Evaluation of the TRAF Family of Models

Testing of the CORFLO and FRESIM Models

WA-RD 282.1

Final Report
December 1992

Washington State Department of Transportation
Washington State Transportation Commission
Transit, Research, and Intermodal Planning (TRIP) Division

in cooperation with the
United States Department of Transportation
Federal Highway Administration

TECHNICAL REPORT STANDARD TITLE PAGE

1. REPORT NO.	2. GOVERNMENT ACCESSION NO.	3. RECIPIENT'S CATALOG NO.
WA-RD 282.1		

4. TITLE AND SUBTITLE	5. REPORT DATE
EVALUATION OF THE TRAF FAMILY OF MODELS TESTING OF THE CORFLO AND FRESIM MODELS	December 1992 6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) Eldon L. Jacobson, Final Report Compiler	8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS Washington State Transportation Center (TRAC) University of Washington, JE-10 The Corbet Building, Suite 204; 4507 University Way N.E. Seattle, Washington 98105	10. WORK UNIT NO. 11. CONTRACT OR GRANT NO. GC 8286, Task 17
12. SPONSORING AGENCY NAME AND ADDRESS Washington State Department of Transportation Transportation Building, MS 7370 Olympia, Washington 98504-7370	13. TYPE OF REPORT AND PERIOD COVERED Final Report 14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

This study was conducted in cooperation with the U.S. Department of Transportation, Federal Highway Administration.

16. ABSTRACT

This final report describes the key findings of a Washington State Department of Transportation (WSDOT) and Federal Highway Administration (FHWA) project. The research was undertaken during the 1988-1989 time period using mainframe computer versions of the programs. Using Corridor Flow (CORFLO), the investigators modeled the traffic impacts on local and regional roadways that would be caused by the reconstruction of I-405 through the City of Renton, Washington, which is in the Seattle metropolitan area. Using Freeway Simulation (FRESIM), the investigators also modeled I-405 on the northeast side of Renton, where the high occupancy vehicle (HOV) lane, when completed, will transition from the inside to the outside of the freeway (across general purpose traffic).

Traffic volume data, traffic signal parameters, and roadway geometric data were obtained and used as needed in each of the computer traffic modeling programs.

The CORFLO model could not be adequately calibrated to represent existing traffic flow. The researchers could not determine whether the difficulties in calibrating the model were related to weaknesses in the model itself or to weaknesses in the input data. Use of the CORFLO mainframe computer program for construction traffic simulation by WSDOT is not recommended at this time. The program requires extensive, detailed data, which is usually unavailable and too costly to acquire given the resources normally available for this type of project. Modifying the CORFLO program to run on personal computers is suggested, and was released by McTrans in September 1992.

While the FRESIM model appeared to be able to handle the proposed HOV lane crossover, this could not be verified because the FRESIM output was so complex that it was unreadable. A graphic display of the FRESIM output as a supplement to the existing tabular output is recommended.

17. KEY WORDS	18. DISTRIBUTION STATEMENT
Computer traffic simulation model, TRAF, CORFLO, FRESIM, HOV, High Occupancy Vehicle.	No restrictions. This document is available to the public through the National Technical Information Service, Springfield, VA 22616

19. SECURITY CLASSIF. (of this report)	20. SECURITY CLASSIF. (of this page)	21. NO. OF PAGES	22. PRICE
None	None	20	

Final Report

Research Project GC 8286, Task 17
TRAF Software for I-405 Lane Construction

EVALUATION OF THE TRAF FAMILY OF MODELS

TESTING OF THE CORFLO AND FRESIM MODELS

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Washington State Transportation Commission
Department of Transportation
and in cooperation with
U.S. Department of Transportation
Federal Highway Administration

December 1992

DISCLAIMER

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TABLE OF CONTENTS

LIST OF FIGURES

SUMMARY

This is the final report on a test and evaluation done on a portion of the Traffic (TRAF) family of computer traffic simulation models. The TRAF family of computer models were developed by a consultant for the Federal Highway Administration. The Freeway Simulation (FRESIM) and Corridor Flow (CORFLO) portions of TRAF were tested. Two previous reports on CORFLO are summarized in this paper. The test of FRESIM is also reported in this paper. These tests were done on the 1988-1989 version of the computer models, which were written for use on mainframe computers.

