
TRANSPORTATION TECHNICAL REPORT

APPENDIX B

Traffic Analysis Methods White Paper

MEMORANDUM

To: Ken Robie, Vermont Agency of Transportation

cc.: Judith Dillon

From: Larry Pesesky, The Louis Berger Group

Re: Circ-Williston EIS –Traffic Analysis Methods and Software for Detailed Analysis

Date: May 24, 2007

1.0 Introduction

This document outlines the proposed methods and software to be used for detailed traffic analysis and simulation for the various types of travel facilities included in the short-listed alternatives and identifies the supporting rationale for each method. The detailed traffic analysis will primarily be performed using the methods of the *2000 Highway Capacity Manual (HCM)*, published by the Transportation Research Board (TRB). This is the accepted practice in all 50 states.

The methodology and measures of effectiveness vary for each different type of facility. Each of the short-listed alternatives has several components. The types of facilities that will need to be analyzed as part of the Environmental Impact Statement (EIS) include:

- Signalized intersection
- Unsignalized (stop-controlled) intersection
- Modern roundabout

There are several software options for analysis and simulation of these facilities. Capacity and queuing analysis software packages include HCS Plus (HCS+), Synchro, aaSIDRA (SIDRA), RODEL, and ARCADY. Micro simulation software packages include CORSIM, SimTraffic, VISSIM, and Paramics. It should be noted that HCS+ data can be transferred to CORSIM for simulation. Similarly, Synchro data can be transferred to SimTraffic, CORSIM, or VISSIM for simulation or review of corridor measures of effectiveness (MOEs).

2.0 Capacity Analysis

There are several software packages available to perform capacity analysis for the various types of facilities. For each type of facility, the applicable software packages are identified including consideration for the data input requirements, methodology, and the advantages and disadvantages for their application.

2.1 HCS+

HCS+ software was developed to translate the capacity analysis methodology of the HCM into a computer model. HCS+ can be used to analyze most types of traffic facilities.

For a signalized intersection the MOE used to calculate LOS is average delay per vehicle in seconds. The basic premise is that a user/driver perceives how well a signalized intersection is working based on how long it takes him/her to pass through it. As congestion increases, delays and queue lengths increase, and a motorist may have to wait several cycles to clear the intersection. The inputs to determine average delay in HCS+ are: traffic volumes in vehicles per hour as well as signal data such as cycle length, green ratio, clearance times, etc. The HCS+ analysis yields average delay, LOS, and v/c ratios. The program now also offers a queuing module that can provide the average and 95th percentile queues for each lane group.

As with other types of intersection geometry and control, the MOE for the modern roundabout is average delay in seconds per vehicle. The basic premise is that a user/driver perceives how well roundabout is working based on how long it takes him/her to pass through it. As congestion increases, the waiting times to enter the circulating roadway and queue lengths increase.

The 2000 HCM contains methodology for analyzing single-lane roundabouts, and this methodology and its procedures are reflected in HCS+. Although the FHWA is in the final stages of a research study that will be the basis for two-lane roundabout methodology in the U.S., the revised methodology will not be released as part of an HCM revision until 2007. The new two-lane roundabout methodology will be based on U.S. empirical data. The algorithm of the new methodology is simplistic enough that a computer program will not be required. However, since the two-lane procedure has not yet been officially released for use, other methods must be examined for analyzing two-lane roundabouts.

The advantage of HCS+ is that it follows the methodology outlined in the HCM verbatim. The disadvantage of HCS+ is that it does not handle interactions between intersections such as queue spillback. The program analyzes each intersection separately as an isolated location. In addition, HCS+ software can not currently analyze two-lane roundabouts.

2.2 Synchro

Synchro was developed privately as an application of the HCM methodology. It can be used to analyze many different facilities, including arterials and intersections. Its primary function has been to analyze signalized intersections.

For an intersection, inputs include traffic volumes, geometrics, and control data including STOP/YIELD, or green time, cycle length, etc. The program explicitly outputs the Intersection Capacity Utilization (ICU) report and ICU LOS. These are based on the Percentile Delay Method, rather than the HCM methodology (Webster's Method). However, the program offers an HCM report for both signalized and unsignalized intersections that is based on the HCM methodology. The report details the delays, LOS, v/c ratio, and average and 95th percentile queues. The results on-screen do not exactly reflect the HCM methodology. However, the HCM report mirrors the MOEs and LOS as described in Chapters 16 and 17 of the HCM.

