
# PLANNING FOR CYCLING IN SMALL CITIES IN WESTERN CANADA

Capstone Project
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# Planning for Cycling in Small Cities in Western Canada

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Cover image: Campbell River, British Columbia. Source: Province of British Columbia.

## Executive Summary


Safe, dedicated cycling infrastructure is key to encouraging a mass modal shift to more frequent cycling. However, most research on cycling infrastructure focuses on case studies of large cities. This capstone project helps address this gap by analyzing the existing state of cycling infrastructure in 45 small cities in Western Canada. The project also explores barriers and opportunities that planners from these cities encounter when attempting to develop more cycling infrastructure. By encouraging a modal shift to cycling, this capstone can help small cities mitigate climate change and improve public health outcomes related to physical activity.

To conduct this research, I used three methods including an infrastructure audit using GIS software, an online survey with 18 municipal employees, and qualitative interviews with 10 municipal employees. I found that the type and quantity of cycling infrastructure varied significantly between cities, but generally off-street bike paths were most common. Cities in Alberta and British Columbia had more bike infrastructure than cities in Manitoba and Saskatchewan. The main barriers that small cities encounter include a lack of funding or financial support, a lack of road space or land availability, negative public perceptions about on-street bike lanes, limited bike mode shares, and cold climatic conditions. Planners said that support from the public and local politicians, financial support from higher levels of government, and requirements for bike infrastructure in new developments would help small cities expand their cycling networks.

Based on these results, I suggest five strategies that could help small cities develop more cycling infrastructure. Higher levels of government could provide active transportation funding for small cities. Small cities could also develop policies to take advantage of development and invest in outreach programs to promote cycling. I also recommend that small cities focus on building multi-use off-street paths and collaborate with non-profit organizations, community groups, and regional agencies to fund, plan, and promote cycling infrastructure.

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# CHAPTER 1
# INTRODUCTION

## 1.1 Introduction

Anthropogenic climate change is one of the most pressing issues of our time. Without drastic reductions in global greenhouse gas emissions, climate change is expected to cause more extreme heatwaves, droughts, hurricanes, tornadoes, forest fires, sea-level rise, and significant biodiversity loss (IPCC, 2014). These widespread changes could lead to mass global migration, resource conflicts, and widespread social and political instability (Wallace-Wells, 2019). One way to help mitigate climate change is to encourage a modal shift away from private vehicles to lower carbon modes like biking (Banister, 2011). This is especially important in highly automobile dependent countries like Canada, where two-thirds of residents drive to work alone and the transportation sector is responsible for a quarter of the country's greenhouse gas emissions (Statistics Canada, 2017; Government of Canada, 2020).

One challenge with encouraging a modal shift to biking is that most people are uncomfortable cycling in mixed traffic. While many classifications of cyclists exist, the most popular is Geller's (2009) typology of four types of cyclists, which suggests most people will not bike in traffic (Dill & McNeil, 2016; Furth, 2021). Geller's first type is 'strong and fearless' cyclists who will ride in any conditions and represent roughly 1 percent of the population. 'Enthused and confident' cyclists—which make up 6 percent of the population—will ride on wide, busy roads as long as there is a shoulder or bike lane. The largest category is 'interested but concerned' cyclists who are unwilling to bike on wide, busy roads without dedicated infrastructure, which represents roughly 60 percent of the population. Finally, Geller (2009) notes that a third of the population are 'no way, no how' residents who are uninterested in ever cycling. This typology suggests that safe, convenient bike infrastructure is key to encouraging a mass modal shift to more frequent cycling.

In the last twenty years, scholars have developed a large body of research on cycling infrastructure. However, most of this research is based on case studies from large cities. When smaller cities are included in this research, it is usually only cities with outstanding cycling rates or infrastructure (McAndrews, Tabatabaie, & Litt, 2018). This narrow research focus is problematic for two reasons. First, small cities generally have different development patterns and lower densities than larger cities. As a result, bike infrastructure that works well for larger urban centres may be unsuitable to smaller communities. Second, small cities may face different social, cultural, and political barriers than large cities when attempting to develop bike infrastructure. The policies and approaches that major cities use to improve cycling conditions may not be effective or relevant in smaller communities (McAndrews, Tabatabaie, & Litt, 2018). Given these differences, McAndrews, Okuyama and Litt (2017) argue that more research is needed on cycling in small cities to develop "more inclusive and effective transportation planning practices and policies for multimodal transportation" (p. 134). This research project helps address this gap by analyzing the existing cycling infrastructure in small cities in Western Canada. The project also explores barriers and opportunities for improving cycling conditions in these cities.

## 1.2 Research Design and Questions

In this capstone project, I used a mixed-methods approach to explore existing cycling infrastructure and factors that limit or support this infrastructure's development in 45 small cities in Western Canada. The two main questions I aimed to address are:

1. What is the current state of cycling infrastructure in small cities in Western Canada?
2. What factors limit or support the development of cycling infrastructure in small cities in Western Canada?

To answer these questions, I used three research methods:

1. An infrastructure audit using OpenStreetMap data to assess what cycling infrastructure currently exists in small cities across the region;
2. An online survey with 18 municipal employees from small cities in Western Canada to explore factors that limit and support the development of cycling infrastructure; and
3. Qualitative interviews with 10 municipal planners from the region to examine barriers and opportunities to create cycling infrastructure in greater detail.


**Figure 1: Types of Cycling Infrastructure**

## 1.3 Terminology

The terms *cycling infrastructure* or *bike infrastructure* refer to all infrastructure designed for use by cyclists (Furth, 2021). However, there is variation in the way this infrastructure is classified. In this capstone, I use four definitions based on the National Association of City Transportation Officials' (2014) guide (see Figure 1). I define *cycle tracks* as physically separated, on-street facilities that are designed specifically for cyclists. Cycle tracks can be separated from traffic using bollards, raised medians, or parking spots. *Bike lanes* are also located on-street but are not physically separated from other traffic. Instead, they are marked by striping on the road or coloured pavement. *Bike paths* are off-street facilities for cyclists that are sometimes shared with pedestrians and other users. *Bikeways* are low-traffic streets with mixed traffic designed to prioritize cyclists and discourage vehicular traffic. They usually include a combination of pavement markings, signage, and traffic calming measures like speed humps or chicanes to slow vehicular traffic.[1]

[1] I also use the term ambiguous infrastructure in this capstone. This does not refer to a specific type of bike infrastructure but rather bike infrastructure that could not be categorized in the infrastructure audit due to a lack of data on OpenStreetMap. In many cases, ambiguous infrastructure likely fits into one of the four NACTO categories.

## 1.4 Document Structure

This capstone is divided into the following chapters:

**Chapter One: Introduction** has provided a general introduction to the capstone topic and my research questions. I also defined four types of cycling infrastructure.

**Chapter Two: Literature Review** summarizes relevant academic literature. Specifically, I highlight research on cycling policies, programs, and infrastructure, with a particular focus on studies that explore the impacts of cycling infrastructure. I then examine research on government barriers to creating cycling infrastructure and implementing pro-cycling policies. I also explore the limited research on cycling in small cities.

**Chapter Three: Context** provides background information on the provinces and cities included in the study. I briefly review the history of small cities across the region and explore the existing legal and regulatory context. I also highlight current demographics including the population and commuter mode share of the small cities.

**Chapter Four: Methods** highlights the methods I used to conduct this research. I begin by describing the process I used to select the 45 cities in this study. I then document my three methods including an infrastructure audit using OpenStreetMap data, an online survey with 18 planners, and semi-structured qualitative interviews with 10 planners from small cities.

**Chapter Five: Results** presents the results of the study based on the methods used. I highlight the existing quantity and density of cycling infrastructure in small cities. I also present barriers and opportunities for building cycling infrastructure that were identified in the survey and interviews. The main barriers include financial or funding barriers; a lack of road space or land; the limited bike mode share and the public's perception of on-street bike lanes. The main opportunities identified were support from the public and local politicians, financial support from higher levels of government, and requirements for new private developments to include trails.

**Chapter Six: Discussion** highlights the environmental and public health benefits of creating cycling infrastructure in small cities. I also discuss five strategies for achieving this goal based on the research results. Higher levels of government could provide small cities with funding for infrastructure. Small cities could develop policies to take advantage of private development and invest in outreach programs to promote cycling. These cities could focus on building multi-use off-street paths and collaborate with non-profit organizations, community groups, and regional agencies to fund, plan, and promote cycling infrastructure.

**Chapter Seven: Recommendations and Conclusion** includes detailed recommendations and limitations of this study. It also highlights potential future research topics.

# CHAPTER 2
# LITERATURE REVIEW

This chapter reviews academic literature that is relevant to the research questions explored in this capstone project. The review begins with an overview of factors that influence cycling behaviour, including a detailed overview of the impact of cycling infrastructure on cycling rates. After that, it explores barriers that local governments may encounter when developing pro-cycling policies and building cycling infrastructure. Finally, the literature review examines research on cycling in small cities. The chapter ends by highlighting how this capstone research will fit into the larger body of literature.

## 2.1 Cycling Policies, Programs, and Infrastructure

Given the environmental and health benefits of cycling, researchers have increasingly studied factors that influence cycling behaviour over the last twenty years (Woodcock, et al., 2009). As part of this process, scholars have conducted comparative analyses of factors that influence cycling across cities and countries with vastly different cycling rates. These analyses strongly suggest public policies and programs significantly impact whether citizens regularly bike, walk, bus, or drive private automobiles (Buehler, 2011; Pucher, 1988). Some of these policies are not explicitly focused on cycling, such as high gasoline taxation, sale taxes, and annual vehicle taxes. Other indirect policies that influence travel behaviour include land-use controls that make driving slower and less convenient, which may encourage more individuals to bike, walk, or bus (Buehler, 2011).

Researchers have also examined the impact of policies and programs that are explicitly designed to increase cycling rates. Examples include integrating bikes with transit and installing end-of-trip facilities like bicycle parking and showers. Programs that discourage driving and encourage active transportation use have also been effective (Pucher, Dill & Handy, 2010; Pucher & Buehler, 2008). Researchers have also found a correlation—but not a causation—between cycling rates and dedicated cycling infrastructure. As these studies generally do not include cycling data from before cities installed the infrastructure, researchers cannot determine whether the infrastructure encouraged more individuals to bike or whether the cities decided to build bike infrastructure in response to high bicycle commuting rates. However, while there are many promising ways to increase cycling rates in cities, scholars point out that successful cities do not rely on a single policy or program. Instead, these cities have implemented comprehensive sets of pro-cycling policies to discourage automobile use and encourage residents to bike (Pucher, Dill, & Handy, 2010).

In short, studies demonstrate that a wide range of factors influence cycling rates across jurisdictions. One of these factors is the presence of dedicated cycling infrastructure. While this infrastructure is important, the installation of bike infrastructure in the absence of additional complementary policies may not significantly increase cycling rates in a community. In other words, governments that want to encourage cycling should implement a range of cycling policies and programs that include investments in infrastructure, among other things. However, as this capstone project primarily explores cycling infrastructure, the next section will explore research that explicitly focuses on the impacts of cycling infrastructure on travel behavior in more detail.

### *2.1.1 Cycling Infrastructure*

In the last twenty years, many cities across North America have built cycling infrastructure, including cycle tracks, bike lanes, and bike paths (Pucher, Buehler & Seinen, 2011; Pucher, Komanoff, & Schimek, 1999). Researchers have used the opportunity to study the impact of this new infrastructure on cycling rates. Many studies suggest there is a positive correlation between cycling infrastructure and cycling rates in North American cities. This correlation is particularly evident in aggregate studies of bike infrastructure involving multiple cities. For example, three aggregate studies of cycling infrastructure and rates across large cities in the United States found cities with more bike infrastructure per square mile had more cyclists per capita (Buehler & Pucher, 2012; Dill & Carr, 2003; Nelson & Allen, 1997).

However, researchers who conducted individual studies that focused on a particular city or piece of infrastructure found more mixed results (Pucher, Dill, & Handy, 2010). Some individual studies found that cyclists will increase their commute length—by up to 75 percent—to use dedicated cycling infrastructure and avoid mixed traffic, suggesting that dedicated infrastructure is important (Dill, 2009; Krizek, 2006; Krizek, El-Geneidy & Thompson, 2007). Other studies found no correlation or more mixed results. For example, Krizek and Johnson (2006) found a correlation between cycling rates and respondents' proximity to on-street bike lanes but not off-street bike paths, while Moudon et al. (2005) found the reverse results. These mixed results may be partially due to the use of different measurements in studies, which makes it difficult to compare and draw conclusions.

These mixed research results also suggest that installing cycle tracks, bike lanes, and bike paths are important but that other factors also play a role in determining individuals' bicycle habits. In response to the results, scholars have started exploring how overall bicycle networks—in contrast to specific infrastructure types—influence cycling rates (Buehler & Dill, 2016). This research is based on the recognition that even in cities with high-quality bike lanes and paths, gaps between dedicated cycling infrastructure may discourage individuals from cycling. For example, in a comparative analysis of 74 American cities, Schoner and Levinson (2014) found the density, connectivity, and directness of a bicycle network all influenced cycling rates. These research results demonstrate that comprehensive and well-connected cycling infrastructure is associated with higher cycling rates. These findings raise the question: what barriers limit or prevent municipalities from implementing pro-cycling policies and investing in cycling infrastructure? The next section will explore the research on this topic.

## 2.2 Local Barriers to Supporting Cycling

In recent years, researchers have started exploring barriers that limit or prevent local authorities from implementing pro-cycling policies and programs. Much of this research is based on a theoretical framework developed by Banister (2005) to understand barriers to implementing sustainable transportation policies. Banister identified six types of barriers that governments may encounter. These include 'resource barriers', 'institutional or policy barriers', 'social or cultural barriers', 'legal barriers', 'side effects', and 'other' barriers (see Table 1). Using Banister's framework, scholars have examined local barriers to implementing cycling infrastructure (Hatzopoulou & Miller, 2008; Wang, 2018).

In general, scholars have found that resource barriers, as well as institutional and political barriers, prevent local governments from developing sustainable transportation policies and investing in bike infrastructure. In particular, multiple studies noted that a lack of funding from higher levels of government made it difficult for local governments to invest in cycling infrastructure or hire dedicated staff members (Aldred et al., 2019; Gaffron, 2003; Hatzopoulou & Miller, 2008). Institutional and political barriers were also cited. For example, researchers found that some local governments did not have the technical expertise to design and build cycling infrastructure and, therefore, relied on engineering standards that prioritized automobile traffic (Aldred et al., 2019; Hess, 2009; Hess & Smith Lea,

| Category of Barrier | Description | Cycling Example |
|---|---|---|
| Resource | Problems in acquiring an adequate amount of financial and physical resources in time | Not enough investments |
| Institutional and political | Problems in the cooperation between organizations and conflicts among different policies | Lack of leadership and political will |
| Social and cultural | Problems in public acceptability of the measures | The public's resistance to construct or use certain types of cycling infrastructure |
| Legal | Measures can be restricted or even cancelled by laws and regulations | Cycling lane construction is not permitted on certain roads |
| Side effects | The effects on other activities | Increased traffic risks for cyclists |
| Other (physical) | Space or topography restriction | Lack of space for cycling lanes, unsuitable topography |

**Table 1: Banister's Barriers to Implementing Sustainable Transportation**

*Text copied directly from Wang (2018), p. 3*

2014). Aldred et al. (2019) and Wang (2018) also found that a lack of political support was a barrier for local governments, while Hatzopoulou and Miller (2008) argued that limited interactions between different levels of government made it difficult for municipalities to implement sustainable transportation policies. While financial, political and institutional factors were the main barriers in these studies, one study also highlighted other barriers, including a lack of physical space and the public's unwillingness to turn parking spaces into bike lanes (Wang, 2018). Overall, the literature suggests that local governments may encounter a wide range of barriers when working to implement pro-cycling policies and build bike infrastructure.

## 2.3 Cycling in Small Cities

As noted in the introduction, one issue with much of the research on cycling infrastructure is that it is based on case studies in large cities. However, there are a few notable exceptions of studies that explore cycling in small cities and rural communities. Some of this research examined which residents are most likely to bike in small cities and rural communities. Two studies found several factors associated with bicycle commuting, including living close to work, having a supportive workplace, having access to off-street bike paths, having higher education, and being concerned about the environment (Handy & Xing, 2011;

Handy, Xing, & Buehler, 2010). Another study found that while cycling primarily occurs in cities, women and young people under the age of eighteen were more likely to bike in rural, small, and low-density areas than in cities (McAndrews, Okuyama, & Litt, 2017). A Canadian study that examined two small mountain communities found a high bicycle commuting rate because recreational mountain-biking opportunities attracted residents who were inclined to cycle for transportation purposes (Assunçao-Denis & Tomalty, 2019). Similar to studies of larger cities, these suggest that good bike infrastructure can encourage more residents to bike in small communities but that other factors also influence travel behaviour (Pucher, Dill, & Handy, 2010).

A small number of studies also explored barriers and opportunities that small cities encountered when developing pro-cycling policies and building bike infrastructure. For example, one study found that many small communities lacked the cultural and political support to plan and construct cycling infrastructure and needed resources to help educate residents on cycling benefits (McAndrews, Tabatabaie, & Litt, 2018). Another study explored the challenges that small and rural communities in Canada encountered when implementing active transportation infrastructure. The study found that communities often have limited resources and major network gaps in their cycling infrastructure (White, 2018). A recent report also examined factors that influenced whether small cities in the United States were able to implement cycling and walking infrastructure. The author found that communities with multiple local champions, bicycle programs, bicycle advocacy organizations, and an easy approval process were more likely to implement active transportation infrastructure than those without the factors (Villwock-Witte, 2019). These studies suggest that small communities face a range of barriers and opportunities when trying to build cycling infrastructure. However, as there are only a few studies on cycling in small communities, it is difficult to draw conclusions from the literature.

## 2.4 Research Contributions

Overall, the literature included in this review indicates that there is limited research on cycling infrastructure in small communities. While a few exceptions have been highlighted here, none of the studies provide a comprehensive overview of existing conditions and barriers for small cities in Western Canada. This capstone project seeks to help address this literature gap.

# CHAPTER 3
# CONTEXT

## 3.1 Historical Context

Small cities in Western Canada have a unique history that shaped their development. After purchasing Rupert's Land in 1869, the newly formed Government of Canada sought to 'open up' the region—including portions of present-day Manitoba, Saskatchewan, and Alberta—to settlers (Friesen, 1987). To support this goal, the government supported the construction of the Canadian Pacific Railway (CPR) across the country between the 1870s and 1930s. Along with the government's land survey, the railway network largely shaped the settlement pattern of Western Canada as towns were strategically established along the CPR's branch lines (Sandalack, 2013). During this time, Friesen (1987) writes that a hierarchy of cities, towns, and villages was established, some of which became the cities included in this project.

Many of these railway cities and towns shared similar characteristics, including a gridiron layout, a railway station, and a Main Street that was parallel or perpendicular to the railway tracks. Buildings along the Main Street were often constructed with timber frames and had false fronts with large windows. The Main Street was often sixty to eighty-feet wide to accommodate horse and wagons, while residential streets were narrower and had sidewalks and tree-lined boulevards (Friesen, 1987; Sandalack, 2013). As these towns were developed prior to the widespread introduction of private vehicles, the streets were designed to accommodate active transportation (Schiller & Kenworthy, 2018). This included walking and cycling, which initially gained popularity around the turn of the twentieth century (Lehr & Selwood, 1999).

During the mid-twentieth century, Western Canada experienced drastic changes including the widespread introduction of the private automobile, which impacted the urban form of new developments. While early towns had a grid street network, developments after the 1950s generally comprised of crescents and cul-de-sacs. Sandalack (2013) argues this resulted in a "jarring discontinuity—in street layout, building density, building setback, and even sidewalk dimension and species of street tree" (p. 291). The design of residential streets also changed. Developers built wide streets with large setbacks and front garages (Sandalack, 2013). These newer 'dispersed' developments were generally designed to accommodate automobiles rather than pedestrians or cyclists (Schiller & Kenworthy, 2018; Adams, Jones, & te Brömmelstroet, 2020). For this reason, the period of a small city's development has an influence on the barriers and opportunities it currently encounters when creating bike infrastructure.

