NDOT Research Report

Report No: RDT01-008

COMPARISON OF ROUNDABOUT OPERATIONS to FOUR WAY STOP and SIGNAL CONTROLLED INTERSECTIONS USING NETSIM SIMULATIONS

July 2001

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TECHNICAL REPORT DOCUMENTATION PAGE

Report No. **RDT 01-008**	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle **Comparison of Roundabout Operations to Four Way Stop and Signal Controlled Intersections Using NETSIM Simulations**	5. Report Date **May 29, 2001** 6. Performing Organization Code	
7. Author(s) **Scott L. Thorson, P.E.; Donald D. Campbell, P.E.; Perry D. Gross, P.E.**	8. Performing Organization Report No.	
9. Performing Organization Name and Address **Nevada Department of Transportation** **1263 S. Stewart Street** **Carson City, NV 89712**	10. Work Unit No. 11. Contract or Grant No. 29563A00	
12. Sponsoring Agency Name and Address **Nevada Department of Transportation** **1263 South Stewart** **Carson City, Nevada 89712**	13. Type or Report and Period Covered January 1999 - To May 2001 14. Sponsoring Agency Code **NDOT**	
15. Supplementary Notes		

16. Abstract

Using the microscopic computer model NETSIM (NETwork SIMulation), a proposed roundabout at the intersection between Fifth Street and Edmonds Drive in Carson City, Nevada was analyzed in comparison with a four-way stop and a signal controlled intersection. It was found that the roundabout had the lowest average time delays and fuel consumption of the intersection for each type of control modeled, being consistent with field observations. The study provided the qualitative steps to take in simulating the operation of roundabouts and helped NDOT in determining if the location was suitable for a roundabout. It was concluded that the NETSIM model can be used to simulate roundabout operations with an acceptable degree of accuracy, and be useful when making a presentation to administrators or the general public.

17. Key Words **Roundabout, NETSIM, traffic simulation, traffic modeling**		18. Distribution Statement **Unrestricted. This document is available through the National Technical Information Service, Springfield, VA 21161**	
19. Security Classif. (of this report) **Unclassified**	20. Security Classif. (of this page) **Unclassified**	21. No. Of Pages 10	22. Price

Comparison of Roundabout Operations to Four Way Stop and Signal Controlled Intersections using NETSIM Simulations

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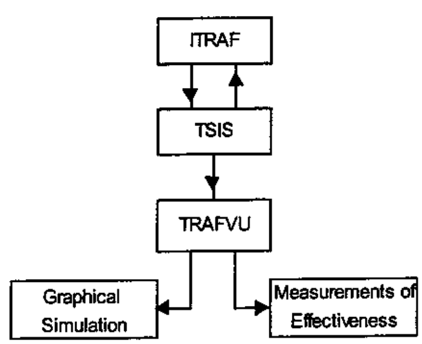
May 2001

Roundabout intersections are intersections that are controlled using a counter-clockwise rotating one-way road to control vehicle rights-of-way. This control strategy requires the vehicle that is entering the roundabout to yield to vehicles that are already in the roundabout, in other words yielding to the entering vehicle's left.

Motorists traditionally are taught to yield to the vehicle on their right. Yielding to vehicles on their left is not comfortable to some motorists and requires time for them to develop the confidence to drive a roundabout properly.

The analysis of a proposed roundabout can be performed using the microscopic computer model NETSIM (NETwork SIMulation), which is now packaged in a program called TSIS (Traffic Software Integrated System). NETSIM and TSIS are part of the TRAF (TRAFic) System of computer programs, which was developed by ITT Systems and Science Corporation with the support of the Federal Highway Administration. The portion of TSIS that runs the animated graphical simulation is called TRAFVU (TRAF Visualization Utility). CORSIM (CORridor SIMulation) and FRESIM (FREeway SIMulation) are also packaged with TSIS. This model assigns individual vehicles, with different driver characteristics, to the network and accumulates measures of effectiveness (MOE's) for the network. These microscopic models are an invaluable tool to analyze the effects of varius roadway elements, as well as driver characteristics, on the operation of a system. Microscopic models also save countless hours of field time and the resulting data reduction in the office.



Microscopic simulation models depict movements of individual vehicles and what effect they have on driver behavior. Changes, such as changing driver aggression levels, changing acceleration rates, changing parking restrictions, or changing the location of a bus stop can be readily observed and evaluated.

Macroscopic simulation models depict less detail and are useful for observing changes in circulation patterns over a wide area. They are also beneficial for displaying the different effects changes to microscopic models have on the overall street network.

There is a high level of confidence for the usage of NETSIM on stop and signal controlled intersections and therefore has been readily accepted by traffic engineer professionals. The use of NETSIM to evaluate roundabouts is the next logical step. However, NETSIM requires calibration of both microscopic and macroscopic models to effectively and accurately model the traffic. This calibration will vary from area to area, even within the same community. The split between frequent users (commuters) and those that have never driven in a roundabout (tourists) will have a definite effect on the operation of the roundabout.