2.3 *SIDRA*

SIDRA is a software package that was developed in Australia to analyze roundabouts. It has been commonly used in the U.S. to analyze roundabouts, particularly two-lane roundabouts. SIDRA is the roundabout analysis software accepted by VTrans. The inputs to SIDRA include the hourly volumes, as well as the intersection geometry. Although the intersection geometry is one of the inputs to SIDRA, it is not explicitly considered in the analysis. Because SIDRA can analyze other types of intersections, including both signalized and unsignalized intersections, particularly those with unusual geometry such as five-legged intersections, the geometry is included in the inputs. However, in the case of roundabout analysis, the geometrics are not used in the analysis. The methodology included in the software is based on critical gaps, much like HCS+. A recent update of SIDRA introduced the use of an adjustment factor to account for the difference between U.S. driving conditions and those in the United Kingdom (U.K.) and Australia, where drivers are more familiar with roundabouts. Recent studies have concluded that SIDRA may overestimate the capacity of single-lane roundabouts and may underestimate capacity for two-lane roundabouts. The MOEs from SIDRA include average delay in seconds, LOS, v/c ratios, and queue lengths.

2.4 *RODEL*

RODEL is a software package that was developed in the U.K by Barry Crowne. RODEL has been used as the standard by some Departments of Transportation (DOTs) to analyze roundabouts, most notably in the Northeast by New York State DOT. The program inputs include the hourly volumes as well as the geometry of the roundabout. The program methodology is based solely on the geometrics of the roundabout. Gap theory does not factor into the results. RODEL can be run in design mode with performance targets specified or in evaluation mode with geometric parameters specified. This allows the user to determine the specific impacts on capacity of varying the intersection geometry. One disadvantage of this method for the Circ-Williston project is that it requires detailed knowledge of geometrics, possibly beyond what will be developed for the DEIS. The program is also not calibrated to U.S. conditions, and recent studies indicate that it may underestimate the capacity of single-lane roundabouts and overestimate the capacity of two-lane roundabouts. The MOEs from RODEL include average delay, LOS, v/c ratios, and queue lengths.

2.5 *ARCADY*

Assessment of Roundabout Capacity and DelaY (ARCADY) is a software package developed by TRL Software in the UK for use in analyzing roundabouts. The program is based upon empirical data in the UK. The MOEs that ARCADY predicts include capacity, delay, queue length, and accident risk. It can address all roundabout configurations, including mini-roundabouts. It also includes a crash prediction model and a pedestrian crossing model based on UK data and equations. Inputs to ARCADY include hourly volumes and geometry. One disadvantage of ARCADY is that there is only a 50 percent confidence interval in the results. It is also not calibrated to U.S. conditions, so may not accurately predict roundabout capacities in this country.

3.0 Simulation

There are several software packages available to perform microsimulation for the various types of facilities. For each type of facility, the applicable software packages are identified including consideration for the data input requirements, methodology, and the advantages and disadvantages for their application.

3.1 CORSIM

CORSIM is the corresponding microsimulation program to HCS+ and was developed by the FHWA. The program works reasonably well for signalized and unsignalized intersections, and various freeway segments, including basic segments, ramps, and weaves. Since the data from HSC+ can be transferred directly into CORSIM, the use of CORSIM for the simulation of freeways and freeway segments is desirable. However, the simulation of an arterial corridor with signalized intersections requires additional inputs into CORSIM to complete the simulation, i.e., intersection offsets, must also be input for the simulation to accurately reflect corridor conditions. For an arterial corridor with roundabouts at intersections, CORSIM does not provide roundabout specific features for input into the simulation model. In addition, there are known flaws with its modeling of roundabouts, particularly two-lane roundabouts. CORSIM can export reports on a variety of measures, including density, travel time, speed, and number of lane changes.

3.2 SimTraffic

SimTraffic was privately developed and is the simulation partner to Synchro. Since SimTraffic and Synchro use the same interface, there is no need to input additional data when transferring from Synchro to SimTraffic. As with CORSIM, a high level of labor intensive calibration is required to have confidence in the simulation results. The primary advantage of the Synchro/SimTraffic package is that analysis and simulation can be done from the same interface. There is no need to input additional data, as the signal data, traffic volumes, link data, and other characteristics of the network are all contained in one file. The results will not exactly match the HCM methodology because Synchro is based upon the Percentile Delay Method rather than Webster's Method. However, for signalized intersections, the SimTraffic simulation gives a reasonable approximation of the expected conditions when properly calibrated. SimTraffic adequately simulates results for single-lane roundabouts; however, the results for two-lane roundabouts are flawed because the user cannot control lane use within the roundabout.

In response to a recent TENC listserv question regarding a corridor analysis project involving roundabouts and the use of SimTraffic, Kittelson & Associates, Inc. (KAI) took a cursory look at SimTraffic's ability to model roundabouts. KAI tested single-lane roundabout capacity by loading a subject approach beyond capacity and then measured the outflow against a range of circulatory flows. What KAI found was that SimTraffic appears to produce higher estimates of capacity at low circulating flows (<600 vph) than either the FHWA urban compact or FHWA single-lane model. At moderate to high circulating flows, the model appears to be in the same range as the two FHWA models. KAI did not check the SimTraffic results against U.S. field data of NCHRP 3-65.

