

**The Place of Complete Streets:
Aligning urban street design practices with pedestrian and cycling priorities**

by

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Abstract

Many Canadian cities are collectively considering pedestrians, cyclists, public transit, automobiles, and the movement of goods through *complete streets*, aspiring to enable all people, regardless of age, income, abilities, or lifestyle choices to use streets. Canadian municipal transportation practices are largely based on conventional approaches, where the movement of motor vehicles is a priority. The purpose of this practicum is to identify ways that selected precedents from Canadian and European municipal practices, may inform Canadian municipalities as they seek to incorporate the needs of pedestrians and cyclists – encompassing city planning, transportation engineering, architecture, and urban design considerations. The results of this research exemplify the interdisciplinary involvement required for creating streets as both links and places. Recommendations for Canadian municipalities include aligning municipal design practices with complete streets practices and incorporating interdisciplinary inputs in street design. Ensuring an interdisciplinary university education is recommended for street design professions.

Key words: complete streets; interdisciplinary design; scales of design; multimodal mobility, accessibility, and sojournability; classification systems; design criteria

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1 Introduction

Streets are the connectors of communities; they are the stages where neighbours meet; the passageways for children to get to school; the corridors that allow young and elderly people to access their daily needs; and the routes that deliver and receive goods. Streets that are functional, safe, and enjoyable allow people of all ages to actively engage in their community and benefit from the economic vitality of their city (Jacobs, 1961; Manheim, 1979; Jacobs, 1993; Gehl, 2001). Countries and municipalities around the world are acknowledging the broader community, economic, health, and environmental implications of transportation (see Section 2.1) (ITF¹, 2014), and complete streets are ensuing design approaches for addressing these challenges at a municipal scale.

Complete streets are an approach for municipalities to consider multimodal street priorities, providing transportation options for people with a variety of physical abilities and lifestyles. Complete streets promote physical activity, reduce pollution, improve multimodal safety, create financial benefits, increase transportation efficiency, and encourage social interactions (Transport Canada, 2009).

Barbara McCann at American Bikes first used the ‘complete streets’ term in 2003, and this organization went on to partner with other groups to launch the National Complete Streets Coalition throughout the United States in 2005 (Smart Growth America, 2015). The Complete Streets for Canada Policy and Design Hub was launched in 2012. Complete Streets for Canada (2012, *Home*) defines complete streets as:

A Complete Street is designed for all ages, abilities, and modes of travel. On Complete Streets, safe and comfortable access for pedestrians, bicycles,

¹ ITF – International Transport Forum – is an annual summit held in Leipzig Germany, where transportation ministers from 54 member countries, industry leaders, cutting-edge researchers, and NGOs meet to discuss transport policies, issues, and innovations. The transport issues included here were some of the main topics discussed at the 2014 Forum.

transit users and the mobility-impaired is not an afterthought, but an integral planning feature (para. 1).

Complete streets are also described as a “political and cultural movement ” (McCann, 2013, p. 4) that changes conversations about how streets are “chosen, planned, and built” (p. 4), from auto-centred design priorities to a multimodal design approach. McCann (2013) suggests there is no “compelling design paradigm” (p. 4) associated with complete streets. This practicum acknowledges that multiple factors impact design (e.g. institutional, political, and societal), but draws primarily from interdisciplinary approaches that guide design practices at a municipal level.

Although the descriptor *complete streets* is often capitalized as – “Complete Streets” – declaring the approach as a proper title (e.g. Complete Streets for Canada or the National Complete Streets Coalition), the descriptor is not capitalized in this practicum. The reason is that complete streets are discussed here in reference to general principles and priorities of design (referred to throughout this practicum, particularly in Section 2.2), describing the holistic design approach to result in “completeness” for the particular street context.

There are challenges when applying complete streets principles to mixed-use arterial streets, as dense mixed-use developments are ideal for pedestrians and cyclists, but arterial streets are primary thoroughfares typically designed for motor vehicles. Mixed-use arterial streets function as links within the regional transportation network, places for human interactions, and connectors between residential, commercial, and community amenities (Bochner & Dock, 2003; Marshall, 2005; ITE, 2010, City of Calgary, 2014).

The Transportation Association of Canada (TAC), the most influential transportation engineering organization in Canada, suggests that urban arterial streets should include traffic movement as a focal characteristic (TAC, 1999, p. 1.3.4.3) (see Appendix A), connecting

neighbourhoods across a city (see Section 3.2.2). Minimal access controls and uninterrupted flow are prioritized, with the exception of intersections (TAC, 1999, p. 1.3.4.3) (see Appendix A); cyclists may be accommodated on widened lanes or separate facilities, and pedestrians may be accommodated on sidewalks separated from motor vehicle travel (TAC, 1999, p. 1.3.4.3) (see Appendix A). Arterial streets are prioritized for motor vehicle movement, as local and collector streets are deemed safe and adequate for pedestrian and cycling activities (TAC, 1999; Hess, 2009). City planners and urban designers commonly refer to mixed-use for land use planning purposes. Mixed-use areas combine residential or office uses with commercial and/or service land uses (ITE, 2010). The *mixing* may occur vertically, where land use changes on different building floors, or horizontally, where land use varies within a short distance (ITE, 2010). Mixed-use streets create ideal pedestrian and cycling environments due to the close proximity of uses and the range/variety of social environments created. This practicum combines the two designated types into *mixed-use arterial streets* to describe streets where interdisciplinary conditions exist: transportation modes require the use of the street as links (i.e. arterial) and places (i.e. mixed-use).

The classification of mixed-use arterial streets is also used by the City of Edmonton (2013)². Some municipalities and organizations have created classifications to describe mixed-use arterial contexts, such as liveable streets or main streets. These street types incorporate the adjacent built form and activities in the naming system. The City of Calgary's *2014 Complete Streets Guide* describes "liveable" streets to prioritize cycling, walking, and commercial activity over the movement of automobiles and goods movement, and value the role of streets as places

²Edmonton's composite classification system also indicates the orientation of the adjacent buildings: "street oriented mixed-use arterial" or a "non-street-oriented mixed-use arterial" (City of Edmonton, 2013, p. 18-22) (see Section 3.3.2). The orientation of buildings (i.e. street-oriented versus non-street oriented) is not specified in this practicum, as this level of detail is not directly addressed.

for social interactions (p. 6). Calgary's classification is unique in its acknowledgement of high motor vehicle volumes present on liveable streets, but its priority for pedestrians, cyclists, and transit (see "liveable urban boulevards" or "liveable neighbourhood boulevard"³) (City of Calgary, 2014, p. 8). The specific term "liveable streets" is a specific term that is not widely used, and thus has limitations for this practicum. The Institute of Transportation Engineers (ITE) (2010) describes "main streets" to include compact, mixed-use development, generally one- to three-storey buildings with no setback, strong aesthetic appeal, on-street parking, and provisions for motor vehicles, transit, pedestrians, and cyclists. Main streets attract social and commercial activity, while also providing residential and office space (ITE, 2010). The following limitations may exist when using the term main street: it is often associated with the main commercial street of a small town or old city; trucks may not be permitted on these streets; and variations in built form may exist. To avoid these limitations mixed-use arterial streets is the classification used, as it is commonly discussed in guidelines (e.g. ITE, 2010), and across disciplines and jurisdictions.

Although not all streets will support every mode, complete streets approaches build multimodal networks to ensure that cities are accessible without the need for automobiles (City of Edmonton, 2013; City of Calgary, 2014). As described throughout this practicum, motor vehicle travel and pedestrian and cycling sojourning on streets may have contrary design priorities, yet the International Transport Forum urges cities to value streets' role in providing equal access to urban opportunities and quality social places (ITF, 2012). The purpose of this practicum is to suggest ways that selected precedents from Canadian and European municipal practice, may further inform cycling and pedestrian design practices in Canadian cities.

³ This is a composite street typology, described in Section 3.3.2.

1.1 Problem Statement and Scope

Although Canadian cities are taking steps towards complete streets, practices account for streets' designs as motor vehicle links, but do not necessarily incorporate the value of streets as multimodal links and places. Conventional design practices are defined to prioritize streets role as motor vehicle links, and this practicum investigates practices that prioritize pedestrians and cyclists and intrinsically consider the needs of all modes of transport. Hess and Smith Lea (2014) identify ways that conventional design practices create barriers to implementing cycling and walking policies. Dover and Massengale (2013) further point out deficiencies in the complete streets approach for supporting streets as places, and they suggest the next step for complete streets is to encourage enjoyable streets that are places for people to spend time. This practicum accepts the value of streets as links and places, and furthers the complete streets approach by investigating interdisciplinary practices for designing streets that align with municipal complete streets policies, particularly regarding streets as places. Aligning practices and policies, complete streets role as places, and interdisciplinary design are inherently included in this practicum's scope.

Cycling and walking policies exist in municipalities across Canada (Complete Streets for Canada, 2012), yet these policies are not necessarily implemented (Hess and Smith Lea, 2014). Hess and Smith Lea (2014)⁴ identified ways practices are not aligning with cycling and walking policies, and they suggest that practices prioritizing pedestrians and cyclists are needed. Hess and Smith Lea (2014) further outline ways urban guidelines and performance measures do not align with pedestrian and cycling policies – guidelines and performance measures are also included in the scope of this project.

⁴ The researcher of this practicum was the research project coordinator, and contributed as a writer for Hess and Smith Lea (2014).

Dover and Massengale (2013) criticize the United States' National Complete Streets Coalition lack of attention given to streets' value as places, as they suggest that multimodal mobility is the pervasive focus: "its primary purpose is to move vehicles (now including bicycles) *through* the city, and little or no thought is given to being *in* the city, on a particular block" (Dover & Massengale, 2013, p. 368-369). Dover and Massengale expand the notion of interdisciplinary street design, describing the roles of city planners, engineers, architects, artists, retail, finance, and law. Quality public space along streets is key to transforming a street from solely a link to also a place, as people are invited not just to move, but to also spend time on the street (Gehl, 2010; Dover & Massengale, 2013). Edmonton's (2013) complete streets guidelines highlight streets' role in accommodating flow and place, demonstrating that some complete streets guidelines do highlight streets' roles as places.

The place and link of mixed-use arterial streets are interdisciplinary by nature: mixed-use is applicable to city planners' land use planning, and arterial streets are applicable to transportation engineers network planning and geometric design. Hess (2009) suggests there are power imbalances between city planners and transportation engineers at the municipal level: transportation engineers' have "narrower, but more developed technical knowledge" (p. 4) related to safety and liability, and city planners have "broad but relatively weak technical knowledge" (p. 4). Transportation engineers' knowledge is resultantly regarded at a municipal political level above city planners (Hess, 2009). This practicum is not intended to validate one design profession over another, but rather draw practices from different professions that elevate streets' roles as links and places for pedestrians and cyclists. This practicum defines a street as the roadway, sidewalk, landscaped area, and adjacent land uses and built form, encompassing practices of city planners, transportation engineers, urban designers, and architects. Terms and

methods employed by various design professions are explained, intending to improve communication and practices between disciplines (see Section 1.6).

1.2 Background

TAC provides design resources that support transportation engineers in the design of streets. These resources are adapted or applied by municipalities across Canada (Hess & Smith Lea, 2014). TAC's resources include the *Geometric Design Guide for Canadian Roads* (1999), *Bikeway Traffic Control Guidelines for Canada* (2012), *Pedestrian Crossing Control Guide* (2012), and *Canadian Guide for Greener Roads* (2015). The *Geometric Design Guide for Canadian Roads*⁵ discusses the importance of balancing the safety, mobility, environmental, aesthetics, and cost impacts of street design⁶; although this guideline is intended to encompass urban and rural environments, design principles applicable to highways and arterial streets are its focus. The *Bikeway Traffic Control Guidelines for Canada* and *Pedestrian Crossing Control Guide* present ways for incorporating cycling and pedestrian infrastructure within streets. The *Canadian Guide for Greener Roads* includes four guidelines related to pedestrians and cyclists: Bicycle Access, Pedestrian Access, Road Safety in Urban Bicycle Facilities, and Safe Intersections and Driveways. Two resources from the United States present ways for balancing the multimodal needs of the urban context: the National Association of City Transportation Officials' (NACTO's) *Urban Street Design Guide* and the Institute of Transportation Engineers' (ITE's) *Designing Walkable Urban Thoroughfares: A Context Sensitive Approach*. However, Hess and Smith Lea (2014) indicate, "there is no current state-of-the-art guidelines that fully

⁵ Geometric design encompasses streets' features and dimensions that relate to a mode's movement and safety (e.g. turning radius, street grade, lane width, storage lane length) and are typically based on transportation engineers' quantifiable criteria (vehicle volumes, speeds, and sizes)

⁶ TAC's 2011 updates to the 1999 Guide suggested the next edition would incorporate context-sensitive approaches, where people's inputs are considered in design (TAC, 1999 [Updated 2011]).

incorporate AT into street design developed by influential Canadian organizations such as TAC” (p. 14). Internationally there is also a lack of standardized indicators that communicate streets’ roles as places (ITF, 2012).

Canadian municipalities are developing complete streets guidelines in Calgary, Edmonton, and Toronto to align practices with multimodal priorities (Complete Streets for Canada, 2012). Other Canadian municipalities, including Winnipeg (City of Winnipeg, 2011), have included complete streets references in their transportation policies; depending on the city, design practices may be adapting to align with multimodal policies, although not necessarily through “complete streets” guidelines. Canadian design processes, guidelines, and criteria, however, are not necessarily aligning with multimodal policies (Hess & Smith Lea, 2014). These issues also speak to a lack of interdisciplinary inputs in street design practices, as the placemaking practices of architects and urban designers may not be included (Dover & Massengale, 2013; Gehl, 2010)

While street design practices between transportation engineers, city planners, urban designers, and architects continue to develop, there are disconnects between their practices (Brown, 2005; Dover & Massengale, 2013). A difference is transportation engineers’ focus on designing streets as links (Manheim, 1979; TAC, 1999), and the desires of city planners, urban designers, and architects to create streets that are places within communities (Gehl, 2001; Hess, 2009; Dover & Massengale, 2013). Professionals around the world increasingly understand the value of streets as places (ITF, 2012).

1.3 Objective and Research Questions

The purpose of this practicum is to suggest ways that selected precedents from Canadian and European municipalities may further inform practices in Canadian cities for accommodating pedestrians and cyclists’ use of streets as links and places. Research into interdisciplinary

practices draws from scholarly literature, grey literature, and practitioner interviews. The driving research questions are as follows:

- 1. In what ways do the conventional and complete streets approaches influence the design of mixed-use arterial streets?**
- 2. What are Canadian and European municipal precedents for designing complete streets, specifically on mixed-use arterial streets?**
- 3. In what ways could Canadian design approaches be adapted to improve complete streets design practices on mixed-use arterial streets?**

Before examining technical matters of street design, the importance of complete streets is discussed from social, economic, and environmental standpoints. Key design themes noted throughout the literature include the street functions of mobility and accessibility (see Section 3.1.1), as well as scales of design (see Section 3.1.2), street classification systems (see Section 3.1.4), and design criteria (see Section 3.1.3). To encompass aspects of streets that contribute to streets' roles as places, including encouraging leisure and social activities and enhancing pedestrians and cyclists' experience, this practicum adds the term *sojournability* to the mobility and accessibility street function framework (see Section 3.1.1). Aspects of sojournability are themes in the literature, and were drawn upon to inform and expand the street function framework, encompassing the value of streets as places.

This practicum discusses these themes in relation to the conventional and complete streets approaches, showing how the approaches influence pedestrian and cycling priorities (see Section 3). Precedents from the City of Edmonton, Vélo Québec (Montreal), the City of Leipzig (Germany), and Gehl Architects (Denmark) are investigated to progress complete streets practices in Canadian municipalities (see Section 4). Interviews are conducted and grey literature is reviewed to collect information on precedents' approaches, interviewees included municipal and consulting practitioners. The precedents are analyzed in relation to complete streets approaches, seeking to understand how municipalities can design complete streets to

accommodate the street functions at different scales of design (see Section 5). The findings and analysis lead to conclusions and recommendations for Canadian municipal design practices.

1.4 Limitations

Due to scope limitations, and the focus of this practicum on pedestrians' and cyclists' use of mixed-use arterial streets, the following pertinent areas were not explored as a part of this practicum: institutional and political priorities, as well as street network configurations, land use patterns, and public transport. This section provides background on these pertinent areas that are not discussed in detail in this practicum.

Street design is a multifaceted endeavour, involving technical, institutional, political, and societal priorities. Technical design aspects involve the processes and tools used to determine designs, and are typically documented in guidelines, manuals, and handbooks. Institutional systems influence how design disciplines, such as transportation engineers, city planners, urban designers, and architects contribute to design process and the subsequent built environment (Hess, 2009). Transportation and land use decisions are steered by political priorities, which affect density limitations and land use distributions (regulated by zoning through land use bylaws), street widening projects, and budgetary priorities (Levine, 1999). Although the influence of technical, institutional, political, and societal aspects on street design is irrefutable, this practicum addressed societal needs and technical design aspects of streets. Topics discussed pertained to transportation engineers, city planners, urban designers, and architects. However, design professions themselves were not explored in detail.

Street network configurations/patterns and land use patterns influence the design of arterial streets. Street patterns include grid, tributary, focal web, layered loops (Marshall 2005). For example, if an arterial street is within a grid network, there are parallel streets that may have

fewer motor vehicles and may be better suited for a bike route. Alternative routes may not be available in other street patterns. Specific street patterns were not discussed in this practicum; the focus was on practices generalizable to all mixed-use arterial streets.

Land use patterns have impacts on transportation systems and the ways streets are used, namely through the density of people or buildings, and land use mix (Litman, 2003). The concept of transect zones considers how variations in urban form (natural zone, rural zone, sub-urban zone, general urban zone, urban center zone, and urban core zone) impact design strategies (Center for Applied Transect Studies, n.d.). Ways that land use patterns and regulations inform pedestrian and cyclist designs were not directly considered in this practicum.

Public transit is a complementary mode to walking, providing citywide access (ITF, 2012). Together with cycling, the three modes can provide citywide mobility (City of Calgary, 2014). Public transit was not directly addressed in this practicum due to the emphasis on pedestrians and cyclists, as well as limited scope. Design aspects pertaining to goods movement are also not directly discussed.

The scope and topical limitations to this practicum influenced the types of conclusions that were drawn (e.g. recommendations on how public transit can support pedestrians and cyclists were not considered, because public transit was not included in this practicum's scope). Limitations to conclusions are revisited in Section 5. The following section (Section 1.5) describes methods used to effectively and ethically glean relevant information for this practicum.

1.5 Research Design

The research questions were addressed sequentially to build understanding in the given topic areas. In the first stage of research, scholarly literature and grey literature was reviewed to investigate the question: *in what ways do the conventional and complete streets approaches*

influence the design of mixed-use arterial streets? Opportunities for improving design practices for complete streets were identified by investigating design approaches used by the selected precedent organizations, addressing the research question: *what are Canadian and European municipal precedents for designing complete streets, specifically on mixed-use arterial streets?* Interview questions for precedent organizations were generated from the literature review. The information gathered was synthesized through a content analysis, responding to the question: *in what ways could Canadian design approaches be adapted to improve complete streets design practices on mixed-use arterial streets?* Sections 1.5.1 and 1.5.2 outline the ethics and research methods used in this practicum.

1.5.1 Ethics

Ethics approval was obtained from the University of Manitoba. Given the subject matter and extremely low risk of the interview questions, the researcher did not deem that confidentiality was required. Interviewees were asked to discuss their professional knowledge and experience concerning street design, and confidentiality would not encourage participants to share information they would not otherwise. Interviewees were professionals talking about their professional responsibilities in areas that present very limited risk of any kind. Personal information collected was limited to names, professional titles and organizations, and a professional history – all of which is available online. Data was kept on a password-protected computer. Since data was not considered confidential, no other precautions were taken.

The researcher emailed summaries of results to interviewees to ensure the collected information was accurate. Two weeks were given for interviewees to confirm the accuracy of the collected information, which was also the last opportunity to withdraw data from the research. The researcher will disseminate the practicum's results by oral defense, digital online copy, hard

copy at the University of Manitoba Architecture/Fine Arts Library, and through potential publications. Participants were made aware of how their information would be disseminated before their signed consent was collected. Only participants who provided consent were included in this practicum. See Appendix B for the full ethics submission.

1.5.2 Methods

This section provides context for the research findings by explaining how Canadian and European precedents were identified, information was collected, and the data was analyzed. The primary research methods conducted were interviews and content analysis.

The researcher created criteria and attended national and international conferences to identify precedents that were applicable to the Canadian context. The following criteria were used when selecting precedents:

- Precedent organization acknowledge streets as links and places
- Precedent organization has a design process that considers the needs of pedestrians and cyclists as a priority, not a secondary consideration after motor vehicles

Through attending the following conferences in 2014 and having conversations with practitioners, the researcher identified precedent organizations for this practicum.

- International Transport Forum, Leipzig, Germany: City of Leipzig (Germany) and Gehl Architects (Denmark)
- Complete Streets Forum, Toronto: City of Edmonton
- Winter Cycling Congress, Winnipeg: Vélo Québec (Montreal)
- Transportation Association of Canada Annual Conference, Montréal: no additional precedents identified⁷

The precedents are not intended to be comprehensive of all complete streets design practices, nor were they selected to provide comparability between the practices employed. Rather, these precedents were selected to provide example practices that can inform how complete streets are

⁷ The researcher learned about Ottawa's pedestrian level of service, and included this information in Section 3.3.1.

designed. Other potentially informative precedents exist, but were not included due to the scope set and resources available for the research. The uniqueness of each organization’s approach affords opportunities for sharing practices between municipalities and design disciplines. Design focuses and terms used by the other organizations are provided in Table 1. The selected precedent organizations have different mandates for design, and their design practices reflected this. For example, while Vélo Québec strives to increase cycling and walking, the City of Edmonton is responsible for all modes of transport, and must make decisions to balance and compromise between modes. The range of precedents selected demonstrated ways that design decisions can balance priorities, and also ways that pedestrians’ and cyclists’ unique needs can be facilitated.