This study utilized a single intersection. The intersection was controlled by a four-way stop prior to the installation of the roundabout. This intersection was chosen for a Nevada Department of Transportation research project for four primary reasons:

- Single lane approaches
- Relatively high peak volumes
- Commuter traffic
- Lengthy delays on two approaches

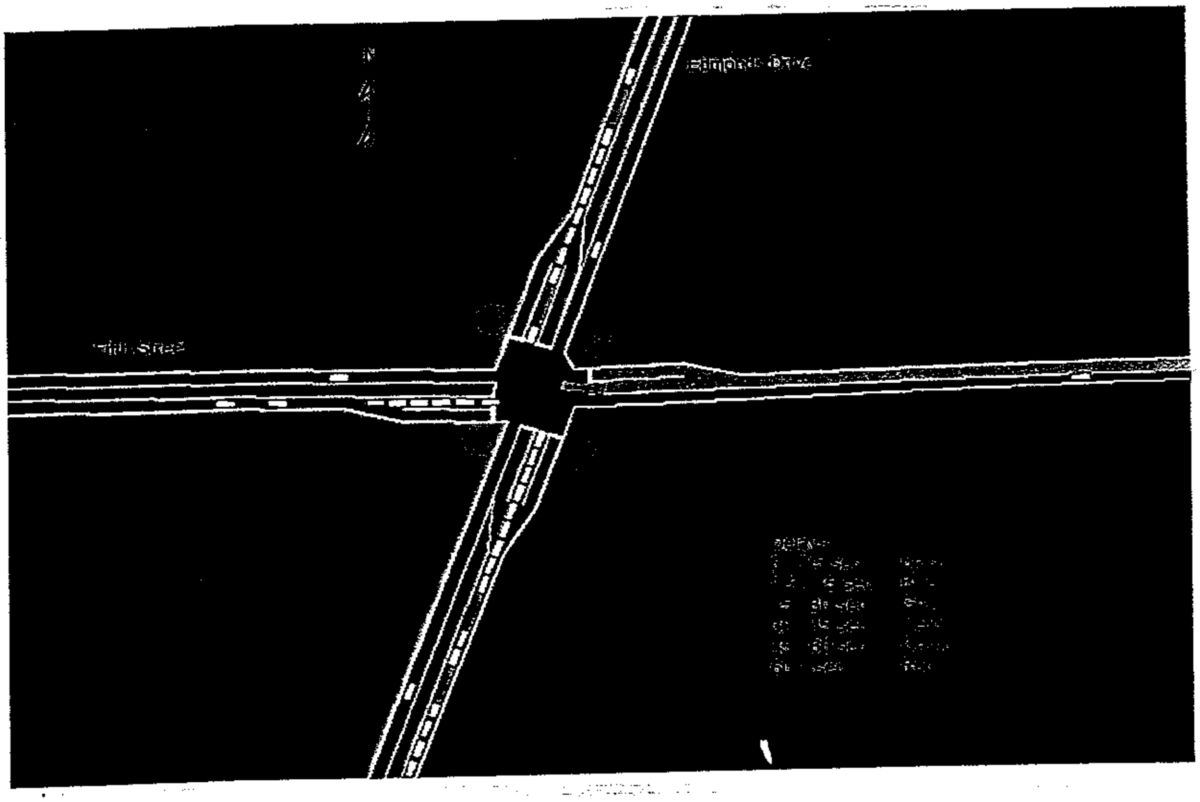
The afternoon peak hour traffic volumes on the four approaches were, at the time this study was initiated, northbound - 680, southbound - 740, eastbound - 400, and westbound - 160. The north and southbound legs are used as a commuter route, the east leg serves a subdivision, and the west leg serves both the subdivision and commuters. The delays on the north and south approaches were observed at over two minutes, with traffic backed up for over 1000 feet.

Video data was collected while the intersection was still a four-way stop, after it was converted to a roundabout, and continues to be periodically collected and analyzed. After a base condition was established a comparison between actual operations and the computer simulation was made. This was accomplished utilizing the extensive MOE capability of NETSIM. The MOE's that are readily observable are compared directly.