The investigators modeled the traffic impacts on local and regional roadways that would be caused by the reconstruction of I-405 through the City of Renton, Washington, which is in the Seattle metropolitan area. I-405 is a four-lane freeway that is currently being rebuilt to six lanes. The additional lanes will be reserved for high occupancy vehicle (HOV) use. The process of reconstruction has resulted in some temporary lane reductions, which have had a negative effect on traffic flow in the area. The CORFLO computer traffic model was used to examine the likely extent of the problem.

The investigators also modeled I-405 on the northeast side of Renton, where the HOV lane, when completed, will transition from the inside to the outside of the freeway (across general purpose traffic). The FRESIM computer traffic model was used to study this situation.

The CORFLO model could not be adequately calibrated to represent existing traffic flow. Use of the CORFLO mainframe computer program for construction traffic simulation by the Washington State Department of Transportation (WSDOT) is not recommended at this time. The program requires extensive, detailed data, which is usually unavailable and too costly to acquire given the resources normally available for this type of project. Modifying the CORFLO program to run on personal computers is suggested, and this program was released by McTrans in September 1992.

While the FRESIM model appeared to be able to handle the proposed HOV lane crossover, this could not be verified because the FRESIM output was so complex that it was unreadable. A graphic display of the FRESIM output as a supplement to the existing tabular output is recommended.

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

Both the CORFLO and FRESIM portions of the TRAF family of mainframe computer models were tested as part of this project. For complete details pertaining to the CORFLO modeling effort see the two papers published separately: *Evaluation of the TRAF Family of Models*, a Working Paper, by Toby Rickman, et al., March 16, 1989, and *Evaluation of the TRAF Family of Models, Testing of the CORFLO Model's Simulation Capabilities Using Turning Movement Inputs*, a Draft Working Paper, by Mark E. Hallenbeck, et al., August 1989. For the FRESIM test details, see portions of this report.

CORFLO

CORFLO is an integrated model that can simulate traffic on a network that includes both arterials and freeways. TRANSYT, MACK, and the traffic assignment model, which are among CORFLO's components, have enjoyed successful use in their independent versions. However, CORFLO does not appear to be an appropriate model for the reconstruction application attempted in this project. This study demonstrated that the level of detail required by the simulation models surpasses what is normally available for most regional planning studies.

- Despite extensive effort using existing and some collected data, the CORFLO model could not be calibrated to existing conditions for the I-405 reconstruction project.
- Manipulating the modeling inputs sufficiently to force calibration would have distorted the basic simulation and rendered the results of the model invalid as a prediction tool for the reconstruction effort.
- In order to "push" enough vehicles onto the arterial network, major changes to the signal timing plans would have to be made. (For example, much longer green phases on the major arterials, and unreasonably long cycle lengths would have been required.)

- The model's network coding structure (the number and location of entry points and "zonal connectors") differs depending on whether it uses the turning movement option or the traffic assignment option.

- The turning movement option is even more sensitive to point loading of traffic volumes and requires an even smaller zone structure than does the traffic assignment model option.

The researchers could not determine whether the difficulties in calibrating the model were related to the weaknesses of the model itself or to weaknesses in the input data.

FRESIM

The FRESIM output was challenging to read and understand. The researchers had problems interpreting the printed error and warning messages. They also were unsure as to whether or not the vehicles had successfully completed a desired maneuver (such as a lane change). The individual vehicle speeds varied when they all should have been close to the same speed.

While the FRESIM computer model did not appear to function in the case that we modeled (an HOV lane that switches from the inside to the outside of the freeway), we cannot say that the program would have problems in other situations. Perhaps the FRESIM output was an indication that the proposed HOV lane switch is confusing and/or impossible.

RECOMMENDATIONS ABOUT CORFLO

- Use of the CORFLO mainframe computer program for construction traffic simulation by WSDOT is not recommended at this time.

  The model is too complex, and available data too sparse to warrant its use in the vast majority of WSDOT evaluations. The model might, however, be useful in cases in which WSDOT is faced with several alternatives to major freeway or arterial construction efforts. The resources required to collect the information necessary to adequately simulate traffic are far beyond the budget normally available; WSDOT would need to allocate special resources to perform these studies.

