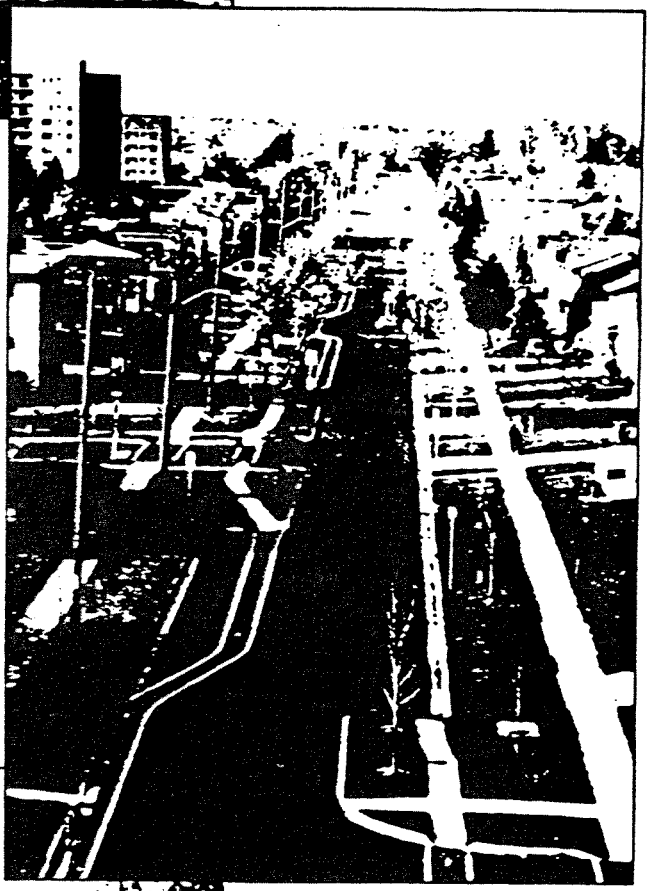


A Scenic View of Heritage Drive

Figure 2.

Figure 3.

Traffic calming – Heritage Drive, Kitchener, Ontario

(Continued from page 10)

sion of the existing curb. This technique decreases the radius of the intersection and forces traffic to slow down as they enter and exit. At all three intersections, the stop bar was left at its' original location, ensuring that vehicles do not conflict with cyclists and pedestrians.

Nodes are positioned between residential driveways and offset from each other on each side of Heritage Drive between Indian Road and the west leg of Oakhurst Crescent. Each node extends 3 meters out into the travelled portion of the roadway and are furnished complete with trees, sod and bicycle lanes (see Figure 2). The node and bicycle lane combined leave 6 meters of roadway for two way traffic. Pavement markings on each approach to the nodes guide bicycles safely through the maze of curb work.

Strategically located on-street parking and a 40 km/h posted speed limit augment the traffic calming measures.

Figure 3 clearly displays all traffic calming measures.

STAGE TWO

A 2.5 meter centre median design is planned to be implemented on the section of Heritage Drive from the east leg of Oakhurst Crescent to Ottawa Street in the summer of 1995. The median will be furnished with shrubs and deciduous trees, adding to the perception of the narrowed roadway. The bicycle lane will continue through this section to Ottawa Street, providing cyclists with access to the Arena, High School and Recreation Centre.

COST

Total cost for stage one was $94,000. This included asphalt, all concrete work, sidewalks, bicycle lanes, catch basin and drain relocation, and landscaping.

Estimated cost for stage two is $188,000. This cost includes an angled parking area providing additional parking for the Arena and the Recreation Centre. This phase is scheduled to be completed in conjunction with road resurfacing funded through the Capital Road Works Program.

STUDY RESULTS

Extensive O-D, volume and speed studies were conducted on Heritage Drive both before and after the traffic calming measures were implemented.

Traffic volumes on Heritage Drive from Lorraine Avenue to Indian Road dropped from 3865 AADT to 1520 AADT. Traffic speeds (85th percentile) on Heritage Drive were measured in excess of 65 km/h before the traffic calming measures, and were reduced to 59 km/h after.

SUMMARY

The Heritage Drive experience was successful in reducing traffic volumes and lowering vehicle speeds. Perhaps more importantly, the consensus from area residents, the community as a whole and technical staff is a positive one. Traffic and Parking Division staff hope to implement similar traffic calming measures on more streets this year.❑

THE TRAFFIC CALMER

by Ian M. Lockwood, P. Eng.

What is Traffic Calming?

Traffic calming is one of the latest buzz-words in Ontario's transportation scene. However, there are different views on what traffic calming is. Nevertheless, there is a growing opinion that traffic calming is a valuable tool that will help solve many of our urban problems related to motorized vehicle use. Because of traffic calming's rising profile, dealing with traffic calming and its implications is becoming important. To help the public, transportation professionals, municipal staff, and politicians communicate effectively about traffic calming, a common understanding of the terminology would be beneficial, which is the subject of this column. Comments are welcomed and can be sent to the address at the end along with the questionnaire.

The definition of traffic calming is the combination of policies and measures that help correct the negative effects of motorized vehicle use on individuals and society in general. Traffic calming achieves this by changing the design and role of streets to serve a broad range of transportation, social, and environmental objectives.

The goals of traffic calming are to increase the quality of urban life, improve condition for people, create safe and attractive streets, reduce collision frequency and severity, and help reduce the negative effects of motorized vehicles on the environment.

The objectives of traffic calming are to achieve slow speeds for motor vehicles, improve the real and perceived safety for non-motorized users of the street, incorporate the preferences and requirements of the people using the area (residing, working, playing, etc.) along the street(s) or at the intersection(s), provide more greenery (trees, shrubs, etc.), increase access to land for all modes of transportation, and promote pedestrian, cycle and transit use.

Typical traffic calming measures include vertical changes in the road (speed bumps, raised intersections), lateral changes in the road (chicanes, lateral shifts), constrictions (narrowings, islands, pinch points), traffic circles, small corner radii, gateway features, and street scaping (street furniture, lighting, landscaping). Different combinations of traffic calming measures are appropriate depending on the balance that is desired between non-motorized traffic activities and motorized traffic.

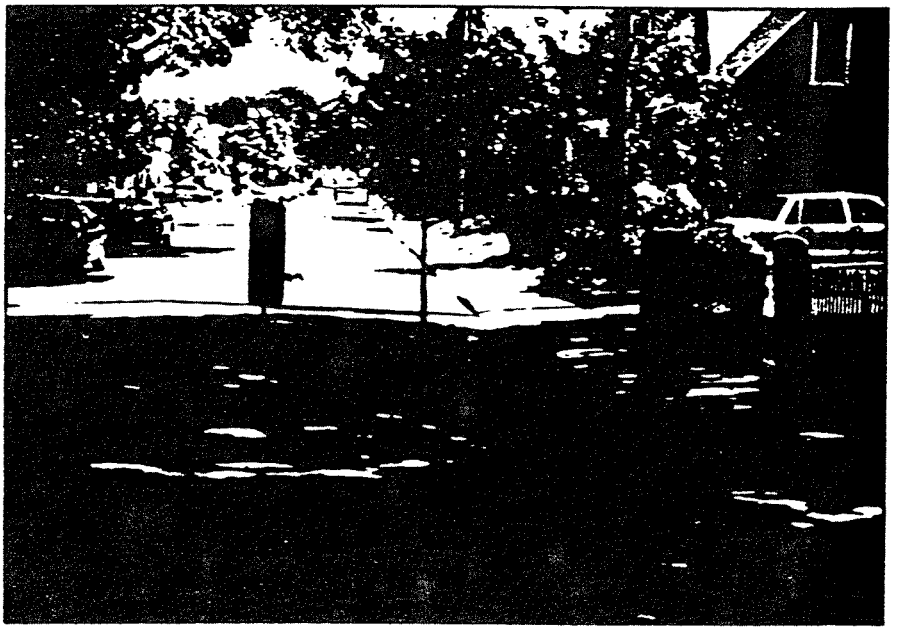
What is *not* Traffic Calming?

Traffic management is frequently confused with traffic calming. Traffic management typically employs turn restrictions, one-way streets, and closures. It is often employed to reduce through-traffic from particular areas by changing the flow of motor vehicles on the street network. Traffic calming, on the other hand, lowers the speeds of drivers in the particular areas, which can also reduce through traffic.