Table 1 – Precedent organization design focus and terms

Precedent Organization	Design Focus	Key Term Used to Encompass Design Focus
City of Edmonton	Pedestrians, cyclists, public transit (buses and light rail), automobiles, and the movement of goods	Complete Streets
City of Leipzig	Pedestrians, cyclists, public transit (buses and light rail), automobiles, and the movement of goods	No key term – simply discusses pedestrians and cyclists
Vélo Québec	Pedestrians and cyclists	No key term – simply discusses pedestrians and cyclists
Gehl Architects	Pedestrians and cyclists	Human Scale

Note that “complete streets” and “human scale” are both incorporated into this research, and are not strictly associated with the organizations given in Table 1.

Interview questions were developed based on the findings of the literature review, as identified through content analysis (outlined below). To understand the design approach of each precedent organization, information was gathered through scholarly literature, grey literature, and interviews. Scholarly and grey literature provided a first round of responses to the interview questions, and outstanding questions were answered through interviews.

In the cases of the City of Edmonton and Gehl Architects, responses to the interview questions were found in the literature. Literature responded to many of the questions for Vélo Québec and the City of Leipzig, but interviews were conducted to directly clarify points, and generally inquire about practices. Precedent research was also reviewed and findings validated by the interviewee from Vélo Québec, as well as by two transportation engineers from the City of Edmonton, and a German transportation engineer. A copy of the practicum was sent to Gehl Architects, but a response was not needed due to the extensiveness of the literature available on their approach. The review and validation for the City of Leipzig was particularly important, as the researcher used online translating programs to study the German language *Guidelines for Design of Urban Streets* (FGSV, 2006).

To accommodate the interviewees' availability, Vélo Québec's interview was held in Montréal at the Vélo Québec office (an audio recording was not used). Leipzig's interview was conducted through email. Interview conversations or emails began with an introduction to the project, and the process of consent and validation were described. The researcher continued by asking specific questions not adequately answered in the grey literature. Interviewees were encouraged to ask questions at any time. Interview questions targeted information related to practices, which can generally be accessed by the public. Opinions or sensitive information was not of interest, and so confidentiality was not required. The interview questions are included in Appendix B. Conversations with contacts from the City of Edmonton and with Gehl Architects directed the researcher to documents that responded to interview questions; however, these conversations were not used in in this practicum.

Questions were developed from the literature review to generally guide the precedent studies, and additional questions were asked to directly inquire or clarify concepts. Wilson (2012) explains that semi-structured interviews use general questions to direct the researcher and

interviewee, and additional findings are inquired as uncovered. Although questions were used to review grey literature *and* interview people, the general approach was similar to a *semi-structured interview*: the researcher compiled guiding questions, and reviewed literature to respond to guiding questions and to uncover additional practices. Wilson (2012) noted that comparing data in semi-structured interviews is more difficult because there is less restriction on the types of findings that may be discovered. Comparing findings was not a goal of this practicum; rather, investigating practices was the objective. Interviews were the chosen method because the researcher wanted to uncover practices not included in the literature or to clarify practices that may not have been fully explained in the literature.

Findings from the literature review and precedent studies were analyzed through a content analysis. Content analyses examine communication mediums to draw inferences about a message, or the people sending or receiving the message (Weber, 1990). Content analysis can be used in a quantitative or qualitative manner in a way that neither the sender nor receiver of the message is aware of what is being studied (Webb et al., 1981). It involves creating categories for dividing the data, where each category is one or many words, and consistent coding of the data reflects the categories. Coding is a sensitive process in which biases can be introduced in the interpretation and explanation of data. Webber (1990) cautions that there is a risk of poor information interpretation in content analysis, as the data is analyzed according to determined categories. This method was chosen to identify research themes related to conventional and complete streets approaches, and to correlate literature review and precedent study findings with themes.

1.6 Definitions

This subsection defines terms to improve interdisciplinary clarity. Clarity is required for the following reasons: a term may be specifically used by only one design profession; the term may be used by multiple professions, but each profession may associate a different meaning; or the researcher is using a common term that she is associating with a specific meaning. These terms were also important for framing and directing the practicum. Reading these definitions will improve the clarity of this practicum.

Accessibility – the ability of a person or mode of transport to reach a desired *opportunity* (Litman, 2003, p. 5), where an opportunity may involve a destination, service, or activity.

Automobile – refers to a motor vehicle that is used to carry one or more people, potentially including a car, van, pickup truck, or motorcycle. Automobiles are not used for carrying freight or large numbers of passengers (City of Edmonton, 2013).

Arterial Streets – streets that have a primary function of moving motor vehicles. Speed limits are typically set between 50 and 100 km/h, and motor vehicle volumes are approximately between 5000 and 30 000/day; conditions that cause motor vehicles to stop or slow down are minimized; pedestrian and cycling facilities may be provided (TAC, 1999, p. 1.3.4.3) (see Appendix A).

City Scale – a scale of design applicable to several square kilometers or across a city or metropolitan area, typically accessed by motor vehicles (Handy et al., 2002; ITE, 2010; Manheim, 1979).

Classification System (aka typology) – a collection of street types that can be characterized under a theme (e.g. the functional classification system consists of freeways, expressways, arterials, collectors, and locals) (Marshall, 2005).

Derived Demand – the premise for transport systems analysis, where activities on a street are understood in terms of their connections to destinations (Handy et al., 2002)⁸.

Design – the process of selecting physical attributes – namely geometric and urban design – that can be constructed in the built environment; attributes may include street block's shape, street connectivity, buildings' type and orientation, modal facilities' layout, lighting, and street furniture (Vélo Québec Association, 2010b).

⁸ Uses of streets that are not associated with destinations are not included in this analysis (e.g. exercising, street games, patio sitting) (Handy et al., 2002).

Design Criteria – the priorities of a given project that are analyzed and set in order to determine a design – this term is used to encompass design controls, performance measures, and other project goals (ITE, 2010; NACTO, 2013).

Design Vehicle – the largest/heaviest vehicle a facility is designed to accommodate; curb radius and lane width particularly depend on design vehicle (ITE, 2010; TAC, 1999).

Direct Observation – a method of design, where the existing or desired uses and activities on a street are studied and correlated with designs (Gehl & Svarre, 2013).

Geometric Design – a street’s features and dimensions that relate to a mode’s movement and safety (e.g. turning radius, street grade, lane width, storage lane length) and are typically based on transportation engineers’ quantifiable criteria (vehicle volumes, speeds, and sizes) (TAC, 1999).

Guideline - A guideline provides detailed technical guidance relating to specific aspects of design – for example, geometric design guidelines (TAC, 1999) and urban design guidelines (City of Toronto, 2014).

Human Scale – aspects of design and activities that are applicable to the uses of streets by pedestrians and cyclists; specifically, designs that can be used and experienced within a short distance, at a travel speed of approximately 5 km/h (Gehl, 2010; ITE, 2010).

Land Use – the general activity occurring on a particular piece of land. Typical classifications for activities may include residential, commercial, industrial, and institutional (Handy, 2002).

Level of Service – a measure that is typically used to communicate the level of mobility or congestion for motor vehicles, comparing the travel demand/flow to the capacity of the transportation system (Manheim, 1979)⁹.

Mixed-use – areas where land uses combine residential or office uses with commercial and/or service uses. The *mixing* may occur vertically, where land use changes within a building, or horizontally, where land use varies within a short distance (ITE, 2010).

Mobility – the measurement of people or goods moving from one place to another (Litman, 2003).

Motor Vehicles – any vehicle requiring fuel or electricity to move; this designation typically includes automobiles, goods movement trucks, and transit buses.

Neighbourhood Scale – aspects of design and characteristics applicable to a scale of several city blocks or a neighbourhood; this scale is primarily concerned with the integration of people, land uses, and streets (Bochner & Dock, 2003; Handy et al., 2002).

⁹ Sources have developed methods for calculating pedestrian, cycling, and transit level of service, as discussed in Section 3.2.1. Each method may vary in how it defines each mode’s level of service. These measures are not commonly used for pedestrians and cyclists in Canadian cities.

Network Design – A scale of design concerned with how major streets are laid out and spaced for each mode of transport, providing citywide mobility and accessibility (Bochner & Dock, 2003; ITE, 2010).

Passive Design – designs accommodate the worst-case scenario, where the largest and heaviest expected vehicles, 85th percentile travel speeds, and the highest expected motor vehicle volumes are the basis for design (NACTO, 2013).

Placemaking – collective efforts to reshape public spaces, for the purposes of benefiting communities (Project for Public Spaces, n.d.). “Cultural, economic, social, and ecological connections” between people and place are addressed through placemaking (Project for Public Spaces, n.d.).

Proactive Design – designs, including geometric, landscaping, and built form designs, which impact the desired travel behaviours (NACTO, 2013).

Sense of Place – feelings of identity, enjoyment, and comfort that result from a particular location’s character (Lynch, 1995)¹⁰.

Street – the space composed of the roadway, sidewalk, landscaped area, and adjacent land uses and built form (ITE, 2010).

Sojournability - a measure of a streets’ ability to provide users with enjoyable sitting, walking, watching, listening, and playing opportunities (definition informed by Gehl, 2001 and ITF, 2012).

Transportation Policy – a framework for future growth and development of a municipality’s transportation infrastructure and services, which is typically discussed in the land use plan¹¹ or transportation master plan (Hess & Smith Lea, 2014).

Transportation System – the physical infrastructure, including roads, sidewalks, bike paths, railroad tracks, bridges, and transportation services – including transit frequency, car/bike sharing availability – that enable mobility and accessibility (Handy et al., 2002).

Travel Demand – societal pressure put on transportation systems, as influenced by changes in demand, technology, and values (Manheim, 1979, p. 10).

Type – A general name given to describe a street’s form, function, or jurisdiction (e.g. parkway, loop road, lane, local road, arterial, transit mall, foot street, high speed, national road) (Marshall, 2005).

¹⁰ The character of a street may relate to its history, culture, architectural and landscape design, and the past or present activities that occur (Lynch, 1995).

¹¹ A land use plan has a different name depending on the province. For example, they are called development plans in Manitoba and official plans in Ontario.

Typology (aka Classification System) - a collection of street types that can be characterized under a theme (e.g. the functional classification system consists of freeways, expressways, arterials, collectors, and locals) (Marshall, 2005).

Urban Design – the functional and aesthetic layout of public spaces that influences the ways people interact and types of activities enabled by the built environment, encompassing the city, neighbourhood, and human scales of design (Creating Places for People, 2014; Handy et al, 2002).

1.7 Outline of Sections

The practicum layout provides a technical basis of how streets are currently designed in Canada, and then explores precedential ways of designing complete streets. The literature review, provided in Section 2 and Section 3, creates a case for complete streets, and then compare philosophies of conventional approaches and complete streets approaches. Established or developing street classification systems and design criteria for each approach are explored. Section 4 investigates Canadian and European municipalities' and practitioners' approaches for designing complete streets. Recommendations for Canadian municipalities and the planning practice are provided in Section 5, where the literature review and the precedent findings are synthesized. Lastly, Section 6 presents the conclusions, next steps, and further research for designing complete streets in Canadian municipalities.

2 A Case for Complete Streets

This section deliberates on the importance for walking and cycling as important urban modes of transport, discusses the purposes of streets, and describes the shift that occurs when designs are centered on pedestrians and cyclists, rather than motor vehicles. Research shows the neglect of walking and cycling scales in Canadian and international municipal design practices (Jacobs, 1961; Gehl, 2001; Hebbert, 2005; ITF, 2012; Hess & Smith Lea, 2014); these scales are also fundamental to complete streets approaches (City of Edmonton, 2013; City of Calgary, 2014).

2.1 The Value of Cycling and Walking

Walking and cycling are the most positive and least harmful modes of transport: community vitality is activated, financial barriers to transportation diminish, health conditions increase, emissions are non-existent, and fossil fuels are not needed (ITF, 2012; OECD/ITF, 2013; Litman, 2014). Walkable streets activate liveliness in a city (ITF, 2012). Whether people are walking between amenities or leisurely enjoying a space, “walking and sojourning are at the heart of urban life and contribute to liveable, attractive, prosperous and sustainable cities” (ITF, 2012, p. 9). Cycling is: an alternative to cars, providing *door-to-door* service; an alternative to public transport, which runs on a set schedule and only services certain stop locations; and an improvement to walking, increasing travel speeds (OECD/ITF, 2013). The rest of this section describes the benefits of walking and cycling, for individuals, communities, and societies.

Allan Jacobs and Jane Jacobs explain pedestrian activities that occur on streets, interactions that may be seen as insignificant, are paramount to the well-being of cities. Allan Jacobs (1993) suggests that streets’ designs play vital roles in strengthening communities, stating that, “a great street should be a most desirable place to be, to spend time, to live, to play, to work, at the same time that it markedly contributes to what a city should be. Streets are settings for

activities that bring people together” (p. 8). Jane Jacobs (1961) deliberates about the vital community uses and values of a sidewalk in *The Death and Life of Great American Cities*. She argues that the presence of people on sidewalks is important in three ways: people on a sidewalk provide community-scaled surveillance, creating a sense of safety and security against crime and violence (“eyes on the street”); people on a sidewalk facilitate opportunities for community interactions and the development of relationships, enticing a sense of community cohesion and trust; children playing on sidewalks draw others to join in, allowing them to interact with their environment while under community-scaled supervision.

Tolley (2003) and Litman (2014) identify the costs and benefits of walking and cycling. The community benefits of walking and cycling may be difficult to quantify, but they can be described (Litman, 2014, p. 60)¹². People’s quality of life increases, regardless of income level, as they safely enjoy the pleasures of being active, interacting with other people, and shopping at local businesses (Tolley, 2003; Litman, 2014).

Cycling, walking, and public transport infrastructure are fundamental components of streets that are useable for all people (ITF, 2012; OECD/ITF, 2013; OECD/ITF, 2009), and designing streets to support all people is a matter of ensuring human dignity (ITF, 2014, p. 20). Litman (2014) states that 20-40% of people in most communities are not able to drive because of disabilities, income, or age (p. 18). Cycling and walking pose minimal financial, skill, and age barriers to people, and are thus a viable option for most people in society.

The economic health benefits of cycling and walking considerably outweigh the negative impacts by several orders of magnitude (Rabl & de Nazelle, 2012). Rabl and de Nazelle’s (2012) health analysis encompasses pedestrian and cyclists’ physical health and collisions, as

¹² Litman (2014) also provides methods of evaluating the benefits and costs of active transportation.

well as air pollution exposure to an individual who changes their transport mode to walking or cycling, and to the greater population that is influenced by an individual's change in transport mode. Figure 1 shows the results of Rabl and de Nazelle's (2012) study for cyclists, and similar results incurred for pedestrians (pedestrian figure shown in ITF, 2012, p. 34). These figures acknowledge the health risks associated with walking and cycling – which include collisions and pollution exposure – but demonstrate the insignificance of these risks and exposures in comparison to health gained from being active. Approximately 1200€/year/person is saved for every cyclist or pedestrian, and less than 100€/year/person is required to pay for the adverse health outcomes of walking and cycling.

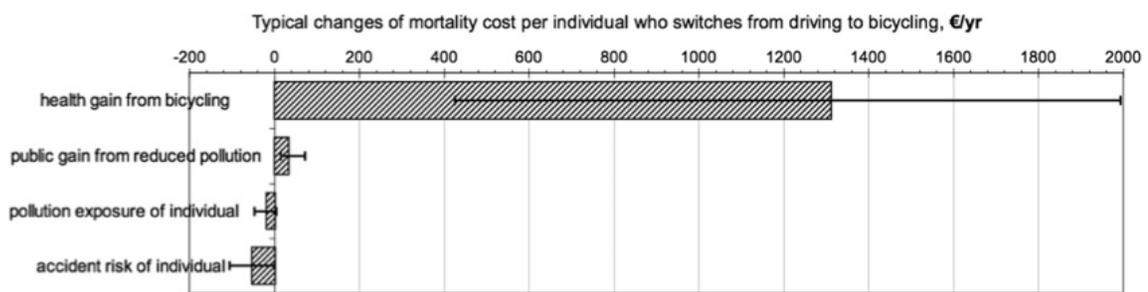


Figure 1 – Economic health impacts (Euros/year/person) of an individual changing their commuting mode from driving to cycling (Rabl & de Nazelle, 2012, p. 128; reproduced with permission from Elsevier)

Research also shows physical activity to reduce heart disease, hypertension, stroke, depression, diabetes, osteoporosis, cancer, obesity, depression, and dementia (OECD/ITF, 2013; Litman, 2014). These economic and health benefits provide strong rationale for why it is important to facilitate cycling and walking (ITF, 2012).

While walking and cycling are the most energy efficient modes of transport and do not require fossil fuels (Vélo Québec Association, 2010b). To travel 1km, a cyclist requires 8 kilocalories, a pedestrian requires 55 kilocalories, and a motor vehicle consumes 539-820 kilocalories/person depending on speed (Vélo Québec Association, 2010b, p. 3). This is a substantial difference, particularly because motor vehicles typically consume fossil fuels and

produce harmful emissions, and pedestrians and cyclists consume grains, fruit, vegetables, and meat (Vélo Québec Association, 2010b).

The following sections continue to provide context for complete streets' case. The next section conveys the design philosophies behind streets as links and places; and the last section reframes the design process from the perspective of cyclists and pedestrians. These sections emphasize the importance of multimodal transportation, and the design of streets as places.

2.2 The Purposes of Streets

Public and private values determine for what purposes streets are designed, whether social equity, ecological sustainability, or economic efficiencies (Manheim, 1979). Conventional design guidelines have supported the value of efficient motor vehicle movements at a city scale (TAC, 1999); complete streets guidelines are addressing the gap in consideration for people walking, biking, or taking transit (Complete Streets for Canada, 2012). The design of streets as places is central to walkable and bikeable streets (Gehl, 2001; Dover & Massengale, 2013; ITF, 2012).

A specific street's design as a link is generated by travel demands. Societal pressures on a transportation system determine travel demands, where these pressures are caused by changes in demand, technology, and values (Manheim, 1979). Population, income, and land-use patterns influence travel demand; changes in technology involve mechanisms for improving travel without the construction of additional travel ways (e.g. driverless vehicles, carpool policies, road tolls, and auto-restricted areas). Changes in public and private values influence whose needs are supported through the transportation network, whether social equity, ecological sustainability, or economic efficiencies are priorities (Manheim, 1979).

The field of transportation planning conventionally emphasizes that the relationships between transportation and land uses create travel demands, and these relationships influence travel distances, infrastructure requirements, and preferred modes of travel (Handy et al., 2002, p. 67). Combinations of origins and destinations generate trips (Handy et al, 2002, p. 67), and these combinations develop based on social structures, political institutions, and housing markets (Manheim, 1979, p. 12). Travel is also generated by the provision of transportation infrastructure and services (Manheim, 1979; Handy et al., 2002). Practices to support motor vehicle travel demands are widely used in Canada (see Section 3.2), and processes to support multimodal travel and the design of streets as places are developing.

Although moving and sojourning on streets may appear as contradictory priorities, these activities can be juxtaposed to ensure equal access to urban opportunities and quality social places (ITF, 2012). Table 2 outlines Calgary's and Edmonton's complete streets design priorities, which balance the different roles of streets. For this practicum, the most significant aspect of Calgary's complete streets objectives and Edmonton's complete streets principles are their intentions to design streets as places within communities, while continuing to improve mobility for everyone. Calgary (2014) shifts their approach from seeking to maximize motor vehicle mobility, to acknowledging that mobility is a "means, not an end" (p. 2). Calgary states their desire to increase civic spaces and social interactions, showing their desire to improve sojournability on streets. Health, liveability, and aesthetics are also included in Calgary's objectives. Edmonton summarizes their intentions for designing streets as places in the last point of Table 1, where social vibrancy and aesthetics are included as street design goals. "People-places" (p. 10) are further acknowledged to improve people's quality of life. Table 1 shows that Calgary and Edmonton are applying a new palette of street design priorities that acknowledge

streets' value as links and places, contrasting Manheim's (1979) conceptual analysis of streets in terms of their value to connect origins and destinations.

Table 2 – Calgary and Edmonton's complete streets objectives and principles (City of Calgary, 2014, p. 2; City of Edmonton, 2013, p. 10)

Calgary's Complete Streets Objectives	Edmonton's Complete Streets Principles
<p>Complete Streets approach seeks to design a transportation network that will:</p> <ul style="list-style-type: none"> • serve the land uses adjacent to the street, integrating mobility as a means, not an end; • encourage people to travel by walking, cycling, and transit; • provide transportation options for people of all ages, physical abilities, and income levels; • enhance the safety and security of streets, from both a traffic and personal perspective; • improve people's health; • create liveable neighbourhoods; • reduce the total amount of paved area; • reduce streetwater runoff into watersheds; • maximize infiltration and reuse of stormwater; • reduce greenhouse gas emissions and other air pollutants; • reduce energy consumption; • promote the economic well-being of both businesses and residents; • increase civic space and encourage social interaction; • promote alternative streetscapes. 	<p>Complete Streets in Edmonton are intended to:</p> <ul style="list-style-type: none"> • Provide travel options for all users and trip purposes in a safe, accessible, context sensitive way in all seasons. • Form a network of streets that together accommodate all users and allow for efficient and high quality travel experiences. • Be adaptable by accommodating the needs of the present and future through effective space allocation the many functions of the street. • Contribute to the environmental sustainability and resiliency of the city. • Consider both direct and indirect costs, as well as the value of the roadway and the adjacent real estate. • Be vibrant and attractive people-places in all seasons that contribute to an improved quality of life.