- More research pertaining to the traffic assignment model is needed.

  More research on the traffic assignment model is needed to determine why trips were assigned off the freeway, through a signalized intersection, and then back onto the freeway. Correction of this problem may require improvements to the traffic assignment algorithms.

- Allow for actuated traffic signals in the model.

  Improve NETFLO Level I Signal Modeling to allow for actuated traffic signals. The user is required to change the model's fixed time signal settings manually if he or she wants to correctly model the effects of diversion on an actuated traffic signal.

- Expand lane channelization codes.

  To improve the coding ability, modify the lane channelization codes to include: 1) an exclusive turn lane option, and 2) an option for a lane that allows traffic to either proceed straight through the intersection or to turn . This would be in addition to the existing unrestricted, right-only, left-only, closed, or special use by HOVs options.

- Allow modeling of eight-phase actuated traffic signals.

  The modeling of eight-phase actuated signals would allow a more realistic coding of many of the signals commonly found in urban areas. It would also reduce the amount of arbitrary network tinkering required to replicate some signal networks.

- Decrease the time required to develop and code the highway network.

  The development of a pre-processor, data entry/edit routine for CORFLO would greatly improve the model's utility. A utility similar to the pre-processor provided with TRANSYT-7F might meet the majority of these needs quite well. Such a processor should provide menu-driven input for node and link data. A graphic interface (such as the one used by QRS II) would be helpful, especially if

developed in conjunction with a graphic display of the tabular output (see the next recommendation). A graphic input system would be most useful in providing the X/Y coordinate of each node and link.

- Reduce the time required to convert the output tables into a more usable format.

The output should be displayed graphically. The model's tabular output is useful in that it provides a wide variety of measures of effectiveness (MOEs), but some kind of simplified graphic display is needed to assist in analyzing the output tables. A simpler means of identifying the performance of entire streets or geographic areas is needed, particularly in the calibration process. Currently, the output tables must be transcribed manually onto paper copies of link/node maps drawn by hand (or copied from originals). This process is time consuming and subject to error (the voluminous output tables are difficult to read because they are very long and contain vast quantities of data). Moreover, the process reduces the engineer's ability to examine the operations of the network as a whole.

The project team recommends that a network output routine be developed that produces maps of the network along with the MOEs selected by the user. Such MOEs could be plotted in color in up to four categories of the user's choice. For example, the user should be able to specify the map output of network speeds by four categories (say 0 to 5 mph, 5 to 10 mph, 10 to 20 mph and 20+ mph). This would allow immediate identification and concentrated analysis of congested areas.

- Shorten the time required to debug the highway network when errors are found.

To assist in the debugging process, the user should also be able to retrieve information on any node in the network from an existing data set. These data should be displayed in the data entry menu structure and should allow the simple examination of basic (but easily miscoded) information such as:

- the number of lanes in each direction,
- the length of each attached link,
- the percentage of vehicles turning at a particular intersection, and
- signal timing parameters.

- Decrease the cost of running the simulations.

The project team's final recommendation is to convert the CORFLO modeling system so that it can operate on microcomputers. Currently, a mainframe computer is required. Existing microcomputers are no longer limited in central processing unit (CPU) power, memory, or disk space. They are capable of running the most sophisticated modeling packages, and it costs much less to run such programs on microcomputers than it does on comparable mainframe CPUs. While microcomputers process jobs more slowly than do unloaded mainframes, they can usually be connected to inexpensive peripherals (plotters, laser printers) to provide for high quality output. Moreover, they are available to almost all engineering and planning professionals.

Conversion of the mainframe CORFLO modeling system to run on microcomputers would allow engineers to code larger highway networks without the worry of increased processing charges, and would provide them easier access to screen utilities that can assist in the graphics and menu functions noted above. Conversion would also allow a greater number of academic and operational users around the country to be exposed to and use the CORFLO model.

A personal computer version of CORFLO was released by McTrans in September 1992.

RECOMMENDATIONS ABOUT FRESIM

- Develop an easier way to input freeway geometrics.

A graphic interface for input would improve the coding of freeway geometry.

- Develop a graphic output.