The advantage of traffic management is that it is inexpensive. However, the disadvantages are that local access tends to be circuitous, compliance of restrictions requires enforcement, and one-way streets can encourage speeding.

Traffic control devices are also frequently confused with traffic calming measures.

Traffic control devices are signs, signals, and markings that are designed to regulate, warn, guide, and inform. Though a traffic control device and a traffic calming measure could share the common goal of slowing down car drivers, the traffic control device is an attempt in communication, while the traffic calming measure is a part of the design of the street or intersection.



Lateral Shift in Street.

Feature Traffic Calming Initiative: Balloil Street, Toronto

The traffic calming work on Balloil Street is a shining example of what can be achieved through traffic calming. The residential street connects

the look of the neighbourhood, five tastefully designed raised intersections were constructed. In addition, the intersections were narrowed to 5.0 meters by extending the sidewalks and making space for landscaping and trees, Seven mid-block narrowings (also 5.0 meters) were installed, again with landscaping and trees. The traffic calming measures were constructed with a variety of good quality materials. The coloured pavers, landscaping, and good design definitely enhances the aesthetics of the neighbourhood and makes it truly pleasant for walking, cycling, or simply have a conversation along the street.

Extensive before and after studies have shown that the project was successful on many fronts. Speeding was reduced significantly, noise levels fell, and the collision data looks encouraging (from about two per year to zero since implementation in 1994), fuel consumption fell by a staggering 32% which is very encouraging from an environmental and cost perspective.

In addition to creating a safe and attractive street, the project was used to help answer a lot of questions. The measures posed no difficulty for snow clearing, street sweeping, or winter driving. The measures which employed vertical changes in the road were more effective for reducing speeds

hazard signs that were used to mark the narrowings. These signs are now being replaced with nicely designed bollards. Not only do the bollards fit in with the neighbourhood, but they are visible from 360°.

Project Manager Andrew MacBeth, P.Eng., standing next to bollard.

PLEASE RESPOND

The Board of Directors of the O.T.C. is asking for input from its members in response to a resolution endorsed by North York City Council.

The City's Transportation Department received a request from the North York Advisory Committee for Persons with Disabilities to consider the following:

That the Ministry of Transportation of Ontario be requested to consider legislation requiring a uniform set fine for all municipalities in Ontario for illegal parking in spaces designated for disabled person parking permit holders.

Installation of advisory tabs under the parking signs for disabled person parking permit holders, identifying the fines associated with illegal parking.

As previously stated, the City endorsed the request and is asking for comments from the O.T.C. Therefore, we are asking for your input on any suggestions our readers might have on the matter. Please forward them to the address listed on the editorial page.

Just as a footnote, a committee was struck by the Ministry of Transportation several months ago to deal with the Disabled Parking Persons Permit Holders Issue. Discussions dealt with the above.

The O.T.C. has representation on the committee. It would be greatly appreciated that you get your comments in as soon as possible.□

54

The Balloil Street project was successful primarily because of the dedicated people involved, including the local residents, the project manager, and the many other staff members at the City of Toronto. These people can be proud of their accomplishments which has become one of the best examples of traffic calming in Ontario.

Traffic Calming Questionnaire

One of the first tasks of the Ontario Traffic Conference's newly formed volunteer committee on traffic calming is to gather traffic calming information from throughout the province. The subcommittee will use the information to help establish provincial guidelines that will help all municipalities. Please have someone from your municipality fill out and submit this questionnaire to the following address:

Information Facilitator:
Traffic Calming Subcommittee
The Ontario Traffic Conference
Suite 121, 20 Carlton Street
Toronto, Ontario
M5B 2M5 ❑

TRAFFIC CALMING QUESTIONNAIRE

MUNICIPALITY: _____

CONTACT NAME: _____

ADDRESS: _____

_____

PHONE NUMBER: _____

FAX NUMBER: _____

Has your municipality traffic calmed?	Yes	No

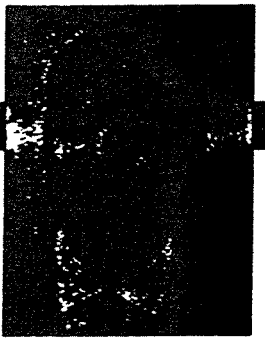
What measures have been used by your municipality?

What measures does your municipality plan to use?

Does your municipality have any traffic calming policies or legislation?	Yes	No

Please provide your views, questions, and other comments on traffic calming

Any additional documentation about traffic calming that you can provide regarding your traffic calming experiences would be very helpful and appreciated (eg. before/after studies, plans & drawings, cost/funding information, procedures & process, policies & legislation, standards, etc.)



THE TRAFFIC CALMER

IAN LOCKWOOD
P.ENG.

Traffic Calming in Rural Communities

Many rural communities grew up around the main street which was typically part of the through highway. Historically, the main street accommodated "community" functions including: business functions, social functions, celebrations, communication functions, access to abutting land uses, as well as "traffic" functions. Since World War II, motorized vehicle traffic has dominated the main streets, conflicting with community functions. The very quality of life people expect in rural communities is being eroded. Traffic calming may be a solution.

Up to now, there were two solutions to address the main street problems: 1) modify the main street to accommodate motorized traffic, or 2) build bypasses. The problem with the first solution is that it exacerbates the conflicts between the community and traffic functions. The problems with bypasses are their high costs, the negative economic impact on the main street businesses, undesirable highway-oriented development, and they may not ultimately solve the problems on the main street.

Traffic calming main streets in rural communities began in the early 1970's in Denmark. Though initially controversial, the results included: improved business and aesthetics, reduced collisions, and increased pedestrian activity. After the implementation, the majority of local people and through-drivers supported the changes. Traffic calming became the third alternative solution and has since been successfully applied to hundreds of rural communities throughout Denmark. Despite a wide spectrum of cultures, topography, and climates, it has spread successfully to other countries including: Belgium, the Netherlands, France, Austria, Germany, and Switzerland. Traffic calming is now being adapted to suit rural communities in North America. In fact, the author's firm is currently at various stages of completing traffic calming solutions in five rural communities in Ontario and the United States.

Compared with traffic calming in large urban areas, rural traffic calming has many similarities including: the issues with speeding, driver behaviour, safety, on-street parking, barrier and environmental effects, and the public consultation process. The differences include the increased uniqueness of the community's culture, the street geometrics, the lack of public transportation, and the need to accommodate through traffic.

Case studies from around the world indicate that main streets can be traffic calmed without problems in communities with: traffic volumes of up to 8,000 vehicles per day, populations of up to 5,000, and the length of the main street corresponding to a travel time of 5 to 10 minutes. Successful solutions are possible at higher values as well (1).

Typically traffic calming in rural communities begins with notifying drivers that they are approaching a traffic calmed community using information/warning signs, rumble strips, etc. Next, conspicuous gateway features indicate arrival and slow down drivers, some employing lateral and/or vertical changes. Along the main street, there are traffic calming measures designed to maintain the desired speed (ranging between 30 to 50 km/h) and to achieve other community objectives (more greenery, promote pedestrian traffic, provide space for business and community activities, etc.). These measures can vary greatly depending on the original street's design and the community's layout and preferences.

