Bicycle Lanes in Toronto

THE INTRODUCTION OF BICYCLE LANES IN TORONTO AND OTHER NORTH AMERICAN CITIES OVER RECENT YEARS MARKS AN IMPORTANT TREND. PERHAPS FOR THE FIRST TIME IN NORTH AMERICA SINCE THE INVENTION OF THE AUTOMOBILE, ROAD SPACE FOR MOTOR VEHICLES IS BEING REALLOCATED TO BICYCLES.

BY ANDREW G. MACBETH

IN 1995, TORONTO WAS NAMED "The Number 1 Cycling City in North America" by *Bicycling Magazine*. The award, given only once before (in 1990), is highly coveted by cycling communities across Canada and the United States. The magazine attributed Toronto's success to an "impressive blend of programs, ridership and natural amenities," including its expanding network of on-street bicycle lanes. These lanes, initially put on residential streets, are now being installed mostly on downtown arterial roads carrying typically 15,000 to 20,000 motor vehicles/day. They have been added to an already congested road network to improve the safety of cyclists and to encourage cycling.

By careful attention to detailed design issues, they result in relatively minor reductions in road capacity for motor vehicles. In many cases, two-way, four-lane roads are being converted to two-lane roads (for motor vehicles) with a bicycle lane in each direction and curbside parking on one side or both, depending on the road's width. At signalized intersections, where parking is prohibited, an extra lane for left-turning traffic is usually provided to minimize reductions in traffic capacity.

Some 50 kilometers (km) (30 miles) of bicycle lanes have been installed in central Toronto, with additional lanes in a few suburban locations. The introduction of bicycle lanes in Toronto and other North American cities over recent years marks an important trend. Perhaps for the first time in North America since the invention of the automobile, road space for motor vehicles is being reallocated to bicycles.

HISTORY

In 1975 the Toronto City Cycling Committee was established by the City Council to promote cycling and cycling safety. It comprises citizen activists and city councillors and is serviced by a number of full-time staff with assistance from many volunteers.

The first bicycle lane was installed in Toronto in 1979, at the request of the cycling committee, on Poplar Plains Road, a narrow residential street that had just been converted to one-way operation. With the elimination of one direction of traffic, the road now had sufficient width to accommodate a bicycle lane, which narrowed the road for motor vehicles, helping to discourage wrong-way traffic, while assisting cyclists. Queens Quay, the next street chosen (1990), was a downtown arterial road near Lake Ontario that carried its heaviest traffic volumes on summer weekends. It already was used by many cyclists (up to 5,000/day) as part of the Martin Goodman Trail, a mainly off-street recreational trail across Toronto's waterfront. These lanes improved the continuity of the trail through the city's downtown area.

In 1991, a bicycle lane was installed on Russell Hill Road, a one-way street adjacent to Poplar Plains Road, that provided for traffic flow in the opposite direction. In the same year, bicycle lanes were put on each side of the Bloor Street Viaduct, a bridge carrying 55,000 motor vehicles/day. One of the six motor-vehicle lanes was removed to make room for the bicycle lanes, which now carry approximately 1,600 bicycles/day (800/direction). In total, these early facilities accounted for about 8 km (5 miles) of bicycle lanes.

Bicycle traffic volumes reported in this feature are year-round average weekday volumes. Summer cycling levels are several times higher than winter levels. Toronto gets moderate amounts of snow in the winter months [averaging 125 centimeters (cm) or 50 inches (in.) annually]. Snowplowing operations on streets begin when 10 cm (4 in.) of snow accumulates. Streets with bicycle lanes receive the same priority for snowplowing as arterial roads (most are in fact on arterial roads anyway). When plowing roads with bicycle lanes, snowplow operators attempt to clear at least 1 meter (m) of each bicycle lane.

CURRENT PROGRAM

By 1993, bicycle traffic entering and leaving the downtown area of the city appeared to be growing and had become a noticeable presence (about 17,000 bicycles/weekday), while motor-vehicle traffic volumes remained static. Bicycles constituted about 3 percent of all vehicles on downtown streets. About 15 percent of all reported collisions resulting in injuries involved cyclists.

