Case Studies in Integrating Transportation, Land Use and Health Objectives in Road Design

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ABSTRACT

A convergence of perspectives is occurring favouring more compact urban development including the need to reduce traffic congestion and efficiently support greater public transit, achieve greater environmental sustainability, and promote the public's health by supporting greater active transportation. Engineers are central to balancing the needs of competing right-of-way users and objectives, while maintaining road functionality, operations and safety. This paper will describe the experiences of six municipalities who successfully managed these competing agendas and offers insight into future approaches highlighting the need for a more diverse range of context-specific designs and closer integration with land use planning.

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INTRODUCTION

A convergence of perspectives is occurring favouring more compact urban development. Key drivers of change include the desire to: reduce traffic congestion and efficiently support greater public transit; reduce air pollution and greenhouse gas emissions; reduce municipal infrastructure costs; protect natural spaces and farmland; attract business and young professionals; and, build physical activity into daily lives through walking and cycling (active transportation). These newer objectives join the existing task of optimizing the efficient movement of goods and people. Engineers are central to balancing the needs of competing right-of-way (ROW) users and maintaining road functionality, operations and safety, which requires a more diverse range of context-specific designs and closer integration with land use planning.

The purpose of this paper is to describe the experiences of six municipalities or regions across Canada that are successfully managing these competing agendas and to identify key themes for future approaches.

APPROACH

Key informant interviews were conducted with engineers from six municipalities or regional agencies across Canada to gather information on recent initiatives involving the integration of transportation and land use with a particular interest in active transportation (AT) and/or public transit. The informants were provided an opportunity to review and comment on a draft version of this paper. Key themes were then identified from the interviews. In two instances, an additional informant from their organization was contacted at the suggestion of the primary key informant.

CASE STUDIES

This section summarizes key points for each of the case studies.

Rothesay, New Brunswick

The town of Rothesay is a suburban community of approximately 12,000 people located ten minutes outside the city of Saint John. Following a change in most of the members of the town's Council, there was a marked increase in political support for recreation and physical activity. Complementary AT and traffic study plans were completed with a recommendation for a cycling route through the town's downtown centre. The key challenge was a 1.2 km section through the business area with existing single traffic lanes and a common centre lane for left hand turns. The plans involve expansion of the ROW, narrowing lane widths, creation of dedicated bike lanes, installation of multiple cross-walks, creating controlled left hand turn lane pockets, and streetscaping.

Planning for the downtown section involved working with various stakeholders including local businesses to align their entranceways with the planned fixed turning pockets and to negotiate bicycle parking on their properties. Expansion of the ROW required discussions with individual local landowners who had extended their land use onto town property. Approval by provincial authorities was also needed for installing the cross-walks since the road is a former provincial highway.

Design guidance was sought from various sources to determine how best to address street widths narrower than standard widths in the geometric design guidelines. Table 1 shows a comparison of bicycle facility guidelines provided by the Transportation Association of Canada (TAC)[1] and the American Association of State Highway and Transportation Officials (AASHTO),[2] which were prepared by the project consultant engineer. Application of the guidelines occurred in several case studies during the project. Overall, the AASHTO Guide generally provides commentary on the application of various bicycle facility treatments, which practitioners can use to make an educated decision on facility design even though specifics are lacking in some cases. The perspective was that it would be helpful if the TAC Guide, when updated, provided guidance on treatment selection and width recommendations for various site conditions for both new and retrofit scenarios.

The project will be fully implemented in 2014 and has been aided by a collaborative approach among municipal managers and committed leaders on the local Council.

<u>Peel Region, Ontario</u>

Peel Region is an upper-tier municipality located immediately west of Toronto comprised of the cities of Mississauga and Brampton, and the town of Caledon. The Region's population is 1.3 million. A Road Characterization Study brought together multiple stakeholders to develop a set of designs that establish ROW priorities, meet multi-modal demands on the roadways, and support current and future land use.[3] This included staff from the Region's public health unit who are working with partners to increase options for walking and cycling. The six road typologies with cross sections and access control measures were developed following a review of best practices of current technical guidance in both Canada and the U.S.