KAI believes that the logic for lane selection should be the same for roundabouts as for any other intersection. For example, on a two-lane approach with two receiving lanes on the far side of the intersection, a driver would turn left from the left lane, right from the right lane, and proceed through from either lane, unless traffic control devices dictate otherwise. The MUTCD is being updated to better clarify lane use, including providing examples of circulatory roadway and exit striping to guide motorists.

SimTraffic assumes that a multilane roundabout operates as a series of T intersections with a section of circulatory roadway between the legs. Therefore, each downstream exit is considered independent of the upstream entry. However, at most roundabouts the paths of entering vehicles cross vehicles leaving the roundabout at the adjacent downstream exit rather than join and separate. As a result of this assumption, it appears that SimTraffic cannot accurately simulate the normal lane configuration for a standard two-lane roundabout with two-lane entries and two-lane exits on all approaches. Due to these findings, KAI did not check the capacities that could be derived by SimTraffic for a two-lane roundabout.

3.3 *VISSIM*

VISSIM is a simulation program developed overseas and distributed in the U.S. VISSIM can simulate arterials with both signalized and roundabout intersections. The FHWA's research shows that the results of roundabout simulation correlate closely with empirical data gathered at roundabouts within the U.S. VISSIM's graphical interface makes it more user friendly than some other simulation models. VISSIM can also simulate interaction with transit facilities, pedestrians, and other similar specialized cases. Simulation of special cases will be necessary for the Circ-Williston EIS at the Five Corners intersection in Essex Junction due to the proximity of at-grade rail crossings and the high number of pedestrian movements. The outputs from VISSIM include travel time, queue length, and delay, just to name a few. A specific path or paths can be defined in VISSIM, for which the program will explicitly output travel times. For these defined paths, the program will also output delays. Queue counters at specific locations can also be specified in VISSIM to determine queue lengths at key locations. VISSIM can report average queue length, maximum queue length, and the number of stops within the queue. VISSIM allows the user to import a CAD file or aerial photograph as the background, thus making it easier for the public to relate to the location that is being simulated.

3.4 *Paramics*

Paramics is another microscopic simulation model, which was developed in Scotland. It has a good graphical interface, including 3-D animation. Although Paramics explicitly models roundabouts, experience by some Departments of Transportation (DOTs) indicates that it can be quite cumbersome to set up the network. In addition, Paramics is extremely costly. As a result, the use of Paramics in the U.S. has been extremely limited to date.

4.0 Conclusions

Based on a review of the available software to perform capacity analysis and microsimulation of various types of facilities, several software packages were chosen to be used for the Circ-Williston EIS. The software packages include Synchro, Sidra, and VISSIM. Table 1 summarizes the software that will be used for each facility type for capacity analysis and microsimulation.

**Table 1
Capacity Analysis and Microsimulation Software**

Software	Facility Type	
	Signalized & Unsignalized Intersections	Roundabouts
Capacity Analysis		
HCS+		
Synchro	√	
SIDRA		√
RODEL		
ARCADY		
Simulation		
CORSIM		
SimTraffic		
VISSIM	√	√
Paramics		

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SIDRA will be used to analyze roundabouts. The capacity adjustment factors for both programs as recommended by KAI will be used in the analysis. The most-recent update of SIDRA includes this adjustment factor, called the U.S. capacity adjustment factor.

The LOS results from Synchro are similar to those from HCS+. However, Synchro was selected to analyze and simulate signalized and unsignalized intersections over HCS+ and CORSIM because Synchro has the advantage of having all of the input data for the network stored in one file, rather than requiring manipulation of individual files for each intersection. Synchro is VTrans' preferred software package for these types of applications. Several sections of the Circ-Williston EIS Project Area roadway network were previously modeled in Synchro for existing conditions by VTrans.

Since SimTraffic and CORSIM do not explicitly handle two-lane roundabouts as part of their simulation capabilities and railroad crossings, VISSIM will be used for simulation of the Five Corners intersection in Essex Junction and the Industrial Avenue/Mountain View Road and VT

2A intersection and the Marshall Avenue/Maple Tree Place and VT 2A intersection in Williston. Paramics can model roundabouts, but other users in the U.S. have encountered problems in setting up the model files. To meet the schedule of the Circ-Williston EIS while ensuring valid results, Berger will use VISSIM to model signalized intersections and roundabouts at these three intersections in the VT 2A corridor. The use of VISSIM as a microsimulation tool to determine the effect of roundabouts in close proximity on an arterial corridor (VT 2A, Circ, etc.) has merit and in certain scenarios could be beneficial at public meetings. After evaluating the DEIS analysis results, VTrans can determine if VISSIM microsimulation is warranted at other locations in the project area.

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