With a strong, official plan in support of cycling, relatively high levels of cycling activity and significant safety concerns, the time was right to embark on a bicycle-lane program. Between 1993 and 1998 inclusive, some 40 km (25 miles) of lanes were installed.

In the central area of Toronto, measuring approximately 10 km eastwest by 5 km northsouth, there are now four eastwest routes with bicycle lanes and two northsouth. The eastwest routes total about 14 km in length. With bicycle lanes on each side of the street this results in 28 km of bike lanes. About 9 km of northsouth routes exist, with bicycle lanes on each side of the street (18 km of bike lanes).

MOTOR-VEHICLE AND BICYCLE TRAFFIC VOLUMES

Generally, motor-vehicle traffic volumes are unaffected by the installation of bicycle lanes, while bicycle traffic volumes increase by various amounts, as illustrated in Table 1. Since 1994, bicycle traffic levels generally have remained constant, at a level of between 15,000 and 18,000 cyclists/day to and from the central area. Since 1994, however, bicycle traffic levels appear to have declined about 4 percent/year, which may be attributed to declining employment in the central area or because of an aging population (older people are less likely to cycle than younger people). Despite the slight decline in cycling activity overall, it appears that the number of cyclists on streets with bicycle lanes is growing, while declining on other streets. Increases of up to 42 percent in bicycle traffic have been recorded on streets with bicycle lanes, typically measured two years after bike-lane installation. On the six routes recorded in Table 1, the average increase in bicycle traffic was 23 percent.

CONSULTATION AND APPROVAL PROCESS

Requests for bicycle lanes may come from residents, residents' associations, ward councillors, or the city's cycling committee. In some cases, traffic calming is requested for an arterial road, and bicycle lanes are suggested by transportation staff as a type of traffic-calming solution. They can "calm" traffic by reducing streets from four lanes to two (for motor vehicles), which reduces speeding and overtaking opportunities for motorists. They also have been used to narrow travel lanes on one-way (one-lane) residential streets, while providing dedicated space for cyclists. Narrowing travel lanes has a slight traffic-calming effect.

Typically, the cycling committee or councillors will host a public meeting in the neighborhood outlining the project to determine the level of community support for a proposal. If community support appears to exist, staff prepare a technical report to explain the proposal, including an analysis of the effects on motor-vehicle traffic, transit, parking capacity, traffic-signal capacity and the estimated installation costs. An extensive procedure of public notification and meetings is undertaken, usually lasting several months, before final council approval is obtained.

DESIGN

Bicycle-lane design is a time-consuming exercise. As the project goes through the consultation and approval process, staff review the width of each section of roadway to determine the appropriate design features, including the proposed cross sections at midblock and intersection locations. Detailed design drawings are prepared at a scale of 1:500 to allocate widths for the various lanes and to determine the geometric design for the transitions from midblock to intersection locations. The design drawing is essential to calculate the effect on parking for individual property owners alongside the facility and to identify any necessary parking bylaw amendments. Eventually, the

Table 1. Before and after traffic volumes for selected streets with bicycle lanes.

Facility	Installation Date	Motor Vehicle Traffic[a]			Bicycle Traffic[b]		
		Before	After[c]	% Change	Before	After[c]	% Change
Davenport Road (North of Dupont Street)	May 1995	22,000	22,000	0%	600	850	42%
Gerrard Street (West of Sherbourne Street)	Aug. 1995	18,000	18,000	0%	800	900	13%
Sherbourne Street (North of Gerrard Street)	Sept. 1996	16,000	15,000	–6%	550	570	4%
Harbord Street (West of Bathurst Street)	Aug. 1997	15,000	16,000	7%	1,100	1,500	36%
St. George Street (North of College Street)	Aug. 1993	16,000	16,000	0%	1,500	1,650	10%
College Street (West of St. George Street)	Oct. 1993	20,000	20,000	0%	1,450	1,900	31%
Average		17,800	17,800	0%	1,000	1,230	23%