A key aspect of the study was to address road access to reduce or limit access as a safety measure to reduce potential conflict points between motor vehicles, cyclists and pedestrians. Past access control practice made no distinctions as to the character of the roads other than their functional class. In the new typology, the scope of access control measures reflects the blend of mobility and property access intended for the road context. The intention is that access control measures will respond to evolving land uses that need different spacing. For example, for areas with increasing development and intensification, the intersection spacing can be reduced supporting the creation of a network of streets to create more commercially valuable municipal street frontage within a short distance of an arterial road, and provide greater connectivity for pedestrians and cyclists. Overall, a fine grain road network, like that presented by city blocks, satisfies many access control intents.

The new road classifications and finer grain characteristics are beginning to be implemented in development applications and regional planning documents.

Thus through the Road Characterization Study, the Region of Peel re-examined its approach to the Regional road right-of-way design. A “one size fits all” approach that focussed on moving single occupant vehicles and motorist safety was previously employed. A more balanced response to meet the needs of pedestrians, cyclists, transit users, motorists and trucks within the limited Regional rights-of-way is now being pursued.

Waterloo, Ontario

The Region of Waterloo is an upper-tier municipality located northwest of Toronto comprised of the cities of Kitchener, Cambridge, and Waterloo, as well as surrounding townships. The Region’s population is 553,000. The Region has developed Context-Sensitive Regional Transportation Corridor Design Guidelines that establish a well-defined and descriptive hierarchy addressing five overall types of roads, address the convenient and comfortable movement of goods and people, integrate public transit and AT, and respond to the diversity of adjacent land uses.[4] The guidelines contain a series of worksheets that outline a decision-making process that first considers the type of street and then the priority mode of transportation.

Consultations occurred with a wide range of stakeholders to develop the guidelines. Approved by Council, the guidelines have reduced, although not eliminated, the extent of negotiations required for individual projects. In balancing multiple objectives and differences in contexts, the guidelines provide pragmatic support to augment the existing geometric design guidelines, which had previously been viewed as the standard. For example, some roads have been narrowed to support addition of bike lanes, while others have had lanes removed to accommodate bike lanes. Expectations for developers have changed so that at times, they are being asked to do more such as putting in landscaping. However, there is potential for such changes to increase value of the development and in some instances, the ROW is decreased freeing up more land for developers’ use.

Edmonton, Alberta

The city of Edmonton has a population of 812,000. The city’s Transportation Master Plan (TMP), *The Way We Move,* was approved by Council in 2009. It provides a set of complete street guidelines that includes advice on Roadway Design, Travel Lanes and Lane Widths to accommodate all modes of transportation.[5] It represents a major change in planning with a shift in transport mode hierarchy, rethinking of street design from a previous set of 3 types to multiple types and options for each, as well as a goal of 500 km of bike lanes over a 10-year period. To align structure with function, the transportation planning department was re-organized into four units to support the TMP’s implementation. One of the units focuses on sustainable transportation and it received an increase in dedicated staff at the time of its creation. The unit focuses on capacity building with production of guidelines and supports, and provides assistance with initial implementation.

Overall, a series of supporting policies have been developed to support the TMP including an AT policy, a complete streets policy, and a congestion policy. The initial implementation of the cycling plan focussed on 'low hanging fruit' by adding bike lanes if resurfacing a road or if establishing a new neighbourhood. The shift in transport mode hierarchy and intent for greater sustainable transport has meant that the former predominance of motor vehicles has been reduced with the potential loss of traffic lanes in order to support bike lanes, public transit, sidewalks, etc. Over time, public concerns have increased and altering the TMP's implementation became a major focus of the last municipal election. Subsequent direction by the new Council has been to focus implementation on two new bike routes and to place a hold on the rest of the cycling plan pending its review. As a department, they have a strong culture for traffic counts utilizing pole-mounted cameras and are applying this to their cycle paths.

In planning bike routes, they have needed to access additional sources of information beyond geometric design guidelines to address cycling infrastructure. While the geometric design guidelines indicate that smaller widths are supportable, 3.7 m has historically been the standard in many large cities like Edmonton. As part of their complete streets work, they have needed to rethink road widths identifying for some streets 3.2 m widths in travel lanes and 2.4 m for parking.