## 3.2 Legal and Regulatory Context

The current legal and regulatory context in Western Canada also has an impact on the ability of municipalities to increase revenues. As defined in Canada's Constitution Act, 1982, provincial governments have jurisdiction over municipal affairs and land-use planning issues, which means that cities are "creatures of the province" (Levi & Valverde, 2006, p. 411). Each province has legislation that governs cities and gives them the power to enact by-laws, raise taxes, and borrow funds. Provinces also have legislation on planning and land-use issues, which governs whether municipalities need to adopt development plans and what considerations need to be included in the plans.

## 3.3 Demographics

There are many different ways to classify cities based on their population size. This capstone project applies Hartt and Hollander's (2018) classification of small, medium, and large Canadian cities (see Table 2). According to the 2016 census, almost one million people—or approximately 8 percent of the total population of the region—live in small cities in Western Canada (see Table 3). The median household income is similar or slightly higher in small cities in the region compared to the median incomes in the provinces as a whole (see Figure 2). Commuter data from the same census shows that residents of small cities are more likely to drive themselves to work than the average provincial resident (see Figure 3). This highlights the need for more research on alternative transportation modes like cycling in small cities.

**Table 2: City Classifications**

| Classification | City Size |
|---|---|
| Small City | 10,000 - 50,000 Residents |
| Medium City | 50,000 - 500,000 Residents |
| Large City | 500,000 + Residents |

| | Large | Medium | Small | Other* | Total |
|---|---|---|---|---|---|
| | Total in thousands (percentage of total) | | | | |
| Alberta | 2,172 (53.4%) | 447 (11%) | 202 (5%) | 1,247 (30.7%) | 4,067 |
| British Columbia | 1,149 (24.7%) | 1,528 (32.9%) | 441 (9.5%) | 1,530 (32.9%) | 4,648 |
| Manitoba | 705 (55.2%) | - | 115 (9%) | 459 (35.9%) | 1,278 |
| Saskatchewan | - | 461 (42%) | 162 (14.8%) | 475 (43.2%) | 1,098 |
| Total | 4,026 (36.3%) | 2436 (22%) | 919 (8.3%) | 3,710 (33.4%) | 11,092 |

**Table 3 : Provincial Populations by City Size, 2016**

**Other includes all municipal designations other than 'city'*

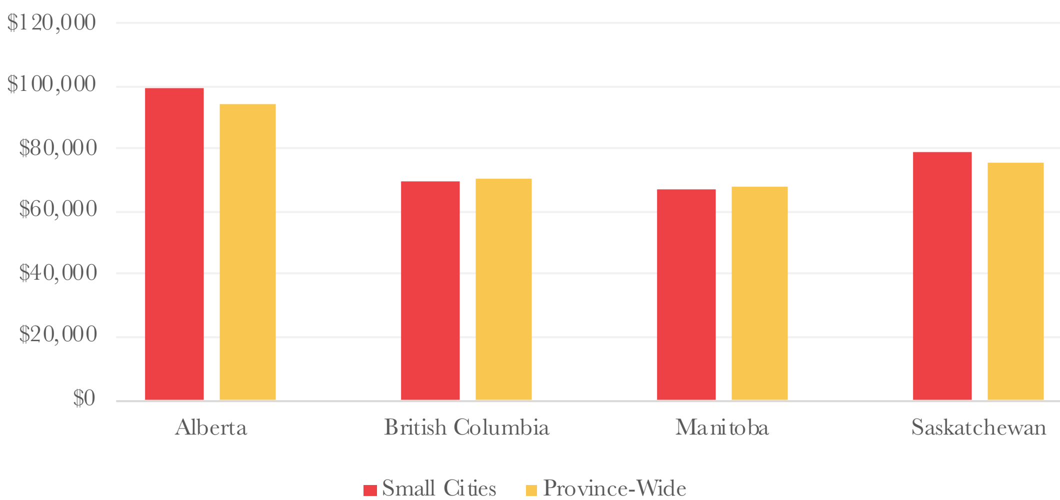



**Figure 2: Median Total Income of Households, 2015**

*Note: This figure includes the average of the median total income of households for small cities in each of the four provinces.*

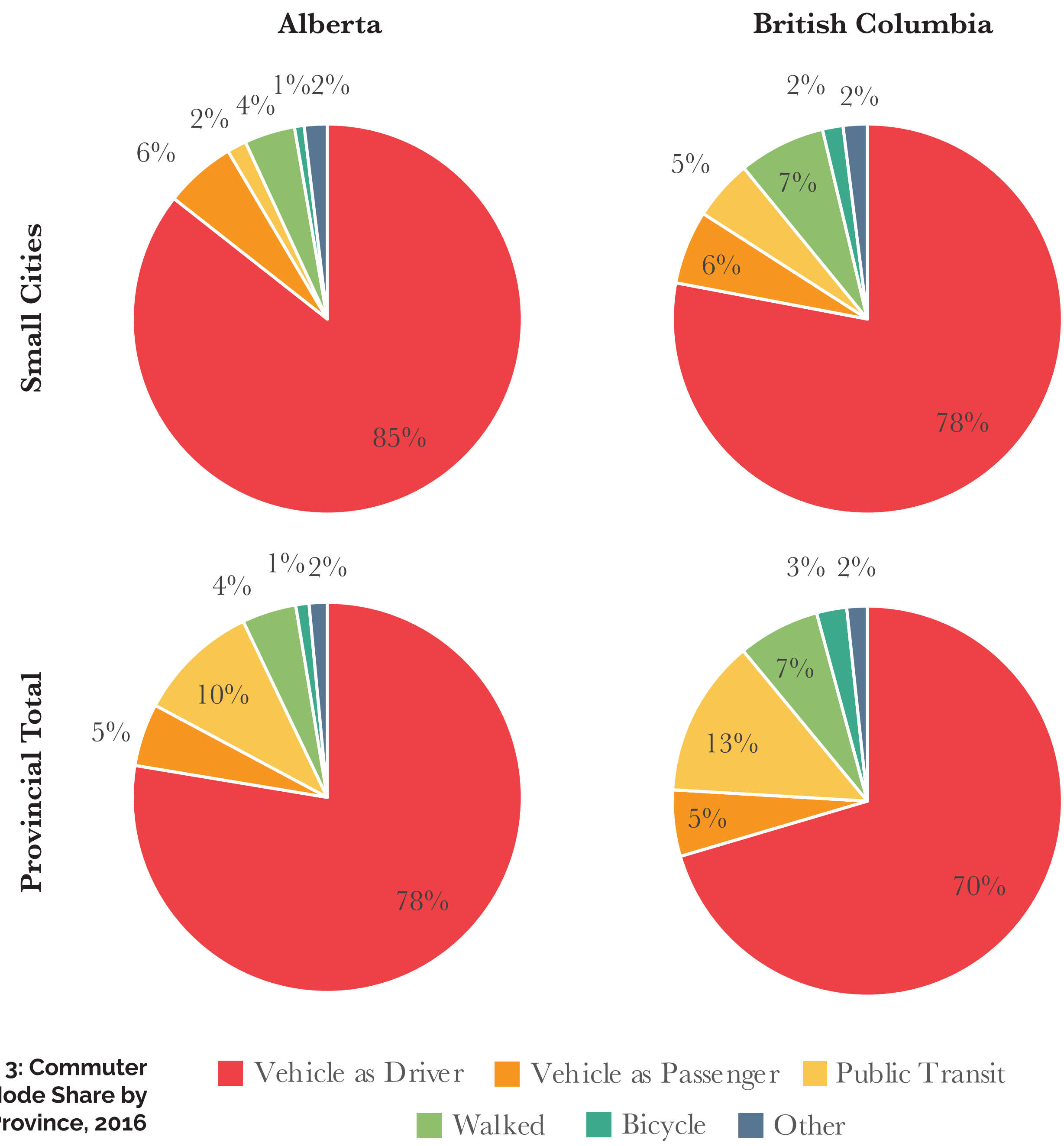



**Figure 3: Commuter Mode Share by Province, 2016**

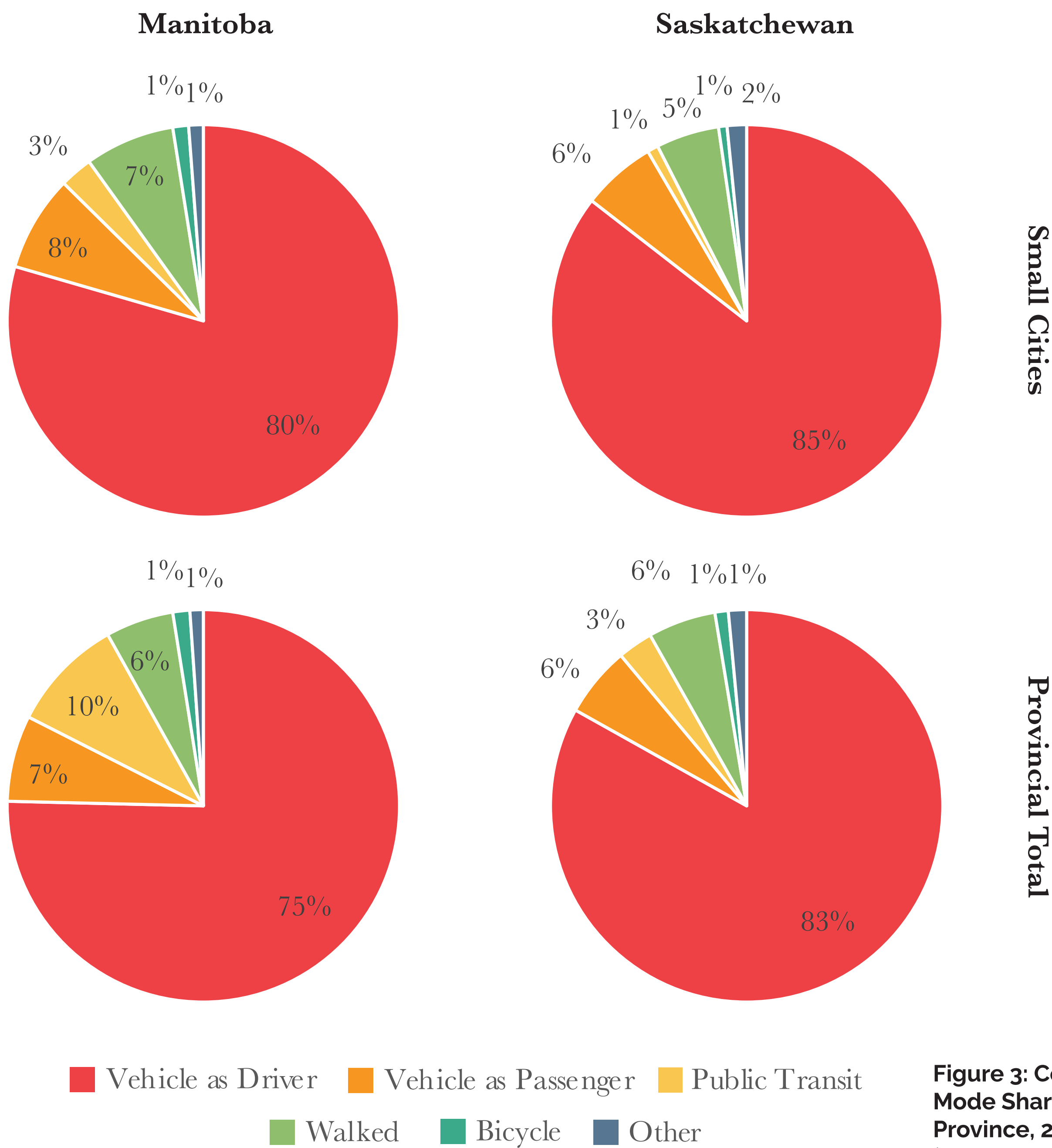



**Figure 3: Commuter Mode Share by Province, 2016 (Continued)**

# CHAPTER 4
# METHODS

This section provides an overview of the methods I used to complete this capstone. This includes selection criteria, an infrastructure audit, an online survey, and qualitative interviews.

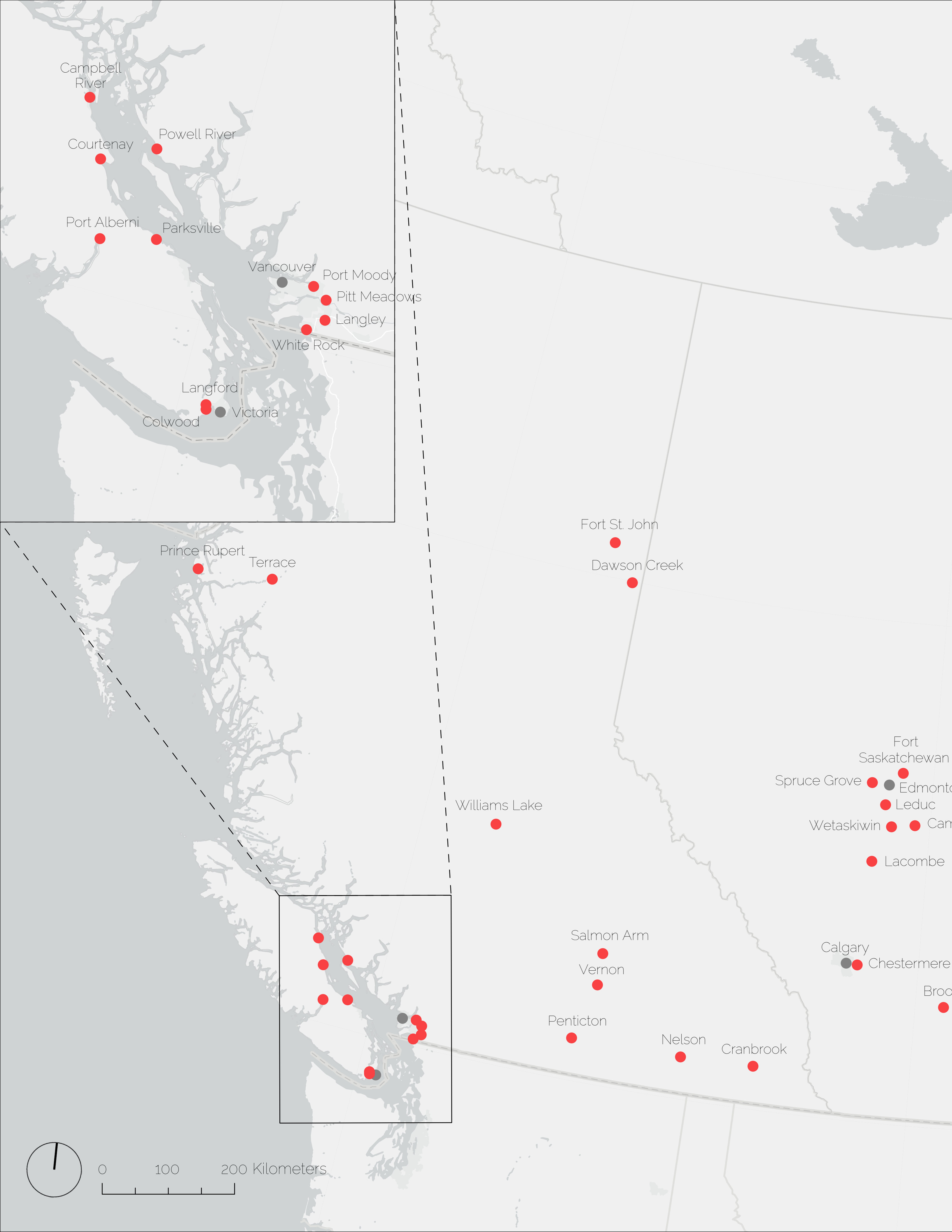
## 4.1 Selection Criteria

As part of this capstone, I explored cycling conditions in 45 small cities in Western Canada. To select these cities, I applied Hartt and Hollander (2018) 's classification of small, medium, and large Canadian cities (see Table 3). I only focused on cities in Manitoba, Saskatchewan, Alberta, and British Columbia, which is generally known as Western Canada. This is because cities in the region developed during similar eras and may experience similar challenges and opportunities related to planning for cycling. I included all incorporated small cities in Western Canada with more than 10,000 residents and fewer than 50,000 residents. As of the 2016 census, 45 small cities fit these criteria (see Appendix 1 for the full list of cities; see Figure 4 for a map).

## 4.2: Infrastructure Audit

### *4.2.1: OpenStreetMap Audit*

One of the challenges of analyzing cycling infrastructure from multiple cities is finding comparable data. To address this, I conducted an infrastructure audit using open-source data of cycling infrastructure from OpenStreetMap (OSM). In a recent Canadian study, Ferster et al. (2020) compared OSM data on cycling infrastructure to official data from cities in three large and three medium Canadian cities. They found that concordance between the data sources varied between cities but was relatively high for all cities. In this study, I followed their methodology for processing and analyzing OSM data. All OSM features have user-generated tags, which consist of two parts: a key and a value. The key describes the overall category or topic while the value describes specific attributes or information about the key. For example, to describe a cycling lane, a user may tag a map feature with the key "cycleway" and the value "lane", which would be coded as "cycleway = lane". While there are recommended standards, there are no fixed lists of tags (OpenStreeMap, n.d.). In general, most cycling infrastructure is tagged with the keys "highway" or "cycleway", but there are different values associated with these keys.



Campbell River
Powell River
Courtenay
Port Alberni
Parksville
Vancouver
Port Moody
Pitt Meadows
Langley
White Rock
Langford
Colwood
Victoria
Fort St. John
Dawson Creek
Prince Rupert
Terrace
Fort Saskatchewan
Spruce Grove
Edmonto
Leduc
Wetaskiwin
Cam
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Williams Lake
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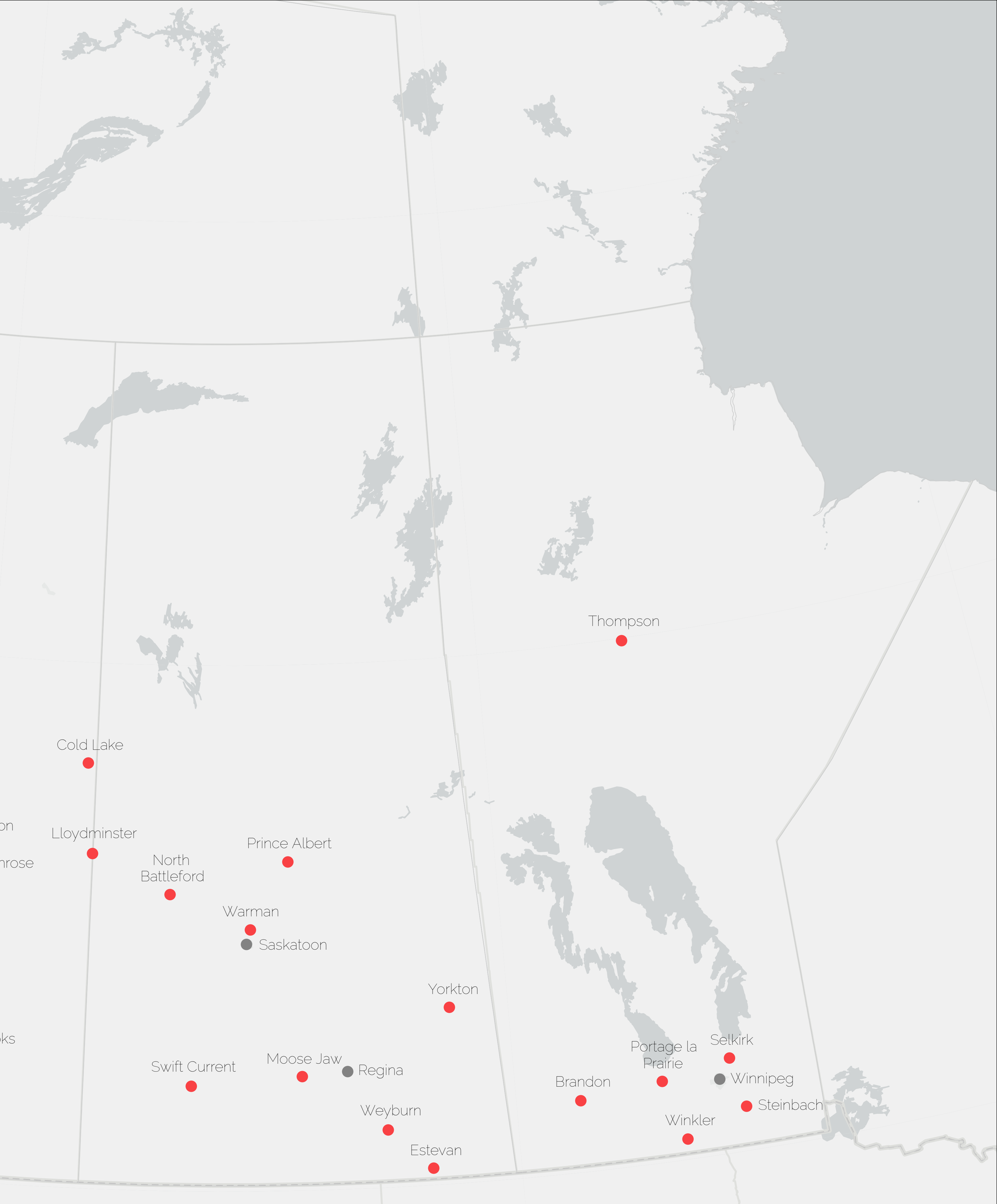


**Figure 4: Map of Small Cities Included in Capstone Project**

The infrastructure audit involved a number of steps. On September 12, 2020, I downloaded all OSM data tagged with the keys "highway" or "cycleway" in Western Canada using a QGIS plugin called QuickOSM. I also downloaded all of the 2016 Canadian census subdivision files, which align with municipal boundaries (Statistics Canada, 2020). I then imported the data into ArcGIS Pro and categorized it into five different types of cycling infrastructure, which are: cycle tracks, on-street bike lanes, local street bikeways, paths, and ambiguous infrastructure (see Figure 5 and Appendix 2). These types are primarily based off of Ferster et al. (2020) with a few modifications to ensure most of the cycling infrastructure on OSM was captured in the analysis. Following this, I created a new feature class in ArcGIS Pro that classified all of the infrastructure into one of these five types. I then clipped this file using the municipal boundaries file and used the 'Intersect' geoprocessing tool to determine which pieces of infrastructure were in each city (see Appendix 8 for an example of the maps generated through this process). Finally, I calculated the length of each piece of infrastructure and then exported the table to Microsoft Excel, where I used pivot tables to determine the quantity of each type of bike infrastructure in each city.