The City of Calgary's 2011 guide further notes that "Streets are not just conduits to move cars; they are the identity of each community. Streets should be a place for people to connect, interact and be filled with the joy of living" (p. 60). Jan Gehl (2001), Allan Jacobs (1993), and Jane Jacobs (1961) suggest that a street's design as a place is central to an equitable and accessible city for all people. These social scientists and architects suggest that to successfully design a street, the people dynamics of the activities on streets must first be understood. The next section introduces the social science of understanding people's activities on streets, and additional discussions are included in Sections 3.3 and 4.4.

2.3 Designing for People

But if we understand the principles behind the behavior of cities, we can build on potential assets and strengths, instead of acting at cross-purposes to them. First we have to know the general results we want—and know because of knowing how life in cities works. We have to know, for instance, that we want lively, well-used streets and other public spaces, and why we want them. But knowing what to want, although it is a first step, is far from enough. The next step is to examine some of the workings of cities at another level: the economic workings that produce those lively streets and districts for city users (Jacobs, 1961, p. 140).

In the above quote, Jacobs (1961) suggests that an understanding of the types of activities occurring on streets is foundational to improving them. Jan Gehl based his architectural firm's (Gehl Architects') work on his understanding of people, which he acquired while studying public spaces around the world (Gehl & Svarre, 2013). Susan Handy et al. (2002) suggests transportation engineers consider individuals' travel behaviours (or disaggregate data sets) in order to accommodate pedestrians and cyclists; conventionally, transportation engineers account for trends in large data sets (or aggregate data sets). Jacobs, Gehl, and Handy agree that designing for pedestrians and cyclists involves understanding individual's traveling and sojourning needs.

While many streets are designed at a motor vehicle scale, where planning occurs from a helicopter perspective to support the efficiency of a city at a 60 km/h pace, Gehl (2010) suggests that the human scale occurs at eye level with a travel speed of about 5 km/h. At the human scale, a finer grain of design detail stimulates human senses and invites the use and enjoyment of streets and public spaces (Gehl, 2010). The performance of streets and public spaces for utilitarian, recreational, and social activities – places for people to walk, cycle, sit, talk, and play – is specifically linked to the *quality* of urban environment at a pedestrian/human scale (Gehl, 2010) (see Section 3.3 and Section 4.4). Dover and Massengale (2013) criticize the United

States' National Complete Streets Coalition for their lack of attention to these pedestrian and cyclist sojourning activities.

Although municipalities have conventionally prioritized motor vehicle mobility, accessibility is the essential goal of transportation systems (Litman, 2003). Through accessibility, individual people are able to *reach* their desired opportunity, and not just *move* along streets (Litman, 2003) (see Section 3.1.1). Sojourning is also a missing element of transportation policies, monitoring, and budgets, as the enjoyment of quality places for pedestrians is undervalued in cities (ITF, 2012, p. 9). New tools and approaches are needed to account for pedestrians and cyclists moving and lingering on streets (New York City, 2012; Gehl & Svarre, 2013).

3 The Conventional and Complete Streets Design Approaches Reviewed

Complete streets shift the design philosophy from one that is based on linking motor vehicles from origin to destination, to one that is responsive to the context and multimodal needs, and supports the role of streets as links and social places (City of Edmonton, 2013, p. 4, 15). Streets have different modal priorities for accommodating autos, cyclists, goods movement, pedestrians, and transit, and the City of Edmonton (2013) acknowledges that different streets prioritize different modes.

This section explains conventional approaches that prioritize motor vehicle mobility and accessibility, and complete streets approaches that inherently consider pedestrians and cyclists along with motor vehicles. Conventional approaches are not invalidated, as some streets will prioritize motor vehicle movements. Complete streets rather create another layer of analysis, where the multimodal priorities are evaluated and the values of streets as places are validated (City of Edmonton, 2013).

This section first introduces the research themes, and then discusses in the context of conventional approaches and complete streets approaches. Conventional approaches are driven by motor vehicles' derived demand for transport, while complete streets approaches acknowledge the varying uses and users of streets, and designs based on the given context and needs. A synthesis of the findings is lastly given.

3.1 Research Themes and Framework

The main themes of the literature review are: street functions (i.e. mobility, accessibility, and sojournability), as well as scales of design, street classification systems, and design criteria.

These themes are common in currently used municipal design guidelines (TAC, 1999; City of Chicago, 2013; NACTO, 2013; City of Calgary, 2014) – with the exception of sojournability,

which was created for the purposes of this practicum (see Section 3.1.1). The following sections outline the research themes, and will provide a foundation and framework to analyze the remainder of the literature review. With the help of these research themes, conventional approaches and complete streets approaches are analyzed.

3.1.1 Street Functions

Sidewalk width is invariably sacrificed for vehicular width, partly because city sidewalks are conventionally considered to be purely space for pedestrian travel and access to buildings, and go unrecognized and unrespected as the uniquely vital and irreplaceable organs of city safety, public life and child rearing that they are (Jacobs, 1961, p. 87).

Street functions are an overarching theme in street design literature, with mobility and accessibility conventionally the framework for these functions within engineering guidelines. The researcher found the words *accessibility* and *mobility* to vary in meaning across sources, disciplines, and individual practitioners, and these variations are discussed in this section.

Mobility is generally understood as the function of streets for moving people or goods from one place to another, and the capacity and travel time enabled by a design is typically associated with streets' level of mobility (Litman, 2003; TAC, 1999). Conventional approaches use motor vehicles as the unit of analysis, but mobility can also be measured with respect to the number of people or the amount of goods moved (ITE, 2010; Litman 2011). Another way of regarding mobility is through a person's physical condition, age, social, economic, or geographic situation that allows them to move and use various modes of transport (Church et al., 2000). For the purposes of this practicum, mobility is considered the measurement of people or goods moving from one place to another – however, the context in which the word is used should be considered when determining its meaning. This definition was chosen because it expands conventional approaches' perceptions of mobility according to the complete streets definition:

mobility is now considered for the purposes of moving people and goods, not simply vehicles. This is important, as conventional approaches' definition of mobility may treat one bus moving 50 people the same as a one car moving one person. Higher mobility is acknowledged by measuring the number of people moved as opposed to the number of vehicles moved.

Quantitative measures typically indicate mobility, and data may include counts, travel surveys, and travel speeds (Litman, 2003). Level of service is a primary method used for measuring mobility in Canadian cities (TAC, 1999; Hess & Smith Lea, 2014), where the motor vehicle traffic flow during peak periods is compared to the capacity of a street. Level of service is described and discussed further in Section 3.2.1. Designated transit, high occupancy vehicle (aka HOV), sidewalks, crosswalks, and cycling facilities provide multimodal mobility and modal connectivity (Litman, 2003). Overall, mobility measures the performance of a street as a link.

Accessibility can refer to various aspects of design. Conventional guidelines refer to accessibility in terms of motor vehicles' ability to reach particular land uses (TAC, 1999). Jacobs (1993) discusses accessibility in three ways: the ability of various modes to comfortably travel along a street; the ease with which people can get to a street (which involves the network layout, and intersection density); and the provision of designs to enable disabled people to use the street comfortably. Vélo Québec (2010b) specifies that accessibility indicates the ability of pedestrian and cycling networks to serve all buildings and land uses. ITE (2010) describes accessibility as the ease at which the maximum number of people can reach something. When comparing these definitions to mobility's definitions, one can see the interdisciplinary ambiguity of these terms. For the purposes of this practicum, accessibility will generally refer to the measure of a person or good to reach a desired "opportunity" (Litman, 2003, p. 5), where an opportunity may involve a destination, service, or activity. Design focused on accessibility does not necessarily require a destination, as streets may be used for purposes unrelated to travel (e.g. street hockey) or a

destination (e.g. exercising) (Litman, 2003). Multimodal transportation and dense mixed-use development increase accessibility, as travel times are decreased (Litman, 2003, p. 5). This definition for accessibility was chosen because it aligns with the purpose of conventional approaches' understanding of accessibility – in that it refers to the ability to access a land use – but it expands the definition in accordance with complete streets – encompassing multimodal transportation and various street uses.

Measurements indicating the level of accessibility may be qualitative or quantitative, specifically “time, money, discomfort and risk (the *generalized cost*) required to reach opportunities” (Litman, 2003, p. 6). Designs focused on multimodal accessibility address the integration of transportation and land use from the perspective of various modes, seeking to improve connectivity between land uses and through modal transition points (e.g. at a bus stop, a person may transition between being a transit user and a pedestrian).

The researcher created the word *sojournability* to describe a street's function for being enjoyed in leisurely, socially, and aesthetically pleasing ways, accounting for conventionally ignored social responsibilities of a street described in the above quote by Jane Jacobs (1961). Gehl (2001) uses the term *human scale* to refer to the design of quality urban places that invite people to walk, stand, sit, watch, listen, talk, and play. ITF (2012) uses the term *sojourning* to describe the result of aspects of design that allow people to enjoy and spend time on streets and their adjacent public spaces.

The term “sojourning”, is a term used to describe the experience of simply being in a public place, purely for the enjoyment that being there offers, or to participate in the activities of everyday life (e.g., trading and vending, waiting for others or public transport, playing, or meeting friends, family or other members of one's community). It does not necessarily involve movement, other than travelling to or from the chosen place. It refers to the enjoyment or other advantage derived from spending time in a public space, either alone or with others (p. 15).

For the purposes of this paper, a measure of a streets' ability to provide users with enjoyable sitting, walking, watching, listening, and playing opportunities is referred to as *sojournability* (definition informed by Gehl, 2001 and ITF, 2012). This term is used because it communicates the value of a street as a place in a comparable way to a street's value for mobility and accessibility. Although evidence of this term in other street design literature was not found, aspects that make a place enjoyable to stay are commonly discussed in the literature (Jacobs, 1961; Whyte, 1980; Jacobs, 1993; Gehl; 2001, 2010; Dover & Massengale, 2013). These sources may refer to elements of *sojournability* as walkability, human scale, or pedestrian activities.

Gehl Architects routinely study and assess qualities of the urban environment that are associated in this practicum with sojournability (see Section 4.4). Measurements of sojournability may include public seating, mapping of pedestrian movements and activities, and notes regarding the demographics of people present on a street.

Mobility, accessibility, and sojournability, are the primary functions of streets identified in the literature. These three functions are discussed throughout this practicum, and they will particularly be examined in the context of various scales of design. Conventional approaches and complete streets approaches fundamentally vary in how they associate scales of design with mobility, accessibility, and sojournability (see Section 3.2 and Section 3.3)

3.1.2 Scales of Design

Scales of design were frequently cited frameworks for explaining street design in the literature (Gehl, 2001, 2010; Handy et al., 2002; ITE, 2010). Pedestrians experience a city at about 5 km/h, and motor vehicles often experience a city at about 50 to 60 km/h (Gehl, 2010). As pedestrians take each step, their senses make them aware of smells, sounds, activities, building designs, storefronts, and urban or natural vistas (Gehl, 2010). As you “zoom-out” on a pedestrian walking

in a city, frequent street crossings, mixed land uses, and small block sizes improve a pedestrian's ability to use and move throughout a city (Gehl, 2001, 2010; Handy et al., 2002). Motor vehicles travel faster than pedestrians, and so they are less able to engage in the finer details (Gehl, 2001, 2010; Handy et al., 2002). Opposite elements of design improve motor vehicle mobility: non-street oriented buildings, minimal street crossings, and large block sizes (Gehl, 2001, 2010; Handy et al., 2002). In relation to a pedestrian or a motor vehicle, elements of design can be associated with a scale. For example, frequent street crossings are a relevant design consideration to a smaller scale than the layout of a city's street network. Relationships between scales of design and conventional and complete streets approaches are discussed throughout this practicum, and lessons are drawn from these relationships.

3.1.3 Design Criteria

Design criteria describe the desired ways a street may be designed (NACTO, 2013).

Transportation engineers may use the phrase *design controls* for design criteria, where the selected speed, volume, and vehicle size/mode are considered (ITE, 2010; NACTO, 2013; TAC, 1999). While design controls conventionally relate to streets as links, this practicum will also consider design criteria that relate to the use of streets as places.

Performance measures, a type of design criteria, compare the performance of a street to specific objectives (ITE, 2010). A performance measure communicates the successes and shortcomings of design criteria under current conditions or proposed changes (NACTO, 2013). For example, a current street configuration may be analyzed with traffic volumes anticipated in 25 years to measure its future performance and need for design changes, such as additional lanes and roadway widening. As found in this practicum, transportation engineering guidelines tend to analyze quantitative performance measures related to mobility (TAC, 1999; CITE, 2008), and

urban designers and architects consider quantitative and qualitative performance measures related to sojournability (Gehl, 2001, 2010).

There are complexities involved in determining design criteria, as streets that support one mode or activity may cause challenges for other modes or activities (NACTO, 2013; TRB, 2010). For example, intersections may provide pedestrians with sufficient signalized crossing times; however, this may cause increased traffic congestion (NACTO, 2013). Or streets that provide on-street parking for delivery trucks may create conflict points for cyclists (NACTO, 2013). Performance measures may also focus on the function of streets at particular scales. NACTO (2013, *Performance Measures*) suggests the following for improving the use of performance measures:

Performance measures must take a multi-disciplinary approach, looking at urban streets and traffic at the macro and the micro scale, through the lens of safety, economy, and design, and inclusive of the goals and behaviors of everyone using the street. (para. 1)

This communicates the multifaceted nature of performance measures, specifically with respect to the research themes: design criteria (i.e. “performance measures”), interdisciplinary approach (i.e. multi-disciplinary approach), scales of design (i.e. “macro and the micro scale”) and multimodal/multiuse (i.e. “behaviors of everyone using the street”).

3.1.4 Classification Systems

A street type refers to a general name given to describe a street’s form, function, or jurisdiction, such as parkway, loop road, lane, local road, arterial, transit mall, foot street, high speed, national road (Marshall, 2005). A generic cross section may be used to represent a particular street type.

A classification system or typology is a collection of types that can be characterized under a theme (e.g. the functional classification system consists of freeways, expressways, arterials,

collectors, and locals) (Marshall, 2005). For the purposes of this practicum, classification systems are used rather than typologies because classification systems are frequently used in guidelines. Municipalities and engineering organizations, such as TAC, ITE, and the National Association of City Transportation Officials¹³ (NACTO), use street types and classification systems to present their geometric and urban design recommendations. Motor vehicle mobility and land use accessibility (see Section 3.2.2) and/or land use context and urban conditions (see Section 3.3.2) may be used to determine the street type – depending on the design approach used.

Many classification systems have been developed by engineering, planning, and architectural disciplines, which focus on various aspects of design (Marshall, 2005). While conventional approaches use the functional classification system, the researcher has not found any two municipal complete streets guidelines to use the same classification system, as each municipality is using various assortments of street types (see Section 3.3.2).

3.2 Conventional Approach

The prime benefit of a roadway is the mobility it provides its users. This benefit can be measured by the capacity of a roadway related to the traffic volumes using it, which results in various levels of service and average speeds, with commensurate costs of travel time (TAC, 1999, p. 1.1.3.1).

Conventional approaches are used by Canadian cities, largely through the guidance of TAC's resources (TAC, 1999; Hess & Smith Lea, 2014). Transportation systems are analyzed based on city scaled travel demands, as well as social, economic, and political considerations (Manheim, 1979). Streets are designed according to this analysis (Manheim, 1979).

Conventional approaches are based on three interrelated variables, which are treated as separate physical entities: the transportation system, activity system, and flows of travel

¹³ An organization based in the United States that has released two cutting edge street design guidelines – *Urban Street Design Guide* (NACTO, 2013) and *Urban Bikeway Design Guide* (NACTO, 2011).

(Manheim, 1979). Flow is generated by both the provision of transportation infrastructure and services (i.e. transportation system), as well as trip origins and destinations (activity system) (Manheim, 1979, p. 12). The activity system is influenced by social structures, political institutions, and housing markets, which are all prone to change (Manheim, 1979, p. 12). The interaction of these three variables largely determines how a transportation system is adapted to accommodate the travel demand. In this approach, streets are links used to access land uses, which are places.

This idea of three separate but interconnected variables is applied to arterial streets across Canada; however, researchers have criticized its shortcomings related to complete streets. Jacobs (1993) describes streets that functions as both links and places, which meshes the notion of a transportation system and activity system into one linear entity. Handy et al. (2002) criticizes the approach of designing streets based on the derived demand, arguing that this method does not capture trips without a destination, which is the case for some pedestrians and cycling trips. Although some models used for analyzing travel demand may include cycling and pedestrian trips, travel demand models typically assume that modes of transport choose their route based on the minimization of time, failing to account for other aspects that influence route choice (Handy et al., 2002). Bouchner and Dock (2003) further point out that conventional approaches prioritize minimizing congestion. These criticisms highlight conventional approaches' lack of sensitivity to the complex urban environment conditions.

3.2.1 Design Criteria

The geometric design of mixed-use arterial streets is typically determined based on the desired level of motor vehicle mobility, the maximum motor vehicle size, volumes, and speed for the particular street type, and optimum levels of motor vehicle safety (TAC, 1999). NACTO (2013)

describes this approach as the passive design approach, as it facilitates the worst-case scenario. High speeds are allowed, and minimum buffers, clear zones, and setbacks are enforced to improve safety for motor vehicles (TAC, 1999). The passive approach is applied in many engineering fields, such as stormwater management or slope stability analysis, where failure to accommodate the “maximum load” results in disaster (NACTO, 2013). For reasons discussed in this practicum, the “maximum load” concept does not apply in the same way for mixed-use arterial streets, as you are dealing with people using streets who do not act in the same way as uncontrollable rainfall or unstable slopes (NACTO, 2013), and the use of streets as places is not incorporated.

While conventional and complete streets guidelines suggest that all users (including pedestrians, cyclists, transit, and motor vehicles) are factored into the design of urban streets (TAC, 2007, p. 1.2.3.7), this does not necessarily mean that pedestrians and cyclists are prioritized on mixed-use arterial streets. For example, TAC (2007) suggests that pedestrians and cyclists should set the design speed for local and collector streets, but “the spacing of signalized intersections, the selected type of median cross section, the presence or absence of curb and gutter along the outside edges of the traveled way, and the amount and type of access to the street” (p. 1.2.3.8) determines the design speed of an arterial street. Bicycle and pedestrian considerations are not given within the design criteria. Additional design guidelines, such as *Bikeway Traffic Control Guidelines for Canada* (2012) and *Pedestrian Crossing Control Guide* (2012), may consider how pedestrian and cycling accommodations can be subsequently added to the given street.

Level of service is a tool for evaluating, planning, and operating transportation systems efficiently (Donnelly & Toop, 2011). This performance measure is commonly used, and it is

measured when new developments¹⁴ or street configurations are proposed (NACTO, 2013). A street's motor vehicle capacity and/or the size and density of a new development is determined in relation to the other to ensure desired motor vehicle mobility (e.g. a street's capacity and desired level of mobility limits the density and size of a development that accesses the street) (Hebbert, 2005). Software models, such as those created by Synchro Trafficware, are used in Canadian cities to simulate conditions at an intersection with particular lane provisions and traffic volumes, further providing level of service results. With this software, streets are analyzed as a series of links and the flow used to evaluate the design is the current or projected travel demand, based on the activity system. Synchro Trafficware has limited abilities for considering bicycle and motor vehicle design factors (Hess & Smith Lea, 2014), such as the complexities of pedestrians and cyclists' movements and activities along mixed-use arterial streets.

Level of service (LOS) can range from LOS A to LOS F. LOS A (a high level of service) indicates that the flow is lowest in relation to the street or intersection's capacity, and LOS F (a low level of service) indicates that the flow is equal to or greater than the street or intersection's capacity. Low-density development, unimpeded flow, and minimized land access are among the ideal characteristics for a high level of service under uninterrupted flow conditions, which is typical of freeway operations (Levine, 1999; TAC, 1999; Hess, 2009; Henderson, 2011).

Geometric designs that support high-density development or enable multimodal transportation options, such as bike lanes, designated bus lanes, and traffic calming measures – where all may contribute to complete streets – may not be considered because their presence may reduce levels of service (Henderson, 2011; Levine, 1999).

¹⁴ The transportation effects of new developments are considered through transportation impact analysis/studies. Guidelines that determine the process of transportation impact analysis/studies are not discussed in this project, although research has shown their procedures to be a barrier to implementing active transportation (Hess & Smith Lea, 2014).

Recent perspectives have identified the shortcomings of applying motor vehicle level of service to complete streets. Donnelly and Toop (2011) point out that as Canadian design priorities have shifted to incorporate multimodal design approaches, “quantitative measures of performance used by transportation professionals [i.e. levels of service] have not evolved in conjunction” (p. 1). The City of Edmonton has explored the potentials of multimodal performance measures, explaining that the current performance measures used in practice and in the *Canadian Capacity Guide to Signalized Intersections* (CITE, 2008) and *Highway Capacity Manual* (TRB, 2010) are not consistent with its multimodal policies (Vriend, 2012). The City of Chicago (2013) suggests that relying on motor vehicle level of service goals results in streets that are contrary to complete streets principles, because

1. streets are routinely “upgraded” for higher traffic volumes at the expense of other users
2. streets designed for rush hour volumes end up with excess speed and width off-peak and at night (p. 110)

While the *Highway Capacity Manual* (TRB, 2010) and the *Canadian Capacity Guide for Signalized Intersections* (CITE, 2008) suggest the use of a 15-60 min time period for measuring level of service, the City of Ottawa has found more leniency for reallocating roadway space to bicycles by using a 2.5 hour time period (TCAT, 2013). With a longer time period, lower motor vehicle volumes are used in the analysis, as opposed to creating a design that supports the highest traffic volumes during the peak 15 minutes of the day. NACTO (2013) points out that level of service addresses the function of streets as links, and the roles of streets as places may not be captured. A primary characteristic of complete streets is that streets are both links and places, which is particularly the case for mixed-use arterial streets.