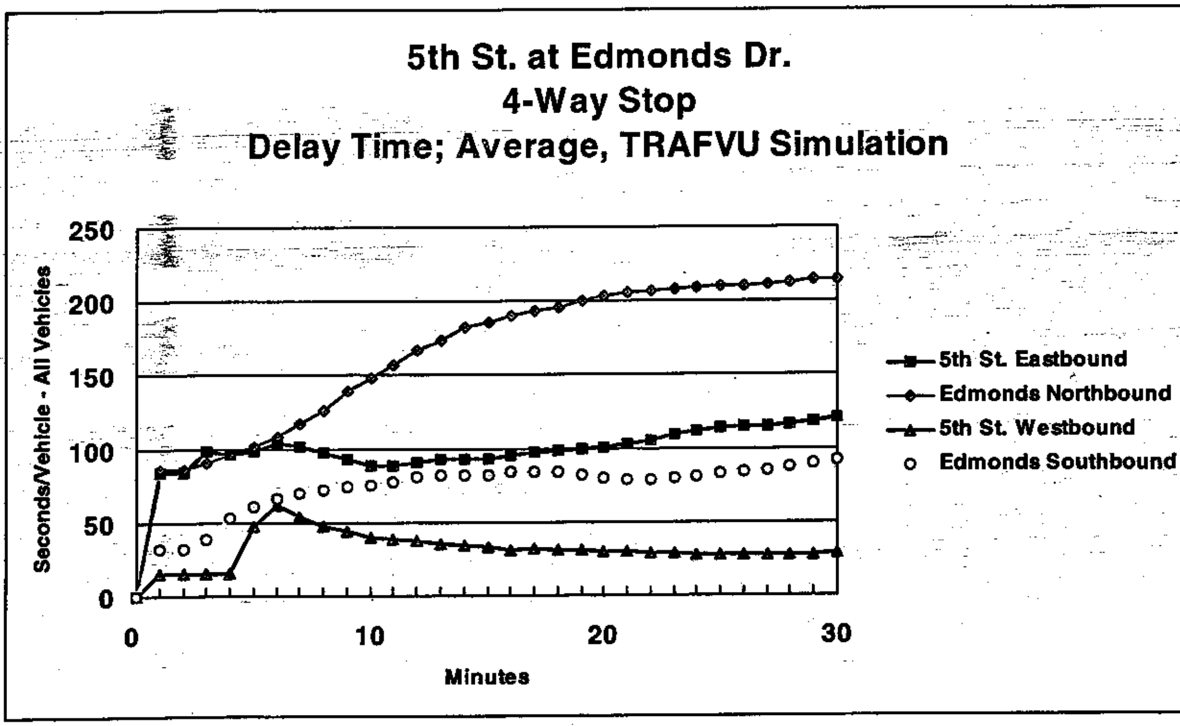
The next phase is to adjust the NETSIM modeling inputs. This is an iterative process that proceeds until the actual conditions match the modeled conditions within an acceptable tolerance.

The intersection was modeled as a four-way stop, as a roundabout, and as a signalized intersection. This was used to demonstrate to the various governmental agencies, as well as the general public, what the existing and predicted delays were, and would be, for the three types of intersection control.

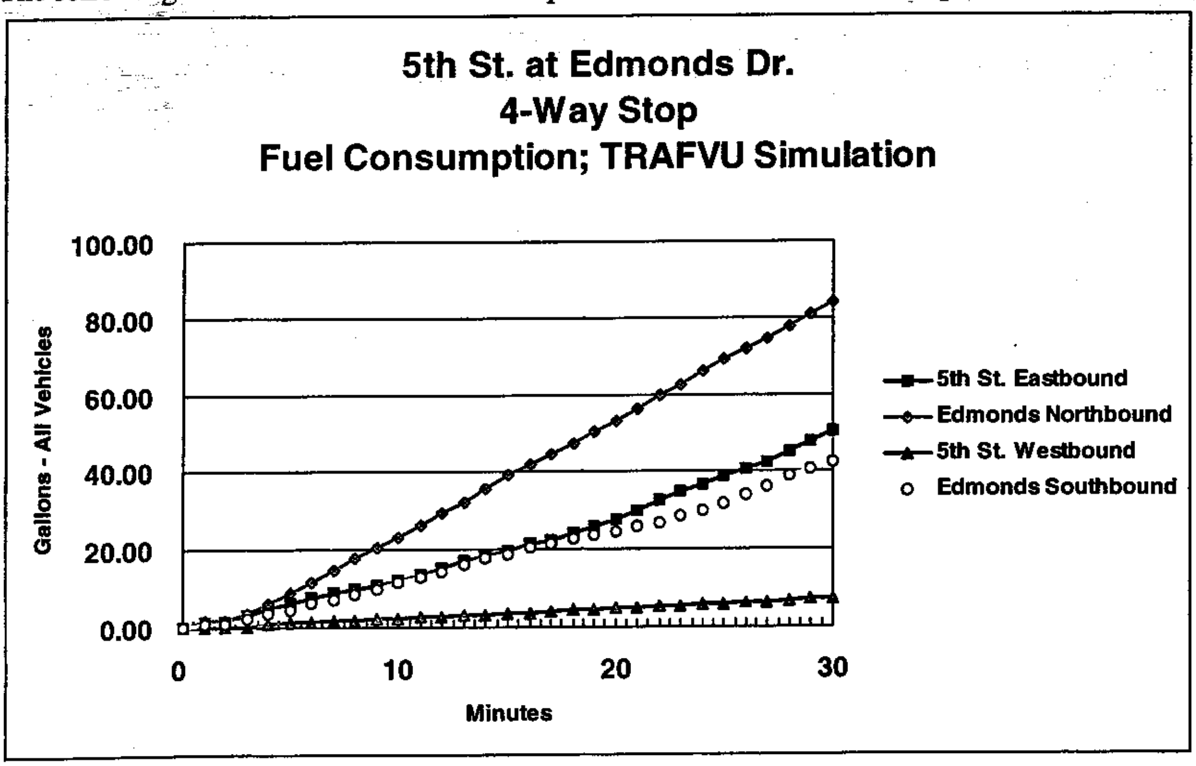
Following is a picture taken from TRAFVU showing the intersection modeled as a four way stop controlled intersection, and the resulting delays.