The main limit with this method is that OSM data is crowd-sourced and not verified by local authorities. This means there may be gaps in the data, and infrastructure types may be tagged inconsistently within and across jurisdictions. As noted above, Ferster et al. (2020) compared OSM cycling data to official data in large and three medium Canadian cities and found there was consistency. However, Ferster et al. (2020) also note that other assessments of OSM have found the data is generally the most accurate in large urban centres. OSM data is not always as accurate in smaller cities like the ones included in this study. Further, there are some variations in how multi-use paths are tagged. According to the OpenStreetMap Wiki webpage description, a 'footway' is a "minor pathways which are used mainly or exclusively by pedestrians" (OpenStreetMap, 2020). Therefore, footways were only included in the analysis if they also had the tags 'Bicycle=Yes' or 'Bicycle=Designated'. However, after conducting qualitative interviews with planners, it became clear that some of the footways that were not included were used by pedestrians and cyclists. Despite these two limits, audits using OSM data remain a useful way to compare infrastructure across many cities.

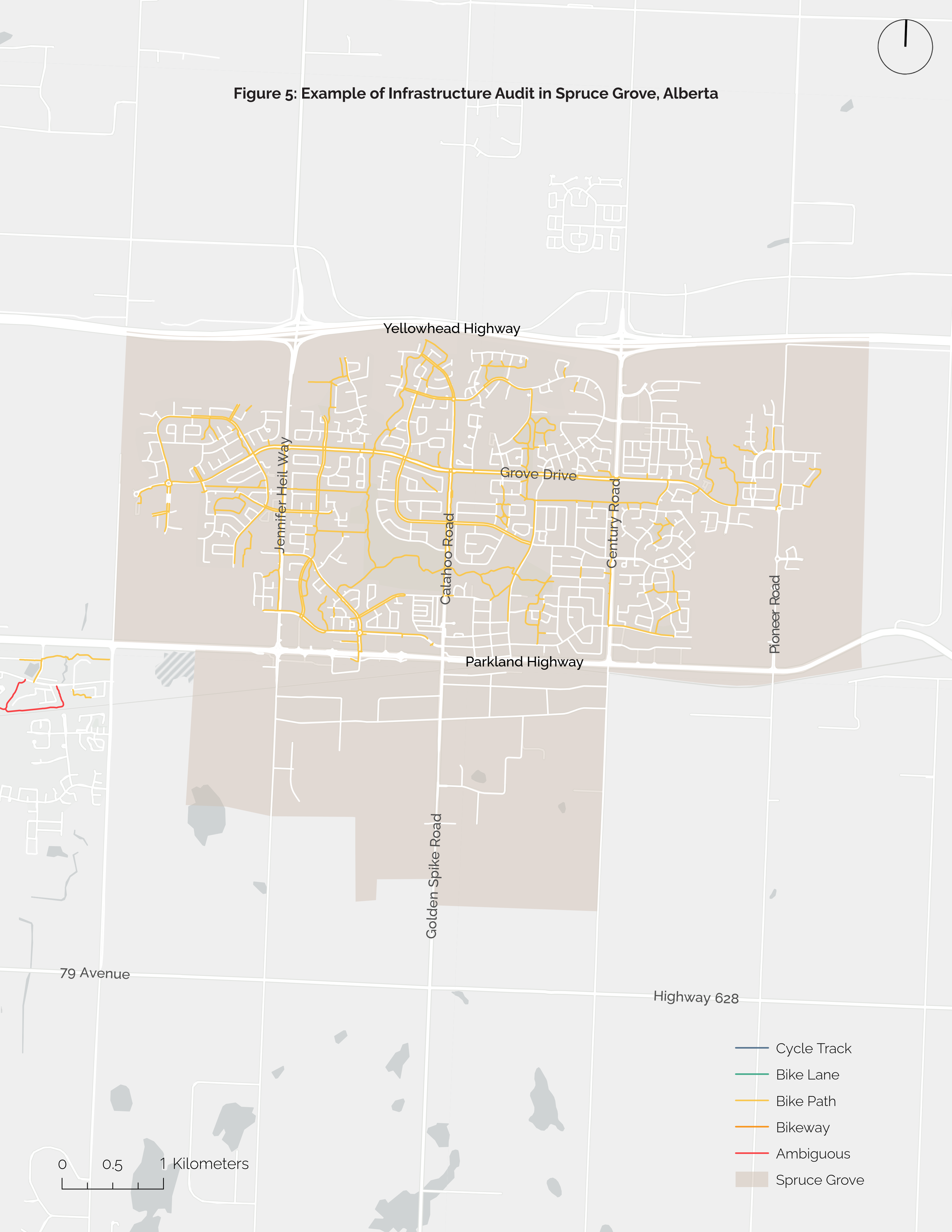


**Figure 5: Example of Infrastructure Audit in Spruce Grove, Alberta**

### *4.2.2 Google Street View Assessment*

As OSM data is open-sourced, I used Google Street View to evaluate the accuracy of the infrastructure audit (Rundle et al., 2011). To do this, I used ArcGIS Pro to generate 50 random points along the cycling infrastructure feature class and then imported these points into Google Earth Pro. I then used Google Street View and Google satellite imagery to assess whether the infrastructure I identified in the audit was accurate (Rundle et al., 2011) (see Appendix 9). Using Google Earth Pro, I found the majority of the 50 randomly generated points along the cycling infrastructure were accurate. Specifically, 42 points or 84 percent of the points were accurate while 5 of the points were inaccurate. There were two inaccurate points on bike lanes, two on bike paths, and another one on ambiguously marked infrastructure. Finally, I was unable to determine whether 3 of the points for off-street paths were accurate due to low resolution satellite imagery and thick forest canopies.

However, there were limits with this approach. Google Street View images are on available on vehicular roads. Off-street bike paths cannot be easily analyzed through this approach. However, in some cases, off-street bike paths intersect with roads, which makes it possible to assess their quality through Google Street View. Further, the quality of the imagery varied partially because it was collected at different points between 2007 and 2020. Some of the satellite imagery was low-resolution and some of the Google Street View imagery was several years out of date, particularly in more remote communities. Finally, I was unable to assess whether any cycling infrastructure was missed in the OSM audit. Instead, this exercise only evaluated whether the cycling infrastructure identified in the OSM audit was accurate. This was because I generated the random points along the cycling infrastructure that I had identified rather than anywhere in the small cities in this study.

## 4.3 Online Survey

While the infrastructure audit was useful for exploring existing infrastructure, a complementary method was needed to explore the barriers and opportunities for planning for cycling in small cities. As there are 45 small cities in Western Canada, it would have been impractical to conduct in-depth interviews with representatives from all of the communities as part of this capstone project. For this reason, I created an online survey for city employees from small cities in Western Canada. The survey included questions about factors that limit and support the development of cycling infrastructure (see Appendix 3 for the survey). The questions are loosely based off the studies by Wang (2018) and Aldred et al. (2019).

To recruit participants, I contacted planners from all small cities in Western Canada using publicly available email addresses. If email addresses were unavailable online, I contacted the city using a general email and request their planners' contact information. If a city did not have a full-time planner on staff, I contacted a civil servant or politician involved in the local planning process. In total, I reached out to planners from 31 cities. I did not reach out to planners who I selected for the qualitative interviews. I provided survey participants with information about the research and a link to an online survey hosted through Qualtrics. One month after sending out the survey, I followed up with cities that have not completed the survey through email (Vehovar & Manfreda, 2016). Out of the 31 individuals I contacted, a total of 18 individuals completed the survey (see Table 4).

## 4.4 Qualitative Interviews

I also conducted qualitative interviews with planners from 10 cities. The purpose of the interviews was to explore the factors that influenced the small cities to build cycling infrastructure (Hay, 2005). The interviews were also designed to examine any barriers the cities may have encountered, and what recommendations the planners have for other small cities that want to build bike infrastructure (see Appendix 4 for the interview questions).

Based on the results from the infrastructure audit, I selected five cities with relatively high amounts of cycling infrastructure and five cities with relatively low amounts of infrastructure to explore in the interviews with planners. To select the cities, I compared the overall quantity and density of cycling infrastructure. I also considered whether the city was part of a larger metropolitan area such as the Metro Vancouver Regional District. As many of these cities had high amounts of infrastructure, I only selected one of them for the interviews to ensure I had representation from a range of cities. Finally, even though cities in British Columbia and Alberta have more cycling infrastructure on average than cities in Manitoba and Saskatchewan, I wanted to ensure each province was represented in the cities I selected.

To recruit participants, I contacted planners from the selected cities using publicly available email addresses. Four did not respond to my request, so I selected and contacted planners from four comparable cities. Two planners who completed the online survey expressed enthusiasm for the project and also completed an interview. Planners who agreed to be interviewed were be provided with an info sheet (see Appendix 5) and asked to sign a consent form before the interview began (see Appendix 6 for the consent form). In one case, the city did not employ a planner so I spoke with their Asset Management and GIS technician. In total, I conducted five interviews with representatives from 'high infrastructure' cities and another five interviews with representatives from 'low infrastructure' cities (see Table 4). Only one of the planners worked for a small city that was part of a major metropolitan region. Due to the COVID-19 pandemic, I conducted all the interviews through Microsoft Teams video conferencing software. I recorded audio of the interviews and transcribed them with assistance from Microsoft Stream software.

**Table 4: Survey and Interview Participants by Province**

| Province | Surveys | Interviews |
|---|---|---|
| Alberta | 3 | 3 |
| British Columbia | 11 | 4 |
| Manitoba | 2 | 2 |
| Saskatchewan | 2 | 1 |
| **Total** | **18** | **10** |

Following this, I did a content analysis of the interviews using a combination of inductive and deductive approaches with Dedoose software. As there is limited research on barriers to building bike infrastructure in small cities, I started with an inductive approach that allowed “the categories and names for categories to flow from the data” (Hsieh & Shannon, 2005, p. 1279). After one round of inductive coding, I had 32 ‘barrier’ codes and 33 ‘opportunity’ codes. However, many of the codes overlapped and could be viewed as either a barrier or an opportunity, depending on the circumstances. I also realized the codes could be categorized into four of the six governmental barriers to sustainable transportation that Banister (2005) identified (see Table 1). For the following rounds of content analysis, I reorganized the codes using a combination of deductive and inductive coding until the coding structure was finalized.

# CHAPTER 5
# RESULTS

## 5.1 Infrastructure Audit

There was a significant variation in the cycling infrastructure identified through the OSM audit. While some cities did not appear to have any bike infrastructure, three had upwards of 60 kilometres of infrastructure for cyclists (see Figure 7 or Appendix 7 for details). There was also a large variation in the density of bike infrastructure, which was measured as the kilometres of bike infrastructure per square kilometre of land (see Figure 8). Some types of cycling infrastructure were also more common than others (see Figure 6 and Table 5). Bike paths were most common while cycle tracks were least common. The average quantity and density of infrastructure also varied by province, with cities in Alberta having the highest density of cycling infrastructure (see Table 5). There was no clear correlation between the average density of bike infrastructure in a city and the bicycle commuting rates from the 2016 census (see Figure 9). However, there did appear to be a connection between the density of bike infrastructure in a city and the city's average January temperatures (see Figure 10).

