Lane Widths and Other Cross-Section Elements on Urban Roads: An Annotated Bibliography

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- Table A-1 has pre-1999 references cited in TAC for cross section guidance, urban roads.
- Table A-2 has references regarding effect of lane width on speed and on capacity at signalized intersections
- Table A-3 has references regarding effect of lane width on traffic safety
- Table A-4 has references to studies of parking lane width and bike lane width
- Table A-5 has references to other relevant guidelines

Note: TAC is shorthand for the Canadian roadway design manual, *Geometric Design Guide for Canadian Roads* published by TAC (Transport Association of Canada) in 1999 with some updates in 2011.

Table A-1: Relevant References Cited in TAC's Chapter on Cross Sections

Reference	**What it Supports in TAC**	**Comment**
Zegeer, C.V. and F.M. Council (1992). Safety Effectiveness of Highway Design Features – Vol III – Cross Sections. FHWA report RD-91-06.	Wider lanes and wider shoulders reduce incidence of run-off-the-road collisions.	Data supporting this finding is mainly from rural roads. Run-off-the-road collisions are a predominantly a rural phenomenon.
Highway Capacity Manual (HCM), 1985	"The capacity of a roadway is markedly affected by lane width."	Older versions of the HCM, through the 2000 edition, treated 12 ft (3.7 m) as the standard lane width for intersection capacity analysis, with capacity decreasing by 3% for 11 ft (34 m) lanes and by 7% for 10 ft (3.0 m) lanes. However, in the most recent HCM (2010), based on the most recent research, there is no capacity reduction until lane width falls below 10 ft (3.0 m).
Hauer, Ezra (1998, updated 2000). Literature and Review on Lane Widths. Univ. of Toronto.	"Little is known about the effect of lane width on multilane or urban roadways."	This is a paraphrase of Hauer. Consistent with this statement, TAC provides a table taken from Hauer indicating the percentage of single-vehicle and head-on crashes that will be averted by widening lanes on 2-lane rural highways; no such tools are given for urban roads.
ibid.	"In general, safety increases with wider lanes up to a width of about 3.7 m. There is no increase in safety for lane widths beyond the 3.7 m range."	Consistent with the previous quote, this is a finding based almost entirely on data from rural roads; there is no basis for applying it on urban roads.
ibid	"On roadways that are identical	This is Hauer's explanation as to what causes the safety benefits of wider lanes to disappear as lanes

Table A-1 (continued): Relevant References Cited in TAC's Chapter on Cross Sections

Reference	**What it Supports in TAC**	**Comment**
	except for lane widths, drivers may tend to drive faster and follow the preceding vehicle more closely on the road that has wider lanes."	get wider. Recent research by Fitzpatrick (2001) confirms that on urban and suburban arterials, drivers tend to go faster where lanes are wider.
Harwood, D.W. (1986). "Multi-Lane Design Alternatives for Suburban Highways." NCHRP report 282.	Describes experiences with adding lanes, particularly 2-way left turn lanes, on suburban highways.	This report is relevant to higher-speed suburban highways without curbs and with wide intersection spacing. More relevant is the companion report by the same author covering urban arterials (Harwood, 1990). It includes analysis of projects in which lanes were narrowed.
Ogden, KW (1996). Safer Roads: A Guide to Road Safety Engineering.	States that there's a consensus that 3.4-3.7 m lanes are safest and that lanes narrower than 3.0 m contribute to multi-vehicle crashes.	This textbook summarizes knowledge from other studies. All of the studies cited in the sections on lane and shoulder width relate to rural roads; there is no mention of urban roads. For example, it quotes a 1987 American study showing that widening lanes on rural roads reduced crashes.

Table A-2: References Regarding Effect of Lane Width on Speed and on Capacity at Signalized Intersections

Reference	Comment
Highway Capacity Manual (HCM), 2010. Transportation Research Board.	Saturation flow rate at signalized intersections is constant for lane widths down to 10 ft (3.0 m), and falls by 4.4% for lane widths of 9.5 ft (2.9 m).
Potts, Ingrid B., John F. Ringert, Karin M. Bauer, John D. Zegeer Douglas W. Harwood, and David K. Gilmore (2007). Relationship of Lane Width to Saturation Flow Rate on Urban and Suburban Signalized Intersection Approaches. *Transportation Research Record* 2027, 2007, pp. 45-51.	Literature review of past studies finds that lane widths of 3.0 to 3.9 m have essentially equal saturation flow rates. Original research found that lane widths of 2.9 m (9.5 ft) had a 4% lower saturation flow rate than lanes 11 or 12 ft (3.4, 3.7 m) wide. No data was reported for lanes 10 ft (3.0 m) wide.
Zegeer, J. D. (1986). Field Validation of Intersection Capacity Factors. *Transportation Research Record* 1091, pp. 67–77.	Found no difference in saturation flow rate at signalized intersections for lane widths between 3.0 and 3.9 m.
Agent, K. R., and J. D. Crabtree (1983). *Analysis of Saturation Flow at Signalized Intersections.* Kentucky Transportation Research Program, University of Kentucky, Lexington.	Found that lane width had no effect on saturation flow rate at signalized intersections.
Zegeer, John (2007). "The Effect of Lane Width on Urban Street Capacity." Technical Memorandum published in Appendix P of "Conserve by Bicycle: Phase I Report," Florida DOT.	Summarizes the literature, concluding that lane width has no effect on capacity for widths between 3.0 and 3.9 m. The author was an author of two of the four studies providing original research to this topic since 1980.