Red Deer, Alberta

The city of Red Deer is located mid-way between Edmonton and Calgary, and has a population of 97,000. The city conducted a 2-year pilot of a cycling network with 13 km of on-street bike lanes and 5 km of on-street bike routes. Interest in establishing the bike lanes was initially stimulated by an opportunity for project funding through the Red Deer Primary Care Network. While the proposal was not funded, the strong collaborative process to develop the proposal garnered interest among senior management, community members, and Councillors resulting in the Council funding the project.

In planning the routes, they did considerable analysis of existing uses such as parking and held discussions with business and schools to ensure understanding of local needs. Broader participation occurred through a project steering committee with stakeholder involvement. The paths were promoted in local media and through a portable bike map.

As with any significant change, considerable resources were required to deal with inquiries and complaints, which numbered 200 calls a month at its peak. Generally, identified issues were addressed by design modifications and concerns decreased. Some piloted designs were reversed due to citizens' concerns. The largest challenge was design through the downtown area where there was a through lane and parking lane in both directions. To deal with the specific scenarios and options in terms of how best to accommodate public transit buses, parking, bike lanes and a bike buffer area, the geometric design guidelines were augmented with other reference documents. Canadian and U.S. bicycle design guides, peer outreach to other cities, and extensive observations and measurements were undertaken to land on the final design that reduced travel lanes to 3.3 m and parking lanes to 2.2 m, and utilized 1.2 m bike lanes with a 0.6 m buffer. Peer review of the design by an independent engineer was also conducted.

Vancouver, British Columbia

The Metro Vancouver region is home to over 2.3 million people. TransLink is the multi-modal transportation agency for the region responsible for all regional transit, a portion of bridges and the major road network (shared responsibility with municipal partners), regional cycling and a transport demand management (TDM) function. One of the key regional strategies is to develop and communicate an interconnected network of transit service 15 minutes or better during the day and evening, 7 days a week to form a Frequent Transit Network (FTN)[6]. Metro Vancouver, the regional agency responsible for regional growth management and regional district services, explicitly encourages growth to occur in designated Urban Centres and in Frequent Transit Development Areas (FTDAs). Under Metro 2040, Metro Vancouver's regional growth strategy, municipalities can designate FTDAs, which are intended to be higher density, mixed use areas located along either the existing or future FTN. As such, the FTN, Urban Centres and FTDAs form the centrepiece for coordinating land use and transportation in the region. This fosters not only higher transit use, but increased walking, cycling, more efficient transit service provision and reduced congestion in the region as well as associated environmental and health benefits. -.

One of the features of the FTN is that the network is independent of transit fleet type. An FTDA may be located on either a bus-based or rail-based node or corridor and with increased density and other characteristics, higher levels of transit may be supported. Municipal designation of FTDAs is voluntary, but as funding becomes available higher level transit such as rapid transit or expansion of the FTN is anticipated to be prioritized in areas where a municipality shows how they are planning their land use and designing their streets to support walking, cycling and transit. This is a key aspect of how land use and transit use are being coordinated to support higher level transit service as well as increased levels of walking and cycling.

Currently, about half of the region's population and two thirds of jobs are located within walking distance of the FTN. In these locations, sustainable transport mode share is twice as high compared to areas not allocated within walking distance of the FTN (38% vs. 18% for all trip purposes in 2011). It is anticipated that about 90-95% of future regional land use intensification such as apartment buildings, offices, and affordable housing will occur within walking distance of the FTN, which is important as these occupants have higher propensity to take transit. Benefits for developers are that it is easier to market their product with proximity to the FTN, there is need for less parking and household costs are less with reduced expenditures on motor vehicles.

Working with its partners, Metro Vancouver and TransLink have developed guidelines for FTDAs as well as for fostering transit-oriented communities focused on the "6Ds" (density, diversity, destination, design, distance, demand management). Together with other regional land use and transportation strategies, the FTN and FTDAs provide engineers with the planning context for implementing improved street and road design and other infrastructure investments. The

Design “D” in TransLink’s Transit-Oriented Communities Design Guidelines provides examples and best practices for how engineering-focused activities can be better integrated into neighbourhoods. For example, the Guidelines encourage increased street connectivity, multi-modal streets and designing parking to support a pedestrian-oriented urban realm.