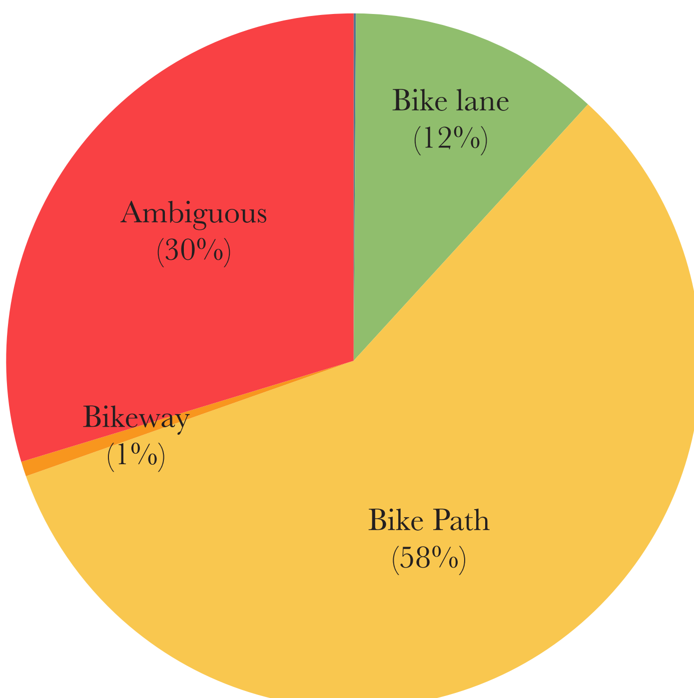


**Figure 6: Proportion of Cycling Infrastructure by Type**

**Figure 7: Total Kilometres of Cycling Infrastructure**

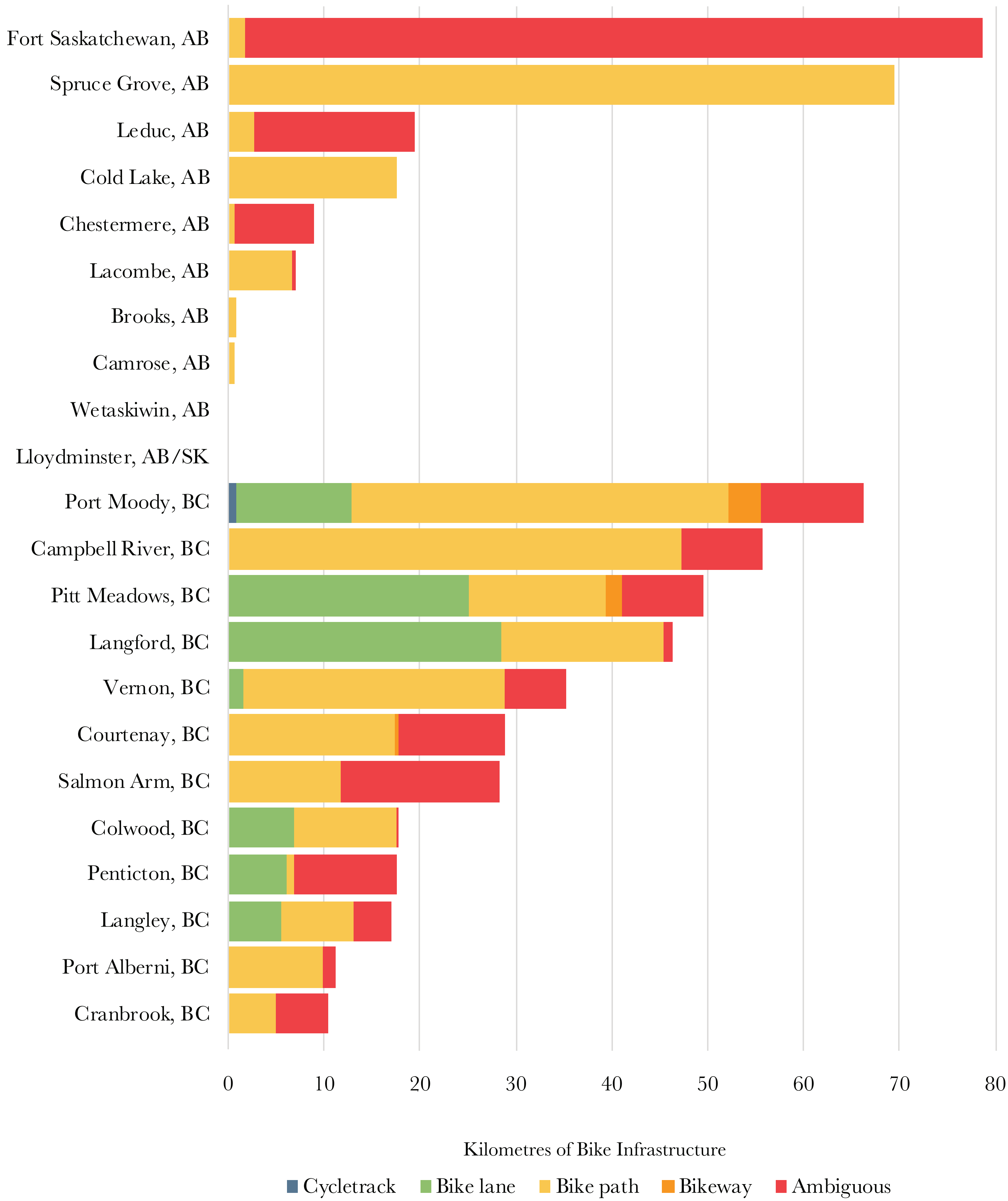

**Figure 7: Total Kilometres of Cycling Infrastructure (Continued)**

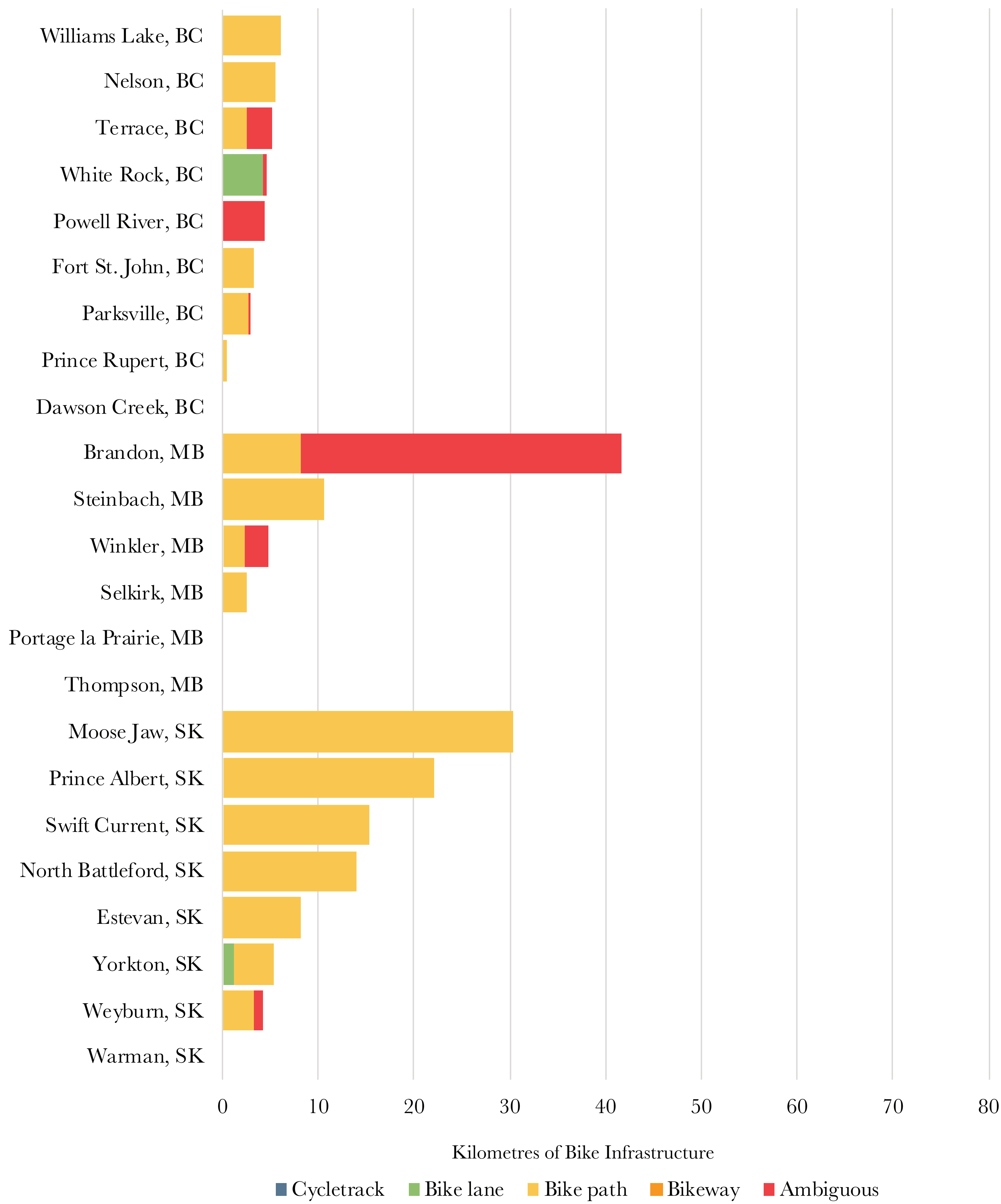

**Figure 8: Density of Cycling Infrastructure**

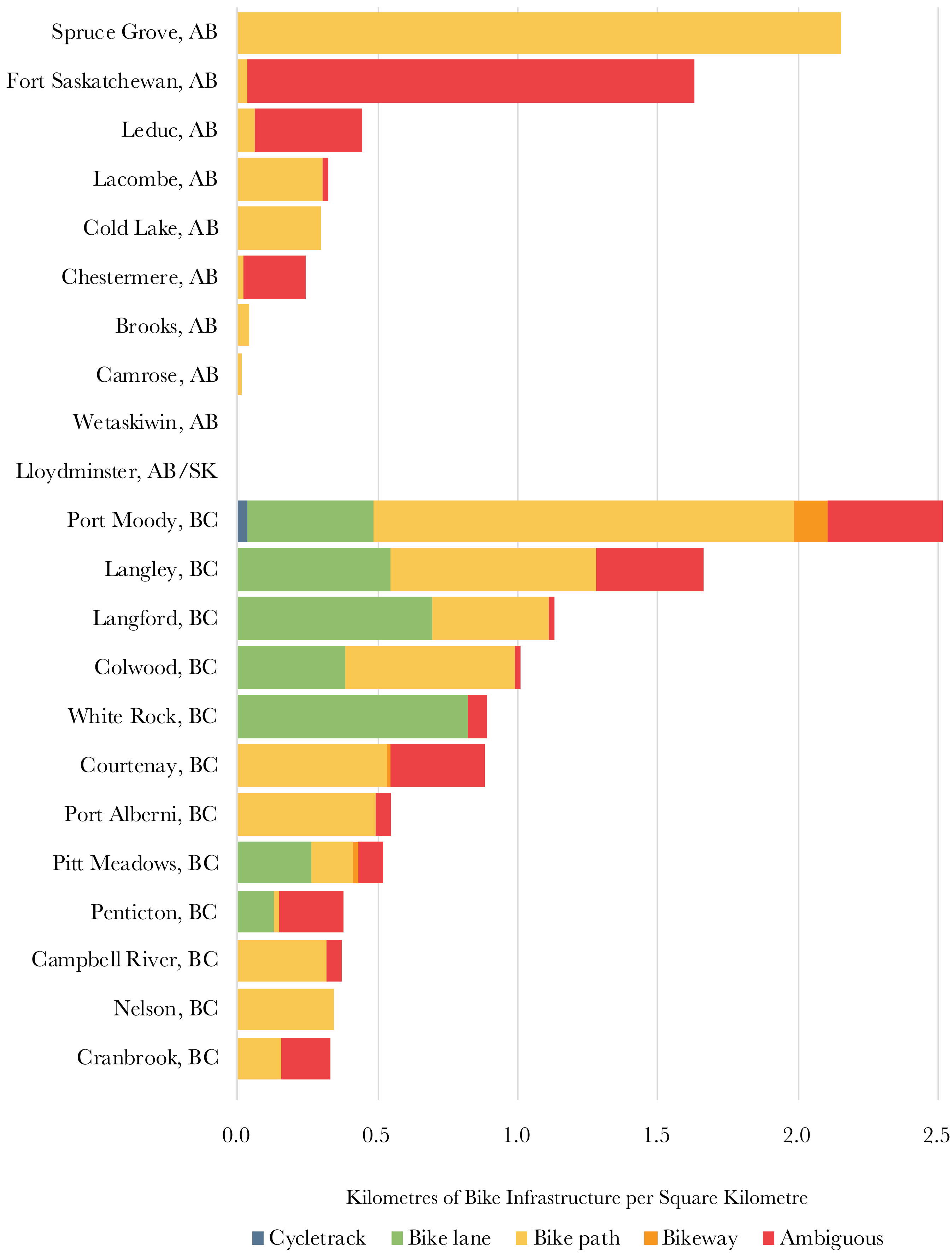

**Figure 8: Density of Cycling Infrastructure (Continued)**

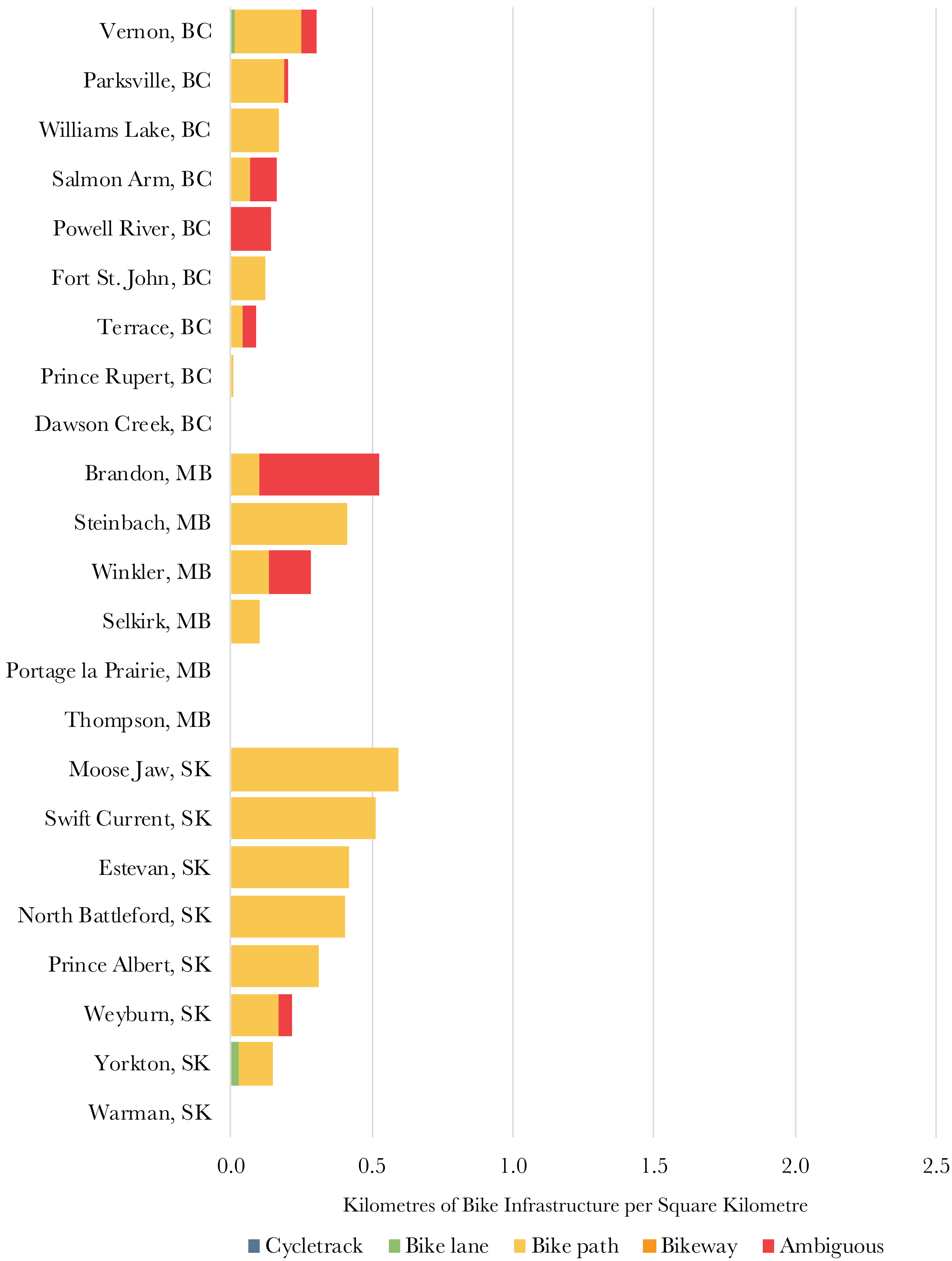

**Table 5: Total Kilometres (Density) of Cycling Infrastructure by Province**

| | Cycle Track | Bike Lane | Bike Path | Bikeway | Ambiguous | Total |
|---|---|---|---|---|---|---|
| | Total in kilometres (density) | | | | | |
| Alberta | 0 (0) | 0 (0) | 100.3 (0.3) | 0 (0) | 102.5 (0.3) | 202.8 (0.6) |
| British Columbia | 0.8 (0) | 89.7 (0.1) | 228.7 (0.2) | 5.4 (0) | 91.9 (0.1) | 416.5 (0.4) |
| Manitoba | 0 (0) | 0 (0) | 23.7 (0.1) | 0 (0) | 35.8 (0.2) | 59.5 (0.3) |
| Saskatchewan | 0 (0) | 1.1 (0) | 97.2 (0.4) | 0 (0) | 0.9 (0) | 99.3 (0.4) |
| **Total** | **0.8 (0)** | **90.8 (0)** | **449.9 (0.2)** | **5.4 (0)** | **231.1 (0.1)** | **778.1 (0.4)** |

*Note: Density is kilometres per square kilometre.*

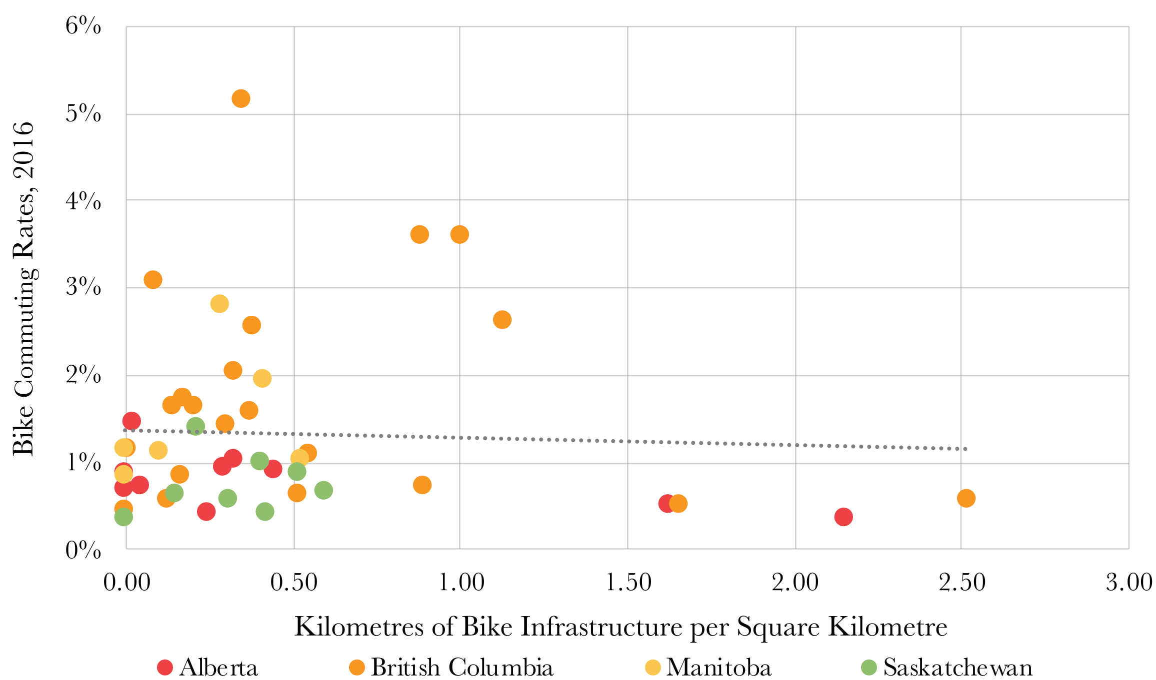


**Figure 9: Bike Commuting Rates vs. Density of Bike Infrastructure in Small Cities**

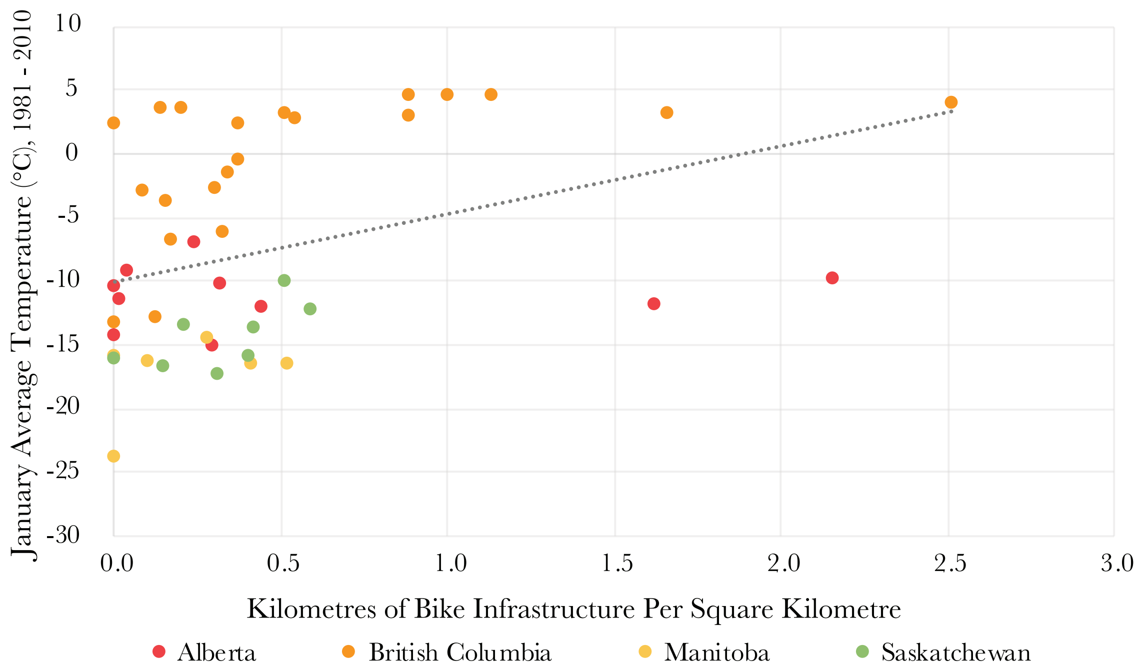


**Figure 10: Average January Temperature vs. Density of Bike Infrastructure in Small Cities**

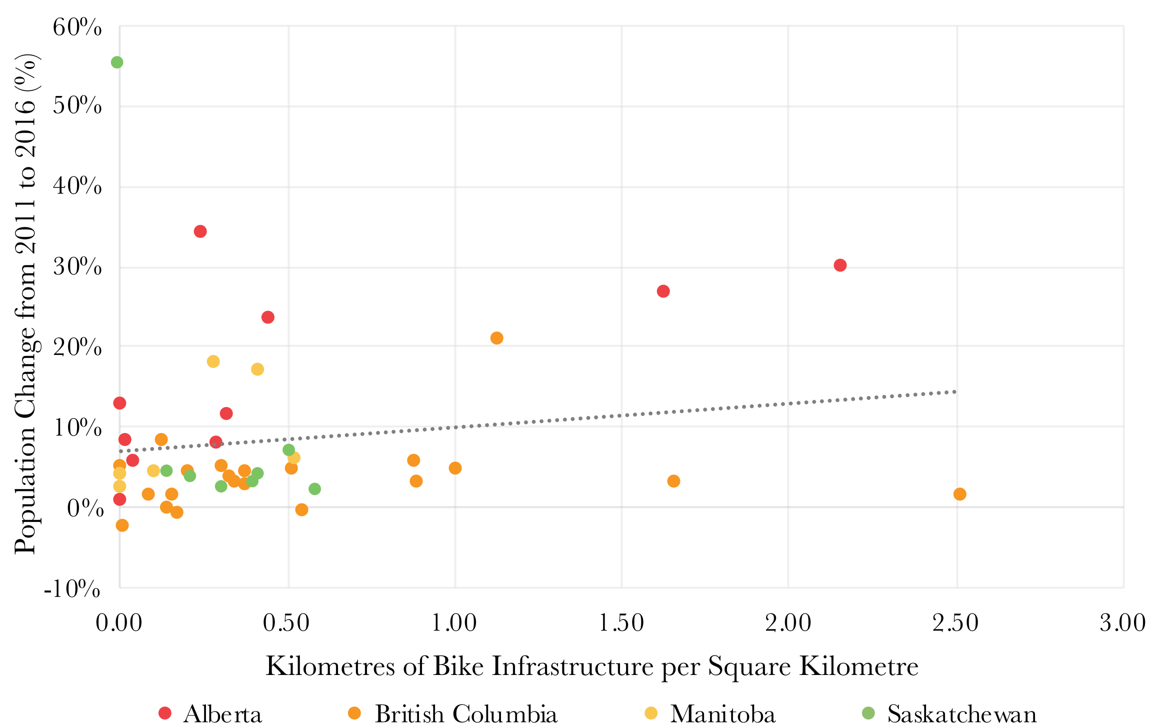


**Figure 11: Population Change (2011 - 2016) vs. Density of Bike Infrastructure**

## 5.2: Online Survey

The online survey explored barriers and opportunities for building more cycling infrastructure. Sixteen of 18 participants said their city was interested in building more cycling infrastructure. When asked why, participants included the following reasons:

- Public health (2)
- Public demand or support (2)
- Environmental sustainability (2)
- Improve road safety (2)
- Improve trail connections (2)

One participant who said their city is not interested in creating more cycling infrastructure said it was because their city is a "very vehicle dominant city."

### *5.2.1: Barriers to Creating Cycling Infrastructure*

The survey included a matrix that asked participants whether a number of factors were barriers to creating cycling infrastructure in their city (see Figure 12). The three biggest barriers were funding, a lack of space, and people's reluctance to bike.

