2 SB
Dir 1 NB


TWOPAS Sample run -traf split 390/175 USER DEFAULTS 7/21/98 14:22
Actual Flows Dir 1 = 380 vehs/hr (85% cars 10% trucks 5% rec vehs)
Actual Flows Dir 2 = 170 vehs/hr (85% cars 10% trucks 5% rec vehs)
Interval: Dir1 43.6 % Dir2 31.7 % Both 39.9 %
% Following
Dir 2 SB
Dir 1 NB
TWOPAS Sample Run traf split 468/210 USER DEFAULTS 7/21/98 14:21
Actual Flows Dir 1 = 462 vehs/hr (85% cars 10% trucks 5% rec vehs)
Actual Flows Dir 2 = 211 vehs/hr (85% cars 10% trucks 5% rec vehs)
Interval: Dir1 48.1 % Dir2 33.7 % Both 43.6 %
% Following
Dir 2 SB
Dir 1 NB

APPENDIX E

SAMPLE TWOSUM OUTPUT FILE PRINTED FROM WITHIN THE INTERFACE

```
1                    ***** PROGRAM TWOPAS:  RURAL TRAFFIC SIMULATION;  OUTPUT SUMMARY *****

 1RUN NO.    1      Sample run TWOPAS improvements report July 1998
   ROAD:JULY98    TRAF:JULY98    OBS:JULY98    DATE: 7/21/98  TIME: 9:22 NB SB
   RANDOM NUMBERS:  18827963  95922895  22870807  82720374  93824144       USER DEFAULTS
 0      WARM TIME= 12.000 MINUTES        TEST TIME= 60.000 MINUTES         TOTAL TIME= 72.000 MINUTES
 OVERALL TRAVEL TIME=   80.1 SEC, S.D.=  13.9 SEC
 OVERALL % TIME NOT IN STATE 1:  DIR1=  43.4 DIR2=  26.5 COMB=  38.7
 LENGTH=    18800.
 DIR1 FLOW RATE=  390. ENTERING % FOLL.=  33.    DIR2 FLOW RATE=  175. ENTERING % FOLL.=  33.
 TRAF COMPOSITION    DIR 1 TRUCKS=  10.0 RVS=   5.0 CARS=  85.0  DIR 2 TRUCKS=  10.0 RVS=   5.0 CARS=  85.0
 STANDARD DEVIATION  DIR 1 TRUCKS=  3.50 RVS=  3.00 CARS=  4.00  DIR 2 TRUCKS=  3.50 RVS=  3.00 CARS=  4.00
 SPEEDS              DIR 1 TRUCKS=  60.0 RVS=  60.0 CARS=  62.0  DIR 2 TRUCKS=  60.0 RVS=  60.0 CARS=  62.0
```