DISCUSSION

While the six case studies have unique features, they share a pursuit of supporting greater active transportation and/or public transit use. They have also demonstrated leadership solving practical problems by developing successful design approaches that are a useful input to the review of the geometric design guidelines. Several themes are common among many of the case studies.

In response to major changes in planning objectives and contexts, municipal transportation departments are needing to re-conceptualize their roads. This includes moving away from a one size fits all standard design, to a range of road types with different user profiles, land use contexts, and road widths. A perspective where roads are first and foremost for motor vehicles is shifting towards ‘complete streets’ with, in some locations, an explicit re-prioritization of road users. This paradigm shift has required workforce development efforts among internal engineering staff, as well as education of transportation stakeholders. The process of re-thinking road types and their application has been important for achieving understanding and buy-in. However, from an efficiency and consistency perspective, there may be a role to support and provide greater guidance to transportation departments and their engineers in their analysis and uptake of these approaches.

The case studies highlighted the fact that the Engineers, Planners, Health and other professionals need to work together to address the complexity of community and infrastructure building. New study methods and approaches will evolve that balance the local land use context while developing safe healthy and activity promoting communities.

Another common theme is that the complexity of the design challenges being faced by transportation engineers is not being fully met by the existing geometric design guidelines. Engineers are dealing with specific scenarios involving different ROW sizes and multiple road users and would benefit from guidance that helps them identify the options and the selection of the most appropriate one. For example, in one of the case studies, engineers were faced with what to do if there is less than 1.5 m available for a bike lane and how to accommodate a smaller corresponding buffer door zone. In addition to peer outreach, key informants identified a number of additional resources beyond TAC guidelines that they have been using to inform decision making or to develop local guidelines, including the AASHTO bicycle facilities guide,[2] the National Association of City Transportation Officials (NACTO) Urban Bikeway Design Guide,[7] and the Bicycle Facilities Design Course Manual from British Columbia.[8]

In addition to workforce development, a range of change management strategies have been utilized. This has included reorganizing the transportation planning department to align with strategic objectives. It has also included the development and use of local guidelines that has involved a range of stakeholders to seek agreement on the new vision and approaches, which are then formalized with Council endorsement. Application of the new guidelines by one region was identified to have reduced the extent of negotiations on individual projects.

Eligibility for higher order transit has also been used as an incentive for municipalities and developers to pursue the planning of more compact, complete communities. The need to engage and respond to stakeholders was another theme with one of the case studies highlighting the need to establish capacity to manage the additional inquiries from the public when implementing projects. For those sites implementing new AT routes, the extent of measurement of impact with respect to AT users varied ranging from no measurement to the use of pole mounted cameras. As public and political interest in such routes increases, the usefulness of baseline and trend count data will likely increase particularly if planning decisions are contentious.

Considering the interested involvement of multiple stakeholders and the major change in thinking and operations, political support has been critical. Where it has existed, it has facilitated the development of new plans and the endorsement of new approaches. Reflecting public concerns, politicians have requested pilot designs to be returned to the status quo. Political leaders have also been replaced in response to public perceptions that changes to roads have been too large and/or too rapid. Even if political support exists, implementation may be limited by the level of allocated funding.

CONCLUSION

The profiled case studies illustrate the work and challenges of front-line engineers and planners to adapt roadways to balance the needs of competing ROW users while maintaining road functionality and operations. The case studies indicate that through leadership, ingenuity and perseverance, municipalities and their staff have found approaches to resolve practical issues. Their experiences are therefore informative to the field and their colleagues involved with the Transportation Association of Canada's geometric design review.