Participants were also asked if there were other barriers to creating cycling infrastructure in their city. Responses included:

- Narrow road widths (2)
- Lack of demand (2)
- On-street parking (1)
- Aging population (1)
- Limited staff capacity (1)
- Weather conditions (1)

When asked for additional comments, respondents emphasized the following barriers:

- Funding (3)
- Limited staff capacity (1)
- Maintenance issues (1)
- Topography (1)
- Lack of demand (1)

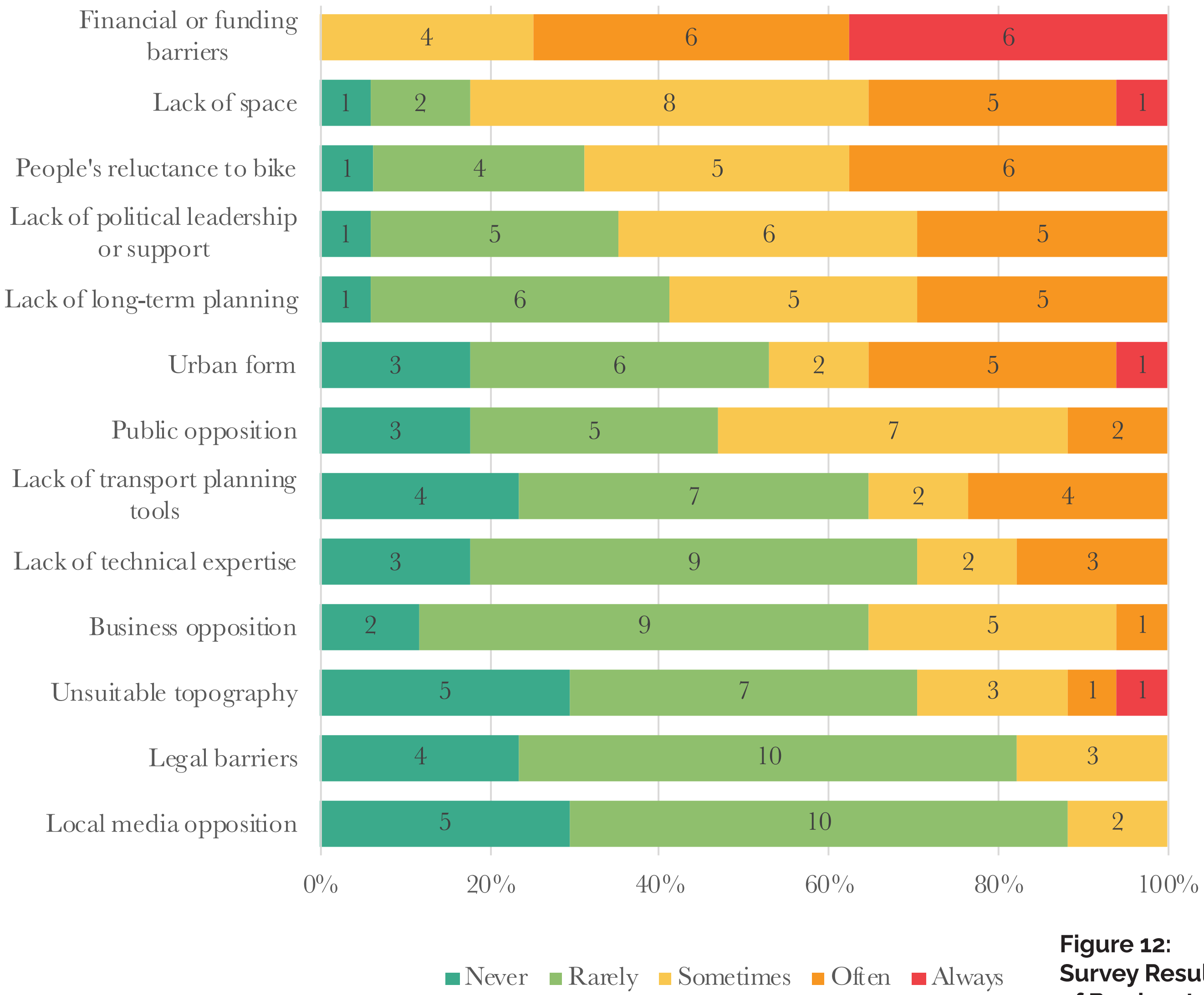


**Figure 12: Survey Results of Barriers to Creating Cycling Infrastructure**

### *5.2.2: Potential Opportunities for Creating Cycling Infrastructure*

Respondents were also asked to complete a matrix on potential supports for creating cycling infrastructure (see Figure 13). The three most promising opportunities were support from local politicians, supports from the public, and financial support from the provincial government.

Participants were also asked if other factors could support the creation of cycling infrastructure in their city. Responses to this question included:

- Support from CN Rail (2)
- Funding (for land) (2)
- Mixed land uses (1)
- Public awareness and support (1)
- More cyclists (1)

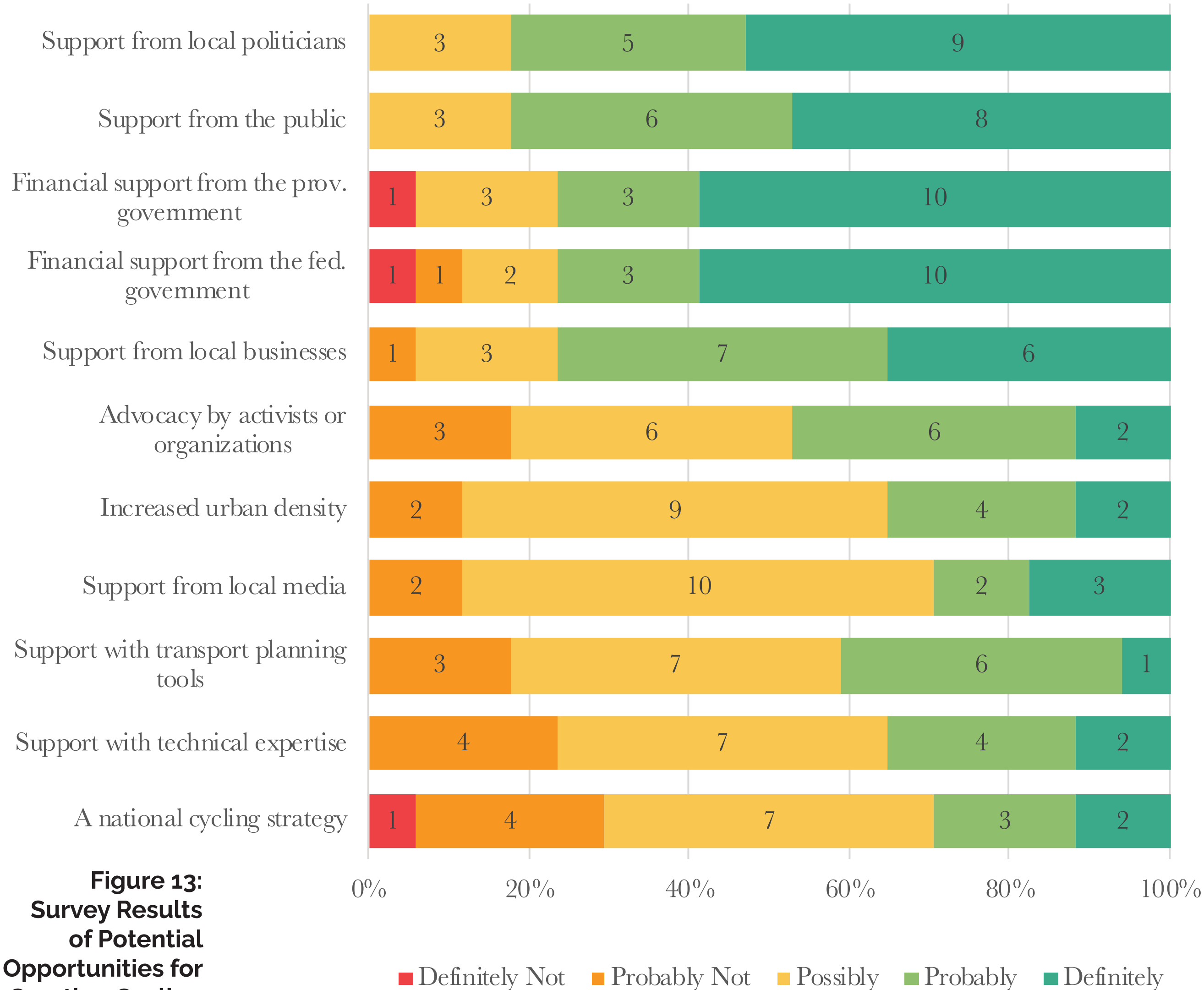


**Figure 13: Survey Results of Potential Opportunities for Creating Cycling Infrastructure**

When asked if they had additional comments potential opportunities for creating more cycling infrastructure, respondents highlighted the following resources that would help them:

- Funding (for maintenance) (2)
- Political support (1)
- Bike infrastructure guidelines (1)
- Support from schools (1)

## Qualitative Interviews

The qualitative interviews also explored barriers and opportunities for building more cycling infrastructure. The two most common barriers identified were negative perceptions of on-street bike lanes and a lack of road space or land availability (see Table 6), while the biggest opportunity was taking advantage of private development (see Table 7). These factors are organized into Banister's (2005) categories of barriers to sustainable transportation (see Table 1), including resources, institutional or policy factors, social or cultural factors and other factors.

### *5.4.1: Resources*

Limited resources were a barrier to building bike infrastructure for many of the cities. Planners from five of the cities noted that financial or funding issues were a barrier. They said their cities needed financial support not only to pay for construction costs but also to buy the necessary the right-of-way beside the road. Interestingly, more planners from 'high infrastructure' cities than from 'low infrastructure' cities said funding was a barrier. Three planners also highlighted funding as an opportunity. Planner 6 said their city had limited funding for bike infrastructure but had received financial support from provincial programs to build bike paths. In contrast, planner 7 said their city had few budget constraints because it was rapidly growing. They said, "we've never had to have those tough conversations about what our priorities actually should be because we're able to make everything a priority." This suggests funding was a major barrier for some—but not all—cities represented in the interviews.

The majority of planners interviewed highlighted private development as an important resource for their cities, especially for small cities in Alberta that were growing quickly. Planners said they often required developers to include new off-street bike paths or on-street bike lanes in their projects as part of the approval process. Sometimes these requirements were based off detailed network designs in the cities' plans. Other times they were based on more general policies that required developers to connect their neighbourhood to the existing trail network. Two planners also said private developers were required to contribute off-site levies or funds to build infrastructure elsewhere, which helped their city fund bike infrastructure. One planner also said their city now required new multi-family buildings to include end-of-trip facilities like secure bike parking and charging stations for electric bikes. Participants said private developers generally recognized the value of adding bike infrastructure to their new communities and did not 'push back' against the requirement. Overall, planners agreed that these development requirements helped their cities expand their cycling network.

## Table 6: Interview Results of Barriers to Creating Cycling Infrastructure

| Barrier to Cycling Infrastructure | Explanation/Example | Planner: 'High' Infrastructure 1 | 2 | 3 | 4 | 5 | 'Low' Infrastructure 6 | 7 | 8 | 9 | 10 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Resources** | | | | | | | | | | | | |
| Lack of funding | Lack of funding for construction and purchase of land, especially during COVID-19 | x | | | x | x | x | | | x | | 5 |
| Maintenance | Limited resources to clear snow, paint lines, repair potholes and cracks | | | | | | x | | x | | x | 3 |
| Limited staff capacity | Limited staff to work on projects | | x | | | | x | x | | | | 3 |
| **Institutional or Policy Factors** | | | | | | | | | | | | |
| Lack of political support | Local councillors do not prioritize bike infrastructure investments or cycling policies | | x | | | | | x | | | x | 3 |
| Lack of collaborations | Limited collaborations with nearby municipalities, regional planning boards, or non-profits | x | x | | | | x | | | | | 3 |
| Engineering standards | Technical standards that prioritize vehicular traffic over bikes, or do not account for snow-blowers | | | | | | | x | x | | | 2 |
| Asset management approach | Infrastructure is constructed in piece-meal fashion not based on key destinations or network connectivity | | | | x | | | | x | | | 2 |
| **Social or Cultural Factors** | | | | | | | | | | | | |
| Perception of on-street lanes | Lack of support or resistance to on-street bike lanes due to reallocation of traffic lanes and parking or discomfort driving near cyclists | | x | x | | | x | x | x | | x | 6 |
| Mode share | Limited bike commuters; residents dependent on vehicles due to lack of public transit | x | | x | | | x | | x | x | | 5 |
| Lack of advocates | Lack of advocates to educate the public or put pressure on politicians | | x | | | | x | | | x | | 3 |
| Recreational perception | Public perception of cycling as a recreational activity rather than transport mode | | | x | | | | | | | x | 2 |
| **Other Factors** | | | | | | | | | | | | |
| Lack of road space or land availability | Do not own right-of-way next to roads or through neighbourhoods; narrow streets difficult to retrofit | x | x | | x | | x | | | x | x | 6 |
| Urban form and land use | Low-density developments with separated land-uses discourage cycling | x | | x | x | | | | | x | x | 5 |
| Cold and snowy winter climate | Discourage cycling; cause snow removal issues | x | x | x | | | x | | | | x | 5 |
| Mountains or hilly topography | Conditions make it more difficult to bike | | | | x | | | | | x | | 2 |

### Table 7: Interview Results of Opportunities for Creating Cycling Infrastructure

| Opportunities for Cycling Infrastructure | Explanation/Example | Planner: 'High' Infrastructure 1 | 2 | 3 | 4 | 5 | 'Low' Infrastructure 6 | 7 | 8 | 9 | 10 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Resources** | | | | | | | | | | | | |
| Private development | Developers required to build bike infrastructure or contribute off-site levies | x | x | x | x | x | | x | | x | x | 8 |
| Available funding | Funding from higher levels of government; municipal revenues in 'booming' cities | | | | | | x | x | | | x | 3 |
| **Institutional or Policy Factors** | | | | | | | | | | | | |
| Political support | Local councillors support investments in bike infrastructure and/or cycling policies | x | | x | x | | | x | x | x | | 6 |
| Municipal plans and policiess | Establish vision, objectives, and network design; policies include requirements for developments | x | x | x | | x | x | | x | | | 6 |
| External collaborations | Support from regional agencies/associations or non-profit organizations | | | x | x | x | x | x | | | | 5 |
| **Social or Cultural Factors** | | | | | | | | | | | | |
| Perception of off-street paths | Support for off-street multi-use paths that can be used by cyclists and pedestrians | x | | x | | | x | x | | x | | 5 |
| Local advocates | Advocacy groups or individuals who put pressure on politicians and/or educate the public about cycling | | | | x | | x | x | | x | x | 5 |
| Cultural trends | Local 'mountain bike' or university culture encourages development of cycling infrastructure | | | | x | | | x | | | | 2 |
| **Other Factors** | | | | | | | | | | | | |
| Available road space or land | Newer cities have wider streets with more space for bike lanes; trails can be built in parks, public utility lots and on disused mine shafts, rail lines and roads | x | | x | x | | | x | | x | | 5 |

### *5.4.2: Institutional or Policy Factors*

Planners also discussed the importance of institutional and policy factors, including political support. Three planners said that limited support from local councillors was a barrier to building bike infrastructure. They said that politicians generally responded to demands from the business community, advocacy groups and the general public, who were not always interested in bike infrastructure. Planner 10 explained, "If the community wants an outdoor skating rink, and that's where the pressure is for politicians, they are likely to respond to that that public pressure … it's that public will and pressure that really drives a lot of the change." However, six planners said support from local politicians was key to the success of their cycling projects. These planners said their councillors supported bike paths and lanes by developing committees, supporting active transportation plans, putting aside municipal funds for infrastructure, and implementing policies that required private developers to build bike infrastructure. In some cases, the politicians were cycling advocates themselves while in other cases they responded to community demand. Interestingly, planner 5 said politicians were indifferent to bike lanes because the process for building them had become as commonplace as upgrading sewers. Overall, these findings suggest support from politicians helped cities expand their bike network.

Planners also emphasized the importance of municipal plans and by-laws, which were approved by political leaders. Planners from six cities—including four of the five 'high infrastructure' cities— said municipal plans helped their city prioritize and coordinate investments in bike infrastructure. These plans included municipal development plans, transportation master plans, active transportation plans, and green space plans. Two planners also discussed how their municipal policies required developers to add bike infrastructure in new developments or contribute off-site levies. Planner 1 emphasized these policies were key to their city's success. They said, "our system is developed because, at a policy level, it became imperative that developers provide the rights-of-way and construct the trails." In short, interview participants believed municipal plans and policies were key to expanding their cycling networks.

Another institutional factor that planners discussed was external collaborations. Three planners said they were having trouble coordinating regional bike infrastructure with external partners, including their planning board and a neighbouring municipality. However, five planners highlighted the importance of external collaborations. One planner from a city in the Lower Mainland Region of British Columbia said their regional transportation agency, TransLink, helped them coordinate and fund bike infrastructure. Another planner said their city was part of a regional alliance of several municipalities that coordinated the creation of bike trails. The planner said the alliance had helped establish a network of trails across the region.

### *5.4.3: Social or Cultural Factors*

The planners interviewed felt that the public's perception of bike infrastructure was an important factor. As planners had not conducted their own surveys to evaluate public perception, they based their responses on formal and informal interactions with community members. Interestingly, there was a distinction between on-street bike lanes and off-street multi-use bike paths. Six planners—including four from low-infrastructure cities—felt the public was generally not supportive of on-street bike lanes because they involved reallocating parking spaces or traffic lanes. Planner 2 said there "is the heavy reliance upon the on-street parking network [and] residents value on-street parking more than they do cycling infrastructure." However, five planners noted that although the public was opposed to on-street bike lanes, they were supportive of off-street paths that could be used by cyclists and pedestrians. Planner 3 explained their off-street trails were well supported because they accommodated multiple users. They said the trails were "open to everyone to use, like cyclists, dog walkers, and people who just want to walk … it's important to have a broad user base [as] then you have more support." For these reasons, planners believed it was easier for their cities to invest in off-street multi-use paths than dedicated, on-street bike lanes.

Another challenge that planners discussed was the mode share in their cities. Four planners said that while their existing bike paths were use recreationally, very few people used them to commute to work or run errands. Planner 9 said, "there isn't a lot of bike-to-work activity … it seems like people are sort of satisfied to get around town however they do it, and then go for a bike ride in the woods." A related challenge was a lack of other transportation alternatives. Planner 6 said their city had a very rudimentary transit service, which made it difficult for residents to get to work on time without a vehicle. They said that poor public transit system created a 'catch-22' cycle that forced residents to own private vehicles, which discouraged them from using other modes. Because few residents regularly commuted to work by bike, these planners felt it was difficult for their cities to justify expanding their cycling infrastructure network.

Finally, planners highlighted the role of activists and advocacy organizations. Three planners said there were no or few cycling advocates in their city but believed they could encourage their council to invest in more bike infrastructure. Planner 2 said, “we don’t really have a lot of cycle advocacy groups within the city …. That’s unfortunate because that just means it’s not as much of a priority for us.” In contrast, five planners said that local advocacy groups helped influence city councillors to invest in the cycling network. Planner 6 said a cycling advocacy group had been very influential but then changed their area of focus, so their city lost momentum on building cycling infrastructure. Planner 10 said, “the squeaky wheels are what get a lot of these things from elected officials, right? So, if there’s a strong community presence and desire for this type of infrastructure, I think that’s your best bet.” Overall, the participants agreed that activists and advocacy organizations were an important factor.

#### *5.4.4: Other Factors*

Another notable factor that came up in six interviews was a lack of road space and limited land availability. Planners said that in many older cities, the road widths were relatively narrow, which made it difficult to add on-street bike lanes. As noted above, planners said that residents were generally opposed to the reallocation of traffic or parking lanes to on-street bike lanes. The other option for older cities was purchasing the right-of-way next to roads, but planners said this was often cost prohibitive. For these reasons, several planners said it was difficult for their city to construct on-street bike lanes.