*** SUMMARY SPOT CHARACTERISTICS ***

STN		LOCATION	DIRN	NL	FLOW	%UNIMP	%DESSP	PSIZE	NFOLL	SPTRK	SPRV	SPCAR	SPALL	%IMP	PFOLL	#PASS
1	MILEPOST	0.038	1	1	381.0	86.0	0.0	2.4	95.0	54.1	57.2	57.8	57.4	14.0	24.9	0.0
2	MILEPOST	0.152	1	1	381.0	79.0	0.0	2.4	107.0	51.4	55.4	55.8	55.3	21.0	28.1	0.0
3	MILEPOST	0.265	1	1	382.0	74.0	0.0	2.5	106.0	52.8	56.5	56.0	55.7	26.0	27.7	0.0
4	MILEPOST	0.379	1	1	381.0	71.0	0.0	2.4	110.0	52.8	55.6	55.2	55.0	29.0	28.9	0.0
5	MILEPOST	0.492	1	1	379.0	70.0	0.0	2.4	110.0	46.2	48.4	48.3	48.1	30.0	29.0	0.0
6	MILEPOST	0.606	1	1	379.0	77.0	0.0	2.5	124.0	45.8	48.7	48.5	48.3	23.0	32.7	0.0
7	MILEPOST	0.720	1	1	379.0	68.0	0.0	2.4	122.0	48.2	54.4	53.7	53.2	32.0	32.2	0.0
8	MILEPOST	0.833	1	1	382.0	64.0	0.0	2.5	129.0	47.5	52.6	51.7	51.3	36.0	33.8	0.0
9	MILEPOST	0.947	1	1	380.0	63.0	5.0	2.5	137.0	48.1	56.2	55.0	54.4	37.0	36.1	0.0
10	MILEPOST	1.061	1	1	380.0	64.0	16.0	2.5	142.0	47.0	57.1	55.9	55.1	36.0	37.4	0.0
11	MILEPOST	1.174	1	1	381.0	62.0	0.0	2.6	154.0	41.5	51.4	50.5	49.6	38.0	40.4	0.0
12	MILEPOST	1.288	1	2	381.0	79.0	0.0	2.5	82.0	34.8	49.8	50.5	49.1	21.0	21.5	5.0
13	MILEPOST	1.402	1	2	380.0	89.0	0.0	2.3	81.0	29.3	51.1	53.2	50.5	11.0	21.3	79.0
14	MILEPOST	1.515	1	2	382.0	80.0	0.0	2.3	78.0	30.0	49.8	51.8	49.1	20.0	20.4	55.0
15	MILEPOST	1.629	1	2	380.0	69.0	0.0	2.8	152.0	34.1	49.8	50.5	48.4	31.0	40.0	41.0
16	MILEPOST	1.742	1	1	380.0	64.0	0.0	3.0	152.0	39.1	50.9	50.2	49.2	36.0	40.0	13.0
17	MILEPOST	1.856	1	1	380.0	59.0	47.0	2.9	155.0	42.6	57.3	56.2	54.9	41.0	40.8	0.0
18	MILEPOST	1.970	1	1	381.0	60.0	0.0	3.0	162.0	39.6	49.4	48.1	47.3	40.0	42.5	0.0
19	MILEPOST	2.083	1	1	378.0	51.0	0.0	3.0	162.0	29.7	45.4	42.3	41.1	49.0	42.9	0.0
20	MILEPOST	2.197	1	1	378.0	45.0	0.0	3.0	176.0	25.5	40.5	39.3	37.9	55.0	46.6	0.0
21	MILEPOST	2.311	1	1	378.0	43.0	0.0	3.2	177.0	24.1	41.8	39.5	38.0	57.0	46.8	0.0
22	MILEPOST	2.424	1	1	386.0	38.0	0.0	3.4	189.0	23.5	38.0	36.1	35.0	62.0	49.0	0.0
23	MILEPOST	2.538	1	1	385.0	35.0	0.0	3.5	202.0	24.3	37.9	35.1	34.2	65.0	52.5	0.0
24	MILEPOST	2.652	1	1	385.0	44.0	0.0	4.5	229.0	26.0	44.7	43.0	41.3	56.0	59.5	0.0
25	MILEPOST	2.765	1	2	385.0	73.0	0.0	2.9	137.0	40.9	53.2	52.5	51.8	27.0	35.6	0.0
26	MILEPOST	2.879	1	2	384.0	76.0	0.0	2.7	147.0	46.4	51.1	52.5	51.8	24.0	38.3	62.0
27	MILEPOST	2.992	1	2	383.0	68.0	0.0	3.1	159.0	46.4	49.1	50.5	49.8	32.0	41.5	61.0
28	MILEPOST	3.106	1	2	383.0	55.0	0.0	4.2	225.0	43.0	46.4	47.0	46.4	45.0	58.7	69.0