[a] *Annual average weekday traffic volume.*
[b] *Seasonally adjusted (year-round) average weekday traffic volumes.*
[c] *Typically surveyed two years after installation.*

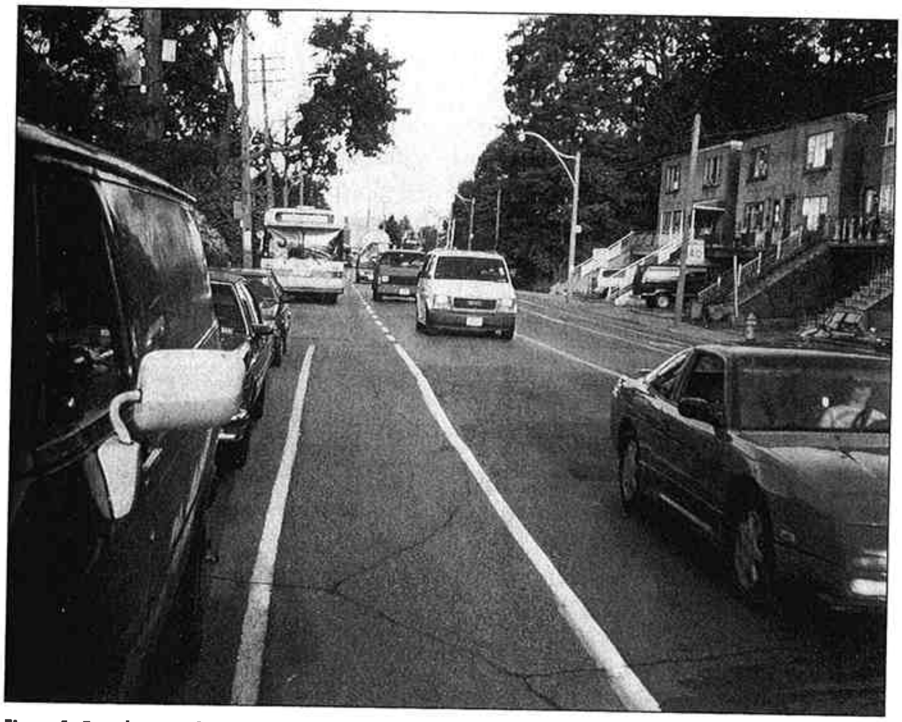

Figure 1. Four-lane roads carrying under 20,000 vehicles/day can often be narrowed to two with the addition of bicycle lanes and parking.