However, five planners said their cities made the most of existing road space and land to add to their bike network. Two planners acknowledged their cities had developed relatively recently and had wide roads, which made it easier to add on-street bike lanes. Four planners also discussed how their city took advantage of existing land to build off-street bike paths. They emphasized the importance of connecting parks, green spaces, and public utility lots to build out their trail network. Planners also said their cities used abandoned rail lines, underground mine shafts, or disused roadways to create new trails. Planner 3 said their city designed many trail accesses so they could be used by emergency vehicles in case the road was blocked. They thought it was important for their trails to serve "dual purposes" to help address funding and public perception issues.

Five planners also discussed how the urban form and land use pattern of their cities impacted their ability to build bike lanes. Planner 3 said their city had separated residential and commercial land uses, which disincentivized cycling. They explained, "that separation of land uses makes cycling for transportation a little bit difficult because then people tend to drive places instead of walking or deciding they could take their bike to get some groceries." Two planners also said the location of major highways prevented some residents from biking to potential destinations such as workplaces. Another planner said their city had a grid street network with regular driveways and access points along the main routes, which made it difficult to safely install bike infrastructure. One planner also said their city's land base was very large but their tax base was small. While these planners encountered different challenges related to their cities' urban form and land use patterns, the problems all made it difficult to build bike infrastructure.

Finally, planners discussed how their city's climate and topography posed challenges for cyclists. Five planners said that cold and snowy winter conditions discouraged residents from cycling all year. Planner 10 said politicians "believe it's very much a winter city and people don't cycle in the winter, which isn't necessarily true but that's sort of the perception that there is." Two planners also talked about how hilly topography made it difficult to create user-friendly bike routes. These challenges made it difficult for planners to justify bike infrastructure.

# CHAPTER 6
# DISCUSSION

## 6.1: Project Significance

The results from this capstone suggest there is currently limited cycling infrastructure in most small cities in Western Canada. While there are a few notable exceptions such as Spruce Grove, Alberta or Port Moody, British Columbia, most cities have very limited or non-existent bike infrastructure (see Figure 6). The average city has only 0.2 kilometres of bike paths and 0.1 kilometres of ambiguous infrastructure per square kilometre (see Table 5), which is not enough to create a well-connected, safe cycling network. According to Geller's (2009) definition of four types of cyclists, most residents would not be comfortable cycling in these conditions. Geller argues that 'interested but concerned' cyclists who are uncomfortable cycling beside busy traffic without dedicated infrastructure make up approximately 60 percent of the population. While there are likely low-stress streets that cyclists could use in many small cities, Gellers's (2009) typology suggests most residents would not be comfortable biking to key destinations—which are often located along major routes—without dedicated infrastructure. This is a challenge for environmental and public health reasons, which are discussed in the following subsections.

### *6.1.1: Climate Change Mitigation*

By encouraging a modal shift to cycling, bike infrastructure can help mitigate climate change, which is arguably one of the most pressing issues of our time. There is widespread scientific consensus that anthropogenic greenhouse gas emissions are to blame. Scientists warn that if countries do not significantly reduce these emissions over the next several decades, we will experience severe impacts (IPCC, 2014). These include more extreme weather events such as heatwaves, hurricanes and tornados. The loss of arctic ice sheets and increasing ocean temperatures will cause sea-level rise, causing severe coastal and inland flooding. Climatic changes will threaten the survival of marine and terrestrial ecosystems. Drought in many parts of the world will likely lead to mass food and water shortages. Warmer temperatures and drier conditions will also cause more extensive and intense wildfires (IPCC, 2014). These widespread changes could lead to mass global migration, resource conflicts, and widespread social and political instability (Wallace-Wells, 2019).

In order to meet its climate change targets, the Government of Canada will need to reduce its greenhouse gas emissions significantly in the coming years. In Canada, the transportation sector is responsible for 186 megatonnes of carbon dioxide equivalent, which is a quarter of the country's greenhouse gas emissions (see Figure 14). Passenger cars and trucks are responsible for almost half of these emissions (Government of Canada, 2020). In large part, this is because many Canadians regularly drive to work, especially in small cities in Western Canada (see Figure 3). As a signatory to the Paris Agreement, the federal government committed to reducing its greenhouse gas emissions to 511 megatonnes of carbon dioxide equivalent by 2030, which is thirty percent less than the country's 2005 levels (Environment and Climate Change Canada, 2020). As part of this, the federal government plans to reduce emissions in the transportation sector by 23 megatonnes, which is the equivalent of removing more than 7 million passenger vehicles from the road (Environment and Climate Change Canada, 2020; Natural Resources Canada, n.d.).[2] While there are a number of ways to reduce transportation emissions such as encouraging electric vehicles, one effective way is to encourage a modal shift away from private vehicles to low-carbon modes like biking (Banister, 2011). However, as noted above, this largely depends on the presence of safe and connected cycling infrastructure.

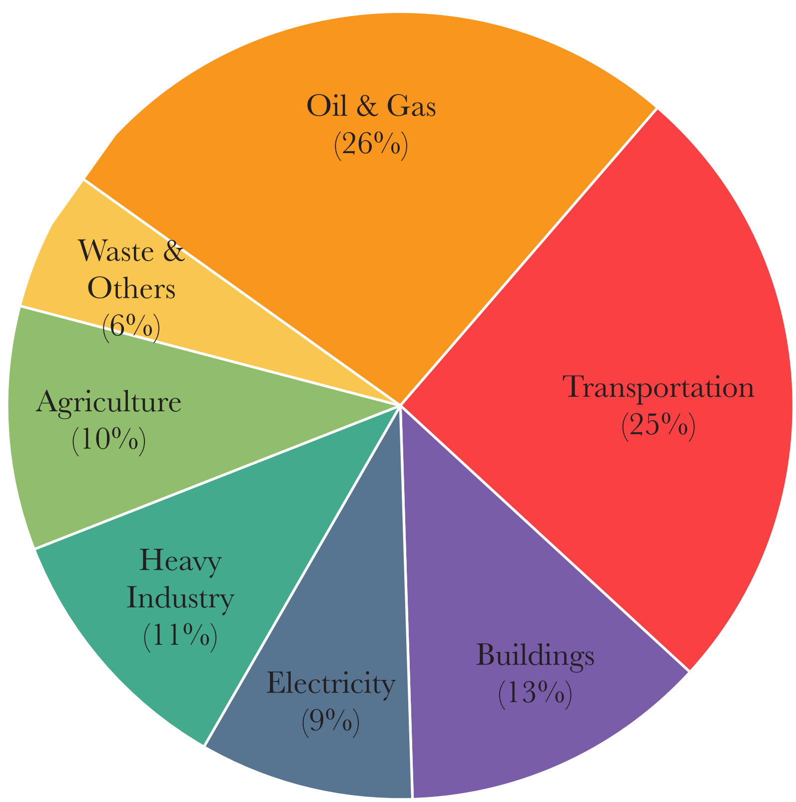


**Figure 14: Canada's Greenhouse Gas Emissions by Sector, 2018**

[2] According to NRCan's Greenhouse Gas Equivalencies calculator, 23,000,000 metric tons is equivalent to what to 7,046,372 passenger vehicles would emit in one year.

### *6.1.2: Public Health Promotion*

In addition to the environmental reasons, there are also compelling public health reasons to encourage residents to cycle more. Across Canada, physical inactivity and poor dietary habits are contributing to chronic diseases including cancer, dementia and heart disease (PHAC, 2017; PHAC, 2018). Recent public health research suggests that physical activity levels are correlated with built environment characteristics including a neighbourhood's density, land-use mix, street connectivity as well as the presence of green spaces, sidewalks, and bike trails (Gavin, 2017). Research also suggests that residents of rural and small communities in Canada generally have poorer health outcomes compared to residents of major urban centres (Kulig & Williams, 2011). For example, in an analysis of potentially avoidable mortality by relative remoteness, Subedi, Greenberg and Roshanafshar (2019) found that Canadians living in more rural and remote areas had higher avoidable mortality rates than those in urban centres. Taken together, this research suggests that residents of small cities may have worse health outcomes due, in part, to the design of the built environment.

One way to address these public health issues is by encouraging more residents to bike. There is a significant body of research highlighting the benefits of physical activity. These include a reduced risk of cardiovascular disease, diabetes, high blood pressure, obesity, and multiple forms of cancer. There are also cognitive and mental health benefits associated with physical activity (PHAC, 2018) To achieve these benefits, the World Health Organization recommends that adults engage in at least 150 minutes of moderate physical activity per week (WHO, 2010). As a form of moderate to vigorous physical activity, cycling can help individuals increase their physical activity levels and improve their overall health. Research suggests that people who regularly bike experience many of these individual health benefits (Garrard, Rissel, Bauman, & Giles-Corti, 2021). More broadly, there are public health benefits associated with reduced motor vehicle usage including lowering air and noise pollution, reducing traffic injuries, and increasing the livability of neighbourhoods (Garrard, Rissel, Bauman, & Giles-Corti, 2021). While there are some individual health risks associated with potential vehicle-bicycle collisions, researchers argue the potential health benefits generally outweigh these risks (De Hartog, Boogaard, Nijland, & Hoek, 2010).

## 6.2: Opportunities for Creating Cycling Infrastructure

Small cities encounter many barriers when it comes to building cycling infrastructure including a lack of resources, limited public and political support, and a lack of road space and land availability, among other issues (see Figure 12 and Table 6). However, as this project highlighted, there are a number of government interventions that could help small cities overcome these challenges. Higher levels of government could provide small cities with financial support for infrastructure. Small cities could develop policies to take advantage of private development and invest in educational and outreach programs to promote cycling. These cities could meet residents where they are at by building multi-use off-street paths instead of on-street infrastructure. These initiatives could be supported by external collaborations with non-profit organizations, community groups, and regional agencies. These five interventions are highlighted in the following subsections.

It is important to emphasize that while all of these initiatives would be beneficial on their own, research suggests that cities with comprehensive strategies that include multiple pro-cycling programs and policies are most successful at encouraging residents to cycle (Pucher, Dill, & Handy, 2010). Therefore, small cities that incorporate multiple recommendations are more likely to be successful than those that only implement one.

### *6.2.1: Financial Support*

One of the main ways the federal and provincial governments can support the creation of bike infrastructure in small cities is through financial support. In both the survey and the interviews, respondents said a lack of funding was a major barrier in their cities. More than a third of survey respondents said that financial or funding barriers were always an issue, while another third said they were often an issue (see Figure 12). Further, half of the planners interviewed said a lack of funding was an issue for their city (see Table 6). These findings reinforce other recent similar studies. For example, Aldred et al. (2019) examined barriers to investing in cycling infrastructure in England. More than a third of their survey respondents said funding was the top barrier, while two thirds said it was one of the top three barriers. In the Canadian context, White (2018) explored challenges with developing active transportation networks in rural communities and small towns. White (2018) noted that a “need for additional financial resources was reiterated in every interview completed” (p. 28). These findings suggest that a lack of funding is one of the major barriers many communities in Canada encounter when trying to develop cycling infrastructure.

There are multiple reasons why small Canadian cities may have limited financial resources to spend on bike infrastructure. One reason may be that cities are “creatures of the province” and therefore have limited options for increasing their revenues (Levi & Valverde, 2006). As noted in Chapter 3, provincial governments determine the types of taxes and fees that cities can collect. Unlike many other developed countries, the largest sources of revenue for Canadian municipalities are property taxes and user fees for municipal goods and services. As of 2019, municipal governments only collected approximately 12 percent of government tax revenue but were responsible for almost 60 percent of the country’s infrastructure (Canadian Union of Public Employees, 2019). Thompson et al. (2014) argue that changes in federal and provincial spending have also impacted municipal budgets. In the 1980s and 1990s, higher levels of government implemented austerity measures that resulted in an infrastructure deficit. At the same time, these higher levels of government downloaded responsibilities for some social services onto municipalities. Thompson et al. (2014) note that municipal budgets have also been stretched due to recent demographic and economic changes, as well as infrastructure damages caused by climate change. As a result of these changes, many Canadian municipalities struggle to fund infrastructure projects.

In addition to their limited taxation powers, municipalities receive limited financial support for bike infrastructure from federal and provincial governments. Unlike some countries, the Government of Canada does not have a national, long-term funding program dedicated specifically to cycling infrastructure.[3] In contrast, countries like Germany and the United Kingdom have national programs that provide millions of dollars of support for cycling infrastructure annually (Buehler & Pucher, 2021). There is some financial support for cycling at the provincial level in Canada, but this varies between jurisdictions. For example, British Columbia has an Active Transportation Infrastructure Grants Program for municipalities. Between 2004 and 2021, the province granted communities more than $75 million

[3] As this capstone was being completed, the Government of Canada announced a $400 million fund to support active transportation projects over the next five years. However, funding has not be guaranteed after the five-year period.

dollars for active transportation projects, including nearly $8.5 million for small cities included in this capstone (Province of British Columbia, 2020). While there is some provincial funding available for transportation projects in Alberta, Saskatchewan, and Manitoba, none of the provinces have comparable grants to British Columbia. This may partially explain why cities in British Columbia had more cycling infrastructure on average than cities in Manitoba and Saskatchewan.

To address these financial shortcomings, higher levels of government could develop annual funding grants for municipalities dedicated to cycling infrastructure. While cycling infrastructure can be cost-prohibitive for small cities with very limited taxation powers, the cost of bike paths and lanes is a fraction of what provincial and federal governments regularly invest in highway infrastructure. For example, Furth (2021) writes that off-street bike paths cost approximately $1 to $2 million dollars per mile to install. In contrast, building the same length of highway can cost upwards of $300 million dollars (Furth, 2021). While the federal government currently has a number of funding programs through Infrastructure Canada that municipalities can apply to for funding for bike infrastructure, none of the programs are specifically dedicated to cycling or active transportation infrastructure. By setting up a cycling infrastructure funding program, the federal government could help municipalities rapidly expand their cycling networks. This could help lower greenhouse gas emissions from motor vehicles and increase physical activity levels.

### *6.2.2: Private Development*

While provincial funding for active transportation may help explain why cities in British Columbia have more cycling infrastructure than cities in Manitoba and Saskatchewan, it does not explain why this is also the case for Alberta. Instead, Alberta's relatively high amounts and density of bike infrastructure is likely due to its recent growth rates and the associated private development. Eight out of ten planners interviewed—including all five planners from 'high infrastructure' cities—emphasized the importance of taking advantage of new private development to expand their cycling network. Planners said private developers helped expand their cities' bicycle networks by creating trails in their new subdivisions and contributing off-site levies for other projects. This was reflected in the capstone results. In recent years, many cities in Alberta have grown faster than others in the region, and there appears to be a slight correlation between recent growth rates and the density of cycling infrastructure in a city (see Figure 11).

These results suggest that new private development has helped some small cities expand their cycling network, particularly in Alberta.

In some cases, small cities had policies or by-laws that required developers to make these contributions. For example, one of the policies in the City of Spruce Grove's Active Transportation Master Plan (2012) is to require the "provision of pedestrian and cycling facilities, including bicycle parking facilities, in all new developments" (p. 20). The City of Fort Saskatchewan's Land Use Bylaw (C23-20) has a similar requirement. It states that "residential development shall, to the maximum extent feasible provide a convenient, well-connected network of sidewalks and trails within the development to create a more inviting pedestrian environment and encourage alternative modes of transportation." It also stated this trail system should "provide connections to major pedestrian and bicycle destinations including, but not limited to parks, schools, and commercial uses located within or adjacent to the development" (ss. 6.10). These policies and bylaws ensured that new developments would include off-street multi-use paths. Secondary research suggests that similar policies and standards in the City of Calgary increased the amount of cycling infrastructure that was built in new suburban communities since the 1990s (Tsenkova & Mahalek, 2014).

Although this finding suggests private developers can help cities expand their cycling networks, it does not mean governments should abdicate their fiscal responsibilities to develop infrastructure to the private marketplace. Since the 1980s, federal and provincial governments in Canada have adopted austerity measures to reduce public spending and privatize public services (Evans & Carlo, 2018). This political transformation is known as neoliberalism (Harvey, 2005). The privatization of public utilities like Manitoba Hydro and the use of public-private partnerships to fund the construction of infrastructure like Ontario Highway 407 are both examples of this trend (Birch & Siemiatycki, 2015). The reliance of small cities on private developers to create cycling infrastructure in new neighbourhoods is not an example of neoliberalism in itself. However, if governments use this development as an excuse to avoid investing additional funds into cycling infrastructure, developers will largely be able to determine where new bike infrastructure is developed based on market demand rather than considerations like equity, density, or network connectivity. This means residents who can afford to live near bike infrastructure will have access to it while those who cannot afford to will not. Given the health benefits associated with cycling infrastructure, this could reinforce existing inequities (Garrard, Rissel, Bauman, & Giles-Corti, 2021). Therefore, while this capstone suggests small cities should take advantage of private development to build bike infrastructure, these private investments should not replace public support for bike lanes and paths.

### 6.2.3: Off-Street Infrastructure

Another way that small cities can increase cycling infrastructure in their cities is by focusing on the construction of off-street multi-use paths instead of on-street dedicated bike infrastructure. The spatial analysis suggests that the majority of current bike infrastructure in small cities is either off-street bike paths or ambiguous infrastructure (see Figure 8). The one exception to this general trend was small cities in British Columbia. Eight of the 21 cities from this province had on-street bike lanes. This may be because most of these eight cities were part of larger metropolitan regions like the Metro Vancouver Regional District. In interviews, six planners—including four from 'low-infrastructure' cities—said residents were generally not supportive of on-street bike lanes because they took up parking or traffic lanes. Five planners also said that local residents were supportive of off-street multi-use paths because they can be used by pedestrians as well as cyclists. For these reasons, multiple planners said their city focused on building off-street bike paths instead of dedicated on-street lanes. This suggests other small cities that are looking to expand their cycling network should consider the same approach.

However, some planners noted that a lack of available land made it difficult to build new bike paths. More than 80 percent of survey respondents said a lack of space was either always, often, or sometimes a barrier to creating bike infrastructure. Although this survey question did not distinguish between on-street and off-street infrastructure, it suggests space is an issue. Planners who were interviewed also said it was difficult to build off-street paths because they did not always own the right-of-ways through neighbourhoods. Despite these challenges, planners also highlighted various ways to connect off-street paths including using disused mine tunnels, rail lines, and old roadways. Communities also used existing public utility lots and parks to expand and connect their bike networks. Small cities could also purchase right-of-ways through neighbourhoods to connect bike paths, though this may be cost-prohibitive for some communities. Overall, this suggests there are creative options available for small cities that want to build out their off-street bicycle network.

However, small cities should also consider the challenges associated with off-street multi-use paths. There is a higher risk of cycling collisions and injuries on multi-use paths compared to dedicated bike lanes. This is because of the diverse range of other users on multi-use paths including pedestrians, joggers, wheelchair users, skateboarders, roller-bladers, which cyclists can collide with (Harris, et al., 2013). There is also a heightened risk of cycling collisions at intersections where multi-use trails cross roadways (Jestico, Nelson, Potter, & Winters, 2017). To reduce the risk of collisions, planners should ensure that bike paths include centre markings and yield signs along the path. Depending on the speed and volume of vehicles, planners should also consider intersection treatments such as marked crosswalks, median safety islands, or active enhanced crosswalks (Federal Highway Administration, 2016). There may also be safety concerns associated with off-street bike paths through parks or wooded areas where there are fewer "eyes on the street" (Furth, 2021). To address this issue, small cities should try to route off-street multi-use paths through visible areas with adequate lighting (Furth, 2021).