29	MILEPOST	3.220	1	1	381.0	47.0	36.0	4.6	235.0	44.3	55.0	52.7	52.0	53.0	61.7	49.0
30	MILEPOST	3.333	1	1	381.0	45.0	0.0	4.4	233.0	44.2	48.0	47.4	47.1	55.0	61.2	0.0
31	MILEPOST	3.523	1	1	380.0	55.0	38.0	4.6	234.0	54.3	56.3	57.3	56.9	45.0	61.6	0.0
301	OPPOSING DIR - MP	3.523	2	1	178.0	89.0	79.0	2.8	56.0	57.9	59.7	61.3	60.8	11.0	31.5	0.0
302	OPPOSING DIR - MP	3.333	2	1	178.0	76.0	0.0	2.6	55.0	48.8	48.8	52.0	51.4	24.0	30.9	0.0
303	OPPOSING DIR - MP	3.220	2	1	177.0	73.0	37.0	2.8	58.0	55.1	56.9	58.9	58.2	27.0	32.8	0.0
304	OPPOSING DIR - MP	3.106	2	1	175.0	74.0	0.0	2.8	56.0	48.8	49.6	52.2	51.5	26.0	32.0	0.0
305	OPPOSING DIR - MP	2.992	2	1	172.0	70.0	0.0	3.0	59.0	45.7	47.4	49.8	49.1	30.0	34.3	0.0
306	OPPOSING DIR - MP	2.879	2	1	172.0	71.0	0.0	3.0	60.0	46.0	49.4	51.2	50.4	29.0	34.9	0.0
307	OPPOSING DIR - MP	2.765	2	1	172.0	70.0	0.0	3.1	58.0	47.3	49.8	51.8	50.9	30.0	33.7	0.0
308	OPPOSING DIR - MP	2.652	2	1	172.0	69.0	34.0	3.1	59.0	49.8	56.4	57.1	56.0	31.0	34.3	0.0
309	OPPOSING DIR - MP	2.538	2	1	171.0	65.0	0.0	3.1	59.0	46.7	47.5	49.3	48.8	35.0	34.5	0.0
310	OPPOSING DIR - MP	2.424	2	1	171.0	65.0	0.0	3.1	61.0	45.4	46.8	48.4	47.9	35.0	35.7	0.0
311	OPPOSING DIR - MP	2.311	2	1	170.0	72.0	0.0	3.2	62.0	48.4	50.0	52.2	51.5	28.0	36.5	0.0
312	OPPOSING DIR - MP	2.197	2	2	167.0	93.0	0.0	2.3	27.0	48.4	48.4	51.8	51.1	7.0	16.2	11.0
313	OPPOSING DIR - MP	2.083	2	2	166.0	92.0	0.0	2.3	25.0	48.4	48.4	51.8	51.1	8.0	15.1	17.0
314	OPPOSING DIR - MP	1.970	2	2	172.0	80.0	0.0	2.8	46.0	47.0	48.4	51.1	50.5	20.0	26.7	12.0
315	OPPOSING DIR - MP	1.856	2	1	173.0	80.0	74.0	3.0	51.0	57.3	58.8	60.0	59.6	20.0	29.5	3.0
316	OPPOSING DIR - MP	1.742	2	1	173.0	80.0	2.0	3.2	53.0	52.1	52.1	54.4	53.9	20.0	30.6	0.0
317	OPPOSING DIR - MP	1.629	2	1	173.0	76.0	0.0	3.2	52.0	50.7	50.7	52.8	52.4	24.0	30.1	0.0
318	OPPOSING DIR - MP	1.515	2	1	172.0	76.0	0.0	2.9	49.0	50.4	50.6	52.5	52.1	24.0	28.5	0.0
319	OPPOSING DIR - MP	1.402	2	1	168.0	79.0	44.0	2.8	45.0	57.7	57.7	59.2	58.9	21.0	26.8	0.0
320	OPPOSING DIR - MP	1.288	2	1	167.0	78.0	0.0	2.8	44.0	51.0	50.9	53.2	52.7	22.0	26.3	0.0
321	OPPOSING DIR - MP	1.174	2	1	166.0	77.0	2.0	2.7	47.0	52.8	53.0	54.8	54.4	23.0	28.3	0.0
322	OPPOSING DIR - MP	1.061	2	1	166.0	77.0	59.0	2.8	46.0	57.7	58.2	59.3	59.0	23.0	27.7	0.0
323	OPPOSING DIR - MP	0.947	2	1	166.0	75.0	1.0	2.7	47.0	54.9	55.1	56.7	56.4	25.0	28.3	0.0
324	OPPOSING DIR - MP	0.833	2	1	168.0	73.0	1.0	2.7	50.0	52.0	52.3	54.1	53.7	27.0	29.8	0.0
325	OPPOSING DIR - MP	0.720	2	1	170.0	72.0	1.0	2.9	53.0	51.2	52.0	53.5	53.0	28.0	31.2	0.0
326	OPPOSING DIR - MP	0.606	2	1	169.0	78.0	0.0	2.9	54.0	48.5	49.0	50.0	49.8	22.0	32.0	0.0
327	OPPOSING DIR - MP	0.492	2	1	168.0	71.0	0.0	2.9	53.0	47.4	47.9	48.2	48.1	29.0	31.5	0.0
328	OPPOSING DIR - MP	0.379	2	1	169.0	75.0	0.0	2.9	55.0	50.1	54.1	55.4	54.5	25.0	32.5	0.0
329	OPPOSING DIR - MP	0.265	2	1	169.0	71.0	0.0	2.9	53.0	52.3	55.0	55.8	55.3	29.0	31.4	0.0
330	OPPOSING DIR - MP	0.152	2	1	169.0	69.0	0.0	3.0	55.0	54.1	55.4	56.1	55.8	31.0	32.5	0.0
331	OPPOSING DIR - MP	0.038	2	1	168.0	78.0	0.0	2.9	59.0	54.2	55.0	56.4	56.0	22.0	35.1	0.0