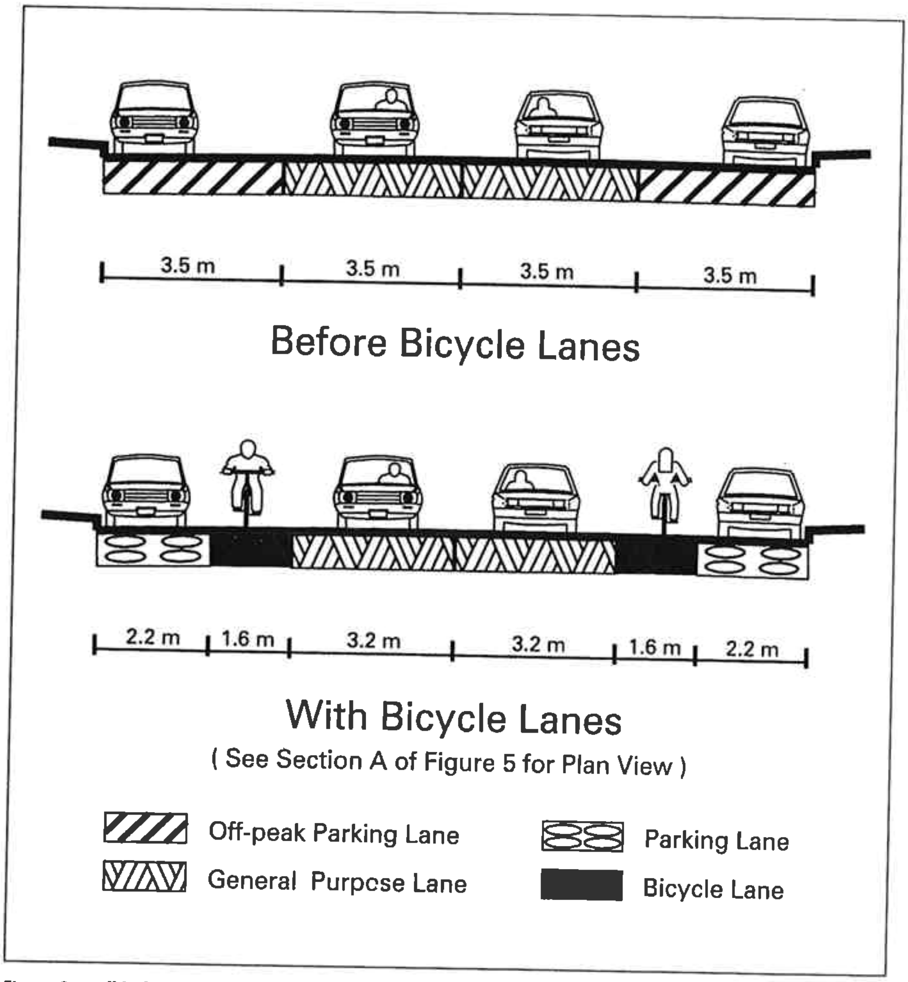

Figure 2. Midblock cross section of street converted to bike lanes.

drawings are used to assist work crews in laying out the pavement markings and traffic and parking signs.

Comprehensive design manuals are available and should be consulted if bicycle lanes are being designed. The following design information is not intended to replace these manuals. Highway-capacity software is used to estimate the impacts on traffic-signal and transit operations and to calculate left-turn-lane lengths. In some cases, bicycle lanes have been omitted at signalized intersections because the theoretical traffic capacity has been insufficient to accommodate the existing motor-vehicle traffic volumes. Generally, however, signal-capacity calculations predict either no change to existing intersection levels of service or a reduction of one level during one peak period (morning or afternoon). Traffic signal pre-emption for buses is soon to be installed on one route where increased transit delays have been experienced.

In most cases where bicycle lanes have been installed, four-lane roads have been reconfigured as two-lane roads (plus bike lanes). Typically, these roads would have had peak-period parking prohibitions on either or both sides of the road, so they would operate as four-lane roads during peak periods and two-lane roads otherwise. When bicycle lanes are installed on these streets, parking can be authorized on one side or both throughout the day, depending on the road width. A minimum of 14 m [46 feet (ft.)] is needed for parking on both sides, as illustrated in Figures 1 and 2. All parking and stopping activities (except for emergency vehicles, taxis and transit vehicles) are prohibited where bicycle lanes are next to the curb.

At signalized intersections, a central left-turn lane is usually provided in each direction (Figures 3, 4 and 5). This reduces delays that would otherwise occur and has the advantage of clearly defining the paths of vehicles through these intersections. Many existing four-lane roadways generate sudden, unpredictable lane-changing maneuvers at signalized intersections as drivers jockey for position between the curb and center lanes. Often, the existing center lane is occupied by left-turning vehicles and

Figure 3. Left-turn lanes are provided at signalized intersections to reduce congestion and make left turns easier for cyclists.