### *6.2.4: Public Programs and Outreach*

In addition to building off-street multi-use paths, small cities could try to increase public support for other types of bike infrastructure through public education and outreach. The findings in this study indicate that a lack of public support for investments in dedicated cycling infrastructure is a barrier in many cities. More than a third of survey respondents said that residents' reluctance to bike was an issue, while more than half of respondents said public opposition was either sometimes or often a barrier (see Figure 12). During interviews, planners noted there were limited bicycle commuters in their cities and residents saw biking as a recreational activity rather than a transportation mode. This may explain why there is no notable correlation between the density of cycling infrastructure in a city and the proportion of regular bicycle commuters (see Figure 9).[4] A

[4] In fact, there are multiple cities with relatively high amounts of infrastructure and low commuter rates such as Spruce Grove and Fort Saskatchewan. There were also cities where the opposite conditions were true such as Nelson, which has the highest bike commuter rate of all cities in the study at 5.2 percent, but relatively little bike infrastructure. This may be because of the so-called 'mountain bike' culture that is prevalent in mountain cities like Nelson. While no representatives from Nelson were interviewed, a planner from another city indicated residents were keen to bike around the city because of the mountain bike culture. This mountain bike culture may attract residents who fit into Geller's (2009) 'strong and fearless' or 'enthused and confident' types of cyclists who are comfortable biking without dedicated infrastructure. In a study of cycling in Canadian cities, Assunçao-Denis and Tomalty (2019) also found small mountain communities had high cycling commuter rates because recreational mountain biking opportunities attracted residents who were inclined to regularly bike. These reasons likely help explain why there isn't a strong connection between the existence of bike infrastructure and bicycling commuter rates.

related issue that planners discussed is that many residents and politicians do not see cycling as a winter activity. Several planners said cold and snowy weather discouraged some residents from biking all year long, and created snow clearance issues. As a result, residents and politicians may not prioritize investments in bike infrastructure in these 'winter' cities. This may explain the correlation between the average January temperature in a city and the density of the city's bike infrastructure (see Figure 10).[5]

The lack of public support for bike infrastructure may explain why local politicians in some cities have been reluctant to support the construction of new infrastructure. More than 60 percent of survey respondents said a lack of political support for bike infrastructure was either often or sometimes a barrier. Three of the planners interviewed also said a lack of support from local councillors for bike projects was a problem. However, planners emphasized that politicians generally responded to the concerns of residents and advocacy organizations. If residents or community groups were advocating for more bike infrastructure, politicians generally supported them by dedicating resources to infrastructure and creating pro-cycling policies. In other words, political support for bike infrastructure is closely tied to public support in many small cities.

In their study with planners from ten small and rural American cities, McAndrews, Tabatabaie and Litt (2018) found similar results. The planners said a lack of cultural and political support was a major barrier to planning and building bike infrastructure. They said many residents are not in favour of reallocating road space to bike lanes and believe negative stereotypes about cyclists. They also said residents were unaware of the social and economic benefits of cycling. Before these planners felt they could build bike infrastructure, they said they had to "build a network of support for bicycling by conducting meaningful outreach to multiple local stakeholders" (McAndrews, Tabatabaie, & Litt, 2018, p. 110). While the social context may be different in Canada than the United States, in both cases planners believed many residents from small communities did not prioritize bike infrastructure. To address this challenge, McAndrews, Tabatabaie and Litt (2018)

[5] However, this correlation is complicated by the fact that many small cities in British Columbia are warmer than cities across Western Canada. Therefore, other factors not examined in this study such as differences in provincial policies may also explain this connection. Further, there are notable exceptions to this trend like Fort Saskatchewan and Spruce Grove, which are relatively cold and have average January temperatures of –11.9 °C and –9.9 °C, respectively. However, these cities also have very high recent growth between 2011 and 2016. Spruce Grove grew by 30.2 percent while Fort Saskatchewan grew by 26.8 percent during this time. As noted above, these high growth rates may help explain why these cities have a relatively high amount of bike infrastructure despite their cold January climate.

argues there is a need for public outreach and education about the benefits of cycling in these small communities.

Other secondary research demonstrates how public outreach and educational programs can increase public support for cycling (Pucher, Dill, & Handy, 2010; Savan, Cohlmeyer, & Ledsham, 2017). In an analysis of cycling in small and medium-sized cities, Handy, Heinen and Krizek (2012) found that programs helped encourage local residents to bike more.  Examples of programs included mandatory bicycle education for school children, 'bike rodeos' at elementary schools, Safe Routes to Schools programs, subsidized helmet programs, bicycle training programs for adults, annual Bike Weeks, 'Business on Bikes' programs, online route-finding systems, bicycle maps and brochures, bike film festivals, radio advertisements promoting biking, and 'bike summits' to identify issues and solutions. A particularly creative example of a program was the 'No Ridiculous Car Journeys' campaign by Malmö, Sweden, which discouraged residents from driving on trips that were less than five kilometres (Handy, Heinen, & Krizek, 2012). In addition to these ideas, research from larger cities suggests cities can promote cycling through programs like Ciclovias, bicycle sharing programs, bicycle giveaways, and comprehensive marketing programs designed to promote cycling (Pucher, Dill, & Handy, 2010). Similar programs could increase public support for cycling in small cities in Western Canada, which may encourage local politicians to invest more resources into cycling infrastructure.

### *6.2.5: Collaborations*

One interesting finding that planners emphasized was the importance of external collaborations, which is not highlighted in the academic literature. Planners discussed the importance of collaborating with multiple stakeholders, including regional planning organizations, nearby municipalities, non-profit organizations, and private companies. For example, while one planner from a municipality in the Metro Vancouver Regional District noted that TransLink helped their city coordinate and fund bike infrastructure, another planner said the lack of support from their regional planning board was a barrier. Another planner from a city near Edmonton said it was valuable to coordinate with neighbouring municipalities through the River Valley Alliance. In contrast, another planner said that a lack of coordination with a nearby municipality made it difficult to create a regional network. One planner also highlighted the importance of working with a non-profit organization that helped with funding and advocacy in their city. Planners also said that collaborations with private companies including the Canadian National Railway (CN) would be very beneficial. These collaborations could help cities build more bike infrastructure and connect it with other regional bike paths.

Interestingly, most cycling scholarship does not emphasize the importance of external collaborations. This is likely because most of the scholarship is based on studies from larger cities, where external collaborations may be less important to the success of a city's bicycle network. In contrast, smaller cities with fewer resources may need to rely more on partnerships with regional alliances, non-profits organizations, and private companies to successfully develop their cycling infrastructure. One exception to this trend is a recent study by Assunçao-Denis and Tomalty (2019) on ways to increase cycling in Canadian communities. The authors found that collaborations with cycling groups and non-profits helped increase utilitarian cycling rates in some Canadian communities including in Revelstoke, Winnipeg, Montreal, and Vancouver. However, the role of community groups varied based on the size of the community. The authors wrote that community groups played a key role in building and maintaining many trails in the small city of Revelstoke. In contrast, community organizations in larger cities supported cycling through advocacy and programs rather than constructing trails. This suggests that smaller cities can benefit from external collaborations in different ways than larger cities with more resources.

### *6.2.6: Summary*

Overall, this capstone highlights strategies for small cities in Western Canada that are trying to expand their cycling network. As these small cities face different barriers than larger cities, they also require different supports and approaches than major urban centres. This discussion has highlighted five opportunities for small cities. First, provincial and federal governments can provide small cities financial support. Small cities can take advantage of private development by requiring bike infrastructure or off-site levies in new projects. Given the differences in public perception, these cities can also focus on off-street bike paths rather than on-street bike lanes. All levels of government can work together on educational programs and outreach initiatives to educate residents on the benefits of cycling. Finally, small cities can collaborate with other municipalities, regional agencies, and non-profits to coordinate, fund, and promote their bike infrastructure.

# CHAPTER 7
# RECOMMENDATIONS & CONCLUSION

## 7.1: Recommendations

This capstone project demonstrates that there are a number of actions that all levels of government can take to improve cycling infrastructure in small cities in Western Canada. The following table highlights some of these actions.

| Recommendation | Responsibility |
|---|---|
| Financial Support | |
| Provide annual funding to small cities for bike infrastructure projects. Allow costs associated with planning the project and purchasing land. | Federal and provincial governments |
| Create a municipal reserve fund for cycling infrastructure. | Small cities |
| Private Development | |
| Implement by-laws that require new developments to include well-connected cycling infrastructure or contribute off-site levies. | Small cities |
| Encourage the development of mixed-use, compact neighbourhoods that support active transportation. | Small cities |
| Off-Street Paths | |
| Prioritize the development of off-street multi-use paths that can be shared by cyclists and pedestrians. | Small cities |
| Conduct a spatial analysis to identify potential off-street bike path connections on existing land. | Small cities |
| Ensure off-street paths include proper markings, signage and intersection treatments to reduce injury risks. | Small cities |
| Public Programs and Outreach | |
| Work with schools to develop Safe Routes to School programs for children and youth. | Small cities |
| Develop programs to help educate residents about how to safely bike on on-street lanes and off-street paths, including during the winter. | All levels of government |
| Create marketing campaigns to educate residents about the social, economic, and environmental benefits of cycling infrastructure. | All levels of government |
| Collaborations | |
| Provide cycling infrastructure planning support through planning boards or regional transportation agencies. | Provincial governments |
| Support the development of partnerships between the Canadian National Railway and small cities. | Federal government and small cities |
| Work with local businesses to establish end-of-trip facilities like bike parking. | Small cities |
| Develop partnerships with nearby municipalities to coordinate regional bike infrastructure. | Small cities |
| Develop partnerships with local bike organizations who advocate for cycling infrastructure. | Small cities |

**Table 8: Recommendations Based on Research Findings**

## 7.2: Project Limits and Future Research

There were several limits to this research project. First, as noted in the methods section, the spatial analysis relied on crowd-sourced data from OpenStreetMap, which is not verified by local authorities. While this data was easier to collect and analyze than official data from all 45 cities, it is also likely less accurate. Though I tried to assess the accuracy of the data using Google Street View, the approach I used only allowed me to analyze whether the cycling infrastructure identified in OSM was accurate. However, I was unable to evaluate whether any bike infrastructure was missing from OSM. For this reason, the data from the spatial analysis should be interpreted with caution. In the future, researchers could explore the accuracy of OSM data in small cities by conducting a comparison of OSM data with official data, similar to the study by Ferster et al. (2020) from large and medium Canadian cities.

Further, this study only examined the total amount and density of cycling infrastructure in the 45 small cities. However, it did not analyze the connectivity of the overall cycling network in these cities. In recent years, scholars have developed spatial methods for categorizing roads based on their level of traffic stress and comparing this with existing bike infrastructure. By doing this, researchers are able to examine whether there are major gaps in 'low-stress' cycling routes that involve a combination of dedicated bike infrastructure and streets with low traffic speeds and volumes (Semler, et al., 2017). This particular capstone project involved a much simpler spatial analysis. In the future, it would be interesting to conduct a more complex analysis of cycling infrastructure in small cities.

Another limit of this study is that it was largely based off the perspectives of planners who participated in the online survey and qualitative interviews. While these planners have many important insights about the cities they work for, many based their answers off of their own observations rather than empirical research. For example, many planners who were interviewed discussed the public's perception of cycling in their city. However, for the most part, these planners had not conducted surveys or focus groups with members of the public to evaluate their perceptions. Instead, they were basing them off limited interactions and informal observations. Therefore, when I discussed issues related to the public perception, I was really discussing planners' perceptions of the public perception of cycling. In the future, it would be interesting to conduct surveys with residents from small cities to understand their perspectives on cycling.

There were also multiple topics discussed in interviews that could be analyzed further in future research. For example, planners noted the importance of policies and by-laws that required developers to build bike infrastructure. However, there was no formal policy analysis conducted as part of this research. An analysis of existing policies and by-laws in the small cities in the study would have been very useful but was beyond the scope of the project. Likewise, planners discussed funding and financial issues in the interviews. While some funding mechanisms were mentioned in general terms, the capstone did not include a detailed analysis of funding structures and programs to support the creation of cycling infrastructure. The capstone also did not compare investments in cycling infrastructure across jurisdictions. These analyses would have strengthened the overall project.

Finally, this capstone only focused on research from small cities in Western Canada. While limiting the scope of the study helped keep it manageable, it also would have been interesting to explore precedents from small cities in other countries. For example, countries like the Netherlands and Denmark have examples of small cities with exceptional cycling infrastructure and high cycling rates (Bruntlett & Bruntlett, 2018). While these cities have different historical, social, political, and physical conditions than small cities in Western Canada, it may have still be useful to explore how they had successfully established extensive networks of cycling infrastructure.

## Figure and Table Sources

**Figure 1: Types of Cycling Infrastructure**

Minneapolis Public Works TPP. "IMG_8832". Available to use under Creative Common 2.0 license. Taken on May 2, 2018. Retrieved on May 17, 2020 from Flickr at: https://www.flickr.com/photos/gompls/43617797961/

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**Figure 2: Median Total Income of Households, 2015**

Statistics Canada. (2017). Median total income of households in 2015. 2016 Census.

**Figure 3: Commuter Mode Share by Province, 2016**

Statistics Canada. (2017). Main mode of commuting for the employed labour force aged 15 years and over in private households with a usual place of work or no fixed workplace address - 25% sample data. 2016 Census.

**Figure 4: Map of Small Cities Included in Capstone Project**

Map prepared by author.

**Figure 5: Example of Infrastructure Audit in Spruce Grove, Alberta**

Original research by author.

**Figure 6: Total Kilometres of Cycling Infrastructure**

Original research by author.

**Figure 7: Density of Cycling Infrastructure**

Original research by author.

**Figure 8: Proportion of Cycling Infrastructure by Type**

Original research by author.

**Figure 9: Bike Commuting Rates vs. Density of Bike Infrastructure in Small Cities**

Statistics Canada. (2017). Main mode of commuting for the employed labour force aged 15 years and over in private households with a usual place of work or no fixed workplace address - 25% sample data. 2016 Census.

**Figure 10: Average January Temperature vs. Density of Bike Infrastructure in Small Cities**

Government of Canada. (n.d.). Canadian Climate Normals: 1981 – 2010 Climate Normals and Averages. Retrieved from: https://climate.weather.gc.ca/climate_normals/index_e.html

**Figure 11: Population Change (2011 - 2016) vs. Density of Bike Infrastructure**

Statistics Canada. (2017). Population and Dwelling Count Highlight Tables. 2016 Census.

**Figure 12: Survey Results of Barriers to Creating Cycling Infrastructure**

Original research by author.

**Figure 13: Survey Results of Potential Opportunities for Creating Cycling Infrastructure**

Original research by author.

**Figure 14: Canada's Greenhouse Gas Emissions by Sector, 2018**

Government of Canada. (2020). National greenhouse gas emissions, Canada, 1990 – 2018. Retrieved from: https://www.canada.ca/en/environment-climate-change/services/environmental-indicators/greenhouse-gas-emissions.html

**Table 1: Banister's Barriers to Implementing Sustainable Transportation**

Concept from Banister (2005); table text copied directly from Wang (2018), p. 3.

**Table 2: City Classifications**

Based on Hartt and Hollander (2018) 's classification.

**Table 3: Provincial Populations by City Size, 2016**

Statistics Canada. (2017). Population and Dwelling Count Highlight Tables. 2016 Census.

**Table 4: Survey and Interview Participants by Province**

Original research by author.

**Table 5: Total Kilometres (Density) of Cycling Infrastructure by Province**

Original research by author.

**Table 6: Interview Results of Barriers to Creating Cycling Infrastructure**

Original research by author.

**Table 7: Interview Results of Opportunities for Creating Cycling Infrastructure**

Original research by author.

**Table 8: Recommendations Based on Research Findings**

Original research by author.

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## Appendix 1: List of Incorporated Small Cities and 2016 Populations in Western Canada

| City | Prov. | Pop. | City | Prov. | Pop. |
|---|---|---|---|---|---|
| Brandon | MB | 48,859 | Swift Current | SK | 16,604 |
| Vernon | BC | 40,116 | Yorkton | SK | 16,343 |
| Prince Albert | SK | 35,926 | Steinbach | MB | 15,829 |
| Langford | BC | 35,342 | Cold Lake | AB | 14,961 |
| Spruce Grove | AB | 34,066 | Brooks | AB | 14,451 |
| Moose Jaw | SK | 33,890 | North Battleford | SK | 14,315 |
| Penticton | BC | 33,761 | Thompson | MB | 13,678 |
| Port Moody | BC | 33,551 | Portage la Prairie | MB | 13,304 |
| Campbell River | BC | 32,588 | Powell River | BC | 13,157 |
| Leduc | AB | 29,993 | Lacombe | AB | 13,057 |
| Langley | BC | 25,888 | Wetaskiwin | AB | 12,655 |
| Courtenay | BC | 25,599 | Winkler | MB | 12,591 |
| Fort Saskatchewan | AB | 24,149 | Parksville | BC | 12,514 |
| Fort St. John | BC | 20,155 | Prince Rupert | BC | 12,220 |
| Cranbrook | BC | 20,047 | Dawson Creek | BC | 12,178 |
| White Rock | BC | 19,952 | Terrace | BC | 11,643 |
| Chestermere | AB | 19,887 | Estevan | SK | 11,483 |
| Lloydminster | AB/SK | 31,410 | Warman | SK | 11,020 |
| Camrose | AB | 18,742 | Weyburn | SK | 10,870 |
| Pitt Meadows | BC | 18,573 | Williams Lake | BC | 10,753 |
| Salmon Arm | BC | 17,706 | Nelson | BC | 10,572 |
| Port Alberni | BC | 17,678 | Selkirk | MB | 10,278 |
| Colwood | BC | 16,859 | | | |

Data source: Population and dwelling counts, for Canada, provinces and territories, and census subdivisions (municipalities), 2016 census – 100% data.

## Appendix 2: Cycling Infrastructure Categories and OSM Tags

| Category | Description* | OSM Tags |
|---|---|---|
| Cycle track | "A paved facility alongside a city street, separated by a curb or barrier, intended for bicycle-only use." | "Cycleway=opposite_track"<br>"Cycleway=opposite_track, track"<br>"Cycleway=track"<br>"Cycleway=separate" |
| Bike lane | "A painted bike lane on the street, with or without parked cars, which may be shared with buses." | "Cycleway=Both=lane"<br>"Cycleway=both=lane"<br>"Cycleway=buffered_lane"<br>"Cycleway=lane"<br>"Cycleway=left=lane"<br>"Cycleway=opposite_lane"<br>"Cycleway=share_busway"<br>"Cycleway=shared_lane"<br>"Cycleway=sharrow;lane" |
| Bikeway | "A designated bicycle route with signs, and possibly cyclist activated traffic signals/traffic calming." | "Cycleway=shared"<br>"Cycleway=designated"<br>"Cycleway=mixed_traffic" |
| Bike path | "An off-street paved path, either bicycle only or shared with pedestrians." | "Cycleway=segregated"<br>"Cycleway=cyclestreet"<br>"Cycleway=path"<br>"Highway=path" AND "Bicycle=Yes" OR "Bicycle=Designated"<br>"Highway=footway" AND "Bicycle=Yes" OR "Bicycle=Designated" |
| Ambiguous infrastructure | | "Cycleway=not_reviewed"<br>"Cycleway=both"<br>"Cycleway=unmarked_lane"<br>"Cycleway=left"<br>"Cycleway=opposite"<br>"Cycleway=right"<br>"Cycleway=track;lane"<br>"Cycleway=1"<br>"Cycleway=yes"<br>"Highway_cycleway" AND "cycleway=[any of others listed]" |
| Not included | | "Cycleway=crosing"<br>"Cycleway=crossing"<br>"Cycleway=no"<br>"Cycleway=none"<br>"Cycleway=shoulder"<br>"Cycleway=sidewalk"<br>"Cycleway=shortcut" |

Note: This table is modified from Tables 2 and 3 of Ferster et al. (2020, p. 67). The descriptions of infrastructure types are a direct quote from Ferster et al. (2020, p. 67)

## Appendix 3: Survey Questions

### *Section 1: Consent Statement*

Study Title: Planning for Cycling in Small Cities in Canada
Principal Investigator: Hillary Beattie, Master of City Planning Student, Department of City Planning, University of Manitoba, beattieh@myumanitoba.ca
Primary Advisor: Dr. Richard Milgrom, Head and Associate Professor, Department of City Planning, University of Manitoba, Richard.Milgrom@umanitoba.ca

This consent form–a copy of which may be saved for your records and reference—is only part of the process of informed consent. You can save a copy at the link at the bottom of this page. It should give you the basic idea of what the research is about and what your participation will involve. If you would like more detail about something mentioned here, or information not included here, please feel free to ask. Please take the time to read this carefully and to understand any accompanying information.

The aim of this survey is to understand factors that limit and support the development of cycling infrastructure in small cities in Western Canada. The survey is part of a capstone research project being conducted by Master of City Planning student Hillary Beattie as part of her capstone research project at the University of Manitoba.