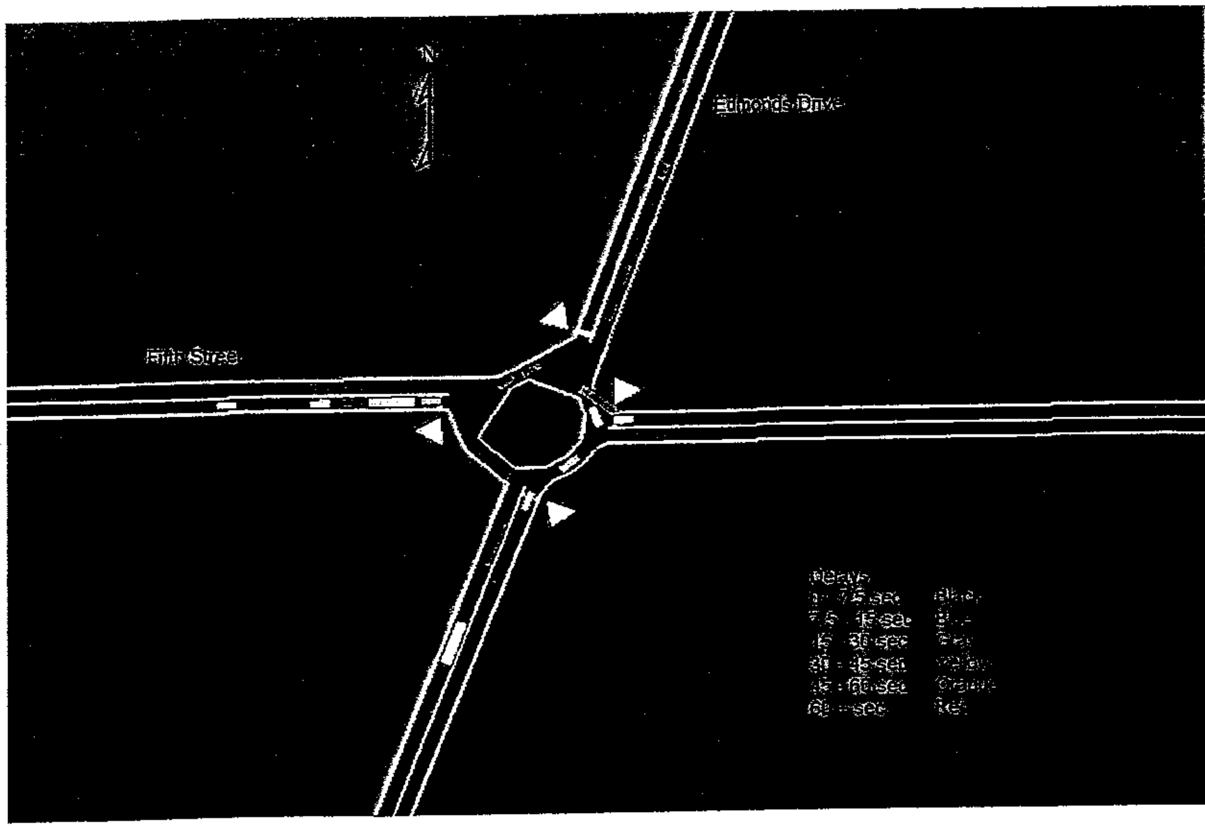
Following is a chart, derived from the Measures of Effectiveness (MOE's) of TRAFVU, showing the average delay time for each approach to the intersection. The run time for the simulation was 30 minutes.



The following chart shows the fuel consumption over the same 30 minute period.