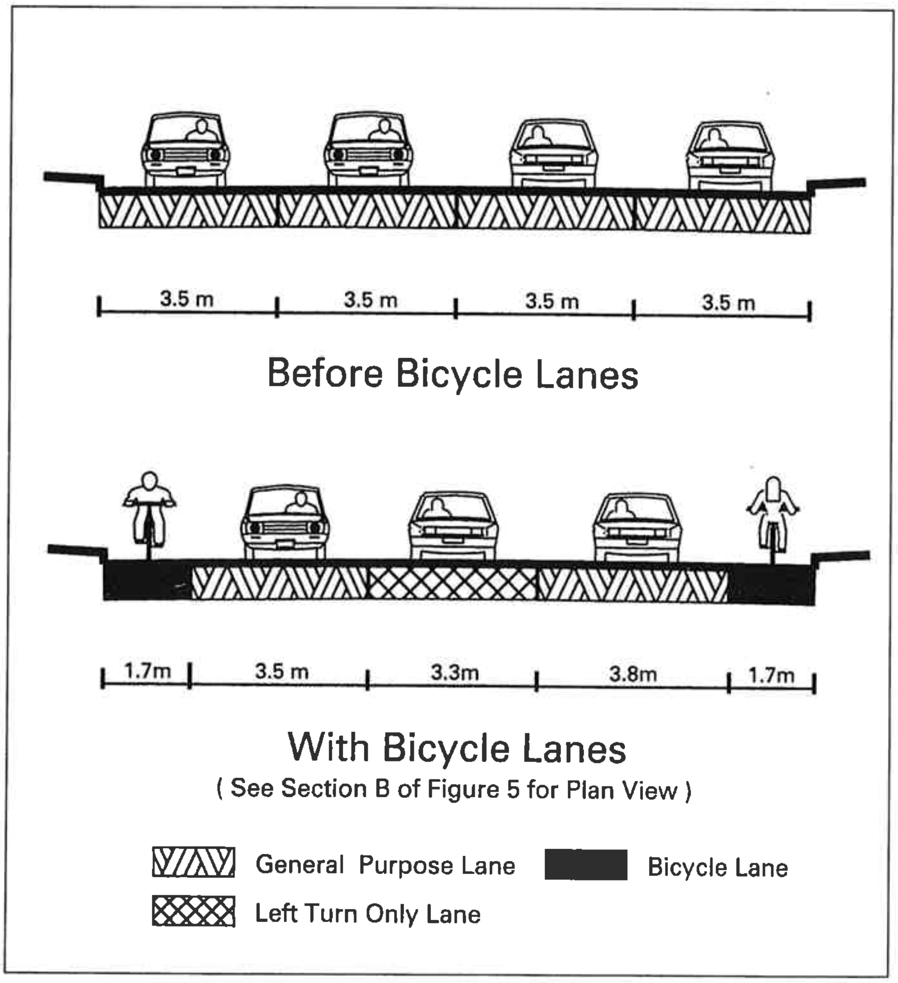

Figure 4. Intersection cross section of street converted to bike lanes.

does not greatly add to the intersection's capacity. A clearly defined left-turn lane and combined through and right-turn lane help motor vehicle drivers position their vehicles as they approach each intersection. Right turns can be made by encroaching into the bicycle lane if it is safe to do so. Left-turn lanes benefit cyclists turning left by enabling them to get out of the through-traffic stream to wait for gaps in opposing traffic. The transition from two lanes to three at signalized intersections is accomplished over a distance of approximately 20 m. No special signage (other than standard bicycle-lane signs and pavement markings) is necessary, and road users (both motorists and cyclists) seem to find the designs user friendly and intuitive.

Another benefit of converting four-lane roads to two is that motor-vehicle speeds are reduced. With two lanes in one direction, aggressive drivers can travel at speeds well above the speed limit by using either lane as a passing lane to overtake other vehicles. When the lane is converted to one lane in each direction, all traffic in a platoon tends to travel at the speed of the leading vehicle. The speed limit on most local streets and some arterials in Toronto's downtown and inner neighbourhoods is 40 km/h (25 miles/hour). If a particular street is being adapted to accommodate bicycle lanes, the speed limit will be reduced to 40 km/h if it is not already so.