Table A-2 (continued): References Regarding Effect of Lane Width on Speed and on Capacity at Signalized Intersections

Reference	Comment
Fitzpatrick, K., P. Carlson, M. Brewer, and M. Wooldridge (2001). Design Factors That Affect Driver Speed on Suburban Streets. *Transportation Research Record* 1751, pp. 18-25.	Finds that wider travel lanes leads to greater driving speed on suburban arterials.

Table A-3: References Regarding Effect of Lane Width on Traffic Safety

Reference	**Comment**
Harwood, D.W. (1990). "Effective Use of Street Width on Urban Arterials." NCHRP Report 330.	A survey of 141 state and local agencies found that 116 (82%) had done projects in which they made travel lanes narrower in order to create space for turn lanes, additional travel lanes, or bike lanes. Of the 141 agencies, 6 used 8 ft lanes, 60 used 9 ft lanes, and 121 used 10 ft lanes. Presumably, many of the narrowest lanes were turn lanes. Only four agencies had observed an increase in crashes, and only three had found it necessary to remark the street because the lanes were too narrow. An additional study with controls was done to test for safety effects of projects that made lanes narrower in order to add travel lanes or turn lanes. No negative effects of narrow lanes could be identified. Where travel lanes were narrowed to create space for turn lanes, there were large decreases in crash rate. Where travel lanes were narrowed to create space for additional travel lanes, there was an increase in crashes at intersections, but not midblock, where any effect of narrow lanes was expected to show clearly. Thus, it is concluded that the increase in crashes at intersections is most likely due to the added lanes, not to narrower lanes. A third part of the study examined videotapes of traffic on roads with narrow lanes. No pattern of unsafe behaviour related to lane width could be found.
Hauer, E., F. M. Council, and Y. Mohammedshah (2004). Safety Models for Urban Four-Lane Undivided Road Segments. *Transportation Research Record 1897,* pp. 96–105.	Study of 4-lane undivided roads in Washington State. For on-road crashes on urban roads, lane width had no effect on injury crashes, while for property damage only (PDO) crashes, "The wider the lanes, the larger the frequency of PDO accidents. The relationship is weak … and is included only because of the traditional interest in this variable."
Harwood, D. W., F. M. Council, E. Hauer, W. E. Hughes, and A. Vogt (2000). Prediction of the Expected Safety Performance of Rural	This study found that narrower lanes increase crash rates on two-lane rural roads. Urban roads were not part of the study.

Table A-3 (continued): References Regarding Effect of Lane Width on Traffic Safety

Reference	**Comment**
Two-Lane Highways. FHWA report RD-99-207.	
Strathman, J. G., K. J. Dueker, J. Zhang, and T. Williams (2001). *Analysis of Design Attributes and Crashes on the Oregon Highway System.* Oregon Department of Transportation and Center for Urban Studies, Portland State University.	Found no significant relationship between lane width and crash rate on non-freeway roads that are part of the Oregon state highway system. Their best estimate – which was not statistically significant – was that that adding 1 ft to lane width reduces crashes by 1.4% on rural roads and by 1.6% on urban roads.
Hadi, M. A., J. Aruldhas, L.-F. Chow, and J. A. Wattleworth (1995). Estimating Safety Effects of Cross-Section Design for Various Highway Types Using Negative Binomial Regression. *Transportation Research Record* 1500, 169–177.	A study of Florida highways (mix of urban and rural) found that for two out of three roadway types (2-lane and 4-lane divided), there was no discernable relationship between crash rate and lane width. For 4-lane undivided, a small negative effect was found: a 10% increase in lane width (e.g., from 3.0 to 3.3 m) leads to a 1% decrease in crashes.
Potts, I. B., Harwood, D. W., & Richard, K. R. (2007). Relationship of lane width to safety on urban and suburban arterials. *Transportation Research Record*, *2023*(1), 63-82.	Extensive study of urban arterials, comparing "narrow" (narrower than 10.5 ft, or 3.2 m) versus "wide" (wider than 3.2 m) lanes for five road types (by number of lanes and whether it's divided). Part 1 looked at 3031 sections (i.e., excluding intersection-related crashes) in Minnesota (metropolitan Minneapolis) and Michigan (suburban Detroit). For the most part, they found no consistent relationship between lane width and safety. In Michigan, 9-ft (2.7 m) lanes on 4-lane undivided roads had a clearly higher crash rate. In Minnesota, narrow lanes had higher crash rates on one road type, 4-lane undivided. However, in the much larger Michigan sample, when 9-ft (2.7 m) lanes were excluded from the "narrow" group, 10-ft (3.0 m) lanes were found to be safer or just as safe as 12-ft lanes for all combinations of road type / crash type. A second analysis looked at intersections: 707 in Minnesota, and 635 in greater Charlotte, NC. For 4 types of signalized intersections and 6 types of crashes (thus 24 cases total), no