3.2.2 *Classification System*

The functional classification system is the dominant system used by Canadian cities, as well as TAC and the American Association of State Highway Transportation Officials (AASHTO). The functional classification system describes streets' responsibilities for providing motor vehicle accessibility and mobility. Freeways, expressways, arterials, collectors, and locals are the primary street types in the functional classification system (Figure 2). The given order transitions from highest mobility to lowest mobility, and lowest land accessibility to highest land accessibility (Figure 3). The level of mobility, in terms of travel volumes, travel speeds, and design vehicles, is used to determine aspects of design, such as lane widths and curb radii. These correlations are based on physics and empirical data, where motor vehicle safety is a priority (TAC, 1999).

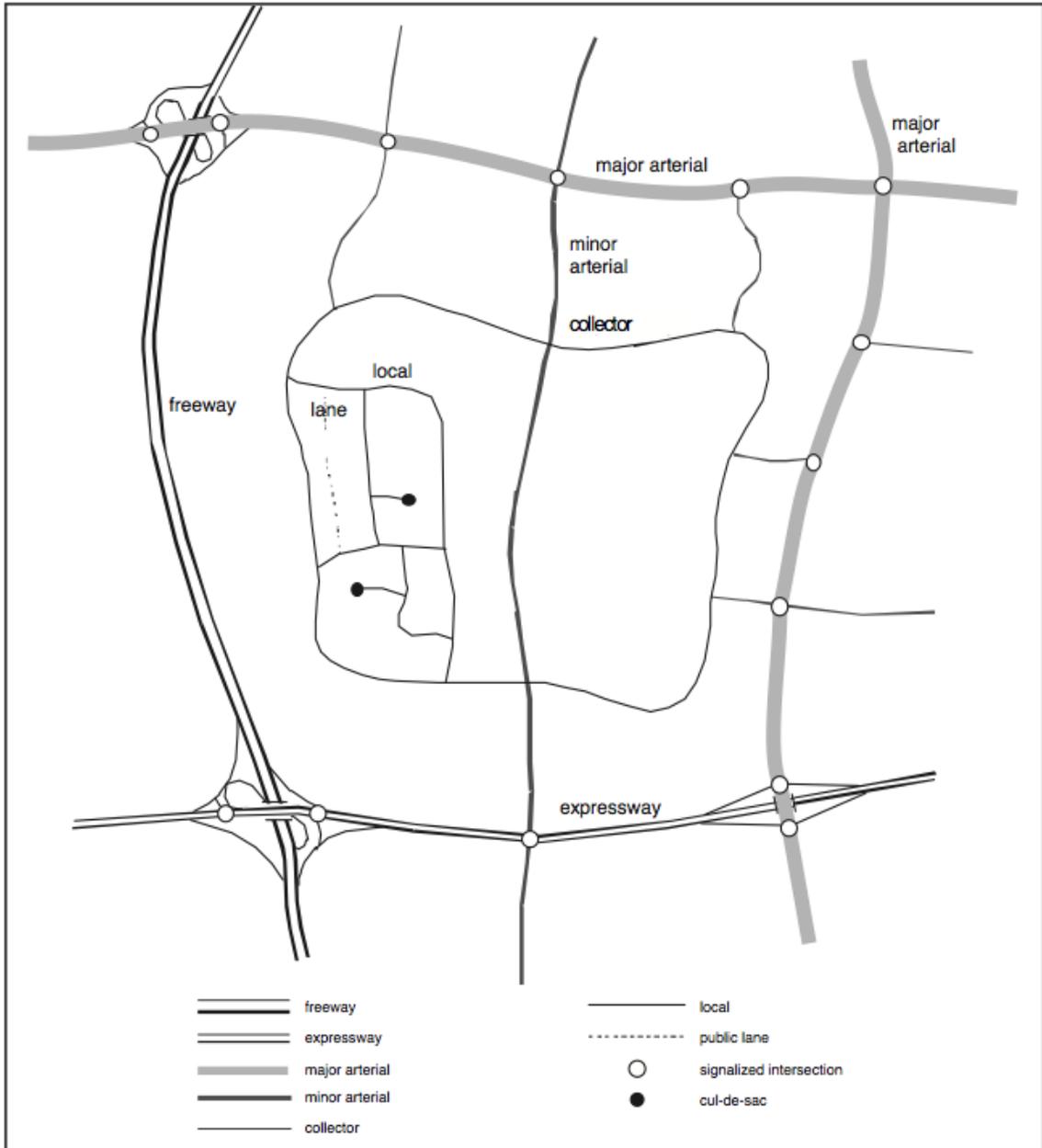


Figure 2 – The functional classification network: this figure shows a hierarchical ordering of streets, where motor vehicles transition from one street to the next with a higher or lower level of speed and capacity (i.e. motor vehicle mobility) and an inverse level of land use accessibility (TAC, 1999, p. 1.3.4.1.; reproduced with permission from the Transportation Association of Canada).

		Street Function	
		Accessibility	Mobility
Street Type	Local Streets		
	Collector Streets		
	Arterial Streets		

Figure 3 – Mobility and property accessibility: this figure shows the inverse relationship between the functional classification system’s service for mobility and land access

The combination of arterials, collectors, locals, and cul-de-sacs focuses traffic to arterial streets, resulting in high volume, high-speed, large intersections (City of Calgary, 2014, p. 13). This set-up not only creates poor connectivity within neighbourhoods, increasing travel distances, but it also increases collision occurrences (Marshall & Garrick, 2011).

The functional classification system is criticized for its inability to support the complexities of urban environments due to its dominant focus on motor vehicle mobility and accessibility (Bochner & Dock, 2003; Marshall, 2005). It is based on a capacity-oriented framework according to a hierarchy (Bochner & Dock, 2003; Marshall, 2005) – which, bluntly stated, makes “big roads bigger over time” (Bochner & Dock, 2003, p. 5). Forbes (1999) highlights the functional classification system’s minimal attention to multimodal transportation

and its exclusive consideration of a roadway's role in providing mobility and access. These issues highlight the functional classification system's incompatibility with complete streets.

3.3 Complete Streets Approach

A Complete Street is designed for all ages, abilities, and modes of travel. On Complete Streets, safe and comfortable access for pedestrians, bicycles, transit users and the mobility-impaired is not an afterthought, but an integral planning feature (Complete Streets for Canada, *What are Complete Streets?*, p. 1).

Design approaches for complete streets are currently emerging as municipalities strategize how to best consider multimodal provisions in their street design processes. While conventional approaches are generally consistent across North American municipalities, various municipalities and organizations are developing unique complete streets practices. Some design practices may not be specifically associated with the phrase *complete streets*, but their multimodal and placemaking principles are consistent. Literature discussed under this section is reflective of sources that incorporate multimodal and placemaking principles. The primary complete streets design philosophies discussed in this section consider community inputs, land use context, and multimodal activities/movements.

Complete streets' design approaches recognize streets' value as links and places, by directly assessing people's values, as shown through consultation and observed activities. Calgary and Edmonton's complete streets guidelines recognize a street as both links and places, splicing the notion of a transportation system and activity system into one entity within streets (as opposed to being separate entities, described in Section 3.2). Pedestrian and cycling network designs are primarily based on locations of opportunity (ITF, 2012), where pedestrian facilities and "continuous public spaces" (p. 50) are provided to connect as many residential areas to educational institutes, transit stations, residential areas, offices, and retail locations – places that

are likely to attract pedestrians and cyclists (ITF, 2012; Jolicoeur, 2005). Designs are shifted away from the generalizable and prevailing context, and shaped to support “the particulars of place” (Ben Joseph, 2005, p. 172). Designs complement the current and future land uses and support multimodal activities (Klassen et al., 2014), not just current and future motor vehicle volumes. Context sensitive solutions are outlined as follows (ITE, 2010):

The principles of CSS [context sensitive solutions] promote a collaborative, multidisciplinary process that involves all stakeholders in planning and designing transportation facilities that:

- Meet the needs of users and stakeholders;
- Are compatible with their setting and preserve scenic, aesthetic, historic and environmental resources;
- Respect design objectives for safety, efficiency, multimodal mobility, capacity and maintenance; and
- Integrate community objectives and values relating to compatibility, livability, sense of place, urban design, cost and environmental impacts (p. 3).

Scales of design are used in the literature as frameworks for designing streets as places and multimodal links within the given context, example sources including Handy et al. (2002), Bochner and Dock (2003), ITE (2010), and Gehl (2010). Handy, who is a city and regional planner as well as a civil engineer, frames her work in terms of the neighbourhood and regional scale (Handy et al., 2002). The neighbourhood scale pertains to the conglomeration of several city blocks, and the regional scale addresses several neighbourhoods, the entire city, or the region. Transportation engineers, Bochner and Dock (2003) as well as ITE (2010), categorize design elements and strategies within the network scale and the street/corridor scale. The network design ensures cities are accessible to all modes of transport, and are integrated with other regional scaled systems, such as land use, the economy, and the environment (Bochner & Dock, 2003; ITE, 2010). The street/corridor scale considers how specific streets are laid out and designed for particular users to access specific land uses, and to accommodate various street uses (Bochner & Dock, 2003; ITE, 2010). Gehl (2010), an urban designer and architect, describes

three scales: the human scale, development/district/community scale, and city scale. Gehl specifically draws attention to the human scale, which is the scale of design people experience as they sojourn, walk, or cycle along a street (2010). Gehl (2010) suggests that designers shape the development/district/community and city scales around the human scale, allowing people to easily walk and bike to their daily activities. These scales of design articulated by various professions are summarized in Table 3, and show concepts of design pertaining to the scales that contribute to streets as links and places. Larger scales typically include the design of many streets in a fine grain manner, accommodating individual modes, and allowing people to easily transfer from one mode to another. Smaller scales characteristically address how pedestrians and cyclists interact with the provided space, infrastructure, and land-uses in their immediate vicinity.

Table 3 – Scales of design by urban element, and associated concepts of design

Design Profession	Scales Described	Definition Given	Applicable Concepts of Design
City and Regional Planning and Transportation Engineering – Handy et al. (2002)	Neighbourhood	A scale applicable to the conglomeration of multiple city blocks	<ul style="list-style-type: none"> • Activity density and intensity • Land use mix • Street connectivity • Street scale (typically described as human scale or automobile scale) • Aesthetic qualities
	Regional	A scale relevant to many neighbourhoods, or across a city or metropolitan area	<ul style="list-style-type: none"> • Activity and transportation facilities’ regional layout • Neighbourhood scale elements at a regional scale
Transportation Engineering – Bochner & Dock (2003); ITE (2010)	Network	A scale of design concerned with how major streets are laid out and spaced for each mode of transport, providing citywide mobility and accessibility; the interaction between the transportation system and other regional scaled systems are considered, including land use, environment, and economy	<ul style="list-style-type: none"> • Integration of street with context • Integration of railways, highways, streets • Development of motor vehicle, pedestrian, bicycle, and transit networks • Street layout and spacing • Number of lanes
	Street/Corridor	A scale of design addressing the specific features and layout of a particular street, including its geometric design and right-of-way provided for each mode’s movement, land access, and various street uses	<ul style="list-style-type: none"> • Geometric design (e.g. lane/sidewalk widths, curb radii) • Balances and coordinates multimodal needs and facilities • Connections between adjacent land uses • Provisions for patios, merchandise displays, and other non-transport related activities • Universally accessible features (e.g. curb ramps and tactile strips) • Transit facilities • On street parking • Pedestrian crossings • Design speeds • Crossing times
Architect/ Urban Designer – Gehl (2010)	Human	A scale of design and activities that are applicable to pedestrians and cyclists’ experiences as they use of a street as a place and a link; specifically, designs that can be used and experienced at a travel speed of approximately 5 km/h	<ul style="list-style-type: none"> • Quality places for people to walk, stand, sit, watch, listen, talk, bicycle, and play • Small units and details of design at eye level • Sidewalk obstacles
	Development/ District/ Community	A scale of design considering the spatial design of buildings and spaces	<ul style="list-style-type: none"> • Space designed to facilitate pedestrian and cyclist’s movements and activities • Buildings positioned around pedestrian and cyclist’s movements and activities (e.g. active building frontages, diversity of social and functional programming)
	City	A scale of design addressing relationships between the transportation systems and various areas of a city, and the city’s overall function	<ul style="list-style-type: none"> • City land uses and street networks are organized and designed to allow people to access opportunities primarily by walking, cycling, and public transit • Fine grain network • Local and regional connections • Balanced modal priorities

This practicum is an interdisciplinary research project, and distinctions between design professions are not of primary interest. Rather, integrated approaches that encompass various disciplines are desired. Table 3 displays how interdisciplinary concepts of design contributing to complete streets are applicable to different scales of design. The given sources explain the interrelationships between scales, emphasizing the importance of congruency between scales. By using scales to categorize concepts of design, Table 3 suggests the value of scales to account for the different roles of complete streets. Additional analysis of Table 3 is provided in Section 3.4.

3.3.1 Design Criteria

Design criteria inherently determine what modes are accommodated or prioritized. New York City (2012) suggests that revised metrics are needed to measure the value of the street in the 21st Century. ITF (2012) recommends that walking and sojourning measurements are standardized, creating “indicators of urban sustainability and liveability” (p. 11).

Level of service developed in response to the increase in use and ownership of private motor vehicles, as a tool to evaluate, plan, and operate transportation systems (Donnelly & Toop, 2011). Level of service is intended to communicate capacity issues at intersections, where the motor vehicle travel patterns are generalizable into predictable patterns (Jolicoeur, 2014, personal communication) (see Section 3.2.1 for information on level of service). Multimodal level of service was developed to support design priorities for unique contexts and specific modes, expanding the conventional approach’s primary design criteria, level of service, beyond motor vehicles. Methods for measuring multimodal levels of service were created in the *Highway Capacity Manual* (TRB, 2010), *Multimodal Level of Service Analysis for Urban Streets* (TRB, 2008), and Macdonald et al. (2010).

Various data sets are needed to measure multimodal levels of service, and this data is not readily available (Donnelly & Toop, 2011; Jolicoeur, 2014, personal communication). If all the data is collected and combined into a level of service letter grade, the meaning is lost in this oversimplification intended for cars (Jolicoeur, 2014, personal communication). The behaviours of cyclists and pedestrians are not predictable (OECD/ITF, 2013), and a single meaningful letter grade cannot combine and simplify elements that contribute to cyclists and pedestrians' quality of travel (Jolicoeur, 2014, personal communication). With multimodal level of service "you end up with something that is impossible to communicate with politicians. *Level of service C for pedestrians* means nothing to politicians. Pedestrians have to wait at an intersection for two minutes – that they will listen to" (Jolicoeur, 2014, personal communication). These findings suggest the need for clear and meaningful measures of pedestrian and cycling conditions.

Pedestrian and cycling level of service does not necessarily take priority over motor vehicle's levels of service (Jolicoeur, 2014, personal communication). Jolicoeur (2014, personal communication) suggests alternatives to multimodal level of service for ensuring pedestrian and cyclists' needs are met first before motor vehicles, including pedestrian zones in central districts, cycle tracks on arterials, and 30 km/h zones. Jolicoeur (2014, personal communication) points out that these measures reduce motor vehicle level of service, which should not necessarily be a priority in urban areas.

While conventional guidelines use passive criteria to accommodate peak traffic volumes (NACTO, 2013) (see Section 3.2.1), complete streets suggest proactive design criteria/controls to create the desired conditions (NACTO, 2013; ITE, 2010). In general, the context and community objectives determine the desired design vehicle, speed, volume, and performance measures (ITE, 2010); and the quality of the public realm as a place is central to the use of streets for pedestrians

and cyclists, for which the perception of safety, comfort, and aesthetics are critical elements (Handy & Clifton, 2001; Gehl, 2001, 2010). Qualitative performance measures may set the design criteria, such as: space for people to walk at different paces, aspects that engage people, and streets that are physically comfortable (Jacobs, 1993). There are a number of ways these objectives are accomplished, and the outcome is the focus. Additional examples of complete streets proactive and quality-based design criteria include the following considerations:

- New York’s metrics and treatments are identified to support the City’s new value system of a street, where the goals are: design for safety, design for all users of the street, and design great public spaces. These metrics aligns with complete streets, as the value of streets for different users and uses are encompassed. Table 8 in Appendix C outlines the strategies, metrics, and treatments New York City has correlated to achieving these goals.
- Design criteria for assessing the connectivity of streets may assess the following areas to “provide safe pedestrian crossings and circulation” (ITE, 2010):
 - Number of new safe pedestrian crossings
 - Opportunities for pedestrian amenities and enhancements at intersections
 - Square feet of pathways/sidewalks
 - Number of trailheads directly accessible on foot from the corridor
 - Number of key destinations in the corridor accessible via a connected pedestrian system (p. 40)
- The City of Calgary (2014) accentuates the importance of a dense and interconnected network that prioritizes pedestrian, cycling, and transit trips, respects natural features and ecological system harmony, supports adjacent land uses through social and economic activities above the mobility of automobiles traveling by, and integrates multimodal transportation systems (p. 14-15).
- The City of Calgary (2010) and ITE (2010) provide measures to assess network connectivity and accessibility. The City of Calgary’s indices include the street connectivity index and the active modes connectivity index – both evaluated on the ratio of links and nodes. ITE (2010) provides the Texas Transportation Institute’s *Indices for Network Connectivity and Accessibility* that reflect the links and nodes, intersection ratio, average intersection spacing, intersection density, blocks per square mile, and directness (p. 29) (adapted from Donohue, 2002). The City of Calgary (2014) also provides guidelines (see Appendix D) for improving networks’ conformance with complete streets objectives.

These examples demonstrate the spectrum of design criteria that municipalities can use to measure their desired conditions for pedestrians and cyclists.

3.3.2 *Classification System*

There are various classification systems that account for the unique contexts or uses of streets. Three alternative classification systems to the functional classification system are discussed here: modified versions of the functional classification system, use based classification systems, and the composite street typology.

Modified functional classification systems vary from the original in their description of conventional arterials and collector streets. Bochner and Dock (2003) rename minor arterials as boulevards and avenues, and their function is described as supporting “inter-neighborhood traffic and local circulation” (p. 6). They further describe collectors as connectors, where their role is for “connecting to town, village centres” (p. 6). These adaptations to the functional classification system shift the focus from citywide mobility to neighbourhood connectivity.

ITE (2010) accounts for various community contexts by using boulevard, avenue, and street to describe the various forms arterial streets might take. While the functional classification system is based on the network design, describing connections between streets to provide citywide motor vehicle mobility, the modified functional classification system describes how a community is connected through integrated transportation and land uses (Bochner & Dock, 2003).

Dover and Massengale (2013) point out that the functional classification system is currently applied to American cities and towns in the same way for both urban and suburban contexts – and this is similar in Canada (TAC, 1999). Dover and Massengale suggest that urban areas should be divided into two area types – either urban or suburban. Because of the political controversies of walkable and bikeable designs that decrease motor vehicle mobility, existing suburban streets would continue to be designed according to the functional classification system. Urban streets would be redesigned for walkability and compact development priorities, and

streets that were originally designed for walkability (namely in old towns and cities) would be restored to this form (Dover & Massengale, 2013). Dover and Massengale (2013) suggest this shift would reduce resistance to placemaking designs, as design priorities would follow the best opportunities for walkability. The following elements would be emphasized in a new urban street classification system: “two-way streets, narrow traffic lanes, slower speeds, bicycle sharrows, and a prohibition on slip lanes and turn lanes” (p. 365). They suggest that urban roads, small-town residential streets, and main streets be considered for the new urban street classification.

Use-based classification systems provide information related to how streets are used. NACTO (2013) endorses the following classification system, and *Boston Complete Streets Guidelines* uses similar typologies: downtown street, neighbourhood main street, neighbourhood street, yield street, boulevard, residential boulevard, transit corridor, green alley, commercial alley, residential shared street, and commercial shared street. Additional street types considered at the human scale may include shopping streets, green streets, bike paths, and pedestrian streets (Alexander et al., 1977). By using these types, the street’s uses are first recognized, then streets are shaped and arranged to support activities.

Municipal complete streets guidelines, such as Calgary, Edmonton, and Chicago, use “composite street typologies” (City of Edmonton, 2013, p. 22). Composite street typologies may describe the role of the street, the surrounding land use, the functional classification system designation, and the orientation of buildings to the street. Here is an example of a street’s composite street typology name resulting from the City of Edmonton’s *Complete Streets Guidelines* (2013): Street Oriented – Commercial – Arterial Street. Street classifications from the City of Calgary’s *2014 Complete Streets Guide* could include: Liveable – Urban Boulevard, or a Local – Primary Collector. *Complete Streets Chicago* (City of Chicago, 2013),

explains that their applied types “help in the selection of treatments which best reflect the surrounding environment, best accommodate all modes, best reflect regulatory strictures, and best affect desired outcomes: complete streets” (p. 27). Composite street typologies refer to urban aspects that might be applicable to different professions. This factor may make it more conducive to interdisciplinary design.

3.4 Findings and Analysis

The literature review addressed the question: *in what ways do the conventional and complete streets approaches influence the design of mixed-use arterial streets?* This question was asked by exploring design philosophies, street classification systems, and design criteria. Through the content analysis method, street function’s relationships to scales of design, as well as design philosophies and inputs were analyzed. The research findings for this question are summarized for each approach below:

Conventional Approaches:

1. Motor vehicle mobility is the basis for conventional approaches, and the functional classification system and level of service are the primary frameworks for making design decisions. Pedestrians and cyclists inform designs on local and collector streets, and may be subsequently added to arterial streets where motor vehicle movement is the priority.
2. Section 3.2 discussed how conventional approaches rely on the functional classification system and design criteria to prioritize the movement of motor vehicles throughout a city. Mobility and accessibility are inversely related in relation to the functional classification system’s freeways, expressways, arterials, collectors, and locals. With this inverse relationship between accessibility and mobility, mobility is a high priority on mixed-use arterial streets, and accessibility is a lower priority.

Complete Streets Approaches:

1. Complete streets approaches highlight the mobility and accessibility of all modes, and seek to balance each mode’s needs depending on community inputs, land use context, and multimodal activities/movements. Researchers recognize sojournability

as an additional function of streets, and practices are emerging for factoring it into street design.