LANE WIDTHS, SIGNS AND PAVEMENT MARKINGS

Minimum bicycle lane widths in the City of Toronto are 1.5 m next to the curb (measured from the curb face to the center of the lane line). When bicycle lanes are located next to parking (either with or without parking meters), the combined width is at least 3.8 m. These minima ensure that the lanes can operate as intended even when autumn leaves or winter snow reduce the available lane width. Motor vehicle lanes are at least 3.0-m wide but at least 3.2 m on bus routes. Left-turn lanes are a minimum of 7.5-m long, although 15 m or longer is more typical. Bicycle lanes are generally not wider than 2.0 m, otherwise they might encourage use by motorists.

Toronto's bicycle lanes are generally distinguished by a white solid lane line parallel to the curb. At locations where cyclists or motorists could expect to encounter merging traffic, a broken line is used. Examples include bus stops and intersection approaches (where right-turning motor vehicles would cross the bike lane to accomplish their maneuvers). Regulatory (black and white) bicycle-lane signs depicting a reserved-lane diamond logo, a bicycle logo and an arrow were developed and installed as no provincial standard sign existed at that time. In addition, white reserved-lane diamond logos and bicycle logos were painted with stencils on the pavement. These were replaced recently by pavement-marking tape logos of the city's own design, which are more visible by day or night, more durable and relatively cost-effective (Figure 6).

CASE HISTORIES

Bicycle-lane designs need to be customized to each street to accommodate local circumstances. A number of Toronto's bicycle-lane projects were particularly significant or interesting for different reasons and are discussed here. St. George Street was a four-lane arterial road running for 1 km through the heart of the University of Toronto, carrying about 16,000 motor vehicles, 6,000 pedestrians and 1,500 bicycles/day. In 1993, bicycle lanes were installed and the road was converted from a four-lane road to a two-lane road with parking on one side. As extra road width was available, a median was painted on the street to make it easier for pedestrians to cross. The project was extremely successful and popular, and when the road was reconstructed in 1996, the opportunity was taken to narrow it. The purpose of this was to improve the pedestrian environment by significantly widening the sidewalks. In addition, the aesthetics of the street were enhanced by extensive landscaping, including about 200 new trees. Various traffic-calming measures also were provided. The road was narrowed from 14 m to 11.5 m, still retaining the same configuration of parking and lanes. Staff would probably not have had the confidence to recommend narrowing the road if the bicycle-lane project had not been so successful.

In October 1993, bicycle lanes were installed on parts of College Street and its extension, Carlton Street. The street has a streetcar (light-rail) route and is flanked by commercial, retail and institutional buildings. Retailers complained vociferously about the resulting removal of all parking and associated parking meters on a two-block section of the route running east and west of Yonge Street, the central street in Toronto. In March 1994, in response to these concerns, the City Council decided to remove the bicycle lanes and reinstate the parking meters on about 20 percent of the 2.8-km route. To ameliorate cyclists' concerns about the removal of these bicycle lanes, the council expedited the process to authorize a much greater length of bicycle lanes on Gerrard Street, a nearby, parallel street. This case demonstrates the need to choose routes carefully in terms of adjacent land uses and parking supply and demand; to have a meticulous, detailed design process; and to undertake a good public consultation process to identify and respond to potential difficulties along the route. Experience in Toronto suggests that the impact on the on-street parking supply is usually the most controversial element of a bicycle-lane plan.

In 1994, part of Davenport Road, a six-lane arterial road carrying about 30,000 vehicles/day was reconfigured to accommodate bicycle lanes next to curbside parking and only four general traffic lanes. The initial design included parking on only one side of the road because technically the road was not wide enough to provide parking on both sides in addition to the bicycle and general travel lanes. The road has extensive (and expensive) shops on each side. Under pressure from retailers, parking was provided on both sides. This resulted in general traffic-lane widths of slightly less than 3.0 m, bicycle lanes of 1.65 m and parking-meter stalls of 1.8 m. Some concerns have been expressed by the transit operator because the narrowness of the lanes combined with the serpentine shape of the road makes it very difficult to drive a bus within the