*** SUMMARY INTERVAL INFORMATION ***

DIRN	FROM	TO	DIST	SPEED	TTIME	MTIME	TFDLY	PTD	%UNIMP	PR1	PR2	VTIME	VPH	PASS1L	PASS2L	VEH-MILES	GEDLY
1	1	31	18400.	45.1	106068.	80.1	12.0	43.6	56.6	0.00	1.36	279.1	380.	0	434	1329.56	9.5
2	1	31	18400.	52.7	40676.	68.6	3.3	31.7	73.5	0.00	0.67	239.2	170.	0	43	595.10	6.7
1	11	16	3000.	47.6	16338.	75.6	4.9	29.6	76.2	0.00	1.22	42.9	381.	0	193	216.27	12.0
2	10	15	3000.	50.8	6825.	71.1	2.8	24.7	80.2	0.00	0.67	40.4	169.	0	43	96.12	9.8

COMPUTER TIME FOR THIS RUN WAS: 4.12 SEC.

APPENDIX F

SAMPLE MULTIPLE RUN SPREADSHEET

JULY98

SPREADSHEET JULY98.TSS CREATED DATE: 7/21/98 TIME: 12:50

RUN NUM	RUN DATE	COMPTR RUN TIME secs	ROAD FILE	OBS FILE	SIM LENGTH kms	WARMUP LENGTH DIR1 kms	WARMUP LENGTH DIR2 kms	TOTAL LENGTH kms	SIM TIME min	SETLNG TIME min	TOTAL TIME min	INPUT FLOW DIR1 vph	INPUT FLOW DIR2 vph	INPUT FLOW TOT vph	CARS DIR1 %	TRKS DIR1 %	RVS DIR1 %	CARS DIR2 %	TRKS DIR2 %	RVS DIR2 %	DESPD CARS DIR1 kph
1	7/21/98	4.12	Jul-98	Jul-98	5.61	0.06	0.06	5.73	60	12	72	390	175	565	85	10	5	85	10	5	100
2	7/21/98	4.61	Jul-98	Jul-98	5.61	0.06	0.06	5.73	60	12	72	429	192	621	85	10	5	85	10	5	100
3	7/21/98	5	Jul-98	Jul-98	5.61	0.06	0.06	5.73	60	12	72	468	210	678	85	10	5	85	10	5	100