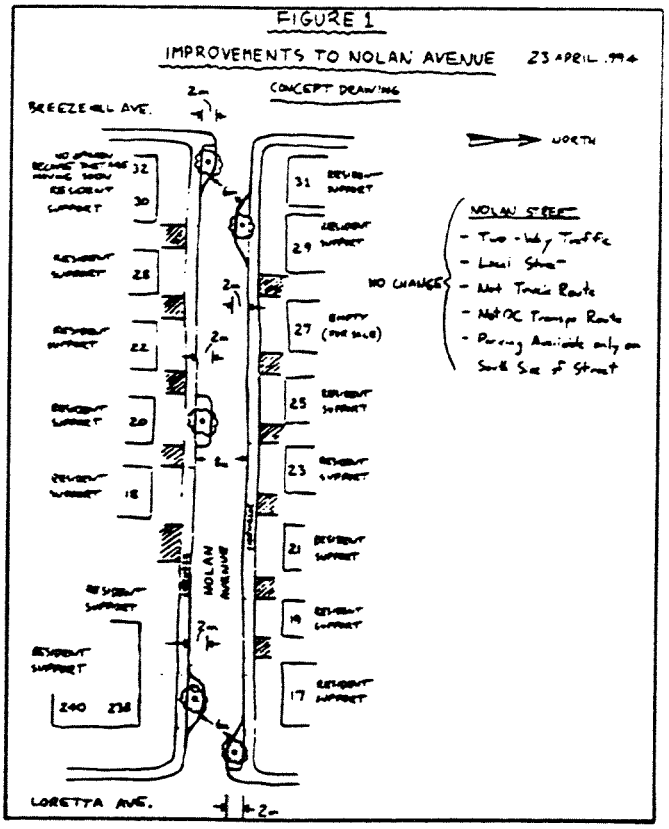
Where there is a choice between traffic calming and a bypass, traffic calming is far less expensive. However, in some circumstances, traffic calming alone may not be feasible and a bypass maybe unavoidable. Judgement is required to make this determination based typically on the individual communities' characteristics, the volume of traffic, and the importance of the traffic functions. Traffic calming may defer a bypass, or both solutions could be implemented simultaneously. The latter scenario

community functions to return to the main street.

Feature Traffic Calming Initiative; Nolan Avenue, Ottawa

Nolan Avenue is a short street in Ottawa providing access to 16 modest homes on narrow lots. Many of its residents objected to reckless drivers whose presence starkly contrasted with the otherwise quiet street. In the summer of 1994, the entire street and both sidewalks were being reconstructed for new sewers.

The residents used the opportunity to develop a traffic calming solution to the reckless driving problem. Their plan also met their on-street parking needs and desire to maintain two-way access at both ends. They liaised with City staff who were very cooperative. The solution included chicanes at each end, a narrowing in the middle, and five trees (see the diagram from the residents' report). As well,



their report listed several safety, aesthetics, and environment reasons for the changes. The City agreed to all the changes except the middle narrowing for maintenance reasons. The public were notified through newspaper ads, and consensus was achieved by petition along the street. With the local councillor's support, the changes were implemented, with only the tree planting remaining.

In the following year, reckless driving was virtually eliminated. The perception is a quieter and safer street with drivers taking more caution. Parents feel that their children are safer when playing or walking to the playground or school. Also, the first time resulting in an increased sense of community demonstrated by neighbourhood parties, impromptu conversations along or on the street, trading of garden plants, porch sitting, etc. The feeling of safety risen due to increased natural surveillance on the street.

As happens every winter, the street was narrowed by snow banks to one lane, completely burying the chicanes. There were no winter-related problems nor difficulties with school buses or garbage collection. Only the hazard signs are considered aesthetically objectionable.

The chicane at the east end of Nolan Avenue in Ottawa, the school and playground in the background, and a young pedestrian.

This project demonstrated that traffic calming: 1) is desirable during reconstruction, 2) can improve the quality of life on low volume streets, 3) can reduce reckless driving, 4) can involve a simplified public consultation process, and 5) can occur on a very small scale.

Reference 1) Djurhuus, Ole, PIARC Technical Committees on Interurban Roads and Roads in Urban Areas, *Through Traffic in Small Towns*, PIARC, Paris, France. July, 1991.

1995-1996 BOARD MEETING DATES

DATE	TIME
FRIDAY, December 8, 1995	11:00 A.M.
FRIDAY, January 26, 1996	11:00 A.M.
FRIDAY, March 22, 1996	11:00 A.M.
SUNDAY, April 28, 1996	10:00 A.M. - WHITBY

57
LAT

Neighbourhood Traffic Calming "London's Experience"

Prepared by:
Bruce M. Elliott P.Eng.

This paper will be designed to review some of the most effective ways to implement traffic calming in residential neighbourhoods.

The City of London, population 316,000, has initiated some limited traffic management schemes in the past to deter short-cutting traffic and reduce operating speeds on residential street systems.

During 1993 however, the City has been inundated with requests from residential communities concerned with traffic issues.

Interestingly, some of these communities are recent subdivision developments, not the neo-traditional neighbourhoods with grid street patterns in the older sections of the City where most traffic engineers traditionally have been requested to deal with residential traffic matters.

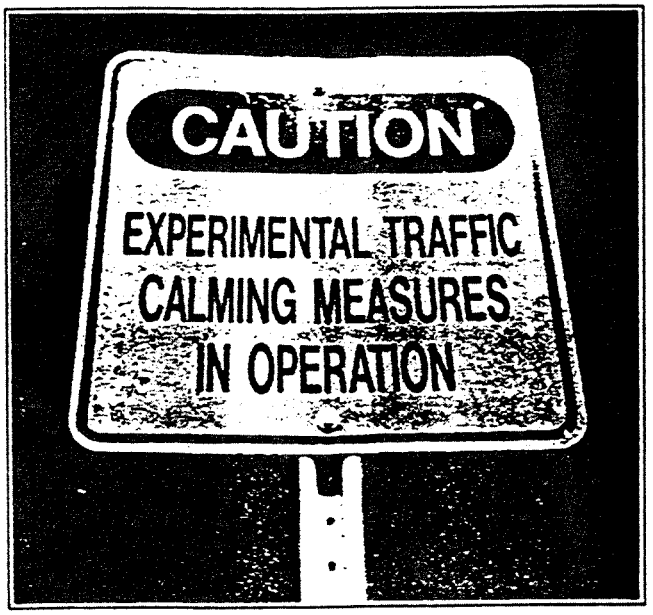
The paper will address the "process" the City of London is utilizing in working in neighbourhood areas to identify the potential area traffic management measures to be used to implement "traffic calming".

Neighbourhood Traffic Calming "London's Experience"

The City of London, Ontario, Canada, population 316,000 has initiated some limited traffic management schemes in the past to deter short-cutting traffic and reduce operating speeds on residential street systems.

During 1993, the Traffic & Parking Division received numerous requests from residential communities concerned with traffic issues.

Interestingly, some of these communities are recent subdivision developments, not the neo-traditional neighbourhoods with grid sheet patterns in the older sections of the City where most traffic engineers traditionally have been requested to deal with residential traffic matters.



I have put together an outline of the "process" that the City of London has been utilizing in working in neighbourhood areas and identifying the potential area traffic management measures used to implement "traffic calming".

We have determined, basically through a trial and error process, that there is a need to develop a positive rapport with the area representatives, and to initiate, at an early stage, a sense of ownership and involvement by a representative group from the affected area.

This "process" that we developed involves a high degree of interaction by key traffic staff and an initiative to act as liaison or facilitator in the development of potential solutions.

We have found that this process resulted in a less "confrontational" environment when it came to the decision making stage with the elected committees and City Council, primarily due to the interaction, involvement, and understanding of the residents "action plan" committee which took place over the duration of the project.

The "process" that we developed is shown in FIGURE 1 below.

FIGURE 1

PROCESS

1) Identify Problem(s)
2) Public Participation Meeting
3) Residents Committee Develop Action Plan
4) Residents Committee Present Plan to City Staff
5) Report to Council Plan Developed by Residents
6) Implement Action Plan
7) Monitor/Evaluate/Public Input
8) Finalize

Prior to holding a public participation meeting in the community where the concerns have been put forward, the Traffic & Parking division would initiate appropriate studies to identify the problem(s). The studies could include all-way stop assessments, traffic flow information, vehicular operating speeds, license plate trace, etc.

These studies play a key role in documenting the extent of the "concerns" and in some instances can serve to diffuse the perceived severity of the identified concerns.

At the first public participation meeting, a presentation by staff would usually introduce the background information, identify the significant study findings, and outline both the "process" and potential traffic management measures.

Key participants at the meeting should include traffic staff, area elected officials, and representatives from the police.

In opening the meeting, it is essential to introduce all staff, police, and elected officials and to outline that the purpose for coming together is to share information and ideas with a view to improving the present situation. It is also essential to stress that there will be a need to establish a small representative working committee to develop an action plan which the community as a whole feels comfortable with, and which recognizes other factors which have to be addressed in providing traffic service to the area.

We would encourage the working committee to take ownership of their recommendations and ensure that their proposed action plan is, as far as possible, generally acceptable to the community as a whole.