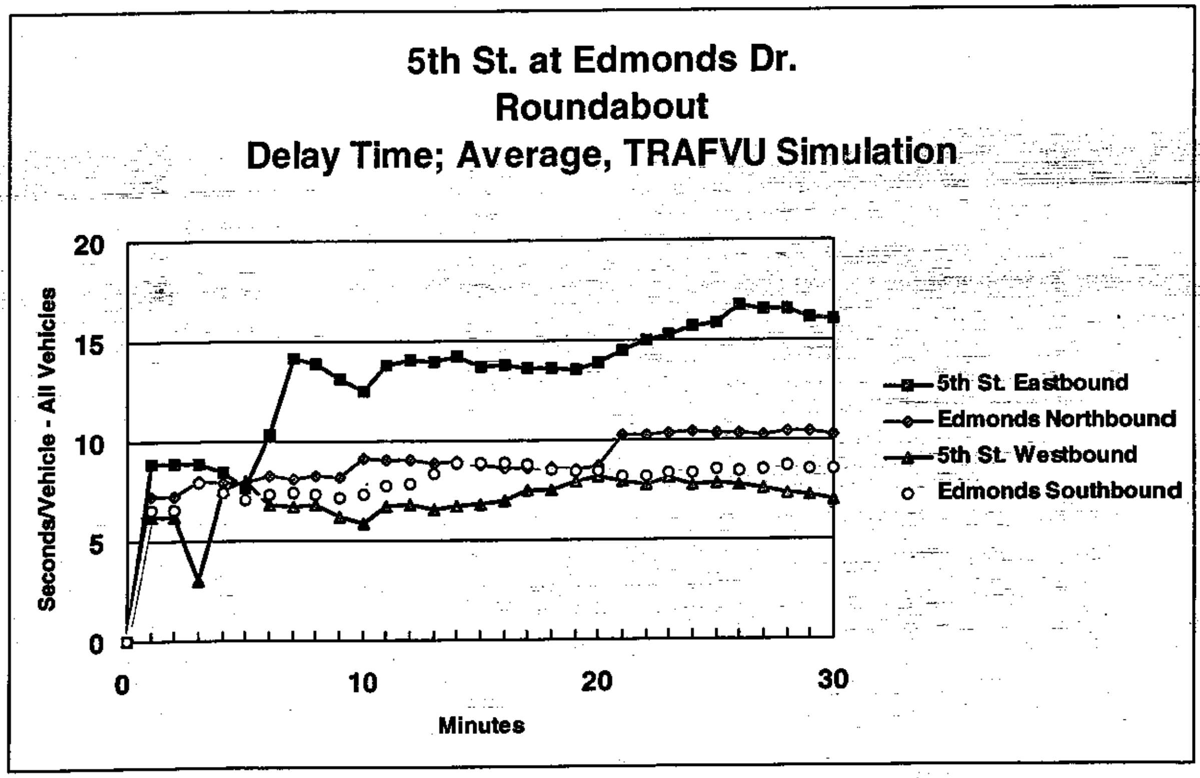


The following picture is taken from the TRAFVU simulation for the roundabout and show the delays over the same 30 minute time period for the same traffic volumes.

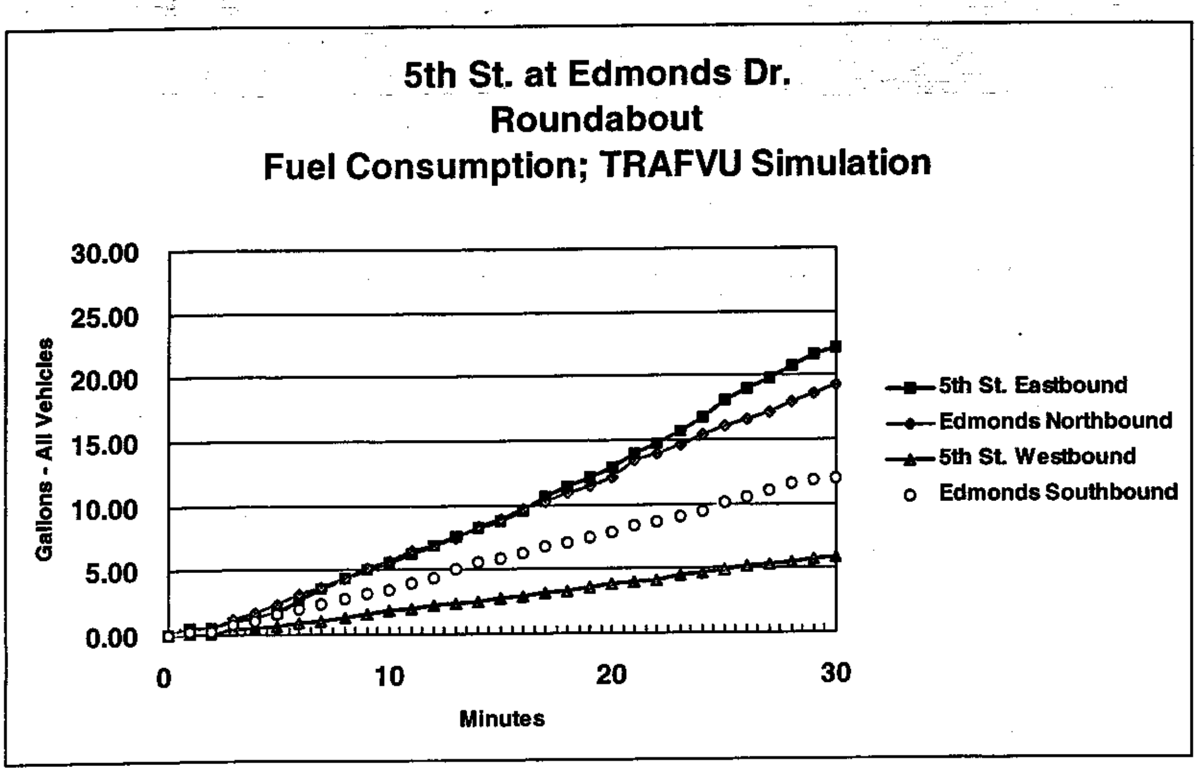


A roundabout is coded with a short, one-way, link connecting the legs of the intersection. The entering links are coded as through links to the next leg of the intersection and the movements of all vehicles are coded as through vehicles until they reach the leg of the intersection that the vehicle will be exiting on. All movements that exit the roundabout are coded as right turns. In other words, the only movements that are coded in, on roundabouts, are through's and rights. This coding of turning volumes closely resembles the steps required to determine the level of service for a roundabout.