The computer program's tabular output was useful for analyzing individual links. However, graphing (mapping) is most effective in providing an overall view. We recommend a color-coded roadway map, which should be available to

the user both on a color monitor and as plotter output. Ideally, the map should show individual vehicles traversing the roadway. This would provide a "reality" check which would determine whether traffic is flowing as expected. A graphic display, such as that available in TRAF-NETSIM, is suggested.

- Develop additional feedback mechanisms.

  The model needs additional computer-generated notes to provide feedback comments such as, "There's a problem on this link."

- Decrease the cost of running the simulations.

  Adapt the program to run on micro-computers, as was recommended for the CORFLO program. This would eliminate the expense of running the program on a mainframe computer; it should also simplify program use.

INTRODUCTION AND DISCUSSION

This is the final report on a test and evaluation done on a portion of the Traffic (TRAF) family of computer traffic simulation models. The TRAF family of computer models were developed by a consultant for the Federal Highway Administration. The Freeway Simulation (FRESIM) and Corridor Flow (CORFLO) portions of TRAF were tested. Two previous reports on CORFLO are summarized in this paper. The test of FRESIM is also reported in this paper. These tests were done on the 1989 version of the computer models, which were written for use on mainframe computers.

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The investigators also modeled I-405 on the northeast side of Renton, where the HOV lane, when completed, will transition from the inside to the outside of the freeway (across general purpose traffic). The FRESIM computer traffic model was used to study this situation.

The CORFLO and FRESIM computer traffic models are part of the larger family of TRAF models. The models are (or were) being developed for the Federal Highway Administration. The TRAF family consists of the following components:

- TRAF Input Processor
- Component Model (Subnetwork) Integration Processing
- Microscopic Rural Road Simulation Model (ROADSIM)
- Microscopic Arterial Simulation Model (NETSIM)
- Macroscopic Arterial Simulation Model (NETFLO Level I)
- Macroscopic Arterial Simulation Model (NETFLO Level II)
- Macroscopic Arterial Simulation Model (NETFLO Level III)
- Microscopic Freeway Simulation Model (FRESIM)
- Macroscopic Freeway Simulation Model (FREFLO)
- Equilibrium Traffic Assignment Model

The CORFLO model, which was used for the first and second parts of this three-part project, consists of some of the macroscopic models from the TRAF family. CORFLO has been developed as a separate unit to be adapted into the future ITDS computer modeling system being developed for the Federal Highway Administration. The CORFLO model consists of the Macroscopic Arterial Simulation Models (NETFLO Levels I and II), the Macroscopic Freeway Simulation Model (FREFLO), and the Equilibrium Traffic Assignment Model. The stand-alone CORFLO model also includes an input processor and model integration programs.

The FRESIM model was used for the last part of this project, which entailed simulation of I-405, on the northeast side of Renton. Figure 1 (page 11) contains (a) a plan view of the proposed freeway configuration, and (b) the coded network representation that came closest to modeling the proposed freeway configuration in the northbound direction. Figure 2 (page 12) depicts the same items for the southbound direction.

Before coding FRESIM for I-405, the researchers spent time getting a practice FRESIM run to operate properly. The computer coding for the practice run was provided by the consultant who was involved in the development of the FRESIM program. Once a few problems had been resolved, the practice run appeared to work adequately.

The coding was changed to fit I-405, and FRESIM was run. Initially, FRESIM appeared unable to handle multiple on-ramps that were located close to one another. The program generated a fatal error message. Spacing the on-ramps farther apart in the model seemed to solve this problem; however, this did preclude modeling the freeway exactly as had been planned.

Extra coding in FRESIM was necessary to model HOVs that were exiting and entering the freeway. It was necessary to code HOVs in a special way so that the program would take the HOV from a right side on-ramp to the left side HOV lane. This extra coding also involved coding destination exit ramps, which did not really exist, on the left side of the freeway.