Following the brief presentation as outlined above, the traffic staff would outline some of the "tools" available for traffic management.

These "tools" or traffic management measures are listed in FIGURE 2 below and cover the majority of techniques which most municipal jurisdictions are either currently using or considering.

FIGURE 2

POTENTIAL AREA TRAFFIC MANAGEMENT MEASURES

1) Enforcement
2) Reduced Speed Limit
3) All Way Stops
4) Turn Restrictions
5) Maze - One Way Street System
6) Narrowings
7) Road Diverters
8) Road Closures
9) Speed Humps/Raised Intersection
10) Traffic Circle
11) Road Texture
12) Road Projects

We have found that by briefly going over the various measures outlined above, the area group develops a better understanding of the pros and cons of the measures and to what general degree they may be applicable in their neighbourhood.

Questions and answers are encouraged, however the overall meeting should be kept informative, friendly, and brief.

The objective of this meeting is to encourage the group to establish a Resident's Committee. This committee should be **representative** of the area, not localized or concentrated in only geographical sections of the community. It should be a **small, working** group.

The staff would make resource materials available to the committee, such as base plans, traffic volumes, etc. and as required, meet with the committee in the development of their action plan. If appropriate, the committee can establish liaison with the elected representatives and/or involve them on the committee.

This process, tends to develop strong positive bonds between community representatives, city staff, police officials, and City Council.

Traditionally, traffic presentations to City Council and/or elected officials, particularly involving neighbourhood issues have tended to be confrontational and sometimes emotional, placing councillors in the awkward position of trying to remain supportive of technical staff, while at the same time not appearing to diminish the concerns of the community.

We have had very favourable response to date from all participants involved in three separate projects currently underway in the city.

Following the process, we felt it would be a major step forward in developing relationships with the community and demonstrating that there is a desire to work in a positive role with respect to neighbourhood traffic issues.

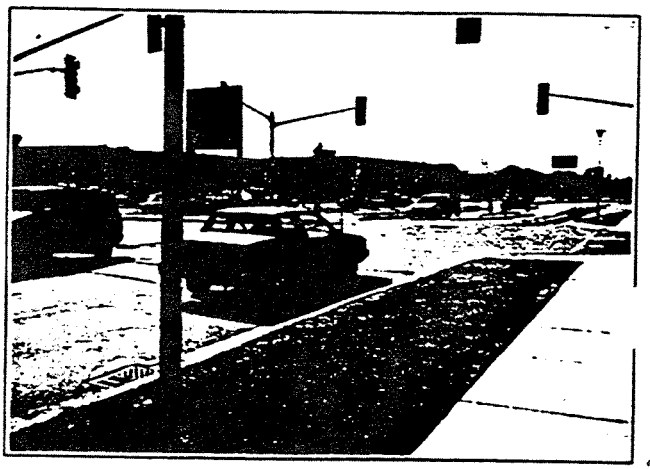
As outlined in the process, monitoring, evaluation, and gathering further public input to refine the measures are key issues in determining the final disposition and success of the action plan.

Implementation of most measures can be accommodated in very economical and effective ways by using "temporary" barricades, signing, etc. This allows for flexibility during the evaluation period and gives the area residents an opportunity to experience the impact of the measures. If changes are required for any reason, during the evaluation process the temporary measures can be easily modified and re-evaluated.

Following the evaluation period, if the measures are determined to have achieved the desired results, conversion to permanent works can be considered and integrated into a future budget year. This would permit such things as landscaping and visual enhancements to be incorporated into the final works. Again, input from the resident's committee should play a key role.

SUMMARY

Traffic calming is beginning to catch on in North America. Traffic calming "involves a fundamental rethinking of metropolitan planning and organization and a revised emphasis on quality rather than quantity of life" writes David Engwicht, an Australian transportation analyst.



In short, traffic calming aims to visually and psychologically remind motorists that streets are not their exclusive property.

Some of the proven ways of achieving this are outlined in FIGURE 2, and include narrowing traffic lanes, adding bikeways, rebuilding streets with gentle curves, drawing greater attention to pedestrian crossing locations by painting or raising them to the same level as the curb with a sloped platform for cars to cross, extending sidewalks a few feet into the intersections, closing some streets to traffic, installing special humps, restricting right turns, and replacing traffic signals with all-way stop signs.

Opponents to traffic calming complain that true measures simply increase traffic and chaos somewhere else. But traffic studies have shown that traffic can often diminish because people, particularly in residential settings, may be encouraged to walk, bike, or consolidate trips. Wolfgang Zuckeman in his book "End of the Road" points out that when Greenwich Village, Washington Park was closed to traffic in the 60's, traffic engineering studies showed that vehicle use on nearby streets actually decreased.

It is interesting to note this in a recent edition of the Toronto Star (April 16/94), the electronic information highway will begin to play a role in subdivision development impacting on road systems and travel patterns.

Montgomery Village, a futuristic community of 600 homes just outside of Orangeville, Ontario will be the first new development in Canada to be wired with fibre optic cable, which will equip the village homes, schools, and businesses for electronic transmission of complex video and sound messages, visual telephone connections, interactive TV, hi resolution fax machines and the ability to send and receive unlimited amounts of information simultaneously at virtually the speed of light.

The intent is to create a village atmosphere to make it first a people place.

"Some of the ways we are going to make a difference is by bringing back the back lane, moving the houses up to the edge of the street where people connect with people. We'll build streets much narrower than you see in today's subdivisions and create smaller residential blocks. The street scapes will be on a pedestrian scale with wide sidewalks, front porches, attractive lamp posts, and by putting cars in back lanes with other municipal services will be able to line the street with trees" says Marvin Green, president of River Oaks Group, the developer.

Obviously if future subdivisions are now taking "traffic calming" into account, there may be a pent up demand to deal with existing neighbourhoods on an equitable basis.

The "process" utilized in London, Ontario may serve as a guide to implement traffic calming for municipal jurisdictions and serve to place a renewed emphasis on the positive role of the traffic engineer with the community.❑

PEOPLE PLACE: *The main street of Montgomery Village will be wide with a tree-lined centre with apartments above ground-floor shops.*

60

Traffic Circles—A Viable Form of Intersection Control?

BY WILLIAM F. SAVAGE AND KHALED AL-SAHILI

Michigan State University, in East Lansing, Mich., is a university with about 40,000 students. A large number of students are housed on campus, with many more living in the immediate adjoining areas. Restrictions on student parking on campus are strictly enforced. Students are required to park in outlying lots and take a bus, walk or bike to their classes. This produces a heavy mix of cars, bicycles and pedestrians at all intersections within the campus environment.

Most of the intersections are controlled by two-way stop signs or traffic signals. There are however, three major intersections controlled by traffic circles (see Figure 1).

With renewed interest and experience in this country using traffic circles and roundabouts (a more efficiently designed traffic circle), a formal comparison of these intersection types might be of assistance in selecting the most appropriate intersection design and operation.

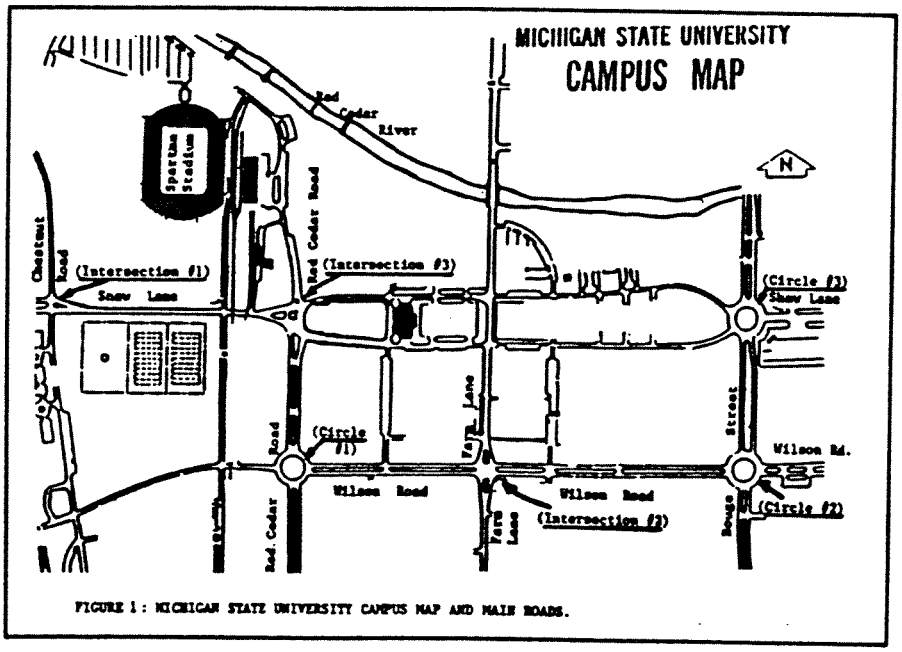


Figure 1. Michigan State University campus map and main roads.