2. Complete streets design criteria use qualitative and quantitative measures to assess the quality of streets as links and places for all modes, and create the desired conditions. Classification systems account for how streets fit within the context and support different modes.

Conventional approaches' conception of mobility and accessibility's inverse relationship to the functional classification system does not align with the street functions for complete streets defined in Section 3.1.1 or the concepts of design at each scale shown in Table 3. This begs the question: how should complete streets re-conceptualize the relationships between street functions and scales of design?

To respond to this question, scales of design from Table 3 are analyzed to determine appropriate scales for this practicum. Handy et al. uses the neighbourhood and regional scales, identifying the city block as the building block for understanding design. Bochner and Dock (2003) as well as ITE (2010) identify the network and street/corridor scale, addressing scales of design as linear entities separate from land uses. Gehl's scales describe how pedestrians and cyclists experience a city, starting with the experience of human senses, and then transition to pedestrian and cyclists' movements throughout developments/districts/communities, and later cities as a whole. This practicum focuses on practices to improve municipalities for pedestrians and cyclists, and thus Gehl's human scale is useful for this practicum to describe the sojourning experiences of pedestrians and cyclists. Neighbourhood and city scales are also selected for this practicum, as they generally describe a pedestrian and cyclists relationship with streets and land uses collectively within their urban environment: a neighbourhood encompasses concepts of design determining how streets and buildings are laid out, with city blocks as the building blocks; and the city scale accounts for the relationships between transportation systems and various areas and functions of cities, as well as the conglomeration of many neighbourhoods.

The city scale is the last scale selected for this practicum, as this practicum specifically applies to urban municipalities. Each of the concepts of design given in Table 3 is re-categorized under these chosen scales, human, neighbourhood, and city scales, by answering the following questions:

- Human: can the concept of design be experienced through the senses of pedestrians or cyclists as they travel along or enjoy a street (Gehl, 2010)?
- Neighbourhood: does the concept of design relate to the spatial design of buildings and spaces, or is it applicable to the conglomeration of multiple city blocks (Handy et al., 2002; Gehl, 2010)?
- City: does the concept of design addresses the relationships between transportation systems and various areas of a city, and the city's overall function; or is it relevant to many neighbourhoods?

The concepts of design from Table 3 were further categorized according to street functions, using the questions below (which are based on the definitions identified in Section 3.1.1).

- Sojournability: does the concept of design improve the enjoyment of a street by people while cycling, walking, or lingering?
- Accessibility: does the concept of design improve a person or good's ability to reach a desired opportunity, where an opportunity includes a destination, service, or activity?
- Mobility: does the concept of design improve people or goods movement from one place to another?

The results of this re-categorization are shown below in Table 4, and include the sources' associated professions.

Table 4 – Design concepts activating functions of sojournability, accessibility, and mobility at each scale (CRP/CE: City and Regional Planner/Civil Engineer; TE: Transportation Engineer; UD/A: Urban Designer/Architect)

		Functions		
		<i>Mobility</i>	<i>Accessibility</i>	<i>Sojournability</i>
Scales	Human	<ul style="list-style-type: none"> • TE – Geometric design (e.g. lane/sidewalk widths, curb radii) • TE – Crossing times • A/UD – Sidewalk obstacles 	<ul style="list-style-type: none"> • TE – Universally accessible features (e.g. curb ramps and tactile strips) 	<ul style="list-style-type: none"> • CRP/CE – Activity density and intensity • CRP/CE – Street scale (typically described as human scale or automobile scale) • CRP/CE – Aesthetic qualities • TE – Provisions for patios, merchandise displays, and other non-transport related activities • A/UD - Quality places for people to walk, stand, sit, watch, listen, talk, bicycle, play • A/UD – Small units and details of design at eye level
	Neighbourhood	<ul style="list-style-type: none"> • CRP/CE – Street connectivity • TE – Integration of street with context • TE – Connections between adjacent land uses • TE – Number of Lanes • TE – Pedestrian crossings • TE – Design Speed 	<ul style="list-style-type: none"> • CRP/CE – Land use mix • TE – Transit facilities • TE – On street parking 	<ul style="list-style-type: none"> • A/UD – Space designed to facilitate pedestrian and cyclist’s movements and activities • A/UD – Buildings positioned around pedestrian and cyclist’s movements and activities (e.g. active building frontages, diversity of social and functional programming)
	City	<ul style="list-style-type: none"> • TE – Integration of railways, highways, streets • TE – Development of motor vehicle, pedestrian, bicycle, and transit networks • TE – Street layout and spacing • A/UD – Fine grain network 	<ul style="list-style-type: none"> • CRP/CE – Activity and transportation facilities’ regional layout • A/UD – Local and regional connections 	<ul style="list-style-type: none"> • TE & A/UD – Balances and coordinates multimodal needs and facilities • A/UD – City land uses and street networks are organized and designed to allow people to access opportunities primarily by walking, cycling, and public transit

The relationships identified between street functions and scales are important for two primary reasons. First, complete streets scholarly and grey literature may reorient themselves to

the design functions, scales, and priorities of streets as multimodal links and places, the researcher did not find literature that directly correlated these elements – as presented in Table 4. Secondly, responsibilities of design professions, including city planning, transportation engineering, urban designers, and architects, are collectively represented. The street functions of accessibility and mobility are conventionally transportation engineering responsibilities, and the layouts of cities at a city and neighbourhood scale are conventionally city planning responsibilities; urban designers and architects may be involved in designing for sojourning at the human scale on site specific projects. This framework for designing streets compiles the applicable street functions and scales for each of these design professions into one table, creating a collaborative platform, where the role and value of each professional focus is understood and valued in relation to the others.

Each scale influences multimodal mobility, accessibility, and sojournability through interdisciplinary practices. While conventional approaches use the functional classification system to move motor vehicles throughout the city, complete streets approaches also consider how streets fit within their context and connect pedestrians and cyclists within their neighbourhoods. The next stage of this research reviews precedents to investigate design practices that support the three street functions at each scale.

4 Precedent Review

Precedents are valuable ways to inform complete streets practices as they develop in Canadian cities. Section 3.4 identified that streets have concepts of design applicable to the human, neighbourhood, and city scales, as well as the street functions of mobility, accessibility, and sojournability. Canadian and European precedent organizations are investigated in this section to identify practices for implementing these concepts of design, responding to the research question: *what are Canadian and European municipal precedents for designing complete streets, specifically on mixed-use arterial streets?*

The criteria for the precedent organizations included their acknowledgment of streets as links and places, and the use of design processes that consider the needs of pedestrians and cyclists as a priority, and not a secondary consideration after motor vehicles (see Section 1.5).

Precedent organizations were considered from the following events:

- International Transport Forum, Leipzig, Germany: City of Leipzig (Germany) and Gehl Architects (Denmark)
- Complete Streets Forum, Toronto: City of Edmonton
- Winter Cycling Congress, Winnipeg: Vélo Québec (Montreal)
- Transportation Association of Canada Annual Conference, Montréal: no additional precedents identified¹⁵

Precedent organizations from the City of Edmonton, Vélo Québec (Montreal), the City of Leipzig (Germany), and by Gehl Architects (Denmark) were identified for this project. The following sections present the collected information, gathered through interviews and the review of grey literature (see Section 1.5).

¹⁵ The researcher learned about Ottawa's pedestrian level of service, and included this information in Section 3.3.1.

4.1 City of Edmonton

Edmonton's *Complete Streets Guidelines* were passed by their City Council in 2013, and are currently being applied to reconstruction projects. The guidelines set a flexible framework for street design by providing clear priorities and processes for making decisions, with the intent of creating outcomes that are based on each area's context (City of Edmonton, 2014e).

Recommended concept plans are based on policies and guidelines, technical requirements, and stakeholder inputs (City of Edmonton, 2014d). The guidelines provide practitioners with flexible but robust guidance through a design process flow chart, innovative design requirements, a progressive congestion policy, a clear tradeoff sequence, and a receptive public engagement strategy. Each of these aspects of Edmonton's *Complete Streets Guidelines* (2013) are discussed in this section.

The flowchart shown in Figure 4 represents the steps of the design process, which includes defining the project goals and scope and modal priorities, identification of the street type (described in Section 3.3.2), selection of design elements, negotiation of tradeoffs, and final design confirmation.

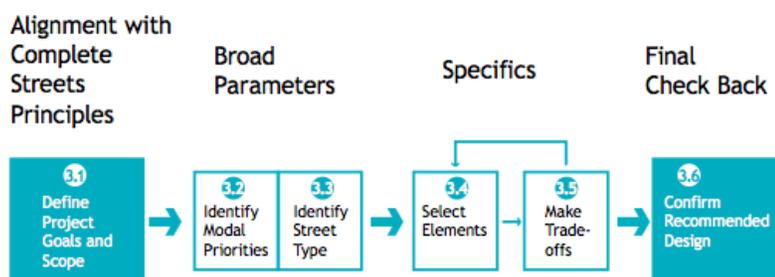


Figure 4 – City of Edmonton complete streets design process flowchart (City of Edmonton, 2013, p. 15; reproduced with permission from the City of Edmonton, Transportation Services, Policy Implementation & Evaluation)

The City of Edmonton's complete streets design process inclusively considers goods movement, transit, pedestrians, automobiles, and cyclists. As discussed throughout this section, the process provides both clear and lenient guidance.

Edmonton's complete streets principles (shown in Table 2) are performance-based design criteria, setting standards for the ways streets perform socially, economically, and environmentally. These principles were identified through a collaborative process with the City of Edmonton departments, external stakeholders, and the public; in the design process, these principles help set project priorities and navigate tradeoffs (City of Edmonton, 2013). The result of Edmonton's design process is based on the unique inputs and needs for each street, rather than a generic design determined by generalizable qualities. The City of Edmonton's (2013) commitment to creativity is reflected in the quote below.

The Principles do not prescribe a single way of developing a complete street; rather the principles guide the development of creative and innovative streets that reflect the surrounding characteristics and users (p. 11).

The modal priorities for a specific project are predetermined by a citywide modal priority network (this is an internal document), where transit, pedestrian, bicycle, goods movement, and automobiles' priority networks are highlighted. The City of Edmonton found that "this has the effect of forcing the analyst to think about the form and function of the roadway as well considering how the local segment fits into the broader network" (Vriend, 2012, p. 4). The level of priority influences the design elements and dimensions chosen; lower modal priorities are subject to trade-offs and constrained dimensions (City of Edmonton, 2013).

The modal priority network, along with a street's classification, and land use pattern, also informs the chosen multimodal level of service (City of Edmonton, 2013). The City of Edmonton's (2012a) City Policy: *Optimization of Transportation System Network* recognizes

that congestion (i.e. low motor vehicle levels of service) is unavoidable, and multimodal transportation is critical to congestion management:

The City recognizes that many physical, financial and community constraints make it infeasible or undesirable to build or expand roads to alleviate all congestion. The City will develop and apply a framework for congestion management that considers all modes of transportation, including pedestrians, cyclists, transit, autos and goods movement (p. 1).

This policy is groundbreaking in its acknowledgement that multimodal transportation can address congestion issues by providing alternative options – as opposed to simply widening streets.

The City of Edmonton's (2013) complete streets process is responsive to community inputs and progressive ways of addressing congestion, and is also guided by a sequential tradeoff process. This process provides direct guidance for designing according to complete streets principles (City of Edmonton, 2013):

When working in a constrained situation and determining how to fit multiple modes into the cross-section, the following potential adjustments should be applied, wherever practical, and in this order:

- A. Reduce lane widths to constrained dimensions
- B. Use constrained dimensions for all elements except those accommodating priority modes
- C. Remove parking lane on one side of the road
- D. Determine if a lower priority mode is better served on an adjacent road
- E. Reduce design speed
- F. Remove medians
- G. Remove auto lanes
- H. Use shared lane markings where constrained widths of lanes for traffic and bicyclists cannot be achieved
- I. Place pedestrian facility next to curb removing boulevard buffer
- J. Consider acquiring land (City of Edmonton, 2013 p. 23)

This sequential process for applying tradeoffs is important, as it directly ensures that complete streets' principles are followed in individual scenarios. The tradeoff process further demonstrates

Edmonton's commitment to multimodal transportation, as motor vehicle provisions are not necessarily the ultimate priority.

Stakeholder input has also been central to Edmonton's design process. In the case of the *142 Street Planning Study* (City of Edmonton, 2014d), industry, associations, invested property and business owners, and the public were involved in interviews, public surveys, and workshops. With this feedback, two concept design options were developed. Concept 1 included motor vehicle lanes reduced from four lanes to three, a shared-use path was added to the east side, and a full sidewalk and boulevard were added on the west side. Concept 2 maintained four lanes of motor vehicle traffic, a shared-use path was added on the east side, and bus stop connecting sidewalks on the west side, but not a full sidewalk on the west side (City of Edmonton, 2014d). The evaluation (Figure 5) shows that Concept 1 best implemented complete streets goals, as a total of 91% of the total circle is filled in for Concept 1, and 75% of the circle is filled in for Concept 2, where the filled in circle indicates the criteria is best met (City of Edmonton, 2014c).

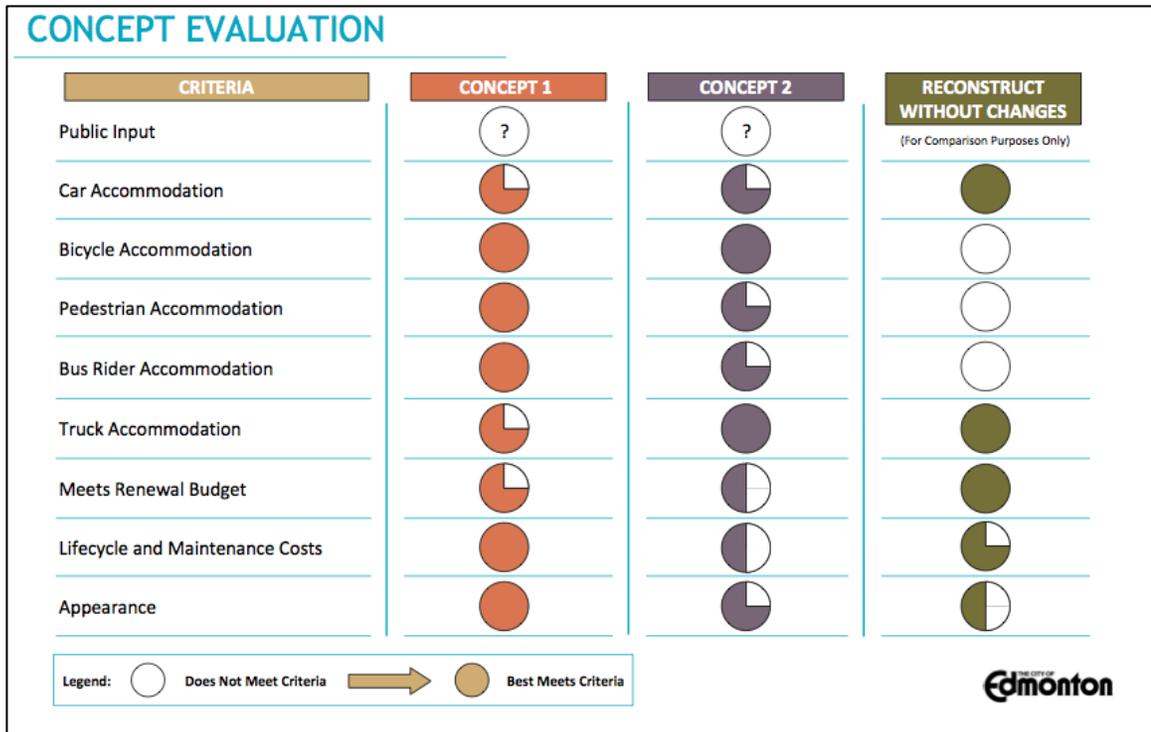


Figure 5 – Concept design evaluation of Edmonton’s 142 Street (City of Edmonton, 2014c, slide 17; reproduced with permission from City of Edmonton, Transportation Services, Facility & Capital Planning)

Concept 2 was selected in the public open house, as 31% were in favour of Concept 1, and 51.5% were supportive of Concept 2 (City of Edmonton, 2014b). The number of lanes was the main point of concern deterring Concept 1 (three lanes) and supporting Concept 2 (four lanes) (City of Edmonton, 2014b). Feedback in support of Concept 2 suggested the roadway capacity was needed to maintain current traffic flow (City of Edmonton, 2014b). People further argued that a full sidewalk was not needed on the west side, and the east shared-use path was sufficient (City of Edmonton, 2014b). The City Council’s Transportation Committee honoured the majority’s input at the public open house, and recommended Concept 2 to City Council (City of Edmonton, 2014a). City Council approved the recommendation on June 11, 2014 (City of Edmonton, 2014a).

The 142nd Street project showcases Edmonton's commitment to their complete streets process. Although the selected design did not reduce motor vehicle volumes and a full sidewalk was not provided on one side of the road, a shared-use path was included in the design, providing passage for pedestrians and cyclists. This decision reflects the City of Edmonton's receptiveness to public perspectives and preferences.

The City of Edmonton demonstrates a flexible design processes that naturally adjusts to priorities based on the given context. The *Complete Streets Guidelines* provide structure to the process of determining priorities: the range of aspirational values for street design are explained in their complete streets principles; the needs and context of each street is determined in the process flowchart; key streets for each mode are pre-designated on priority maps; a policy platform for using multimodal transportation in response to congestion creates alternatives to laden motor vehicle travel; and a sequential tradeoff process embodies the City's values for multimodal facilities. The City of Edmonton's process is unique in its inclusive consideration for all modes, and receptiveness to identify priority modes for a specific street based on the given inputs.

4.2 Vélo Québec, Montreal

Vélo Québec is an organization that encourages cycling and walking by providing technical resources and designs, and organizing community events (Vélo Québec Association, 2010b). Mobility and accessibility are achieved when transportation systems are not simply reliant on cars, and cities are designed for transit, pedestrians, and bicycles – says Marc Jolicoeur (personal communication), a professional engineer at Vélo Québec in Montreal. Vélo Québec suggests cycling and walking are the most ideal and efficient modes of transport, in terms of travel time,

health, spatial use, and finances – not to mention the enjoyability of a trip (Vélo Québec Association, 2010b).

Vélo Québec's (2010) understanding of the context is informed by infrastructure layouts and community inputs, which ultimately shapes their planning process. The following are included into Vélo Québec's understanding of the context:

- The layout of land uses and buildings, and their relationship to population density and an area's frequency of use;
- The serviceability of current transportation networks to the area, namely how safely and comfortably the area is serviced by pedestrian, cycling, and transit infrastructure;
- Identification and mitigation of barriers restricting pedestrian and cycling access – could include natural (e.g. bodies of water and topographic features) or man-made obstacles (e.g. railways, highways);
- An understanding of current route uses, which may include identification of current pedestrian and cycling infrastructure, trip origin/destination information (collected through travel surveys), and observational data regarding the demand for infrastructure and facilities (e.g. cyclists traveling upstream on one-way streets indicates a need for a contraflow bike lane; bicycles locked to street furniture indicates a need for bike racks); and
- Information for the planning process potentially collected through community walkabouts, interviews, focus groups, photojournalism, and other activities (p. 161).

In Vélo Québec's process, cycling and walking opportunities and intermodal points are identified, barriers and obstacles are noted, and quality facilities are recommended. The most impacting opportunities for supporting pedestrians and cyclists are prioritized (Vélo Québec Association, 2010b):

In terms of importance, initiatives should be addressed in order of anticipated impact. Priority should be given to efforts that will be the most meaningful for the greatest number of pedestrians and cyclists (p. 163).

To implement cycling and pedestrian plans, Vélo Québec suggests that essential routes are identified and supporting actions stated. "Clear, concise and measurable" goals and the required actions are needed (Vélo Québec Association, 2010b, p. 162). Essential routes provide better connectivity between neighbourhoods or across natural or man-made barriers. Also, the following facilities may contribute to essential routes: widened and/or separated facilities, traffic-

calming measures, and underpasses and bridges, as well as medians or longer crossing signals at crossings (Vélo Québec Association, 2010b). Vélo Québec suggests that the essential route network should perform in way similar to conventional arterial streets for cars, providing higher levels of mobility and accessibility throughout a given area.

The density of the network of essential routes must accommodate pedestrian and cyclist needs by delivering a performance that is equivalent or superior to that of arterial roadways or public transit systems. Moreover, this network must enable pedestrians and cyclists to bypass at least as many major obstacles as roadways would (Vélo Québec Association, 2010b, p. 162).

Opportunities and barriers influence the types of streets chosen for pedestrian and cycling facilities. Jolicoeur (2014, personal communication) suggests that, when possible, streets with lower traffic volumes are ideal for bicycle facilities – as done in Vancouver. He suggests that pedestrian and cycling activities improve business for store-lined streets, and places with pedestrian activity attract more pedestrians because they feel safer. When high traffic volume streets are the best option for route efficiency or connectivity, Jolicoeur highlights the importance of separated facilities. When right-of-way is limited he suggests on-street parking are the first type of space removed, noting that on-street parking is a private use occurring on public space.

Vélo Québec uses simple methods and measures to assess pedestrian and cycling transportation needs. No modeling software is used; rather, a geographic information system (GIS) is used to understand spatial relationships between an area's characteristics (e.g. land use, density) and transportation facilities. Simple counting and measuring techniques have proven sufficient for their needs. Since 2010, ten bicycle counters have been placed in Montreal, and mobile counters were used before this – Vélo Québec makes use of this infrastructure (Jolicoeur, 2014, personal communication).