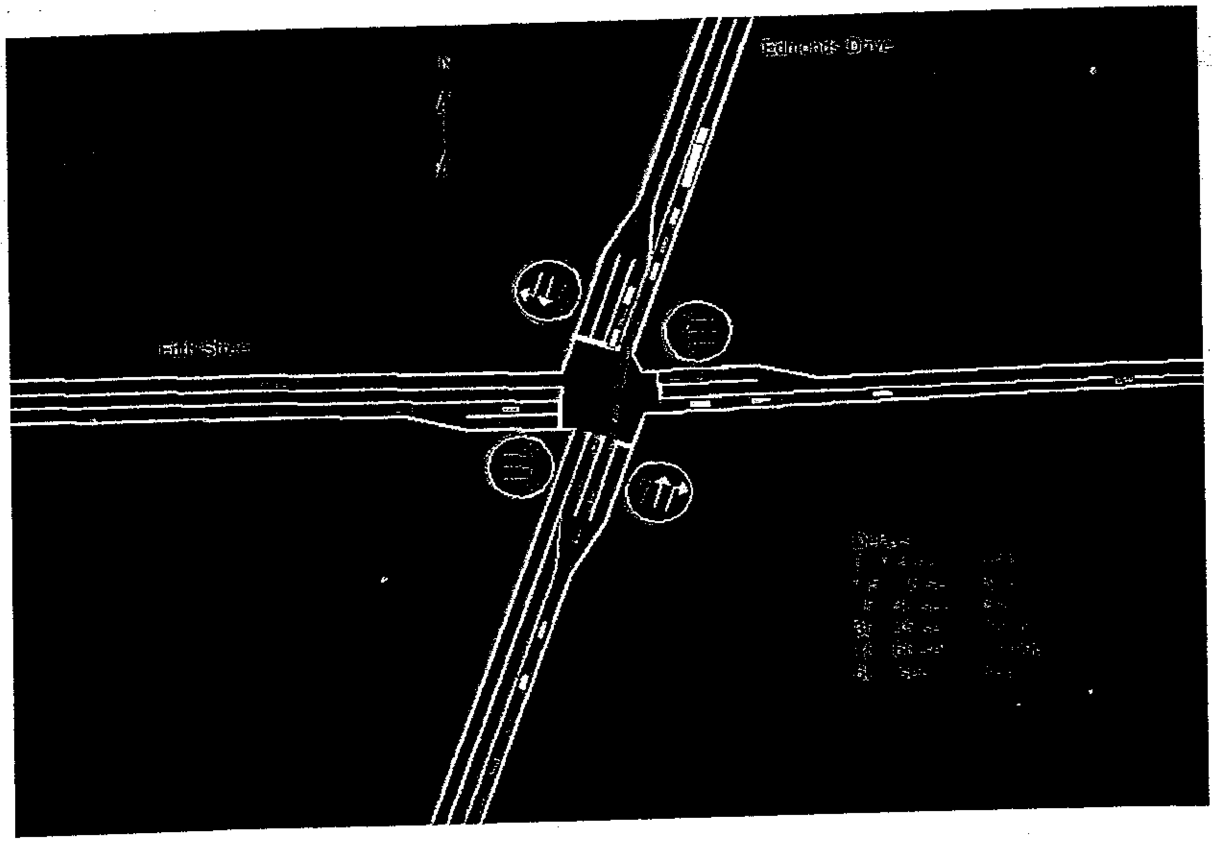
The following chart show the average delays on each approach of the roundabout.



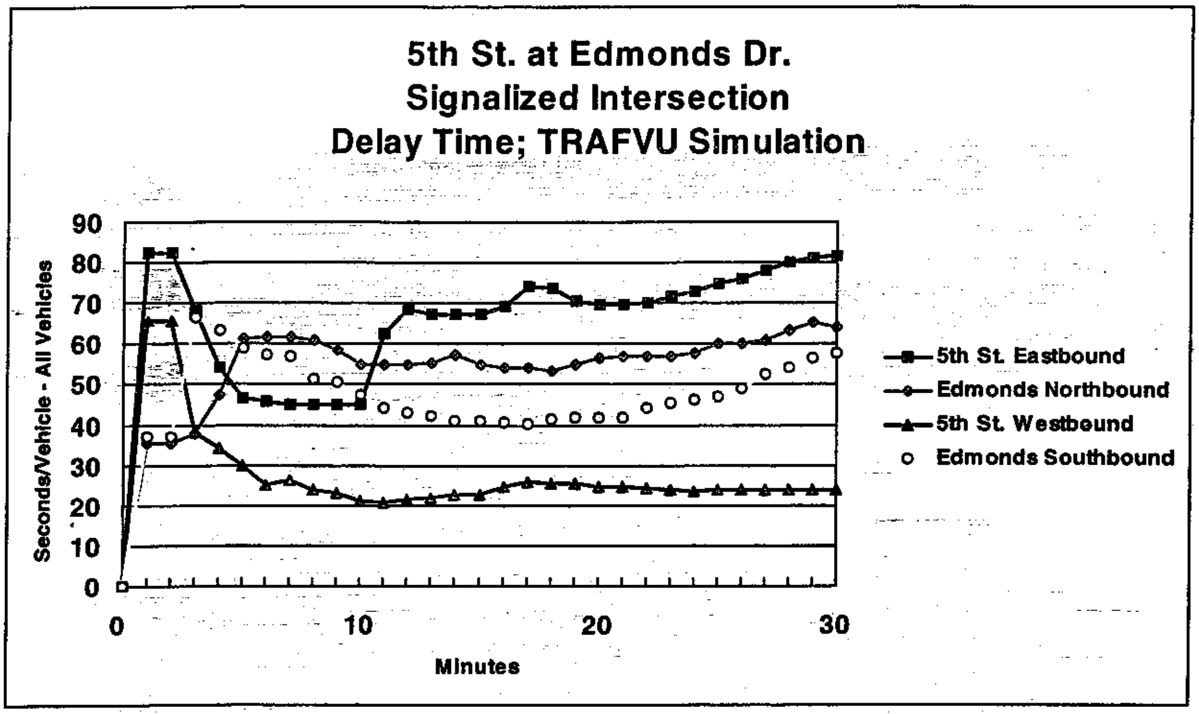
The following chart shows the corresponding fuel consumption for the roundabout.