Purpose of Study

This study originated as a result of operational problems at the intersection of Farm Lane at Wilson Road. This intersection was experiencing a number of right angle accidents, and the Wilson Road traffic suffered considerable delay because of turning conflicts and requiring traffic to stop two times at the intersection.

Because there are three traffic circles in the immediate area that have been in operation for many years, a suggestion was made to consider construction of a traffic circle at this location. Two other two-way intersections also carry similar traffic volumes near to Wilson Road.

To learn more about the existing three traffic circles and corresponding three two-way stop locations, complete traffic counts were conducted at each, and their accident records during the past several years reviewed.

The purpose of this study is to determine if it is feasible or desirable to recommend a change in right-of-way control. Or, to determine if the existing traffic circles would operate better under some other type of control.

Conversion Factors		
To convert from	to	multiply by
ft	m	0.3048

Description of Intersections

The six intersections involved in this study are illustrated in Figure 2.

Traffic Circle 1—Red Cedar at Wilson. Wilson Road is a major east-

west campus arterial, and Red Cedar Drive is a minor arterial. All roadways are divided with two lane approaches, except the west leg of Wilson, which is an undivided roadway and a single-lane approach. The traffic circle has a 150-foot (ft) diameter with a 35-ft wide circulating roadway.

Traffic Circle 2 —Wilson at Bogue. Both Wilson Road and Bogue Street are major campus arterials, and all four roadways are divided with two lane approaches. This traffic circle has the same dimensions as Traffic Circle 1.

Traffic Circle 3—Shaw at Bogue. Both Shaw Lane and Bogue Street are major campus arterials, with the north and south legs having four lane divided approaches. The east leg is four-lane undivided, and the west leg is the start of two-lane, one-way streets through campus. This traffic circle has the same dimensions as the other two circles.

Two-way Stop 1—Shaw at Chestnut. Shaw Lane is a four-lane divided major east-west campus arterial, and Chestnut Street is a two-lane undivided minor arterial. Chestnut traffic is required to stop for Shaw and then "yield" in the 25-ft median before crossing the far direction of Shaw.

Two-way Stop 2—Wilson at Farm. Both Wilson Road and Farm Lane are four-lane divided major campus arterials. Wilson traffic stops for Farm Lane and again in the 25-ft median.

Two-way Stop 3—Shaw at Red Cedar. The intersection is located near the west end of the Shaw Lane one-way street segment. Red Cedar Drive is a four-lane divided roadway to the south and a two-lane undivided roadway on the north. This intersection actually operates as a two-way "yield" intersection, with the Red Cedar traffic yielding for Shaw, and again in the 100-ft median.

Traffic Volume Studies

Eight-hour manual traffic counts were conducted at all six study locations for the hours 7 to 9 a.m., 11 a.m. to 1 p.m., and 2 to 6 p.m. The manual counts include all pedestrian and bicycle movements through the intersections. In addition, 24-hour machine counts were taken for inbound and outbound movements on all approaches.

The studies reveal that traffic volumes at the three traffic circles are similar to the three two-way stop intersections.The peak-hour volumes for each intersection are shown on Figure 1.

The eight-hour pedestrian and bicycle counts show that the traffic circles average 2,940 pedestrians and 502 bicycles, while the two-way stop intersections average 2,815 pedestrians and 889 bicycles.

Study of Accidents

Accidents were reviewed for the years Jan. 1, 1988 through Sept. 30, 1991 (3.75 years), for the six intersections.

As shown in Table 1, the total number of accidents for the three traffic circles is 22.40 accidents per year. These accidents produced a total of 4.26 injuries. The three two-way stop intersections had 48.75 accidents, producing 19.73 injuries.

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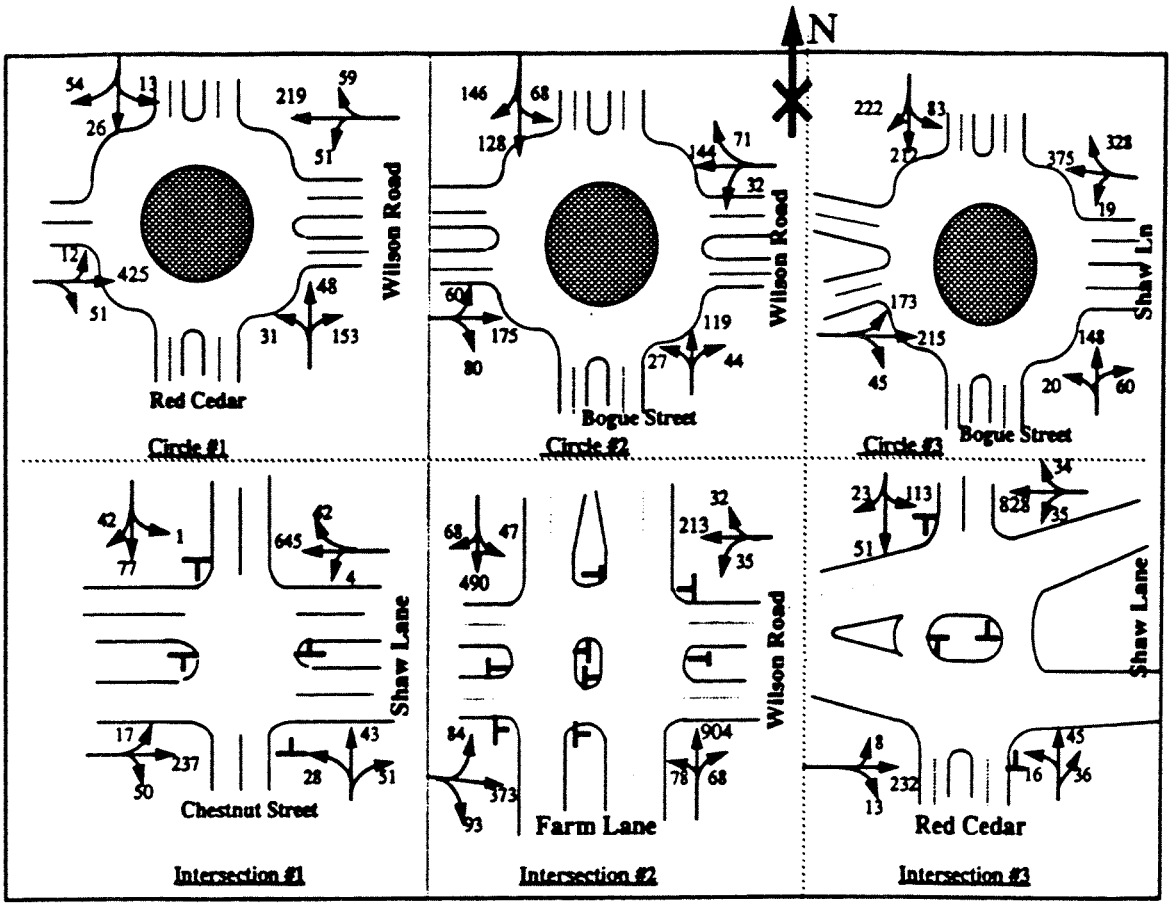


Figure 2. Geometrical sketches and the peak-hour volumes (vph) of the six intersections studied.