Vélo Québec's downtown Montréal cycling plan (*Accessibilité et mobilité à vélo au centre-ville de Montréal – Bicycle Accessibility and Mobility in Downtown Montréal*) demonstrates the use of their design practices. In a study conducted in 2001, 600 000 of the downtown trips were coming from less than 8 km (Agence Métropolitaine de Transport, 2001, p. 170). Based on trip length and trip purpose, Vélo Québec suggested that 20% of trips to Montréal's downtown could use bicycles (trip purposes involving errands and taking children to school were not included in the estimates for increasing cyclists) (Jolicoeur, 2014, personal communication). Cycling routes were chosen based on their location, connecting four university campuses and highly used bicycle routes on both the east and west end (Jolicoeur, 2005), and surrounding population densities (Jolicoeur, 2014, personal communication). About 160 km of cycling facilities were constructed in Montréal, following many of Vélo Québec's recommendations (Vélo Québec Association, 2010a). As a result, cycling increased by 10% between 2005 and 2010 (Vélo Québec Association, 2010a).

Vélo Québec demonstrates an opportunity based approach for pedestrians and cyclists that synergize the following: origins/destinations likely to generate pedestrian and cycling activities; right-of-ways that provide direct, enjoyable, and safe routes; and mitigated barriers to pedestrians and cyclists. Their pedestrian and cycling condition reporting methods are simple, and their data is clear. These practices create a direct approach facilitating cycling and pedestrian needs.

4.3 City of Leipzig, Germany

The German Road and Transport Research Association's (FGSV, 2010 – cited from Difu¹⁶, 2010c) *Guidelines for Design of Urban Streets* (FGSV, 2006 – cited from Difu, 2010c) calls practitioners to ensure the “integration and balance of all modes” through “top quality infrastructure” (p. 1), even in the case of limited space. Mixed-use and high-density neighbourhoods with quality public spaces are aspects of integrated transportation and land use, all contributing to improved conditions for multimodal transportation (Difu, 2010b).

The City of Leipzig uses the software *PTV Visum* (<http://vision-traffic.ptvgroup.com/en-us/home/>) as their platform for modeling current and future travel patterns. *PTV Visum* is a tool developed by *PTV Group*, to model desired multimodal conditions. It correlates characteristics of city cells (e.g. population, work and school location, etc.) with expected trips. The future desired modal split¹⁷ is applied to the trips, and the model distributes the trips to various routes to minimize travel time and distance (Heinemann, 2014, personal communication). The minimum travel time and distance is determined based on the street's maximum speed, number of lanes, provision of separated bicycle facilities, and tram facilities – Heinemann (2014, personal communication) suggests that the software identifies and designates trips where multimodal transportation are the most efficient option. The capacity of a street is limited by the capacity of intersections, where modal allocations, signalization for each mode, coordination between signalization¹⁷ of intersections, and turning lanes contribute to Leipzig's analysis of each intersection's capacity (Heinemann, 2014, personal communication).

¹⁶ Difu is the German abbreviation for the German Institute of Urban Affairs.

¹⁷ Future modal splits are determined based on travel behaviour trends, as found through Technische Universität Dresden's travel surveys performed approximately every five years (Difu, 2010a; Technische Universität Dresden, 2014).

German guidelines limit the motor vehicle capacity of an intersection to level of service D (see Section 3.2.1 for an explanation of level of service); intersections that are built to a higher level of service do not qualify for subsidies from the federal government (Heinemann, 2014, personal communication). Specifications for calculating level of service are provided in their highway capacity manual - *Handbuch für die Bemessung von Straßenverkehrsanlagen*. Upon Legal merit, the City may reduce or ban motor vehicle traffic and goods movement. For example, the maximum speed might be reduced to diminish noise and/or pollution. An alternative route may be provided or heavy traffic access may be restricted to reduce pollution (Heinemann, 2014, personal communication).

Although the City may monitor the quality of traffic flow for cyclists and pedestrians, level of service is not calculated for cyclists and pedestrians, as capacity issues for these modes are not typically relevant measurements¹⁸ (Heinemann, 2014, personal communication). Guidelines currently regulate the provision of appropriate facilities. Sidewalks are mandatory on both sides of urban streets at a minimum width of 2.50 m, and the City may provide over 10 m wide (e.g. Karl-Liebnecht-Straße, Leipzig) (Heinemann, 2014, personal communication). Motor vehicle volumes and speeds primarily determine the type of cycling facility (Difu, 2010c). Cyclists are usually able to travel in both directions on all streets, with contra-flow facilities provided on one-way streets. Leipzig's transportation network has priority cycling links and recreational routes; 30 km/h residential areas are also typical.

Similar to Canada, Germany's conventional approach began by designing streets based on the requirements of motor vehicles, with the remaining space allotted to pedestrians and

¹⁸ This perspective is beginning to change in Leipzig, particularly for cyclists. Research by the federal government may be conducted to understand the appropriate capacity of certain cycling facilities (Heinemann, 2014, personal communication).

cyclists (Difu, 2010d). In the new *Guidelines for Design of Urban Streets* (FGSV, 2006¹⁹), design requirements are first addressed for pedestrians. The next stage of design considers cycling, motor vehicles, parking, loading, and green spaces, ensuring no mode or street use is ignored, ensuring design needs are met from the “edge to the centre” of the right of way (i.e. pedestrians’ needs for sidewalk space are met first, and other modes needs are met sequentially from the outside of the right of way to the centre, where motor vehicle’s driving needs are lastly met) (FGSV, 2006, p.). Parking is the first facility removed, as moving traffic has a higher priority (Difu, 2010d).

Germany’s street classification system includes the following: residential way, residential street, collector street, quarter street, village main street, local access street, local business street, main business/shopping street, commercial street, industrial street, connection street, and freeway (FGSV, 2006). Depending on the street type, the appropriate cross sectional features and dimensions are selected based on the following questions (Difu, 2010d):

1. What type of road in the transport network is being planned and what are the main usage demands given development on and near the road? Is heavy pedestrian traffic, a lot of delivery and loading stops and significant or insignificant bike traffic expected?
2. Will bus or tram transport be relevant?
3. How much vehicular traffic can be expected?
4. And finally: How wide is the street space that requires optimal cross-section planning (p. 2)?

The above questions are depicted in Figure 6, which directly corresponds to Germany’s method for selecting cross sectional dimensions for a specific street type. In this street type, walking alongside, cross-walking, cycling, resting, delivering, and bus public transport are accommodated, as these are shaded in

¹⁹Difu (2010d) is an English document that discusses FGSV (2006).

the figure below. Depending on the volume of cars that are facilitated, various widths are required. In cases where multiple widths are associated with a specific volume of cars, the available right-of-way space and the desired facilities determine the chosen cross section. Each cross section indicates the dimensions for each facility. Similar cross sections are shown for each of the German street types in *Guidelines for Design of Urban Streets* (FGSV, 2006).

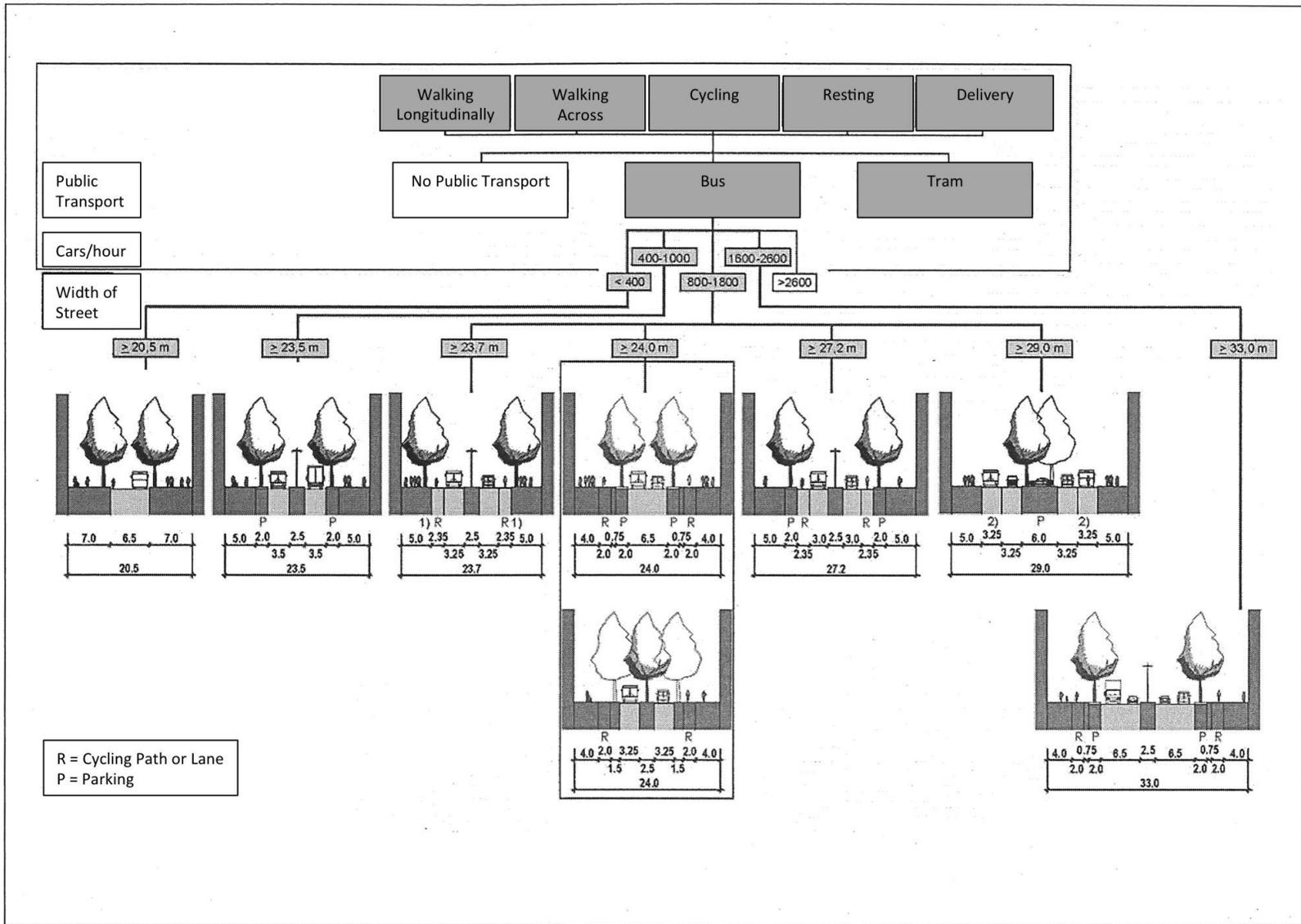


Figure 6 – Possible cross sectional dimensions for street type’s modal provisions (translated and adapted from FGSV, 2006, p. 52)

This cross sectional chart is unique in its approach to specifying modal facilities. Germany's order of priorities is built into the design process, and ensures that pedestrian and cycling spaces are given first and remaining space is allotted to cars. Not only is space provided for cyclists and pedestrians to move, but space is also prioritized for "resting," which contributes to the design of streets as places. Delivery and public transport are also addressed in the initial stages of the process, ensuring that accessibility is dedicated to all users. In unique cases where there are conflicting interests (e.g. high traffic volumes and a narrow right of way), the designer follows the "edge to the centre" concept.

The equivalent German street cross section to a mixed-use arterial street is a Hauptgeschäftsstraße, which literally translates to main business/shopping street. *Guidelines for Design of Urban Streets* (FGSV, 2006) describes this street to fulfill functions of both a main street and access street. Pedestrian crossings and sufficient sidewalk space on these mixed-use arterial streets are a priority, and their provision and design reduces traffic speeds and ensures the visibility of pedestrians to vehicles (FGSV, 2006). The space between the roadway and adjacent buildings are designed based on the specific business type; ideally trees are provided (FGSV, 2006).

Germany's *Guidelines for Cycling Facilities* suggests that a poor quality cycling facility is worse than no cycling facility (Difu, 2010c). The main cycling policy objectives include the following (Difu, 2010c):

- objective safety: avoiding road traffic accidents;
- subjective safety: making cycling appear safer, thereby dismantling one psychological barrier to bicycle use;
- taking into account different cycling speeds;
- minimizing effort and physical energy expenditure while cycling;
- minimizing travel time (p. 2).

While the intensity and diversity of uses on mixed-use arterial streets causes some cyclists to travel on calmer streets, Difu (2010d) explains that such detours are not sufficient for providing high quality infrastructure. Mixed-use arterial streets often provide the most efficient routes and desirable destinations for cyclists; cyclists also provide benefits to mixed-use arterial streets: “Cycling on main streets is paramount to the well-being of retailers and to creating vibrant city centres” (Difu, 2010d, p. 1).

FGSV’s (2006) guidelines prioritizing cycling and walking are supported by Germany’s potential for cycling and walking trips. Half of German car trips in cities are less than 5 km and a quarter are less than 3 km, which are widely accepted walking and biking distances (Difu, 2010b, p. 3). Cycling and walking further enliven urban communities, creating desirable lifestyles, and reducing motor vehicle traffic alternative transport modes (Difu, 2010b).

The City of Leipzig demonstrates how incorporating multimodal priorities can shape streets. From the design of multimodal networks to accommodate desired modal volumes, to street cross sections that prioritize people resting, walking, cycling, delivering goods in trucks, and public transport, Leipzig is demonstrating how city scaled networks and infrastructure are designed to support the human scale. PTV software incorporates multimodal dynamics, and directs designs to integrate these dimensions. Leipzig’s cross sections are notable in their decisive means of allocating motor vehicle space last. If motor vehicle volumes are demanded in excess of the cross section’s capacity, the induced congestion is accepted with the objective that mode shifts will occur to walking and cycling and alleviate congestion.

The implications of the City of Leipzig’s design practices and priorities on mixed-use arterial streets embrace the human scale. Delivery truck priorities are unique among precedents reviewed, and this shows the City of Leipzig’s commitment to servicing commercial and retail

uses. The contributions of cycling to the urban environment are also extolled, and regardless of the higher traffic volumes, cycling is welcomed on mixed-use arterial streets. Pedestrians' inclination to rest *and* walk is further reflected in design practices. The City of Leipzig acknowledges the social, aesthetic, health, economic, and environmental benefits of walking and cycling, and is orienting their design practices to reflect these ideals.

4.4 Gehl Architects, Denmark

Gehl Architects is an internationally regarded firm based in Copenhagen, Denmark (ITF, 2014), and was co-founded by Jan Gehl. Gehl's (2010) process of design begins by understanding the character and type of "anticipated life" (p. 198) in an area. Based on the existing or anticipated activities on streets, spaces and connections for pedestrians and cyclists are then provided. Lastly, buildings/infrastructure are positioned to support pedestrians' and cyclists' scale of activities and movements (Gehl, 2010). This process is summarized as *Life—Space—Buildings* (Gehl, 2010).

For Gehl, designing for the human scale follows from the observation of people – as one could study an animal species through observation (Gehl & Svarre, 2013). Through direct observation, city spaces are observed, and people's activities and behaviours are noted (Gehl & Svarre, 2013). Practitioners' methods of analysis may include counting, mapping, tracking, looking for traces, photographing, journaling, and test walks (Gehl & Svarre, 2013). Direct observational methods are used to understand how people move and spend time on streets, creating correlations between spatial aspects and social interactions (Gehl & Svarre, 2013, p. 22). This method uncovers information that supplements quantitative data (Gehl & Svarre, 2013, p. 32). For example, while an automatic pedestrian counter could be set up at a particular location,

details specifying barriers to pedestrians trying to access a space may not be understood unless a person is physically present at the location to observe. In this way, the quality of a street is better understood through observational methods, allowing the focus of streets' designs to be on the comfort the environment provides for people (Gehl & Svarre, 2013).

In *Life Between Buildings*, Jan Gehl (2001) categorizes the types of activities that occur on streets as being *social*, *necessary*, and *optional activities*, where social activities result from the interaction between necessary and optional activities. Necessary activities – which may include traveling to work, appointments, or the grocery store – are least affected by the quality of design, since the activity needs to occur regardless. Optional activities are most highly dependent on the design quality. People spend time on streets when a quality environment invites them to do so; people may walk and sit leisurely or simply “enjoy life” (p. 11). For Gehl, a street becomes a *place* when optional activities occur – people “stop, sit, eat, play, and so on” (p. 11). *Social activities* on a street can range from simply hearing and seeing people, to casual interactions about the weather, to intimate conversations between close friends. Although necessary activities may occur on streets regardless of their quality, optional and social activities only occur with an “excellent public realm” (Gehl Architects, 2008, p. 16). This theoretical framework for pedestrian activities on streets translates into Gehl Architects' public space/public life surveys.

Gehl Architects' public space/public life surveys utilized in New York incorporated quantitative and qualitative data, where modes were counted and elements of the built environment were noted. This survey involved 40 volunteers counting pedestrians for 10-minute periods every hour between 8:00 am and 8:00 pm (*Gehl Architects, 2008*). By comparing the space allotted for pedestrians and motor vehicles and the modal volumes, Gehl Architects proved

that street space was being designated disproportionately (see Gehl Architects, 2008). Additional findings of the Public Space/Public Life survey included the following:

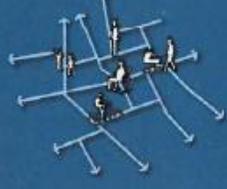
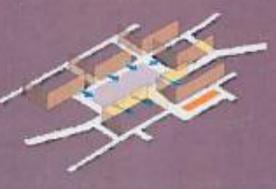
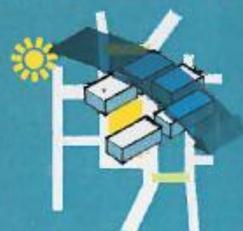
- Congested Sidewalks: Problems with overcrowded sidewalks (p. 20-22) (*measures: percent of the day where overcrowding exists*)
- Obstacles on Sidewalks: The effective width for walking is sometimes 50% of the sidewalk (p. 26) (*measures: space allocations*)
- Sidewalk Crowding Affects Public Transit: It is sometimes hard to get to the subway or bus (p. 26) (*methods: observations*)
- Streets without Seats: Nowhere to rest (p. 25) (*methods: observations*)
- More scaffolding than seating: Scaffolding is left up for too long, while street cafes are few and far between (p. 26-27) (*methods and measures used: mapping of café seating and public seating; counts of café seats per 1000 yards*)
- Few Opportunities to Stop (p. 28-29) (*methods and measures used: mapping counts of motor vehicle and bicycle parking, and places to sit*)
- Few Children and Elderly in the street: Who uses New York Streets (p. 30-31) (*methods: counts of pedestrians under 14 and above 65*)
- Many Public Spaces are Hard to Get to: Many public spaces do not interact with streets and surrounding buildings (p. 32-33) (*methods: observations*)
- Closed Façades: Problems with metal gates (p. 34-35) (*methods: counts of shop fronts with closed metal gates at noon on Sunday, and measures of road space and people space*)

Each of these qualitative and quantitative characteristics noted influence the quality of sojourning experience. For example, measures indicating overcrowding and a lack of seating accentuate the undesirable nature of these areas for enjoyably spending time.

Gehl Architects (2014) suggest that street networks should possess qualities that enable accessible, social, and enjoyable streets. Accessible streets should allow all people to use different modes of transport (namely cycling and walking), while safely and easily transitioning between modes. Social streets instigate activities by congregating people, and engaging them in a variety of activities and interesting built forms. Enjoyable streets allow pedestrians and cyclists

to engagingly move throughout a network of streets, consistently intrigued in design aesthetics and character. Characteristics of accessible, social, and enjoyable streets at a network scale are outlined in Table 5.

Table 5 – Spatial network qualities, showing characteristics of street networks that are accessible, social, and enjoyable (Gehl Architects, 2014; reproduced with permission from Gehl Architects)

ACCESSIBLE	<p>CONNECTED Local & regionally connected networks. Attractive centers.</p> 	<p>INCLUSIVE Accessible and inviting for all user groups and cultures.</p> 	<p>BALANCED Walk and Cycle priority. Protection from accidents. Balance between modes of movement.</p> 
	<p>DIVERSITY Social and functional variety. Multiple activities. Diverse building types.</p> 	<p>CONCENTRATION Concentration of people & activities. Common squares. Spatial hierarchy and legibility.</p> 	<p>INTERACTION Uses and functions related to public spaces. Active facades.</p> 
	<p>FINE GRAIN Fine grain network. Human scale. Small units with lots of detail at eye level.</p> 	<p>RESPONSIVE Maximize the microclimate. Great sun and wind conditions.</p> 	<p>HUMAN SCALE Provide cultural value. Engage public support. Landscape, heritage, character, fine views.</p> 
SOCIAL			
ENJOYABLE			

Gehl Architect’s attention to the human scale is unique among the precedents studied, as it is conceived in the observation of pedestrians and cyclists, and is shaped at larger scales based on these observations. In cases where there is a lack of pedestrians and cyclists, the built environment is enhanced to invite people to walk, bike, and spend time in these areas. Through this process, designs seek to support people as a habitat/environment could support an animal: relationships between behaviours and habitats/environments are observed, and elements are designed based on this understanding.

5 Findings and Recommendations

There is much to be done to create the best possible conditions for walking. Providing more space is not enough. Walking warrants open spaces that inspire, sensitise and encourage communication among inhabitants of cities, towns and suburbs. In general, traffic codes tend to prioritise motorised traffic over the needs of pedestrians, leading to deficiencies for pedestrians in the design and operation of the physical environment. Cities where priority will be given to walking have before them an important task of re-planning the road network in order to ensure not only direct connection, but also uninterrupted walking by pedestrians and compliance by drivers with lower travel speeds (ITF, 2012, p. 15).

Canadian cities are taking steps towards complete streets; however, standardized measures and methods are needed to ensure that pedestrian and cycling policies are implemented (ITF, 2012).

The final stage of research synthesized the first two research questions, and applied these insights to identify *in what ways could Canadian design approaches be adapted to improve complete streets design practices on mixed-use arterial streets?* The first research question explored the design implications of conventional and complete streets approaches, and the second research question investigated Canadian and European municipal precedents for designing complete streets – both applicable to mixed-use arterial streets. Given the Canadian and interdisciplinary nature of this practicum, recommendations are provided for Canadian municipalities and the planning practice – as this is a city planning practicum.