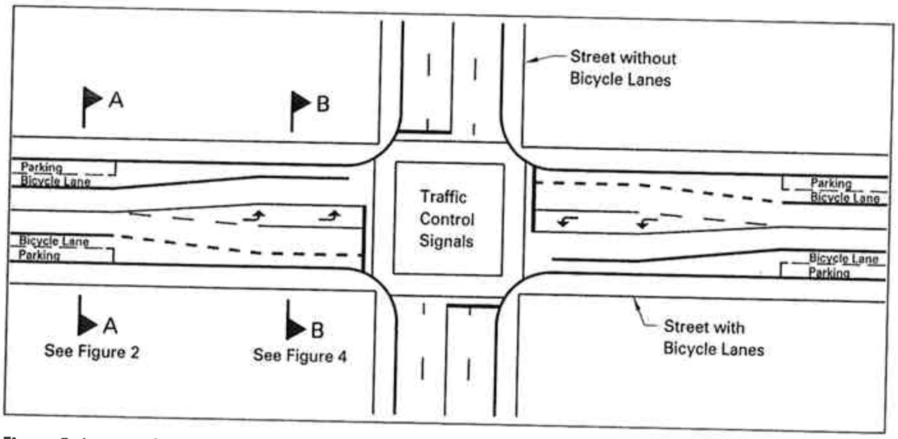

Figure 5. Lane configuration at signalized intersection.

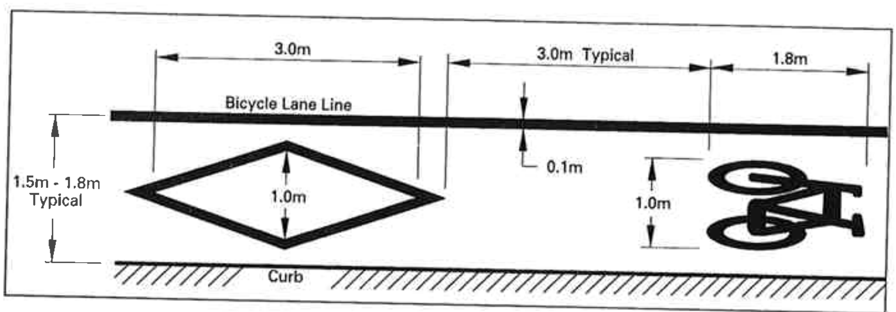

Figure 6. Bicycle-lane pavement markings.

lanes. In addition, larger vehicles are too wide for the parking stalls and encroach into the bicycle lanes. This forces cyclists into the adjacent general traffic lane, which already has no safety margin. Despite these shortcomings, however, the road has not experienced an increase in collisions. Some 89 percent of 154 cyclists surveyed felt that the bicycle lanes had made the road safer for cyclists, and a further 8 percent felt that safety was about the same. In addition, only 6 percent felt that the bicycle lanes were too narrow.

In 1995, the Davenport Road facility was extended northwards by a mere 100 m. However, this was a particularly controversial move because the road at this point traveled through a railway underpass as a busy four-lane roadway and two lanes were removed to provide space for the bicycle lanes. Furthermore, the lanes were unusually narrow (averaging 3.2 m or about 10.5 ft.), which made cycling in this location uncomfortable and potentially dangerous. Daily traffic volumes were about 22,000 motor vehicles and 600 bicycles. The underpass still carries the same amount of motor-vehicle traffic, but bicycle traffic has increased by over 40 percent to around 850/day.

CONCLUSIONS

Toronto's experience has demonstrated that bicycle lanes need to be carefully designed and implemented with ample opportunities for consultation with all key stakeholders. They have shown that many four-lane roads can operate satisfactorily with two midblock and three intersection motor-vehicle lanes. Loss of on-street parking is one of the most controversial issues associated with their implementation.

Bicycle lanes have been installed progressively in downtown Toronto since 1993. They are popular with cyclists, who mostly feel safer on streets with bicycle lanes than they did before the lanes were installed. Bicycle-traffic volumes have increased on streets with bicycle lanes, while remaining static or possibly declining citywide. The impacts on motor-vehicle capacity are relatively modest and are considered an acceptable trade-off for the benefits that arise from encouraging cycling. ■

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