Table 1. Accidents During 3.75 Years Period

Intersection	Total Accidents	Bike & Pedestrian: Bikes	Bike & Pedestrian: Peds	Injury Accidents	Persons Injured	Accidents Per Year	Average Daily Volume	Accident Rate
Circle #1	9	1	0	2	2	2.40	14,633	0.45
Circle #2	20	0	0	2	3	5.33	11,934	1.22
Circle #3	55	2	1	11	11	14.67	23,710	1.60
Intersection #1	52	4	0	18	24	13.87	14,985	2.54
Intersection #2	63	9	0	23	29	16.80	21,598	2.13
Intersection #3	67	10	0	17	21	17.87	18,543	2.64

There were only 1.07 bicycle and pedestrian accidents per year at the traffic circles, while there were a total of 5.60 bicycle and pedestrian accidents per year at the three two-way stop intersections.

Table 1 also shows that the accident rates at all of the traffic circle intersections are less than at the two-way stop intersections. As a group, the three traffic circle intersections combine for an average accident rate of 1.22, while the group of two-way stop locations have a 2.41 rate (almost double).

Accident Severity

The severity of accidents at the traffic circle intersections were considerably less than at the two-way stop locations. There were only 15 injury accidents at the traffic circles (Severity Ratio of 0.18), compared to 58 injury accidents at the two-way stops (Severity Ratio of 0.32). The Severity Ratio is the number of injury accidents divided by the total number of accidents.

In addition, each injury accident at the two-way stops produced 1.28 injuries vs. 1.07 injuries at the traffic circles.

Bicycle and Pedestrian Safety

There were fewer pedestrian and bicycle accidents at the traffic circles (four at the circles and 21 at the two-way stops). The accident rates of .06 and .27 accidents per million vehicles for these kinds of accidents indicates that traffic circles offer considerable safety benefit.

Fuel, Delay and Emission Measurement

Comparisons were made of the efficiencies of the traffic circle and two-way stop designs, by using the NETwork SIMulation (NETSIM) analysis.[1] This analysis simulates the intersection operation and measures the effectiveness of each by determining the fuel consumption, average speed, stops per vehicle

63

Table 2. Measures of Effectiveness at the Intersections Controlled by Traffic Circles and Stop Signs

	Intersection Number								
	Circle #1	Circle #2	Circle #3	Inter-section #1	Circle Conversion	Inter-section #2	Circle Conversion	Inter-section #3	Circle Conversion
# Stops/vehicle	0.01	0.02	0.02	0.27	0.00	1.33	0.02	0.27	0.00
Average speed, mph	15.36	16.00	14.53	14.47	15.36	2.83	15.45	10.90	14.68
Avg. delay/veh (sec)	2.25	1.88	1.85	3.91	1.89	31.40	1.88	6.03	1.75
Total delay (minutes)	7.20	5.70	9.40	13.40	6.60	157.0	9.90	24.00	6.00
Delay/veh-mile (min)	0.80	0.80	1.23	2.03	1.24	18.88	1.15	2.92	1.14
T-time/veh-mile (min)	3.91	3.75	4.13	4.15	4.12	21.20	4.03	5.50	4.09
Fuel consumption (M.P.G.)	11.61	9.88	8.99	5.81	8.80	3.54	9.04	7.64	9.11
Fuel emissions* (grams/veh-mile)									
HC	0.183	0.214	0.245	0.364	0.248	0.639	0.242	0.281	0.243
CO	3.080	3.822	4.405	7.306	4.355	10.352	4.348	5.000	4.399
NOx	0.763	1.099	1.207	2.395	1.245	2.423	1.203	1.413	1.204

*Through and left-turn traffic of East-West direction have to stop twice (as shown in Figure 1) before crossing the intersection
*For composite autos

and so forth of each design. Figure 3 shows the NETSIM Link/Node Diagrams used for the two-way stop and traffic circle control.

The measures of effectiveness as produced by NETSIM are shown in Table 2. The traffic circles generally produced better results than even the best two-way stop intersection. Even though it was suspected that Two-Way Stop 2 was not operating well, the results were much worse than expected.

The study also shows that the measures of effectiveness can be improved by converting the two-way stop intersections to traffic circles.

Capacity Analyses

The capacity and level of service (LOS) of each approach of all six inter-

64
178

Table 3. Capacities and Levels of Service (LOS) for the Intersections Studied

	North Bd.		South Bd.		East Bd.		West Bd.		Overall	
	Capacity	LOS	Capacity	LOS	Capacity	LOS	Capacity	LOS	Capacity	LOS
Traffic Circle #1	2,117	A	2,360	A	1,186	A	1,879	A	7,542	A
Traffic Circle #2	1,032	A	2,324	A	2,278	A	2,123	A	7,757	A
Traffic Circle #3	1,126	A	1,266	A	1,084	A	1,640	A	5,116	A
Intersection #1	205	E	272	D	1,949	A	2,281	A	4,707	C
Circle Conversion	1,083	A	954	A	1,932	A	2,207	A	6,176	A
Intersection #2	2,021	A	1,729	A	437	F	195	F	4,384	C
Circle Conversion	1,307	B	755	C	1,308	A	614	B	3,984	B
Intersection #3	500	C	254	E	1,810	A	1,918	A	4,482	C
Circle Conversion	2,000	A	754	A	1,693	A	2,062	A	6,509	A

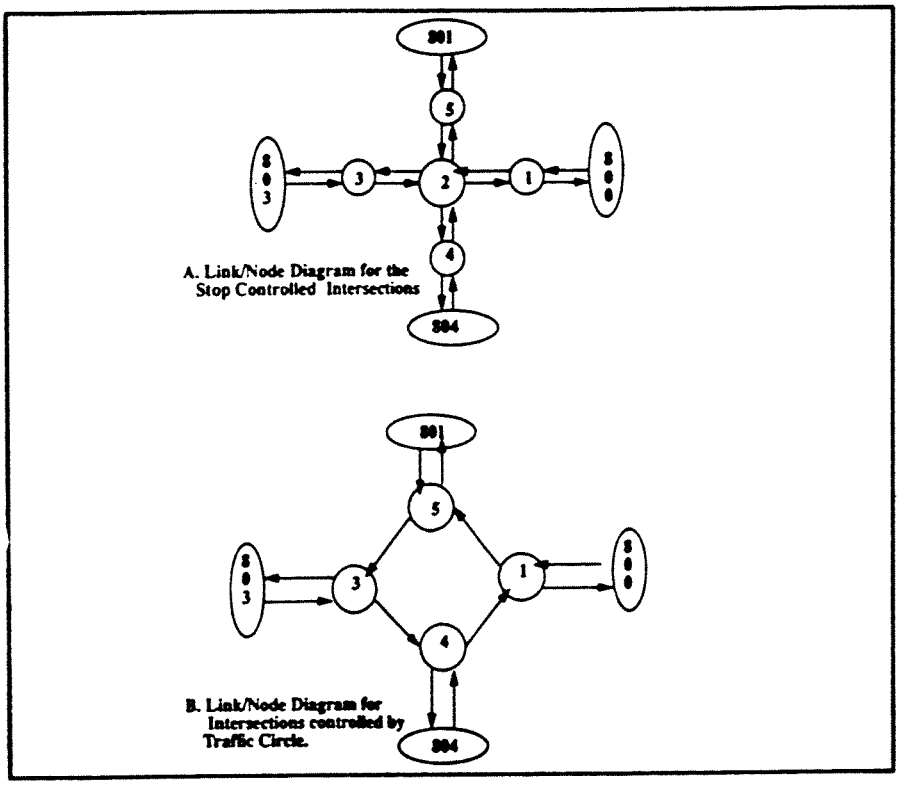


Figure 3. NETSIM's link/node diagrams for stop control and traffic circle control.

sections were analyzed, and the results are shown in Table 3.

All three traffic circles have an overall LOS of "A," while the two-way stop intersections have a LOS of "C." The analysis shows that the capacities of the two-way stop intersections can be improved by converting them to traffic circles.

The *Highway Capacity Manual* (HCM 1985)[2] method and the Highway Capacity Software were used to analyze the capacity of the three intersections controlled by the two-way stop.