5.1 Precedent Findings

The precedent review investigated complete streets design practices from the City of Edmonton, Vélo Québec, the City of Leipzig, and Gehl Architects. Practices were collected to inform concepts of design applicable to the different scales of design and street functions identified in Section 3.4, ensuring the design of streets as links and places. Practices that emerged from this

precedent review are listed below. Physical infrastructure was not directly a part of identifying precedent practices (e.g. bike lanes, speed bumps, and 30 km/h zone); rather design practices, which include processes, tools, and conceptual strategies of design, were of interest. Precedent practices are then categorized by scale of design and street function.

City of Edmonton:

- *Complete Streets Guidelines* (2013)
- Multimodal design process
- Citywide modal priority maps
- Congestion policies utilizing multimodal level of service
- Design tradeoff processes
- Community and stakeholder engagement

Vélo Québec:

- Planning and Design for Pedestrians and Cyclists (Vélo Québec Association, 2010b)
- Travel surveys
- Modal counting and observations
- Cycling essential route and recreational route establishment
- Pedestrian crossing priority
- Intermodal point identification and strengthening
- Network barriers and obstacle mitigation
- Community and stakeholder engagement

Leipzig:

- *Guidelines for Design of Urban Streets (Richtlinien für die Anlage von Stadtstraßen)*
- Travel surveys
- PTV Visum multimodal modeling software
- Maximum motor vehicle level of service with enforcing funding
- Environmental legal merits for reducing or rerouting motor vehicle traffic
- Flexible cross sectional dimensions for specific street types
- Cycling essential route and recreational route establishment
- “Pedestrian first” design priority
- Monitoring of the quality of multimodal flow

Gehl Architects:

- “Human scale” design priority (i.e. Life—Space—Buildings are designed to support the human scale)
- Public space/public life surveys involving modal counting and observations

- Human-scale barriers and obstacle mitigation
- Spatial quality network analysis

To correlate precedent practices with the concepts of design identified in Table 4, precedent practices were classified twice: i) according to the specific street function, and ii) according to the scale that practices targeted. The classifications were accomplished through the questions provided below (similar questions were used in Section 3.4).

Questions related to street function:

- Sojournability: does the practice address the enjoyment of a street by people while cycling, walking, or lingering?
- Accessibility: does the practice address a person or good's ability to reach a desired opportunity, where an opportunity includes a destination, service, or activity?
- Mobility: does the practice address improve people or goods movement from one place to another?

Questions related to scales of design:

- Human: is the practice applicable to a pedestrian or cyclists' experience as they travel along or enjoy a street (Gehl, 2010)?
- Neighbourhood: is the practice applicable to the spatial design of buildings and spaces, or is it applicable to the conglomeration of multiple city blocks (Handy et al., 2002; Gehl, 2010)?
- City: is the practice applicable to relationships between transportation systems and various areas of a city, and the city's overall function; or is it relevant to many neighbourhoods?

The categorized precedent practices are given in Table 6. Here is an example of how practices were classified: PTV Visum multimodal modeling software was classified as addressing mobility at the city scale, because this software guides designers in providing multimodal networks to support the city's needs. Some precedent practices addressed more than one street function. For example, the "human scale" or "pedestrian first" design priorities have implications for mobility, accessibility, and sojournability at the human scale. Such entries were correlated with all of these street functions, as shown in Table 6. Other precedent practices were specified to show how methods or measures could address specific functions of streets. For example, "Public

space/public life surveys involving modal counting and observations” was detailed to show its applicability to mobility, accessibility, and sojournability at the human scale:

- Mobility: public space/public life survey analyzing barriers, delays, and obstacles (e.g. lack of crossings, long wait times at crossings, lack of bike facilities, crowded sidewalks) to people using a street;
- Accessibility: public space/public life survey analyzing who (e.g. age and gender, pedestrians and cyclists) is accessing a street;
- Sojournability: Public space/public life survey counting the number public seating areas and patios, and/or generally analyzing how people are sojourning.

Semantically, the findings of Table 6 are potential practices for accomplishing the qualities of Table 4, ultimately enabling mobility, accessibility, and sojournability for multimodal users.

Table 6 – Precedent practices for designing complete streets

		Function		
		Mobility	Accessibility	Sojournability
Scale	Human	<ul style="list-style-type: none"> • “Pedestrian first” design priority (Leipzig) • “Human scale” design priority (i.e. Life—Space—Buildings are designed to support the human scale) (Gehl Architects) • Crashes and injuries to each mode (New York) 		
		<ul style="list-style-type: none"> • Public space/public life survey analyzing barriers, delays, and obstacles (e.g. lack of crossings, long wait times at crossings, lack of bike facilities, crowded sidewalks) to people using a street (Gehl Architects, Vélo Québec, Leipzig) 	<ul style="list-style-type: none"> • Public space/public life survey analyzing who (e.g. age and gender, pedestrians and cyclists) is accessing a street (Gehl Architects, Vélo Québec) 	<ul style="list-style-type: none"> • Public space/public life survey counting the number public seating areas and patios, and/or generally analyzing how people are sojourning (Gehl Architects) • Economic vitality²⁰ (New York City) • User surveys (New York City)
	Neighbourhood	<ul style="list-style-type: none"> • Design tradeoff processes (Edmonton) • Flexible cross sectional dimensions for street types (Leipzig) 		
	City	<ul style="list-style-type: none"> • Spatial quality network analysis (Gehl Architects) • Citywide modal priority maps (Edmonton) 		
		<ul style="list-style-type: none"> • PTV Visum multimodal modeling software (Leipzig) • Congestion policies utilizing multimodal level of service (Edmonton) • Maximum motor vehicle level of service with enticing funding (Leipzig) • Travel surveys (Vélo Québec and Leipzig) • Cycling essential route and recreational route establishment (Vélo Québec) • Network barriers and obstacle mitigation (Vélo Québec) 	<ul style="list-style-type: none"> • Intermodal point identification and strengthening (Vélo Québec) • Connectivity indices (Calgary) 	

Not all precedent practices are classified in

²⁰ See Table 8 in Appendix C.

Table 6, as some were not associated with a specific scale or street function. This was the case for design guidelines, community engagement, and environmental considerations – each of these could be created to address different scales or street functions. Practices in the literature review associated with organizations other than the four precedent cities (e.g. Calgary’s connectivity indices and New York City’s *Measuring the Street* metrics) were also included in Table 6. Table 6 is a practical tool for municipalities to ensure that all street functions are supported at each scale when creating cycling and pedestrian supportive mixed-use arterial streets. As the City of Edmonton (2013) indicates, not all streets need to prioritize pedestrians and cyclists, as some streets are intended for moving goods and motor vehicles through a city (p. 16). Guided mode prioritization is thus needed, at the discretion of designers, communities, and politicians – precedents of these are discussed in Edmonton’s practices (Section 4.1).

From Table 6, mobility has the most supportive practices given, followed by accessibility, and then sojournability. The lack of processes, tools, and conceptual strategies identified for supporting sojournability at the neighbourhood and city scales is an unexpected finding of this practicum. This practicum identifies the importance of each scale and street function for complete streets; here are two reasons to explain this gap in explicit consideration for sojournability: 1) complete street’s process, tool, and conceptual strategies at the neighbourhood and city scale can collectively address all street functions, and the human scale is most critical for addressing sojournability specifically; and 2) this practicum was not a comprehensive scan of all design practices. The first reason suggests the identified practices suffice in ensuring all street functions are facilitated; and the second reason indicates that additional design practices are needed to activate all street functions. Neither reason is explored

in this practicum, as additional research is needed. However, research limitations (Section 1.4) likely contributed to the lack of practices identified.

Revisiting Table 4's design concept for sojournability at the city scale, the following was given: balances and coordinates multimodal needs and facilities; and city land uses and street networks are organized and designed to allow people to access opportunities primarily by walking, cycling, and public transit. Three of the identified limitations of this practicum (Section 1.4) are its lack of consideration for 1) land use arrangements, beyond the mixed-use nature of arterials, as well as 2) network configurations and 3) public transport – these three limitations are inherently relevant to the city scale. Practices for arranging land uses, configuring networks, and planning public transport were outside of this practicum's scope, yet this practicum highlights their relevance to achieving complete streets for pedestrians and cyclists. This was another unexpected finding of this practicum. Opportunities for addressing this gap in practicum findings are discussed in subsequent recommendation and further research sections. Recommendations for Canadian municipalities and design organizations, as well as the planning practice were derived from Table 6, and are described in the following sections.

5.2 Recommendations

To design complete streets, where the needs of different modes and users are considered, practices are needed that are responsive to the community context, engagements, and observed and potential pedestrian and cycling activities. Conventional approaches' analysis of the transportation system and activity system as separate entities splits the network and street design practices of transportation engineers and land use planning practices of city planners. The design of mixed-use arterial streets as links and places expands practices to incorporate concepts of

design and design practices applicable to transportation engineers, by incorporating the practices of city planners, urban designers, and architects. A primary contribution of this practicum was to identify concepts of design and precedent practices applicable to the human, neighbourhood, and city scales that support mobility, accessibility, and sojournability. As Canadian municipalities integrate complete streets priorities, particularly expanding the function of streets to include sojournability, supporting practices are needed to encompass the value of streets as places. Subsequent recommendations suggest ways municipalities and design professions can improve complete streets design practices.

Municipalities should reevaluate design hierarchies, formalizing design processes that inherently assess pedestrian and cycling needs, and consider the prioritization of these modes.

The core of complete streets is an expanded acknowledgement of different street users and abilities, and the reviewed precedents demonstrated how these priorities are formally encompassed in the ways precedent organizations assess and prioritize street needs. The literature review explored the conventional and complete streets approaches, and design philosophies, design criteria, and classification systems were identified for each. For municipalities to implement complete streets, practices should align with the complete streets priorities identified. The precedents' methods demonstrated different methods for assessing and prioritizing street needs, with the City of Edmonton using a design process that identified the priority mode, Vélo Québec prioritizing essential cycling routes based on origins and destinations with high cycling potential, Leipzig utilizing a cross section selection method that first ensured various pedestrian needs were met, and Gehl Architects studying pedestrian and

cycling activities aligning spaces and infrastructure accordingly. Municipalities should consider how their planning and design practices could align to prioritize the needs of pedestrians and cyclists.

Municipal design practices should account for the three functions of streets in their design practices.

With streets as both links and places in complete streets approaches, this practicum identified the functions of streets as mobility, accessibility, and sojournability. The literature review and precedent review further investigated concepts of design and practices for addressing each of these street functions at the human, neighbourhood, and city scales. Complete streets are responsive to the needs of all modes, and street design professions can understand pedestrian and cycling needs through the community context, engagements, and pedestrian and cycling activities. Municipalities should apply concepts of design and precedent practices, such as those identified in Table 4 and Table 6, ensuring that design at each scale contribute to mobility, accessibility, and sojournability. These tables are not comprehensive, and municipalities could add additional concepts of design and practices.

Incorporate interdisciplinary design practices.

This practicum suggested that contributions from city planners, transportation engineers, urban designers, and architects create complete streets. While these disciplines may function separately at a municipal level, collaborative efforts are needed to respond to the technical and social needs of streets as places within communities and links of movement. To achieve this recommendation, interdisciplinary working groups are recommended for street design projects.

City planners' and transportation engineers' responsibilities for land uses, network configurations, and public transport design are interrelated; however, city planners lead land use designs, and transportation engineers lead network and public transport design. There are interrelationships between these aspects, and both professions respond to the other's designs. Although these design aspects were not researched in detail, they were identified as critical factors for activating complete streets as links and places. Given the interdisciplinary impacts of these practices, interdisciplinary design practices are needed.

Ensure interdisciplinary transportation education.

City planners, transportation engineers, urban designers, and architects' education should include interdisciplinary courses where they are given opportunities to work together with other disciplines. In the University of Manitoba's Master of City Planning program, Transportation and Urban Form class is an example of an interdisciplinary opportunity. The class welcomes city planning and engineering students, and discussions incorporate perspectives from the respective disciplines. Group projects, potentially in the form of a studio, would cause the disciplines to work together in a more intensive manner. Such group projects could allow students to bring their respective design priorities and practices forward, and integrate these approaches to recommend a design.

Professionals and students can also self-educate by reading literature from other disciplines. Key readings that informed this research are listed below, with their associated professions:

- City Planning: *The Death and Life of Great American Cities* (Jacobs, 1961)
- Transportation Engineering: *Geometric Design Guide for Canadian Roads* (TAC, 1999); *Fundamentals of Transportation Systems Analysis* (Manheim, 1979)

- City Planning and Transportation Engineering: *Planning and Design for Pedestrians and Cyclists: A Technical Guide* (Vélo Québec Association, 2010b); publications by Susan Handy
- Urban Design and Architecture: *Cities for People* (Gehl, 2010); *How to Study Public Life* (Gehl, J. & Svarre, B. (2013)

In addition, Canadian municipal street design professionals should be familiar with Canadian complete streets guidelines, such as Edmonton and Calgary's.

6 Conclusions, Next Steps, and Further Research

Although efficient movement and leisurely sojourning on or along streets may have different design interests, complete streets practices set out to juxtapose the functions of streets, ensuring that responsibilities are collectively considered. This practicum overviewed the development of complete streets in Canada, provided a case for encouraging walking and cycling, identified the differences between the conventional and complete streets approaches, investigated practices that align with complete streets, and outlined recommendations to Canadian municipal practices and design professions. This practicum is intended to advance complete streets design practices in Canada by identifying precedent practices for Canadian municipalities. The following sections specify the conclusions to the research questions to emphasize the research findings, provide next steps following the completion of this practicum, and suggest future research areas generated from this practicum.

6.1 Conclusions

This section provides the findings of this practicum with respect to the research questions. Responses to each research question cumulatively informed the next question's findings, ultimately providing recommendations for Canadian municipalities and street design professions to improve complete streets design practices. The research questions are provided below, and subsections are designated for the respective responses.

In what ways do the conventional and complete streets approaches influence the design of mixed-use arterial streets?

Canadian municipal practices are expanding the conventional motor vehicle priorities to encompass complete streets' multimodal approach, where attention is given to the needs of pedestrian and cycling. In the conventional approach, mobility is associated with the highest order of the functional classification system, and accessibility with the lowest; complete streets' classification systems are acknowledging the diverse contextual realities of streets. This new approach is particularly relevant for mixed-use arterial streets, because arterial streets are designated as primary links through a city, but their mixed-use nature is a vital contribution to a city's livability and pedestrian and cycling environments. Mixed-use arterial streets must, therefore, juxtapose the design of streets as links and places into one existence. Indeed, through complete streets, mixed-use arterial streets are recognized as public spaces within communities that ensure equitable mobility, facilitate community interactions, and enhance quality of life.

While conventional approaches use mobility and accessibility to frame the functions of streets, an additional concept is needed to acknowledge the full spectrum of roles that mixed-use arterial streets can have as complete streets. The researcher recommends, as a number of other authors have indirectly suggested, the term sojournability to represent the ability of streets to enable leisure enjoyment and social interactions,. The use of this term should elevate the role of streets as places to the same level as mobility and accessibility. The three terms mobility, accessibility and sojournability, together, are critical concepts for reframing design strategies for multimodal streets as links and places. Moreover, in a similar way that level of service is used to measure the effectiveness of streets designed under the conventional design approach, methods and measures are needed to indicate the effectiveness of streets designed under complete streets approaches. Methods for collecting design inputs include community context factors,

engagements, and observations. The following two research questions investigated current and potential practices for designing complete streets.

What are Canadian and European municipal precedents for designing complete streets, specifically on mixed-use arterial streets?

Design priorities identified from European and Canadian precedent organizations contrasted conventional practices. The City of Edmonton created clear processes for determining multimodal priorities through a modal priority map, multimodal levels of service, congestion policy, tradeoff process, and community engagement. Vélo Québec demonstrated an opportunity based design process, where locations with high cycling potentials were identified, and key streets for cycling were indicated. The City of Leipzig's processes reflected their pedestrian and cycling priorities, as shown through modeling software and cross section selection methods. For Gehl Architects, happenings at the level of pedestrians and cyclists were scrutinized to later inspire the positioning of infrastructure. Each of these examples demonstrated how designers can facilitate the desired conditions, as opposed to projected demands.

In what ways could Canadian design approaches be adapted to improve complete streets design practices on mixed-use arterial streets?

The recommendations for Canadian municipalities, design organizations, and the planning profession involve aligning interdisciplinary design practices with complete streets priorities. The design of streets as links and places require city planners, transportation engineers, urban designers, and architects to contribute their practices in a collaborative manner. Mixed land use, proactive geometric designs, engaging urban designs, and street-oriented buildings are some of

the areas these disciplines can contribute to, all of which create pedestrian- and cycling-friendly streets. The same is reciprocally true: because streets are formed by their land use, geometric designs, urban design, and building orientation, interdisciplinary design is needed to orient these elements towards pedestrians and cyclists as both links and places.

At each scale, professionals can align designs with complete streets priorities to activate streets' functional responsibilities – moving people, accessing opportunities, and sojourning. This framework of understanding mobility, accessibility, and sojournability with respect to scales of design is instrumental for shifting practices from conventional approaches to complete streets approaches. Further expansions of practices are needed to improve design responsiveness to community contexts and engagements, as well as existing and desired pedestrian and cycling activities.

6.2 Next Steps

As conventional priorities are developing to include complete streets priorities, where multimodal and multifunction street roles are valued along with motor vehicle mobility, shifts in design practices are also needed. Canada's current geometric guideline, *Geometric Design Guide for Canadian Roads* (TAC, 1999), prioritizes motor vehicle safety and mobility, and subsequent guidelines consider how pedestrians and cycling facilities can be added. Hess and Smith Lea (2014) also point out the lack of Canadian design guidelines that integrate cyclists and pedestrians' needs into the urban context. TAC is currently creating a new version, and this practicum may be applicable to the new guideline's revisions, or the development of other guidelines. The next steps for future city planning and transportation engineering research, are provided in Section 6.3.

6.3 Further Research

The following street design topics are identified for further research, ideally through a joint city planning and transportation engineering lens. Researchers with experience in both disciplines could accomplish this, or research partners could also perform the research, where one researcher represents each discipline and research is conducted collaboratively.

- Land use arrangements, network configurations, and public transport planning were identified in the limitations section, and these areas could be explored in future research to understand their potential contributions to complete streets practices. This future research could add to this given practicum and the frameworks that were developed, further addressing the gaps and expanding the insights pertaining to land use arrangements, network configurations, and public transport.
- Research of practices and designs to reduce travel distances between origins and destinations appears to be limited, albeit mixed-use development. Additional research could investigate or develop strategies to understand pedestrian and cycling travel patterns, and further identify details of *how* land uses could be mixed strategically to better facilitate pedestrian and cycling activities and movements, and generally reduce travel distances. Relationships between network design and walking and cycling activities could further progress practices.
- The design of streets should compliment and support the community context, engagements, and pedestrian and cycling activities, along with the overall land use organization and network design. Additional research could investigate in what ways mobility, accessibility, and sojournability are needed to support different economic activities and provide socially equitable lifestyles.
- *Synchro Trafficware* is an engineering tool for optimizing intersections, and *PTV Visum* is a tool for optimizing multimodal transportation systems (see Section 4.3), examples of software for analyzing land uses in conjunction to transportation networks was not found. Pedestrian and cyclists benefit from mixed land uses within a short proximity, and neighbourhoods where people can access their daily needs within a short distance encourage walking and cycling. Additional research could investigate tools for optimizing land uses for pedestrians and cyclists.
- Although “mixed-use arterial streets” was a given for this research, this may not be the case in the urban context. Older portions of cities mix land uses, yet new developments segregate land uses. This creates high travel demands to accommodate the ensuing trips. City planners should influence land uses to ensure that pedestrians and cyclists have access to daily amenities.
- This practicum identified two software platforms that are used for urban transportation system modeling: *PTV Visum* and *Synchro Trafficware*. While research has found *Synchro Trafficware* to prioritize motor vehicle mobility (Hess & Smith Lea, 2014), this practicum revealed Leipzig’s effective use of *PTV Visum* for multimodal designs. Further

research could investigate the differences between the two types of software, seeking to understand their strengths and shortcomings for encompassing complete streets priorities.

- This practicum indicates the importance of streets as links and places, and the provision of public spaces as a part of links. Further research could expand this understanding of designing streets and adjacent public spaces (e.g. public squares, green spaces, playgrounds, patios) collaboratively, improving interdisciplinary design work between transportation engineers, city planners, urban designers, and architects.
- Streets' activities/functions shift throughout a day, from people exercising early in the morning, to children biking to school, to workers busing to their place of employment, to older adults walking to the grocery store, to anyone sitting on a street bench, to young people enjoying a midnight patio. A mix of these uses creates a socially and economically enlivened street, which efficiently uses land and energy, and is safe under the surveillance of continually present people (Jacobs, 1961; Dover & Massengale, 2013). Limited research or information was found for guiding how a street's allocations could shift throughout a day (e.g. from on-street parking space to patio space), and this topic could fuel future research.
- Although Edmonton, Vélo Québec, and Leipzig have indicated that on-street parking is one of the first street spaces turned over to cycling or pedestrian space, (this is further supported by Arancibia, 2013), Dover and Massengale (2013) suggest that on-street parking is important for placemaking, as it creates a buffer between pedestrians and moving traffic. The City of Calgary (2014) also discourages the removal of parking in their complete streets guidelines. Additional research could explore this conundrum and provide more clarity.