Table 1 – Comparison of bicycle facility guidelines provided by TAC and AASHTO

<table>
<tr><th rowspan="2">TOPIC</th><th>TAC Geometric Design Guide (1999)</th><th>AASHTO Guide for the Development of Bicycle Facilities (2012)</th></tr>
<tr><th>CHAPTER 3.4 BIKEWAYS</th><th>CHAPTER 4 – DESIGN OF ON-ROAD FACILITIES</th></tr>
<tr><td>Bike Lane Widths

(Basic)</td><td><u>Section 3.4.6 Cross Section Elements</u>

Table 3.4.6.2:

Recommended Width 1.5 to 2.0 m

Add 0.5 m if AADT in adjacent lane > 6,000 vpd or if trucks exceed 10%. Add an additional 0.5 m if roadway speed is 100 km/h or greater.</td><td><u>Section 4.6.4 – Bicycle Lane Widths</u>

Recommended width is 1.5 m to face of curb (1.2 m to edge of gutter).

<u>Exceptions:</u>

- In locations with higher motor-vehicle speeds, the preferred bike lane width is 1.8 m.
- On constrained, low-speed roadways with curbs but no gutter, and where the preferred bike lane width cannot be achieved despite narrowing all other travel lanes to their minimum widths, a 1.2 m bike lane can be used (to face of curb).</td></tr>
<tr><td>Bike Lane Widths

(with On-Street Parking)</td><td><u>Section 3.4.6 Cross Section Elements</u>

Section 3.4.6.1:

“Where bicycles and parked cars share a lane, the minimum lane width is 4.0 m. This width assumes a 2.4 m parking bay.”</td><td><u>Section 4.6.5 – Bicycle Lanes and On-Street Parking</u>

This section provides guidance specifically related to bike lanes adjacent to parking. The guidelines provide some flexibility with minimum and maximum values.

- Recommended bike lanes width adjacent to on-street parking is 1.8 m, but minimum is 1.5 m.
- The recommended width of a parallel parking lane is 2.4 m and the minimum width is 2.1 m.
- A wider bicycle lane (1.8 – 2.1 m) may be desirable for narrower parking lanes (2.1 m) with high turnover, but exceptionally wide bike lanes should be avoided as they could lead to double parking.
- Where parking lane lines or stall markings are not utilized, the recommended width of the shared bicycle parking lane is 4.0 m.
- A minimum shared width of 3.7 m may be satisfactory if parking usage is low and turnover is infrequent.

Section 4.6.5 also provides some general application guidelines for bike</td></tr>
</table>

<table>
<tr><th rowspan="2">TOPIC</th><th>TAC Geometric Design Guide (1999)</th><th>AASHTO Guide for the Development of Bicycle Facilities (2012)</th></tr>
<tr><th>CHAPTER 3.4 BIKEWAYS</th><th>CHAPTER 4 – DESIGN OF ON-ROAD FACILITIES</th></tr>
<tr><td></td><td></td><td>lanes adjacent to diagonal parking, but no dimensions are provided.</td></tr>
<tr><td>Shared Lanes</td><td><u>Section 3.4.6 Cross Section Elements</u>

Table 3.4.6.2:
<table>
<tr><th>AADT
(in the Shared Lane)</th><th>Lane Width (m)</th></tr>
<tr><td>0-1,000</td><td>Standard roadway lane to 4.0</td></tr>
<tr><td>1,000-3,000</td><td>Standard roadway lane to 4.3</td></tr>
<tr><td>3,000-6,000</td><td>4.0 to 4.5</td></tr>
<tr><td>>6,000</td><td>4.3 to 4.8</td></tr>
</table>
Add 0.5 m if AADT in adjacent lane > 6,000 vpd or if trucks exceed 10%. Add an additional 0.5 m if roadway speed is 100 km/h or greater.

The TAC guidance is generally good for shared lanes with respect to recommended widths under various conditions.</td><td><u>Section 4.3 Shared Lanes</u>

AASHTO provides a general description of shared lanes and recommends lane widths from 4.0 m to 4.9 m. Specific criteria are not provided as in TAC, but general considerations are provided in the selection of widths.