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DESPD TRKS DIR1 kph	DESPD RVS DIR1 kph	DESPD CARS DIR2 kph	DESPD TRKS DIR2 kph	DESPD RVS DIR2 kph	STDSPD CARS DIR1 kph	STDSPD TRKS DIR1 kph	STDSPD RVS DIR1 kph	STDSPD CARS DIR2 kph	STDSPD TRKS DIR2 kph	STDSPD RVS DIR2 kph	ENTRNG PLTNG DIR1 %	ENTRNG PLTNG DIR2 %	RANDOM NUM SEED 1	RANDOM NUM SEED 2	RANDOM NUM SEED 3	RANDOM NUM SEED 4	RANDOM NUM SEED 5	DEFLTS	SIM FLOW DIR1 vph	SIM FLOW DIR2 vph	SIM FLOW COMB vph
97	97	100	97	97	6.44	5.63	4.83	6.44	5.63	4.83	33	33	18827953	95922895	22870807	82720374	93824144	user	380	170	550
97	97	100	97	97	6.44	5.63	4.83	6.44	5.63	4.83	33	33	18827953	95922895	22870807	82720374	93824144	user	428	195	623
97	97	100	97	97	6.44	5.63	4.83	6.44	5.63	4.83	33	33	18827953	95922895	22870807	82720374	93824144	user	462	211	673

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SIM SPLT DIR1 %	SIM SPLT DIR2 %	AVG TM FOLLNG DIR1 %	AVG TM FOLLNG DIR2 %	AVG TM FOLLNG COMB %	AVG TM DLYST1 DIR1 %	AVG TM DLYST1 DIR2 %	AVG TM DLYST1 COMB %	AVG SPEED DIR1 kph	AVG SPEED DIR2 kph	AVG SPEED COMB kph	TRIP TIME DIR1 min	TRIP TIME DIR2 min	TRIP TIME COMB min	TRIP TFDLY DIR1 min	TRIP TFDLY DIR2 min	TRIP TFDLY COMB min	TRIP GEODLY DIR1 min	TRIP GEODLY DIR2 min	TRIP GEODLY COMB min	TRIP TOTDLY DIR1 min	TRIP TOTDLY DIR2 min
0.69	0.31	43.6	31.7	39.92	43.4	26.5	38.18	72.58	84.81	76.36	4.65	3.99	4.45	0.7	0.19	0.54	0.55	0.39	0.5	1.25	0.58
0.69	0.31	46.6	34.3	42.75	47.6	30.2	42.15	71.29	84.01	75.27	4.73	4.01	4.5	0.79	0.21	0.61	0.53	0.39	0.49	1.32	0.6
0.69	0.31	48.3	34.6	44	48.9	30.7	43.19	71.46	83.69	75.29	4.74	4.01	4.51	0.8	0.22	0.62	0.53	0.39	0.49	1.34	0.61

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TRIP TOTDLY COMB min	PASSES DIR1 #	PASSES DIR2 #	PASSES COMB #	VEH-KMS DIR1	VEH-KMS DIR2	VEH-HOURS DIR1	VEH-HOURS DIR2	USRINT START DIR1 kms	USRINT END DIR1 kms	USRINT SIMFLO DIR1	USRINT ATFOLL DIR1 %	USRINT ATDST1 DIR1 %	USRINT SPEED DIR1 kph	USRINT PASSES DIR1 #	USRINT START DIR2 kms	USRINT END DIR2 kms	USRINT SIMFLO DIR2	USRINT ATFOLL DIR2 %	USRINT ATDST1 DIR2 %	USRINT SPEED DIR2 kph	USRINT PASSES DIR2 #
1.04	434	43	477	2139.73	957.72	29.46	11.3	1.89	2.8	381	29.6	23.8	76.61	193	3.9	2.99	169	24.7	19.8	81.75	43
1.1	528	52	580	2402.68	1093.59	33.73	13.01	1.89	2.8	427	33.3	28.5	78.05	238	3.9	2.99	193	25.8	21.3	81.43	52
1.11	634	51	685	2603.48	1180.52	36.45	14.09	1.89	2.8	461	34.4	29.6	77.73	278	3.9	2.99	208	27.9	23.2	80.79	51

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