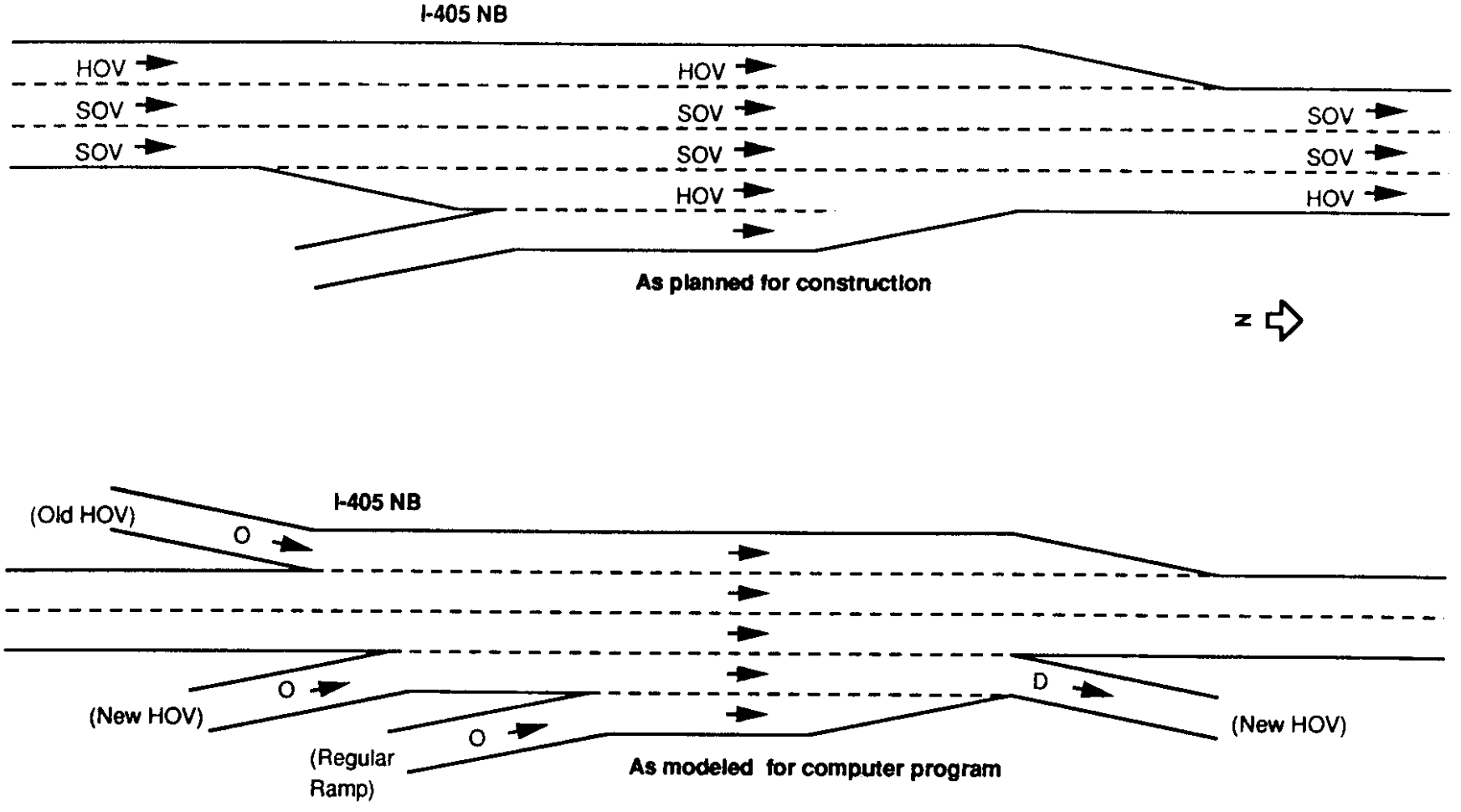

Figure 1. Schematic of I-405 North of Renton, Washington (Northbound Direction)