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Appendix A – TAC’s “Characteristics of Urban Roads” Table

Table 7 – TAC’s “Characteristics of Urban Roads” Table, where TAC’s framework for designing arterial streets is presented (TAC, 1999, p. 1.3.4.3.; reproduced with permission from the Transportation Association of Canada)

	Public Lanes		Locals		Collectors		Arterials		Expressways	Freeways
	Residential	Commercial	Residential	Indust./Comm.	Residential	Indust./Comm.	Minor	Major		
traffic service function	traffic movement not a consideration		traffic movement secondary consideration		traffic movement and land access of equal importance		traffic movement major consideration	traffic movement primary consideration	traffic movement primary consideration	optimum mobility
land service / access	land access only function		land access primary function		traffic movement and land access of equal importance		some access control	rigid access control	no access	no access
traffic volume (veh/day) (typical)	<500	<1000	<1000	<3000	<8000	1000 – 12 000	5000 – 20 000	10 000 – 30 000	>10 000	>20 000
flow characteristics	interrupted flow		interrupted flow		interrupted flow		uninterrupted flow except at signals and crosswalks		uninterrupted flow except at signals	free-flow (grade separated)
design speed (km/h)	30 - 40		30 - 50		50 - 80		50 - 70	60 - 100	80 - 110	80 - 120
average running speeds (km/h) (off-peak)	20- 30		20 - 40		30 - 70		40 - 60	50 - 90	60 - 90	70 - 110
vehicle type	passenger and service vehicles	all types	passenger and service vehicles	all types	passenger and service vehicles	all types	all types	all types up to 20% trucks	all types up to 20% trucks	all types up to 20% trucks
desirable connections	public lanes, locals		public lanes, locals, collectors		locals, collectors, arterials		collectors, arterials, expressways, freeways		arterials, expressways, freeways	arterials, expressways, freeways
transit service	not permitted		generally avoided		permitted		express and local buses permitted		express buses only	express buses only
accommodation of cyclists	no restrictions or special facilities		no restrictions or special facilities		no restrictions or special facilities		lane widening or separate facilities desirable		prohibited	prohibited
accommodation of pedestrians	pedestrians permitted, no special facilities		sidewalks normally on one or both sides	sidewalks provided where required	sidewalks provided both sides	sidewalks provided where required	sidewalks may be provided, separation for traffic lanes preferred		pedestrians prohibited	pedestrians prohibited
parking (typically)	some restrictions		no restrictions or restrictions one side only		few restrictions other than peak hour		peak hour restrictions	prohibited or peak hour restrictions	prohibited	prohibited
min. intersection spacing ¹ (m)	as needed		60		60		200	400	800	1600 (between interchanges)
right-of-way width (m) (typically)	6 - 10		15 - 22		20 - 24		20 ² - 45 ³		>45 ³	>60 ³

- Notes: 1. Further information on intersection spacing is provided in Chapter 2.3, Intersections.
 2. Arterial rights of way 20 m in width applicable to retrofit conditions only.
 3. Wider rights of way are often required to accommodate other facilities such as utilities, noise mitigation installations, bikeways, and landscaping. For new streets, the immediate provision of wider rights of way may be considered to accommodate such facilities.

Appendix B – Ethics Submission

Summary of Project

See Appendix A.

Research Instruments

The predominant research instrument for this project will be semi-structured interviews. The interviews will only be conducted with adults who are volunteering and providing their consent to participate. A copy of the interview guide is provided in Appendix B.

Participants

Semi-structured interviews will be conducted with engineers, planners, or urban designers who have been selected from the researcher's and advisory committee's contacts in Edmonton, Leipzig (Germany), Montreal, and Oulu (Finland). All participants will be experienced professionals who can be identified using public sources, or by their titles as found in publically accessible email and phone directories for organizations. Potential participants will be contacted by telephone or email requesting an interview. As described below, because the study will be treated as non-anonymous and non-confidential, contacting recruitments directly should not raise ethics concerns. Recruitment will occur via telephone or email, and a sample script is provided in Appendix C.

Informed Consent

Upon contact, all potential research participants will be informed about the nature of the study, the types of questions they will be asked, and the anticipated length of the interview. Importantly, all potential participants will be informed that they will not be treated as an anonymous source and that the information they provide will not be treated as confidential. If they are uncomfortable with this, they will be advised to decline their involvement. If they agree to participate, they will be advised that they may refuse to answer any question and that they may withdraw from the interview at any time. If they choose to withdraw, records associated with the interview will be destroyed, without any penalty to the participant. See Appendix C for the phone and email scripts that will be used to make the initial contact with potential research participants.

At the time of the interview sessions, a consent form will be explained with the opportunity to ask any questions about the nature of the study or how their information will be treated (see Appendix D). The interview sessions will only proceed after the participant has signed the form. Interview sessions may be recorded if the participants give permission. If permission is not given for recordings, only written notes will be taken.

Deception

The proposed research does not involve any form of deception.

Feedback/Debriefing

At the conclusion of each interview, an overall interview summary will be provided to participants in accordance with the informed consent. Individual feedback will be provided within two months of the interview date. Feedback will be given to each participant by the researcher by phone, email, in person, or in writing to ensure the information that the participant provided is accurate. In addition, upon the conclusion of the overall study, participants will be offered a copy of the thesis in a digital format.

Risks and Benefits

The research should pose minimal risk, if any, beyond everyday life. This study does not address personal or confidential issues and only asks for professional information about street design. The participation of the research participants is voluntary, and they will be given the right to dismiss any question.

This project will consider how future street design practices can be improved through various approaches to design. Street design has the potential to enable physically active lifestyles, transportation modes with reduced environmental impacts, and streets with increased social and economic exchanges. The sharing of practices and insight is beneficial to the improved design of streets.

Anonymity or Confidentiality

Given the subject matter and extremely low risk of the project, the researchers did not deem that confidentiality was required. Subjects will be discussing their professional knowledge and experience concerning street design. The researchers deemed that there was no advantage to granting anonymity or confidentiality, and that this would not encourage participants to share information that they would not otherwise. Participants will be professionals talking about their professional responsibilities in areas that present very limited risk of any kind. No personal information will be collected beyond names, professional titles and organizations, and a professional history.

Data (voice recordings and written notes) will be kept by the researcher on her password protected computer. Since data is not considered confidential, no other precautions will be used.

Compensation

Although refreshments may be offered to research participants, no other form of compensation will be provided. Compensation is not normally offered in this field when interviewing professionals about their practices.

Dissemination

Study results will be disseminated by the principal researcher through oral defense, digital online copy, hard copy at the University of Manitoba Architecture/Fine Arts Library, and through potential publications. Participants will be made aware of how their information will be

disseminated before their signed consent is collected. Only participants who have provided consent will be included in the research project.

Appendix A: Summary of Project

Purpose:

Complete streets focuses on providing infrastructure to support a variety of lifestyles, and promoting streets as places that are accessible to people, regardless of their income, age, or ability. Complete streets policies have been passed in municipalities across Canada. Complete streets are important because they promote physical activity, reduce pollution, improve multimodal safety, create financial benefits, increase transportation efficiency, and encourage social interactions (Transport Canada, 2009). The objective of this project is to collect and analyze interdisciplinary approaches for designing mixed-use arterials that integrate/synthesize the pedestrian, community, and regional scales of design.

Methodology:

This research will involve a literature review, semi-structured interviews, and an analysis. The literature review will explore major themes of the major degree project and review scholarly and grey literature. Semi-structured interviews will be conducted with engineers, planners, or urban designers. Upon the completion of the analysis, it is anticipated that this methodology will provide valuable insight to improve street design practices.

Appendix B: Interview Questions

Introduction

I will be asking you questions regarding street design goals, informing factors, and tradeoffs.

Additional follow-up questions will be asked, as required. In the context of this research, a street encompasses the public right of way and the adjacent built form. These interview questions are specifically being asked in the context of mixed-use arterial streets.

Interview Questions

Goals:

1. What are your firm's/department's goals for the design of mixed-use arterial streets?
2. What would your firm/department suggest as the ideal street design vision for cyclists, pedestrians, and motor vehicles on mixed-use arterial streets?

Informing factors:

3. In what ways does the land use context and urban form influence the design of mixed-use arterial streets?
4. What are the design guidelines you use to suggest geometric and urban designs on mixed-use arterial streets?
5. In what ways does data influence your design of mixed-use arterial streets?

Tradeoffs

6. How does your municipality/firm balance modal travel demands on mixed-use arterial streets?

Appendix C: Phone Script and Email Draft

Phone Script

Hello ____,

I am a city planning graduate student at the University of Manitoba, and my major degree project is exploring street design practices. I am calling you because of your involvement in the City of ____'s street design process and I'm wondering if you are interested in hearing more about this project and potentially contributing your insight and perspective in an interview.

Conversation.

If the potential research participant is not interested:

Thank you kindly for your time. Feel free to email me if you would like more information. Goodbye.

If the potential research participant is interested:

Great, thank you. This project's working title is *Completing Mixed-use Arterial Streets: Design Approaches for Complete Streets*. The objective of this research is to collect and analyze interdisciplinary approaches for designing mixed-use arterials that integrate/synthesize the pedestrian, community, and regional scales of design. I would like to ask you questions to better understand the practices that you use to suggest geometric and streetscaping designs – whether it be improving pedestrian and cyclists' activities, supporting community goals, or enabling regional transportation. Canadian and European design approaches are being studied, and your practices are of interest to this study for these reasons....

I would like to come to your city to interview you and gain a better understanding of your approach to street design. I also intend to photograph some of your streets to further add to my research. Would you be interested in setting up a 1.5 hour time period for me to interview you? I am planning to be in your city between *[insert dates]*.

Conversation.

Are you able to book a room for the interview?

Conversation.

Do you have one or two other colleagues you think would be valuable contributors to this interview?

Conversation.

Just an additional note, the questions asked will relate to your professional practice, so your information will not be kept anonymous or confidential in any subsequent reports or

publications. However, you may refuse any question or withdraw from the interview at any time. Do you have any issues with this?

Conversation.

Is there an email address I can contact you at for future correspondence?

Conversation.

Those are all the questions I have for you today. Do you have any questions for me?

Conversation.

I would be happy to send you additional project information or my resume if you would like more information about this project or about my background. Please don't hesitate to call or email me if you have any further questions.

Thank you very much for your time and I look forward to meeting with you. Goodbye.

Email Draft

Dear ,

I am a city planning graduate student at the University of Manitoba, and my major degree project is exploring street design practices. I am emailing you because of your involvement in the City of ___'s street design process and I'm wondering if you are interested in hearing more about this project and potentially contributing your insight and perspective in an interview.

This project's working title is *Completing Mixed-use Arterial Streets: Design Approaches for Complete Streets*. The objective of this research is to collect and analyze interdisciplinary approaches for designing mixed-use arterial streets that integrate /synthesize the pedestrian, community, and regional scales of design. I would like to ask you questions to better understand the practices that you use to suggest geometric and streetscaping designs – whether it be improving pedestrian and cyclists' activities, supporting community goals, or enabling regional transportation. Canadian and European design approaches are being studied, and your practices are of interest to this study for these reasons....

I would like to arrange a Skype interview session to gain a better understanding of your approach to design. Would you be interested in setting up a 1.5 hour time period for me to interview you between [dates]? The questions asked will relate to your professional practice, so your information will not be not be kept anonymous or confidential in any subsequent reports or publications. However, you may refuse any question or withdraw from the interview at any time. If you agree to the interview, a consent form will be sent to you before the interview. Please let me know if you have any questions or concerns.

I would be happy to send you additional project information or my resume if you would like more information about this project or about my background. Please don't hesitate to call or email me if you have any questions. Thank you so much for your time and I look forward to hearing back from you.

Sincerely,

Jeana Klassen

If the potential research participant is not interested:

Dear ,

Thank you kindly for considering this research opportunity. Feel free to email me if you would like more information.

Sincerely,

Jeana Klassen

If yes, the following follow-up email will be sent.

Dear ,

Thank you for your willingness to participate in this research. *[Arrange interview details.]* If you have one or two other colleagues you think would be valuable contributors to this interview, please let me know, as I would like to consider their involvement as well.

Thanks again for your time and I look forward to meeting with you.

Sincerely,

Jeana Klassen

Appendix B: Informed Consent

Statement of Informed Consent – to be printed on the University of Manitoba Department of City Planning letterhead.

Research Project Title:

Completing Mixed-use Arterial Streets: Design Approaches for Complete Streets

This consent form is intended to inform you about the research project and procedure at hand. Feel free to ask any questions you might have before, during, or after the interview session. The questions asked will relate to your professional practice, so your information will not be kept anonymous or confidential. However, you may refuse any question or withdraw from the interview within two weeks of when the research summary is given to you. Please take the time to read this form carefully. You may keep a copy for your records and reference. Thank you for your time.

1. Purpose of Research

Complete streets focuses on providing infrastructure to support a variety of lifestyles, and promoting streets as places that are accessible to people, regardless of their income, age, or ability. Complete streets policies have been passed in municipalities across Canada. Complete streets are important because they promote physical activity, reduce pollution, improve multimodal safety, create financial benefits, increase transportation efficiency, and encourage social interactions. This research will focus on how various design approaches' philosophies and their subsequent classification system and design criteria are used to suggest technical and aesthetic designs on main streets. The objective of this research is to collect and analyze interdisciplinary approaches for designing mixed-use arterials, based on complete street priorities. This is being accomplished through a literature review and interviews.

2. Procedures and Data Recording

To complete this research, you are invited to participate in a one-time interview that is anticipated to last less than 1.5 hours. Interview topics will involve questions about your street design process and approach. You may end the interview at any time if you do not feel comfortable proceeding.

With your permission, interviews will be recorded digitally to ensure an accurate record of responses in conjunction with hand-written notes. These recordings will be transcribed to allow for greater accuracy and efficiency of analysis at a later date. Such audio-recordings will be kept in a password protected computer, and will be destroyed by the researcher after the recordings have been transcribed. If you do not wish to be recorded, only notes will be taken.

3. Risks and Benefits

The research should pose minimal risk, if any, beyond everyday life. This study does not address personal or confidential issues and only asks for your professional insight and perspective about street design.

The objective of this research is to collect and analyze interdisciplinary approaches for designing mixed-use arterials, based on complete street priorities. The benefit of this research is the progression of practices based on the sharing of international knowledge and experiences.

4. Confidentiality

Given the subject matter and extremely low risk of the project, the researchers did not deem that confidentiality was required, as you will be discussing your professional knowledge and experience concerning street design guidelines.

5. Credit or Remuneration

There is no credit or remuneration as part of your involvement in the research.

6. Feedback and Debriefing

At the conclusion of the interview, an overall interview summary will be provided to you in accordance with this informed consent protocol. Individual feedback will be provided within two months of the interview. A summary of results will be provided by the principal researcher by phone, email, in person, or in writing to ensure the information collected is accurate. You will have two weeks to confirm that the information provided is correct which will also mark the last opportunity to withdraw your data from the study. In addition, at the conclusion of the overall study you will be offered a copy of the practicum in a digital format.

7. Dissemination of Results

Study results will be disseminated by the primary researcher through a Masters of City Planning practicum – by hard copy at the University of Manitoba Architecture/Fine Arts Library, a digital copy online, and through the oral defense. It is also possible that the study results will be disseminated in a journal article, conference presentation, and a report to be distributed to municipalities.

Contact Information

Principle Investigator:

Jeana Klassen, EIT

Graduate Student

Department of City Planning

University of Manitoba

Research Advisors:

Dr. Richard Milgrom, B.E.S, M'Arch, Ph.D
Associate Dean, Head and Associate Professor
Department of City Planning
University of Manitoba

Phone: 204-474-6868

Email: Richard.Milgrom@umanitoba.ca

Dr. Jeannette Montufar, P.Eng., Ph.D.
Assistant Professor
Department of Civil Engineering
University of Manitoba

Phone: 204-474-6799

Email: montufar@cc.umanitoba.ca

Your signature on this form indicates that you have understood to your satisfaction the information regarding participation in the research project and agree to participate as a research participant. In no way does this waive your legal rights nor release the researchers, sponsors, or involved institutions from their legal and professional responsibilities. You are free to withdraw from the study within two weeks of when the research summary is given to you, and /or refrain from answering any questions you prefer to omit, without prejudice or consequence. Your continued participation should be as informed as your initial consent, so you should feel free to ask for clarification or new information throughout your participation.

The University of Manitoba may look at your research records to see that the research is being done in a safe and proper way.

This research has been approved by the Joint Faculty Research Ethics Board (JFREB). If you have any concerns or complaints about this project you may contact any of the above-named persons or the Human Ethics Coordinator (HEC) at 204-474-7122. A copy of this consent form has been given to you to keep for your records and reference.

Thank you for taking the time to contribute to this project. Your participation and insights are very valuable and are greatly appreciated.

- I consent to being audio-taped during the interview as part of the study.
- I **DO NOT** consent to being audio-taped during the interview as part of this study.

I understand that the information I provide will be incorporated in a presentation and report by the student researcher. I further understand that my name and organization will be associated with my responses in the reports and presentations.

Signature of Participant

Date

Signature of Principal Researcher

Date

Appendix C – New York City’s Street Measures

Table 8 shows New York City’s approach for implementing the street design goals of designing for safety, all users, and great public spaces. This table indicates how elements contributing to strategies will be measured, and how conditions will be improved.

Table 8 – New York City’s *Measuring the Street: New Metrics for 21st Century Streets* (adapted from New York City, 2012, p. 4-15)

Strategies	Key Metrics	Treatments
Designing safer streets , to provide safe and attractive options for all street users	<ul style="list-style-type: none"> • Crashes and injuries to motorists and other vehicle occupants, pedestrians, cyclists, and motorcyclists • Vehicle speeds 	<ul style="list-style-type: none"> • Simplified intersections • Dedicated left, right, and through lanes • Pedestrian safety islands • Protected bike lanes • Leading pedestrian intervals and split phasing • Turn bans • Mixing zones for bicycles and left-turning vehicles • Medians • Wide parking lanes • Speed humps and slow zones
Building great public spaces to create economic value and neighborhood vitality	<ul style="list-style-type: none"> • Economic vitality (sales tax receipts, commercial vacancies, number of visitors) • User satisfaction, revealed through surveys • Number of users 	<ul style="list-style-type: none"> • Create new pedestrian plazas – first using temporary materials, later as capital projects • Street furniture • Seasonal seating platform in curbside lane • Striping and planters • Maintenance agreements with local organizations • Programmed events • Simplified intersections
Improving bus service to bring rapid transit beyond the subway	<ul style="list-style-type: none"> • Bus ridership • Bus travel speeds • Economic vitality (sales tax receipts, commercial vacancies, number of visitors) 	<ul style="list-style-type: none"> • Offset bus lanes • Transit Signal Priority • Bus bulbs • Bus lane enforcement cameras • Pedestrian safety islands • Turn lanes and turn bans • Delivery windows
Reducing delay and speeding to allow for faster, safer travel	<ul style="list-style-type: none"> • Travel speeds and times • Traffic volumes • Crashes and injuries to motorists and other vehicle occupants, pedestrians, cyclists, and motorcyclists 	<ul style="list-style-type: none"> • Adaptive signal control • Signal optimization • Dedicated left, right, and through lanes • Simplified intersections • Neighborhood Slow Zones • Protected bicycle lanes • Pedestrian safety islands • Wide parking lanes
Efficiency in parking and loading to improve access to businesses and neighborhoods	<ul style="list-style-type: none"> • Vehicle travel speeds and volumes • Double parking • Parking duration • Number of unique visitors 	<ul style="list-style-type: none"> • PARK Smart Commercial Paid Parking • Delivery Windows • Muni Meters • Offset bus lanes

Appendix D – City of Calgary Design Guidelines for Street Networks

The City of Calgary (2014) provides design guidelines for street networks, as provided below:

Good network design can be achieved if the following general guidelines are followed:

1. Establish a block size between 150 – 175 meters in length. Where the block size is exceeded, retrofit large blocks with new streets, alleys, pedestrian and/or bicycle connections. For existing street networks, do not allow street closures that would result in larger blocks.
2. Improve accessibility within a block by providing alleys, service courts, and other access ways.
3. Require multiple street connections between adjacent neighbourhoods. This is achieved by having lower order streets that extend beyond the local area (e.g., Primary Collector).
4. Provide separate connections over or under Skeletal Roads and geographic barriers (rivers, bluffs, rail lines, etc.) so pedestrians and cyclists have links between neighbourhoods without having to travel along intersection ramps and roadways that are not suited to those users.
5. Maintain network quality by accepting growth and expansion of the street network (including development, revitalization, intensifications, or redevelopment) while avoiding increasing the street width or number of travel lanes.
6. Provide on-street curbside parking on most streets. Exceptions to this include very narrow streets, streets with bus lanes, high-speed roads or where there is a better use of the space.
7. Design all streets below an Arterial classification to 50 km/h or less. These speeds promote safety for vulnerable users. For long straight streets, consider traffic controls, narrower lane widths, and boulevard features to reduce driver comfort at speeds over the posted limit.
8. Maintain network function by discouraging:
 - one-way streets;
 - turn prohibitions;
 - full or partial closures (except on bike boulevards, or areas taken over for other public space use);
 - removal of on-street parking (except when replaced by wider sidewalks, an enhanced streetscape, bus lanes, bike lanes, etc. rather than additional vehicle lanes);
 - gated streets/communities;
 - widening of individual streets; and
 - conversion of city streets to limited access facilities.

(p. 15)

Appendix E – Copyright Permission Request Sample Letter

Copyright permission request for <<Figure Title>> figure

Dear Permissions Manager,

I am requesting permission to include in my Master of City Planning practicum the following figure:

<<Excerpt Authors>>. (<<year >>). <<Excerpt Title>>. <<Publication/Media Title>>.
<<Publication/Media Author>>. <<ISBN/ISSN/Web address>>.

The practicum, entitled *The Place of Complete Streets: Aligning urban street design practices with pedestrian and cycling priorities*, will be disseminated by hard copy at the University of Manitoba Architecture/Fine Arts Library and a digital copy online. It is also possible that the practicum will be disseminated in a journal article, conference presentation, and a report to be distributed to municipalities.

Please confirm if you are the copyright owner of the work and if permission is granted to use it. If so, a citation and permission statement will appear with the work.

If you do not control the copyright on the above-mentioned work, I would appreciate any contact information you can provide regarding the proper rights holder.

Thank you for your consideration. If you require further information, please don't hesitate to contact me.

Sincerely,

Jeana Klassen, EIT, MCP (candidate)
Graduate Student
Department of City Planning
University of Manitoba