The capacities of the traffic circles were analyzed based on the Troutbeck (1988) recommended formula.[3] This formula is based on the National Association of Australian State Road Authority (NAASRA 1986) Guide. The Gap Acceptance concept forms the basis for the NAASRA Formula, which is shown below:

$$Q_{emax} = \frac{n_e \times q_c(1 - q_c\Delta)e^{-q_c(T-\Delta)}}{1 - e^{-q_c T_0}}$$

where,

n_e = number of entry lanes

Q_{emax} = the maximum entry capacity

q_c = circulation flow (vehicle/-second)

T = the critical gap (s), set to 4 seconds

T_0 = follow-on time (s), set to 2 seconds, and

Δ = minimum headway in the circulation streams, set to 2 seconds for single circulating flow and 0 seconds for multilane circulating lanes

LOSs per approach and overall were based on the HCM 1985 criteria, which are based on the reserve or unused capacity of the lane in question.

Conclusions

The three traffic circles studied are operating better than the nearby two-way stop intersections. The safety benefits show that the accident rate at the two-way stop intersections is double the rate of the circles. The severity rate is three times that of the circles, and the pedestrian-bicycle rate is more than four times greater.

The data also show, however, that the existing traffic circle with the highest volume (Traffic Circle 3) does not operate as well as the other traffic circles. This may indicate that as traffic volumes increase, the safety and efficiencies of traffic circles decrease. Or, it may be that the design or the different arrangement of roadway approaches to Traffic Circle 3 contributed to its less efficient operation.

The apparent reason for the safety benefits of traffic circles are that motorists, bicycles and pedestrians are required to check for traffic from only one direction at a time, thereby simplifying the task. Because of the lower speeds created by the traffic circles, the accidents that did occur were less severe.

This study also shows that the capacity and operation of all the two-way stop intersections can be improved by converting them to traffic circles.

65
179

Results and Recommendations

Michigan State University and the Ingham County Road Commission are aware of the need to improve Intersection 2 (Farm Lane at Wilson Road), because of the number of accidents and poor operation of the existing design. The plan being considered involved adding headed-up left-turn lanes and signalizing the intersection.

As a result of this study, the university and the county are seriously considering the construction of a 100-ft central diameter roundabout. A roundabout is a more efficiently designed traffic circle. The roundabout should provide the following advantages:

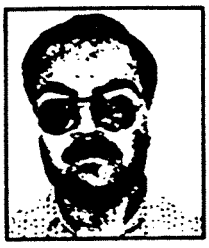
- Improved capacity
- Improved safety
- Retention or increase in existing median areas (the medians will be greatly reduced if left-turn lanes are constructed)
- Creation of a more aesthetic roundabout more in keeping with the beautiful campus setting.

Michigan State University and other jurisdictions should be more aware of the possible benefits of circles and roundabouts. Certainly not all intersections are appropriate for the installation of roundabouts, but their use should be studied as an alternate to a traditional intersection with signal control.

References

1. Federal Highway Administration. *Traffic Network Analysis With NETSIM: A User Guide*. Washington, DC: US Department of Transportation, January 1988.
2. Transportation Research Board. *Highway Capacity Manual*. Special Report 209. Washington, DC: TRB National Research Council, 1985.
3. Troutbeck, R.J. "Intersections—Roundabout and Minis." *Transportation Engineering* 121, A42, 1988: 45-66.

***William F. Savage**, P.E., was employed for 27 years in various areas of traffic engineering by the Michigan Department of Transportation. He currently is a traffic engineering consultant. He received his B.Sc. in civil engineering from Michigan State University and his master's from the University of Michigan. He has been committee chairman and a member of numerous ITE committees. He is the past chairman of Technical Council's Department 4 Measures Division.*



***Khaled Al-Sahili** is a doctoral candidate in transportation, Department of Civil Engineering at Michigan State University. He received his B.Sc. in civil engineering from Yarmouk University, Jordan, and his master's in transportation engineering from Jordan University of Science and Technology. His areas of interest are traffic operations and safety. He is a Student Member of ITE.*

Exhibit: B

RGC SEP 1 8 2001

Ray H.

August 22, 2001
David Courtemanche
Councillor
City of Greater Sudbury

Dear Sir,

We, the local residents affected by the recent alteration to the entry and exit points to Stonegate Street submit the following;

There is an overwhelming outcry and condemnation to the outright and purposeful sudden restriction to access this otherwise historically unrestricted accessible public street. This street is not unlike any other in the area with the same or similar concerns for overuse, speeding and other traffic challenges. The ongoing pursuit for increased safety and protection of it's residents - particularly their children is sought by all members of our community. We all want safer and quieter streets for all residents, however, but never through denial of access to specific residents. Unfamiliar, nonstandard methods as chosen and thus implemented are both a potential winter safety hazard and an unjustified deliberate inconvenience to the attached specific residents of this area. Other concerns and points of view have been raised by many home owners in our area and are far too many to list in this covering letter.

We believe that this decision and consequential addition of restrictive and area specific discriminatory traffic signs be reversed, the signs removed forthwith and the choice of free access returned to the residents of the stated areas as evidenced in the attached petition presented to you.

We look forward to your cooperation in facilitating this request regarding this matter.

Sincerely,

Affected Adanac Ski Hill Residents

cc Mike Petryna
Greg Clausen ✓
D Belisle

Petition

We, the "Adanac Ski Hill Residents" including Cumberland Court, Manchester Court, Beatrice Crescent and Soloy Drive object to the precedent setting decision, initiated and implemented by yourself and the residents of Stonegate Street. The decision to deny and effectively restrict our access and thereby create a pseudo private street using "our" public tax dollars was made without any consideration given to the impact and inconvenience to the aforementioned residents.

Name	Address	Phone Number
Tom Hewitt	782 Beatrice Cres	560-8470
Tina Hewitt	782 Beatrice Cres.	560-8470
D A Bryan	750 Beatrice Cr	566-7862
Lanny Taylor	704 Beatrice Cr	524-3531
Charlene Armitage	698 Beatrice Cres	560-8380
Renford Randall	690 Beatrice Cres	566 9764
Richard Roy	696 Beatrice Cres	566-9345
Gordon Natale	692 Beatrice	566-5686
Andrea Clute	778 Beatrice Cres.	560-6527
M[illegible]	544 Beatrice Cres.	560-5961
Ron Beaulieu	566 Beatrice "	5249183
Maria Pinheiro	710 Beatrice Cres	524-5317
Gwen Gleiwinski	684 Beatrice Cres	566-0092
A Bidwell	676 Beatrice Cres	566-8569
Nancy Shaw	676 Beatrice Cres	524-7205
Katie Kochie	674 Beatrice	524 2522
S T Brown	666 Beatrice	560-6500
Rob Boucher	662 Beatrice	5210218
Tracy Boucher	662 Beatrice	5210218
Kevin Miller	660 Beatrice	521-1741
Chris Dunn	652 Beatrice	566-5498
Ron L[illegible]	638 Beatrice	524-0546

Petition

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Name	Address	Phone Number
Nicole Drolet	634 Beatrice st	566-7121
Chantal Taillefer	626 BEATRICE	566-8052
Lorie Lemay	616 Beatrice Cr.	560-0361
Cynthia Tilson	608 Beatrice Crest	524-6026
Peter Devine	604 Beatrice Cres	525-1538
Victoria Symphia	596 BEATRICE Cres	5605682
Brian Hoare	541 Beatrice	5211464
JEREMY WOOD	580 BEATRICE CRES	566-2892
Carmelle Forget	570 Beatrice Cres	566-7960
Michel Forget	570 Beatrice Cres.	566-7960
Sylvie Huneault-LaRochelle	548 Beatrice Cresc	524-7545
Joanne Huneault	548 Beatrice Cresc.	560-9959
Conrad Beauchamp	558 Beatrice Cres.	566-9986
Lise Lafleur	571 BEATRICE Cr.	527-2378
Louis Bethune	563 Beatrice cres.	560 5903
Jean Pierre Jodoin	565 Beatrice Cres	524-3776
Hélène Hébert	547 Beatrice Cr.	524-6707
Sylvie Poitier	545 Beatrice Cr.	521-1624
Mark Francis	585 Beatrice Cr.	580-0084
Frances Wright	600 Beatrice Cr.	525-6216
Daniel Choquette	624 Beatrice	560-6089
Carmel Carr	612 BEATRICE	560 1438

Petition

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Name	Address	Phone Number
Pat Cundari	95 Cumberland	560 3261
Carey + Claude Bond	113 Cumberland Ct.	566-5829
Joe Arau[illegible]		566-2664
Rita Lartigue	79 Cumberland	560-7272
Karen Pascoli	37 Cumberland	566 4188
Stefanie Pascoli	37 Cumberland	566-4188
Pete [illegible]	95 Cumberland Ct	560-3261
Denny [illegible]	62 Cumberland Ct	566-63[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible] Cumberland	560-[illegible]
[illegible]	56 Cumberland Ct	5[illegible]
[illegible]	29 Cumberland Crt	560 46[illegible]
[illegible]	56 Cumberland	524-1337
Julie Pelletier	56 Cumberland	524-1337
[illegible]	[illegible] Cumberland Ave	56[illegible]
[illegible]	14 Cumberland	525-[illegible]
[illegible]	[illegible]	[illegible]4
[illegible]	[illegible]	524-2549
Catherine Ross Guerito	50 Cumberland	524-2549

Petition

We, the "Adanac Ski Hill Residents" including Cumberland Court, Manchester Court and Beatrice Crescent object to the precedent setting decision, initiated and implemented by yourself and the residents of Stonegate Street. The decision to restrict and effectively restrict our access and thereby create a pseudo private street using "our" public tax dollars was made without any consideration given to the impact and inconvenience to the afforementioned residents.