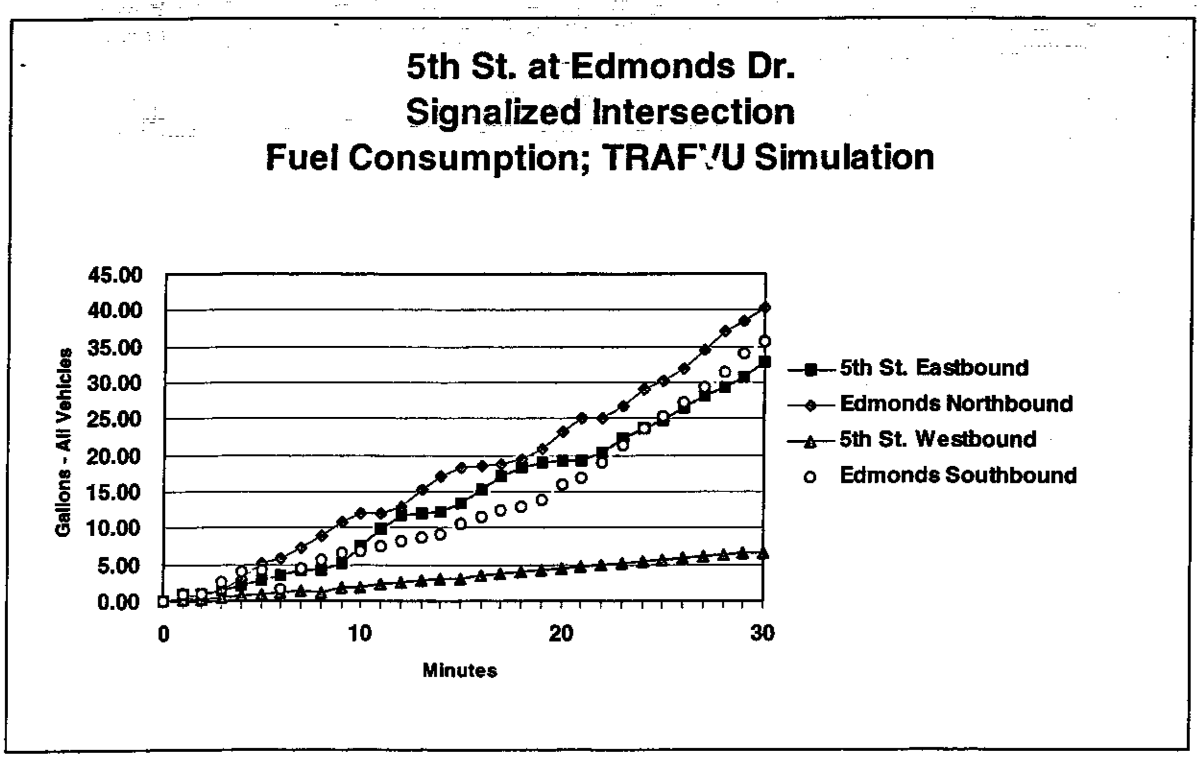
The last TRAFVU picture shows the delays that could be expected from the installation of a signal at the same intersection, for the same time period and traffic volumes.