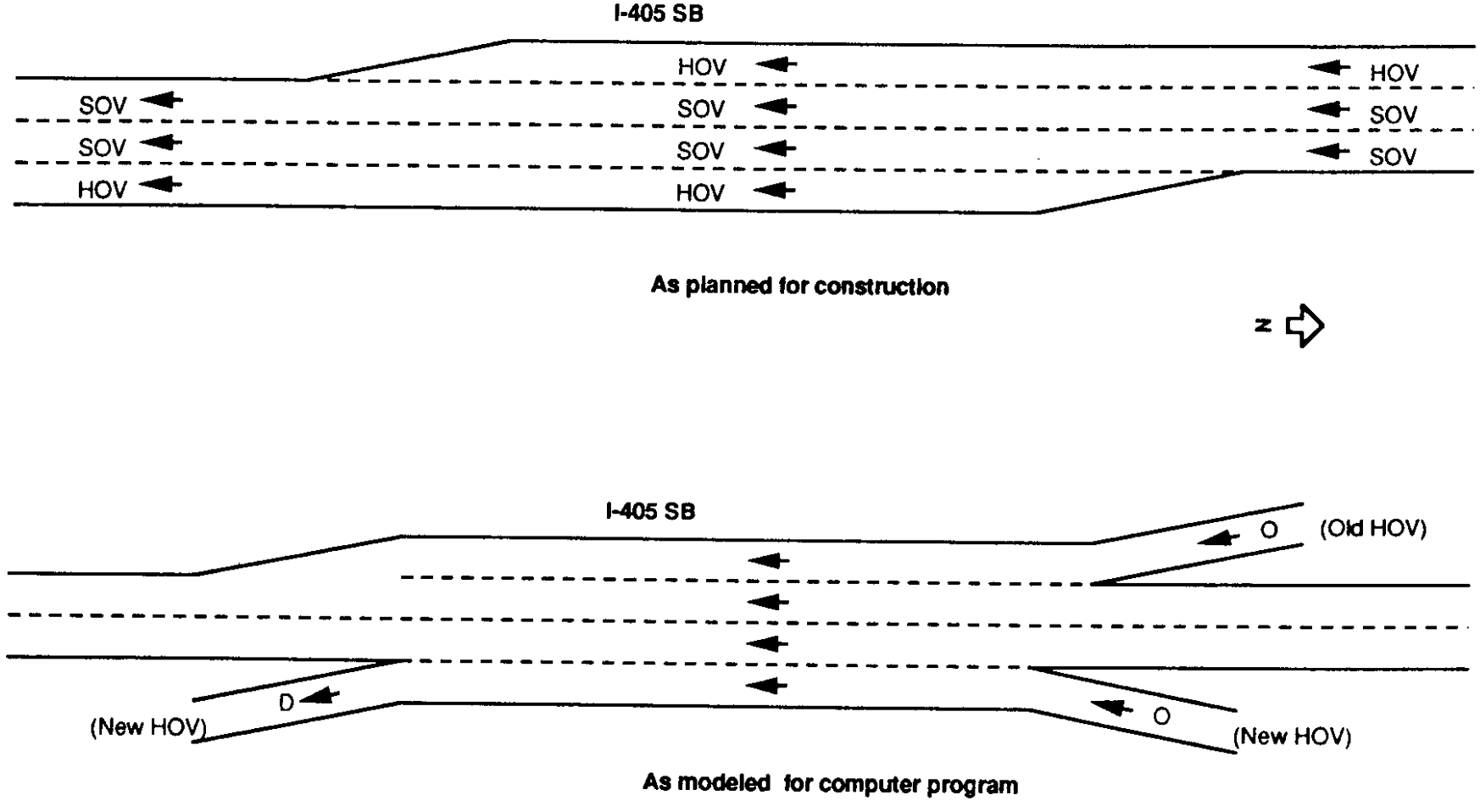

Figure 2. Schematic of I-405 North of Renton, Washington (Southbound Direction)

One of the problems which was encountered was as follows. A right hand on-ramp was modeled in which all vehicles using this ramp were assigned to a downstream left hand off-ramp as a destination. The output indicated that the "DESTINATION WAS REASSIGNED" or that "VEHICLE MISSED DESTINATION" for several of the vehicles. It was assumed in both cases that the vehicles had not managed to exit at the assigned destination. The researchers had two questions about these vehicles:

1. What did the model do with these vehicles? Where does the model send them?

2. What mechanisms within the model are being used to make the determination that these vehicles could not reach their assigned destination? What parameters does the model use to make this determination?

Extra coding was also necessary to differentiate HOVs from the general purpose lane traffic volumes. However, the FRESIM output was not always easily understood, so the utility of the extra coding was unknown.

ACKNOWLEDGMENT

The following individuals assisted in compiling this final report. Their efforts are gratefully acknowledged.

Jua-Been Chang, Mark E. Hallenbeck, Leslie N. Jacobson, Bill Legg, Stephanie MacLachlan, Ron Porter, Toby Rickman, G. Scott Rutherford, Larry Senn, and Duane Wright.