AASHTO also provides some guidance on when to use marked shared lanes (vs. no markings). These guidelines are useful for evaluating special circumstances or when defending a case to provide markings.</td></tr>
<tr><td>Paved Shoulders</td><td><u>Section 3.4.6 Cross Section Elements</u>

Section 3.4.6.1 states:

Widths required for paved shoulders are the same as those required for exclusive bike lanes, varying from a minimum of 1.5 m to 3.0 m depending on the speed and composition of motor vehicle traffic.</td><td><u>Section 4.5 – Paved Shoulders</u>

AASHTO provides commentary on the benefits of paved shoulders and considerations for use. Recommended dimensions are limited to the following:

- Paved shoulders should be at least 1.2 m wide;
- Shoulder width of at least 1.5 m is recommended from the face of guardrail, curb, or other roadside barrier.

Reference is made to the HCM Bicycle Level of Service tool which takes</td></tr>
</table>

TOPIC	TAC Geometric Design Guide (1999)	AASHTO Guide for the Development of Bicycle Facilities (2012)
	CHAPTER 3.4 BIKEWAYS	**CHAPTER 4 – DESIGN OF ON-ROAD FACILITIES**
		shoulder width into account in the calculations.

Retrofitting Streets for Bike Lanes	No specific guidance provided	**<u>Section 4.9 - Retrofitting Bicycle Facilities on Existing Streets and Highways</u>**
		
		The AASHTO guideline provides recognition of situations involving retrofits (which is most often the case when incorporating bike lanes).
		
		- *When retrofitting roads for bicycle facilities, the width guidelines for bike lanes and paved shoulders should be applied. However, undesignated paved shoulders can improve conditions for bicyclists on constrained roadways where obtaining the preferred shoulder widths is not practical. In these situations, the following should be provided:*
		  - *a minimum of 0.9 m of operating space between the edge line and gutter joint (with curb and gutter);*
		  - *A minimum of 1.2 m of operating space between the edge line and the curb face (no gutter) or to the edge of paved shoulder (no curb or gutter).*
		  - *It is generally preferable in retrofit situations to provide the 0.9 to 1.2 m paved shoulder or leave the road unchanged than to provide a narrower paved shoulder. For example if the total width of an existing outside lane is 4.3 m, it would generally be preferable to provide a 3.0 to 3.3 m vehicle lane and a 0.9 m 1.2 m paved shoulder OR to leave the 4.3 m outside lane unchanged than to provide 3.6 m travel lane and 0.6 m shoulder. The latter option provides limited space for cyclists either in the shoulder or in the travel lane.*

Traffic Control Signage and Pavement Markings	Practitioners must refer to the **TAC Bikeway Traffic Control Guidelines for Canada**, a separate publication that provides guidelines for signage and pavement markings for various types of bike facilities and conditions.	**<u>Chapter 4.7 Bicycle Lane Markings and Signs</u>** AASHTO provides pavement marking schemes for bike lanes at various roadway and intersection scenarios. Signage guidelines are limited in this chapter. Practitioners need to refer to the **FHWA Manual of Uniform Traffic Control Devices**, which covers bicycle signage in depth.

TOPIC	TAC Geometric Design Guide (1999)	AASHTO Guide for the Development of Bicycle Facilities (2012)
	CHAPTER 3.4 BIKEWAYS	**CHAPTER 4 – DESIGN OF ON-ROAD FACILITIES**
		Chapter 4.11 Bicycle Guide Signs/Wayfinding The AASHTO Guide does provide commentary and guidance on the application of wayfinding and guide signage for bicycle facilities. This issue is not addressed in TAC publications.
Geometric Design	Both publications provide guidelines on the geometric design of bicycle facilities. Strengths and weaknesses are not addressed here.	

Comparison prepared by Peter Allaby, PEng, MASc, Transportation Lead, Atlantic Canada, exp Services Inc.

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(3) Region of Peel's road characterization study. Region of Peel, 2013.

(4) Context sensitive regional transportation corridor design guidelines. Region of Waterloo, 2013.

(5) The way we move. Complete street guidelines. City of Edmonton, 2013.

(6) Regional transportation strategy. Strategic framework. TransLink, 2013.

(7) National Association of City Transportation Officials. Urban bikeway design guide. NACTO, 2011.

(8) Bicycle facilities design course manual. BC Recreation and Parks Association, 2011.