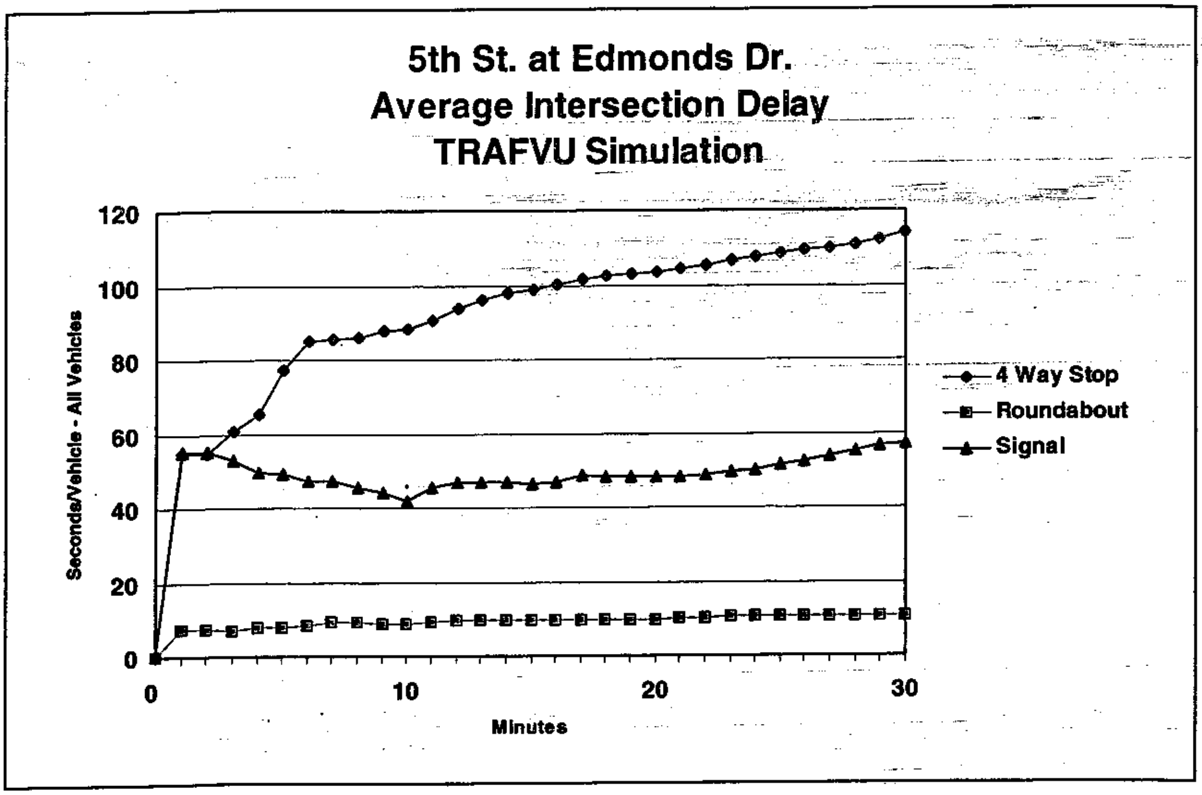
This graph shows the average delays that could be expected from the signalized intersection.

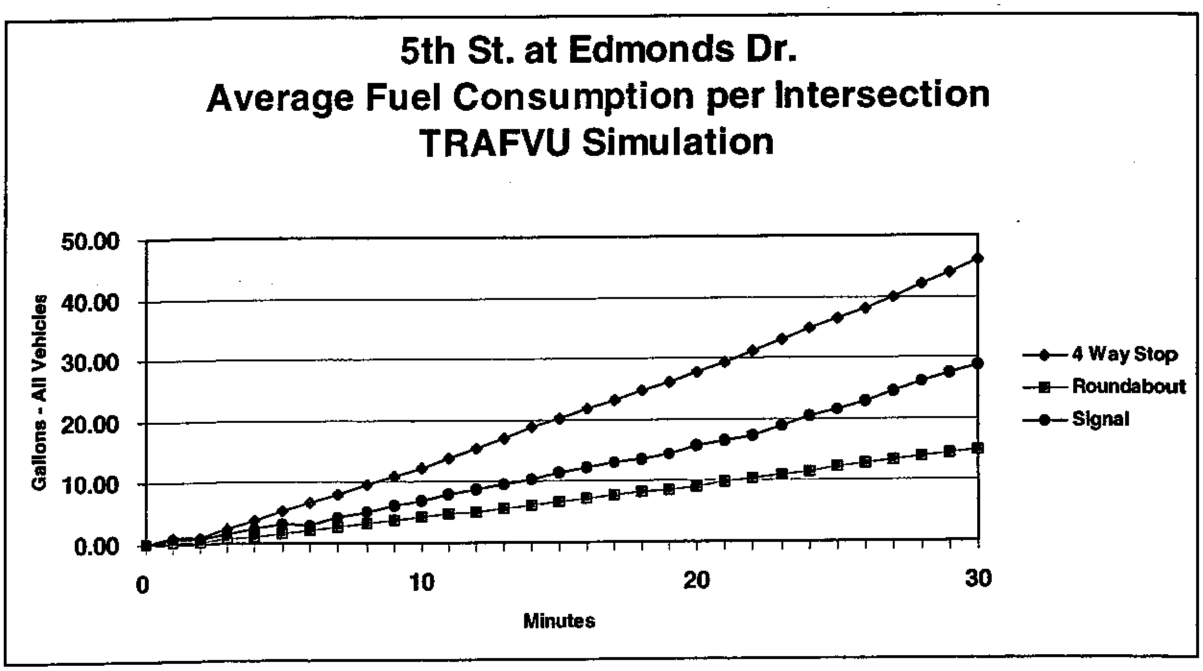


This graph shows the corresponding fuel consumption.



The last set of graphs show the average time delays and fuel consumption of the intersection for each type of control modeled in this study.





Overall the study helped provide the qualitative steps to take in simulating the operation of roundabouts. The output of NETSIM can help with the decision making processes involved in determining if a location is suitable for a roundabout. After a period of time, the model can again be calibrated to reflect the changed driving patterns after the motorists become more familiar with the intersection. In the case of the intersection under study, the traffic volumes have also increased, presumably because of the decreased delays that are now experienced at the intersection.

In conclusion, the NETSIM model can be used to simulate roundabout operations with an acceptable degree of accuracy. The field observations of the four way stop and roundabout operations and the comparison with the NETSIM models of the four way stop and roundabout have verified this. The TRAFVU simulation provides a powerful tool for illustrating, in motion, what the roundabout operation will be like. This simulation is not only useful to the professional traffic engineer, but is invaluable when making a presentation to administrators or the general public.

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