Table A-3 (continued): References Regarding Effect of Lane Width on Traffic Safety

Reference	Comment
	significant relationship between crashes and lane width was found in 22 cases; in the other two cases the results were inconsistent, in that lanes 10 ft (3.0 m) wide and 13+ ft (4.0+ m) wide were both found safer than lanes 12 ft (3.7 m) wide. At intersections in which the side street had stop control, narrower lanes were found to be safer one state and less safe in the other. The study's overall conclusion: "It was concluded from this research that there was no indication of an increase in crash frequencies as lane width decreased for arterial roadway segments or arterial intersection approaches." Also from the conclusions: "There are situations in which use of narrower lanes may provide both benefits in traffic operations, pedestrian safety, or reduced interference with surrounding development and space for geometric features that enhance safety, such as medians or turn lanes. The analysis results indicated that narrow lanes can generally be used to obtain these benefits without compromising safety."

Table A-4: References Regarding Parking Lane Width and Bike Lane Width

Reference	Comment
Torbic, D.J., K.M. Bauer, C.A. Fees, and D.W. Harwood (2014). Recommended Bicycle Lane Widths for Various Roadway Characteristics. NCHRP Report 766.	As parking lane width increases from 7 ft (2.1 m) to 8 ft (2.4 m), average distance from the curb that cars park increases by 100 mm, and with a further parking lane increase to 9 ft (2.7 m), parking offset increases by a further 120 mm. With traditional bike lanes next to parking lanes, cyclists tend to ride in the door zone. Narrow parking lanes that encourage motorists to park next to the curb, together with marked buffers between the parking lane and the bike lane, are recommended. On lower speed streets without parking lanes, 4 ft (1.2 m) bike lanes function adequately. Roadway space allocation plans are provided for roads with parking lanes for a variety of road widths.
Furth, P.G., D.M.Dulaski, M. Buessing, & P. Tavakolian (2010). Parking Lane Width and Bicycle Operating Space, *Transportation Research Record* 2190, pp. 45-50.	When parking lane width increases by 1 ft (0.3 m), the average distance from the curb that cars park increases by 4 inches (100 mm), and the 95-percentile distance from the curb that cars park – which may be taken as the practical boundary cyclists use – increases by 5 inches (125 mm).
Van Houten, R. and C. Seiderman (2005). How Pavement Markings Influence Bicycle and Motor Vehicle Positioning: Case Study in Cambridge, Massachusetts. *Transportation Research Record* 1939. .	For a half-roadway ultimately divided into a 10-ft (3.0 m) travel lane, a 5 ft (1.5 m) bike lane, and a 7 ft (2.1 m) parking lane, measurements as lines were progressively applied showed that with a narrow marked parking lane, cars parked closer to the curb than with a very wide combined bike and parking lane. With travel lane, bike lane, and parking lane explicitly marked, cyclists rode further from parked cars than when no bike lane was marked, or with only a wide combined bike and parking lane marked.

Table A-5: Other Guidelines

Reference	Comment
ITE. Designing Walkable Urban Thoroughfares: A Context Sensitive Approach. 2010.	Introduces concept of "target speed," a design maximum speed, as distinct from "design speed" which is a design minimum speed. Argues that design should aim to limit speed to a target speed appropriate to vulnerable road users such as pedestrians.
NACTO. *Urban Street Design Guidelines*. 2013. (nacto.org/usdg	States that the normal lane width for urban streets should be 10 ft (3.0 m), with 11 ft (3.4 m) possibly used in curb lanes on streets with heavy bus traffic.
City of Toronto. Vehicle Travel Lane Width Guidelines. Version 1.02, January, 2015.	Gives 3.0 m as the desirable width for travel lanes on collectors and minor arterials, and 3.2 m for major arterials. Adjustments for many conditions, including streetcar and bus routes, high pedestrian activity, and presence of a bike lane, are also provided.