Name	Address	Phone Number
[illegible]	13 Cumberland Crt	566-[illegible]
[illegible]	22 Cumberland Crt	525-[illegible]
[illegible]	93 CUMBERLAND CR	566-6924
[illegible]	15 Cumberland	566-6924
[illegible]	754 Beatrice Crt	566-[illegible]
[illegible]	116 Cumberland Crt	524-1244
[illegible]	15 Cumberland Crt	566-3461
[illegible]	30 Cumberland crt	524-[illegible]
[illegible]	110 Cumberland Crt	524-1244
[illegible]	754 Beatrice Cres	566-[illegible]
[illegible]	37 CUMBERLAND CRT.	566-4158
[illegible]	117 CUMBERLAND CRT	566-4244
[illegible]	181 Beatrice	566158
[illegible]	" "	" "
[illegible]	111 Cumberland Ct.	566-[illegible]737
[illegible]	" "	" "
[illegible]	34 Cumberland Crt	524-[illegible]
[illegible]	34 Cumberland Crt	524-[illegible]
[illegible]	34 Cumberland Crt	"

Petition

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Name	Address	Phone Number
Richard [illegible]	[illegible]	[illegible]
[illegible]	34 Manchester	566-1659
Linda Buckingham	99 Manchester	525-0535
Elta Liba	111 Manchester	524-2511
[illegible]	111 Manchester Cres	524-[illegible]
JOHN LIBA	111 MANCHESTER CRES.	524 2511
MIRELLA REYNEN	117 Manchester Cres	521-1593
Joan & Ed Bernard	641 BEATRICE	524-0766
Mercille T. Teresa Johnson	653 BEATRICE	560 4792
Agnes Beck	773 Beatrice	566-3585
Lloyd Beck	773 Beatrice	566-3585
[illegible]	770 Beatrice	566-0960
Nancy B. Keen	738 Beatrice	560-0492
Debbie Quirk	736 Beatrice	524-2230
David Quirk	736 Beatrice	524-2230
Lynn D'Amico	734 Beatrice	521 0448
Dan Woodley	728 Beatrice Cres	560 2179
Larry George	726 Beatrice Cres	524 6502
Cheryl George	726 Beatrice Cres.	524-6502

Pete

Pat - Alex

Curry Bond 566-5824

Petition

95 CUMBERLAND

We, the "Adanac Ski Hill Residents" including Cumberland Court, Manchester Court, Beatrice Crescent and Soloy Drive object to the precedent setting decision, initiated and implemented by yourself and the residents of Stonegate Street. The decision to restrict and effectively restrict our access and thereby create a pseudo private street using "our" public tax dollars was made without any consideration given to the impact and inconvenience to the afforementioned residents.

Name	Address	Phone Number
Mike Witkowski	983 Soloy Dr.	566-3419
Lynn Witkowski	983 Soloy Dr.	566-3419
Mary Beth Witkowski	983 Soloy Dr	566-3419
Yvonne Yersh	1017 Soloy Dr.	566-9026
Victor Low	1012 Soloy Dr	566-5641
Hildegarde Low	1012 Soloy DR.	566-5641
Ophie Landry	1018 Soloy Dr	566-3675
Bob Benoit	1006 Soloy Dr	560-0081
Kim Benoit	1006 Soloy Drive	500-0081
Mary Chamberlain	976 Soloy DRIVE	560-3548
D. Labbe	1011 Soloy Dr.	524-6768
G. CHOMITSCH	1035 Soloy DR	566-5358
D Chomitsch	1035 Soloy Dr	5665358
M Villeneuve	1052 Soloy Dr	5241312
Barb Vagnini		
Rose Milosevic	977 Soloy Dr.	566-0561
Dan O'Reilly	1041 Soloy Dr	560-3631
Sherri Sanfelice	1028 Soloy Dr	5662517
Tony Sanfelice	1028 Soloy Dr	566-2517

Petition

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Name	Address	Phone Number
Mary Lou Jessiman	1054 Soloy Dr	524-7419
Tyler Arseneau	1059 Soloy Dr.	524-1405
Jen Whitehead	1058 Soloy Dr	524-2482
Jodi Whitehead	1058 Soloy DR	524-2482
Jean Vezina	1064 Soloy Dr	524-2480
Peter Vezina	1064 Soloy Dr	524-2480
Sabrina Schram	1076 Soloy Dr	566-1980
Sarah Miller	1088 Soloy Dr.	560-4159
DAN CANAPINI	1101 Soloy DR.	560-8703
Adam Desjardins	1100 Soloy Dr.	566-3547
Dale Canapini	1101 Soloy DR.	560-8703
B.G Hunt	1107 Soloy Dr	524-2720
Jody Mayhew	1034 Soloy Dr.	524-5359
Carol A. Falconi		
CAROL A. FALCIONI	1106 SOLOY DR	566-9849
MARCEL FALCIONI	1106 SOLOY DR.	566-9849
Steve Despot	1095 Soloy	5600386
C.G. Howe	1112 Soloy Dr	521-0668
MARGERITTE Howe	1112 Soloy Dr.	521-0668
Roland Lalibert	1076 Soloy Dr	525-5655
Claire Lalibert	1076 Soloy Dr	525-5655
Celeste Jarvis	295 Gemmell St	524-3155
Annette Hoyo	1065 Soloy	~~524-6003~~ 5208087

74

Petition

We, the "Adanac Ski Hill Residents" including Cumberland Court, Manchester Court, Beatrice Crescent and Soloy Drive object to the precedent setting decision, initiated and implemented by yourself and the residents of Stonegate Street. The decision to deny and effectively restrict our access and thereby create a pseudo private street using "our" public tax dollars was made without any consideration given to the impact and inconvenience to the aforementioned residents.

Name	Address	Phone Number
Kelly Hogg	1065 Soloy	560 8087
Linda Lafrance	1034 Soloy	524-5259
Mia Khomek	- SOLOY DR.	
Dolly Dubé	995 Soloy DR	525-4064
Ed Dubé	995 Soloy Dr	524-9340
Tyler Nadeau	989 Soloy Dr	524-1977
Paulette Nadeau	989 Soloy	524-1972
Gillagan Whkarski	983 Soloy	566-3419
Dana Sutey	838 Marlborough	566-3902
Arlene Sutey	838 Marlborough	566-3902
Laura O'Reilly	641 Soloy Dr.	560-3631
Amy Wittowski	983 Soloy Dr	566-3419
* Brian Latendresse	1021 Soloy	5243138
Alex Felso	971 Soloy Dr.	566-6349
Audrey Felso	971 Soloy Dr	566 6349
Maria Fragomele	1001 Soloy Dr.	560-1983
ARISTIDE MARION	976 SOLOY DR	560-8548 attorney
BRIAN FLESHER	982 Soloy Dr.	560-8854
JANNE FLESHER	982 Soloy Drive	560-8854
BETTY CARMICHAEL	1089 Soloy DR	560-1251
Jim Carmichael	1089 Soloy DR	560-1251
Tony Kadlec	1081 Soloy Dr.	566-3060