Participation will require approximately ten minutes of your time. Your identity will be anonymous. You do not need to provide contact information to participate. The risk to participants in this research should be no more than in everyday life. This survey uses Qualtrics software, which stores its Canadian data on servers located in Canada. If you prefer not to submit your data through Qualtrics, please contact one of the researchers so you can participate using an alternative method (such as paper-based questionnaire). The alternate method may decrease anonymity, but confidentiality will be maintained.

The direct benefits of participating in the survey may include the opportunity for participants to share their perspective on a planning issue or challenge. Indirect benefits are that the final Capstone Projects will contribute to planning knowledge and may result in new strategies or policy directions to address planning issues and challenges. Students will also benefit by learning about conducting ethical research. Results from this research will be disseminated in the researcher's capstone project. The results may also be published in academic or professional journals.

Clicking 'NEXT' indicates that you have understood to your satisfaction the information regarding participation in the research project and agree to participate as a subject. In no way does this waive your legal rights nor release the researchers or involved institutions from their legal and professional responsibilities. You are free to withdraw from the study at any time before you click 'Submit'. You can withdraw by closing the browser. Because the researcher cannot link survey submissions back to the respondent, you will be unable to withdraw from the survey once you click submit. You are also free to 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. If you have any concerns or complaints about this project you may contact the Human Ethics Coordinator at 204-474-7122, or email: humanethics@umanitoba.ca. A copy of this consent form may be saved for your records.

By clicking 'NEXT', you are consenting to participate in this survey.
- Button: Next

*Section 2: Background Information*

1. Which province is the city you work for in?
- British Columbia
- Alberta
- Saskatchewan
- Manitoba

2. How long have you worked for the city?
- Less than 1 year
- 1 – 2 years
- 2 – 5 years
- 5 – 10 years
- 10 – 15 years
- 15+ years

3. What is your role? Select:
- Planner
- Engineer
- Politician
- Other:
- Prefer not to say

4. Does your job, or an element of your job, include a focus on active transportation?
- Yes
- No

*Section 3: Interest in Cycling Infrastructure*

5. Is your city interested in creating more cycling infrastructure?
- Yes
- No

6. Please explain why your city is or is not interested in creating more cycling infrastructure.

*Section 4: Barriers to Creating Cycling Infrastructure*

7. Are any of the following factors barriers to creating cycling infrastructure in your city?

| | Never | Rarely | Sometimes | Often | Always |
|---|---|---|---|---|---|
| Financial/funding barriers | | | | | |
| Lack of political leadership/ support | | | | | |
| Lack of long-term planning | | | | | |
| Public opposition | | | | | |
| People's reluctance to bike | | | | | |
| Business opposition | | | | | |
| Local media opposition | | | | | |
| Lack of transport planning tools | | | | | |
| Lack of technical expertise | | | | | |
| Lack of space | | | | | |
| Unsuitable topography | | | | | |
| Urban form | | | | | |
| Legal barriers | | | | | |

8. Please provide additional details about the most significant barrier(s) to creating cycling infrastructure in your city.

9. Are there other barriers to creating cycling infrastructure in your city? If so, please describe.

10. Do you have additional comments about barriers to creating cycling infrastructure in your city?

### *Section 5: Opportunities for Creating Cycling Infrastructure*

11. Could the following factors support the creation of cycling infrastructure in your city?

| | Definitely Not | Probably Not | Possibly | Probably | Definitely |
|---|---|---|---|---|---|
| Financial support from the provincial government | | | | | |
| Financial support from the federal government | | | | | |
| A National Cycling Strategy | | | | | |
| Support from local politicians | | | | | |
| Support from the public | | | | | |
| Support from local businesses | | | | | |
| Support from local media | | | | | |
| Local advocacy by activists/ community organizations | | | | | |
| Support with transport planning tool | | | | | |
| Support with technical expertise | | | | | |
| Increased urban density | | | | | |

12. Are there other factors that could support the creation of cycling infrastructure in your city? If so, please describe.

13. Do you have additional comments about factors that could support the creation cycling infrastructure in your city?

14. Is there anything else you want to share about barriers and opportunities for creating bike infrastructure in your city?

### *Section 6: Submission*

By clicking 'Submit', you confirm you want to submit your responses to the survey. You will be unable to withdraw from the survey once you click submit as the researcher will not be able to link survey submissions back to the respondent. If you do not want to submit your responses, you can withdraw by closing the browser.

## Appendix 4: Interview Questions

Potential interview prompts are included below main questions.

**Background Information:**

- What is your position at the city of [name]?
- How long have you been working at the city??
- Is your job specifically focused on cycling or active transportation?

**Research Questions**

- Can you describe the bike infrastructure in your city?
- When was the bike infrastructure built?
- Who were the main actors involved in the process?
- Who funded the bike infrastructure?
- What were the main factors that influenced [city] to build the infrastructure?
    - Funding/financial support
    - Public support/advocacy
    - Political support/leadership
- Did the city encounter any barriers during the planning or construction phase? If so, what were they?
    - Financial/funding barriers
    - Public opposition
    - Lack of political leadership
    - Lack of transport planning tools or technical expertise
    - Lack of space
    - Unsuitable topography or weather conditions
- Has the bike infrastructure impacted the city? If so, what impact has it had?
    - Social
    - Economic/tourism
    - Health
- Do you think the bike infrastructure has been successful?
- How do you think cities should measure the success of bike infrastructure?
- What feedback have you received on the bike infrastructure from residents?
- Have you had any issues with maintaining cycling infrastructure?
- Does the city plan on building more bike infrastructure? Why or why not?
- Do you have any recommendations for other small cities that are looking to build cycling infrastructure?
- Is there anything else you want to share about bike infrastructure in your city?

## Appendix 5: Interview Information Sheet

# INTERVIEW INFO SHEET

CITY 7050 CITY PLANNING CAPSTONE PROJECT
Department of City Planning, Faculty of Architecture
(Course Instructor: Dr. Orly Linovski)

**Name of Student:** Hillary Beattie

**Title of Project:** City Planning Capstone Project: Planning for Cycling in Small Cities in Western Canada

**Summary of Project:** The proposed capstone will explore existing cycling infrastructure—as well as factors that limit or support the development of this infrastructure—in small cities in Western Canada. The project will use a mixed methods approach that includes an infrastructure audit, an online survey, and qualitative interviews.

**Specific Activities to be Completed by Project Participant and Time Frame:** Participants are asked to complete a 30-minute qualitative interview with the student researcher about cycling infrastructure between November 2020 and January 2021.

**CONTACT INFORMATION:**


| | |
|---|---|
| Student Name: | Hillary Beattie |
| Student's University Contact Information: | beattieh@myumanitoba.ca |
| Course Instructor: | Dr. Orly Linovski, Assistant Professor<br>Department of City Planning<br>University of Manitoba<br>Telephone: [redacted]<br>Email: orly.linovski@umanitoba.ca |

## Appendix 6: Interview Consent Form

UNIVERSITY OF MANITOBA

# CONSENT FORM

CITY 7050 CITY PLANNING CAPSTONE PROJECT
Department of City Planning, Faculty of Architecture
(Course Instructor: Dr. Orly Linovski)

This Consent Form, a copy of which will be left with you for your records and reference, is only part of the process of informed consent. It should give you the basic idea of what the research is about and what your participation will involve. If you would like more detail about something mentioned here, or information not included here, you should feel free to ask. Please take the time to read this carefully and to understand any accompanying information.

**Name of Student:** Hillary Beattie

**Title of Project:** City Planning Capstone Project: Planning for Cycling in Small Cities in Western Canada

**Specific Activities to be Completed by Project Participant and Time Frame:** Participants are asked to complete a 30-minute qualitative interview with the student researcher about cycling infrastructure in October or November 2020.

**Description of Course Assignment**

City Planning graduate students must complete a Capstone Project as part of their Master's degree. The goal of the project is for students to conduct in-depth research on an issue of importance for planning practice. The students' information-gathering projects will be presented in class and will form the basis for a written report at the end of term. In this case, the objective of the student is to explore existing cycling infrastructure—as well as factors that limit or support the development of this infrastructure—in small cities in Western Canada.

The projects are undertaken under the supervision of the Course Instructor, Dr. Orly Linovski (see contact information below), in accordance with the protocols of the Human Ethics Secretariat of the University of Manitoba for research involving human subjects. The research has been reviewed by the Joint-Faculty Research Ethics Board (JFREB) at the University of Manitoba and approved. A copy of this Consent Form has also been reviewed and approved. Consent Forms listing Project Title and the specific activities to be completed by participants will be submitted to the Instructor and kept on file for information purposes only for two years (or until the next City Planning program accreditation), in accordance with University ethics policies. It is anticipated that interviews with participants will last no longer than approximately thirty minutes. Interviews will take place by phone or video-conferencing software.

**Benefits & Risks**
The benefit of participating in an interview is that you can contribute to research on factors that limit and support the development of cycling infrastructure in small cities in Western Canada. This study may help planners and policymakers improve conditions for cyclists in small cities across the region. The risk of participating in an interview is no greater than risks encountered in everyday life. One potential risk is a breach of confidentiality: that information may be shared in ways that enable you to be identified. To minimize the risk of this occurring, the following procedures will be undertaken.

**Confidentiality**
The data collected through this research is confidential. This means that participants' names or any other personal or identifiable information will not be included in presentations or reports arising from the study.

**Audio-Taping**
With your permission, activities, interviews or other kinds of sessions may be audio-recorded using a digital audio-recorder and transcribed at a later date, so that analyzing the material will be completed with greater ease and efficiency. Such audio-recordings will be kept in a secure place, and destroyed after they have been transcribed. Your name or any other personal information will not be included in the presentation or report materials arising from the study. Where information occurs within a session transcript that will be included in the final project report or presentation, names and other identifying personal information will be omitted.

**Use of Data, Secure Storage and Destruction of Research Data**
Information collected from participants, including quotes, will be used as part of the Capstone Project. All names and other identifying details will be obscured/anonymized. The results from this project, including anonymized details and quotations, may be used for conference presentations and/or publication in journals and other academic and professional resources. Students' completed Capstone Projects will be publicly available through the University of Manitoba's website.

All information will be treated as confidential and stored in a private and secure place, or on a password protected computer and subsequently destroyed at the end of the course (June 2021). The student is responsible for destroying the data.

Copies of consent forms will be securely kept on file by the Course Instructor for information purposes only for two years and then destroyed, in accordance with University ethics policies. 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 subject. 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 at anytime, request that any data provided be omitted from the study (prior to March 1, 2021), refrain from answering any questions you prefer to omit, or request to stop the audio-recording at any time, without prejudice or consequence. If you would like to withdraw, you must notify the course instructor (below) by email prior to March 2021. If you choose to withdraw, all files related to your participation will be destroyed. 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 University of Manitoba 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 at humanethics@umanitoba.ca; or 204-474-7122. A copy of this Consent Form has been given to you to keep for your records and reference.

**CONTACT INFORMATION:**


Student Name: Hillary Beattie

Student's University Contact Information: beattieh@myumanitoba.ca

Course Instructor: Dr. Orly Linovski, Assistant Professor
Department of City Planning, University of Manitoba
Telephone: [redacted]
E-mail: orly.linovski@umanitoba.ca


**Thank you for participating in this project. Your cooperation and insights are very valuable, and are greatly appreciated!**

I, ________________________________________, consent to the dissemination of material
Name of Participant

provided to the student for use in their Capstone Project and in course materials. I understand that the information I provide will be incorporated in a presentation and report. I understand also that all research data will be treated as confidential, stored in a private and secure place, and subsequently destroyed at the end of the course by the student.

I agree to be audio-recorded.
Yes ☐ No ☐

I would like to receive a summary of the results from this project. If yes, please provide your email address or mailing address below.
Yes ☐ No ☐

_________________________________ _________________________

Signature of Participant Date

Participant's contact information (in order to receive a summary of the results from this project):

_________________________________________________________________

*Page 3 of 3*

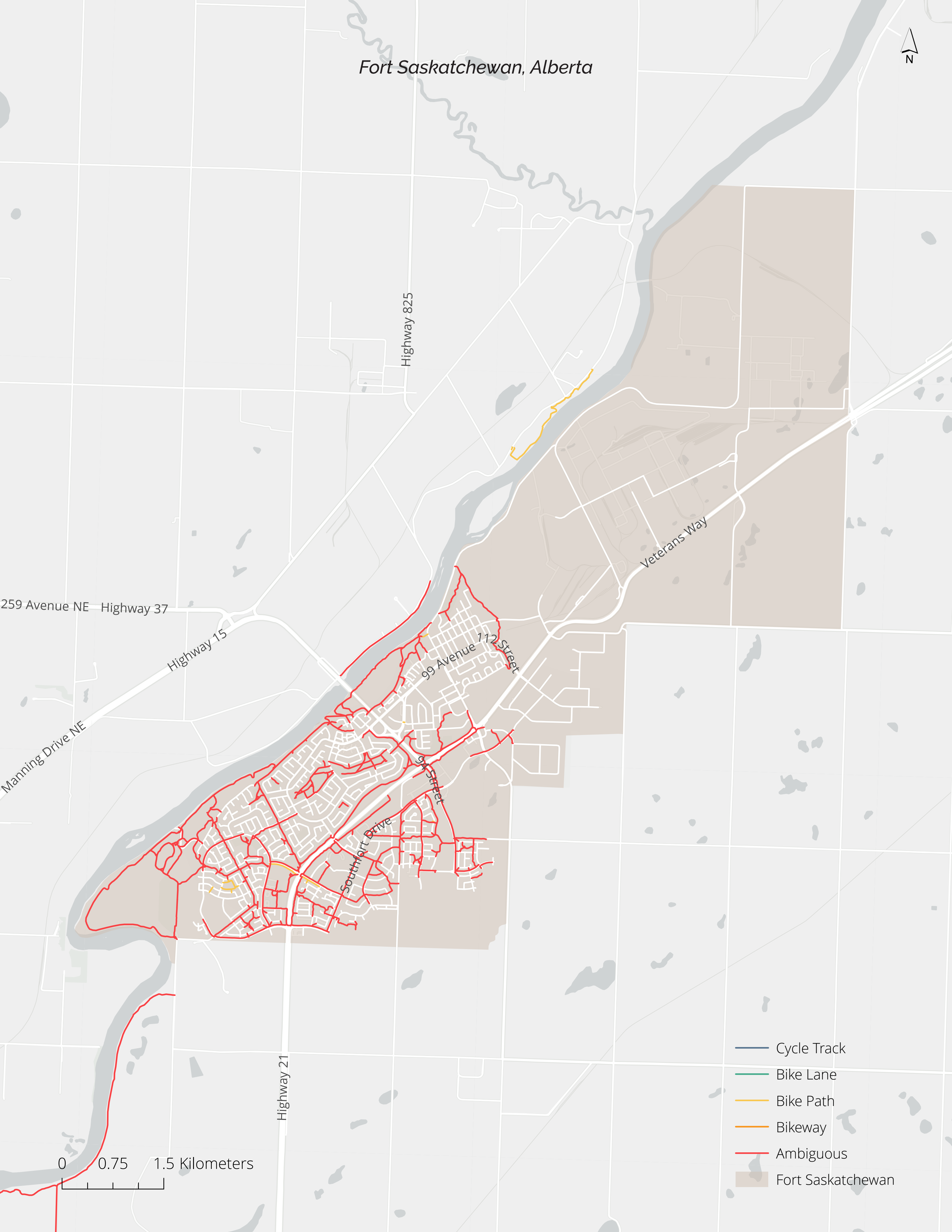
## Appendix 7: Kilometres (Density*) of Bike Infrastructure by Type

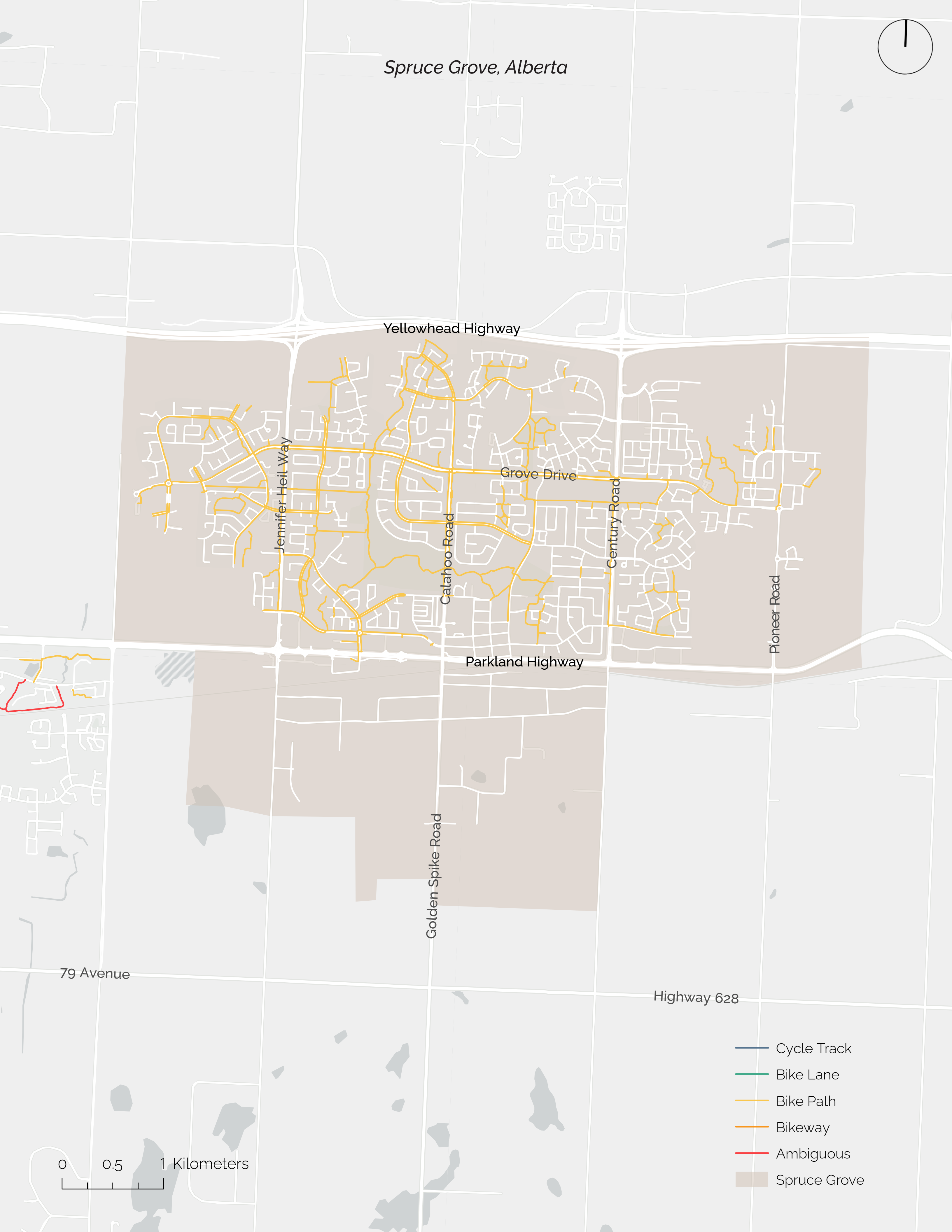
| City | Cycle Track | Bike Lane | Bike Path | Bikeway | Ambiguous | Total |
|---|---|---|---|---|---|---|
| Alberta | | | | | | |
| Fort Saskatchewan | 0 (0) | 0 (0) | 1.7 (0) | 0 (0) | 77 (1.6) | 78.7 (1.6) |
| Spruce Grove | 0 (0) | 0 (0) | 69.5 (2.2) | 0 (0) | 0 (0) | 69.5 (2.2) |
| Leduc | 0 (0) | 0 (0) | 2.6 (0.1) | 0 (0) | 16.8 (0.4) | 19.4 (0.4) |
| Cold Lake | 0 (0) | 0 (0) | 17.6 (0.3) | 0 (0) | 0 (0) | 17.6 (0.3) |
| Chestermere | 0 (0) | 0 (0) | 0.7 (0) | 0 (0) | 8.3 (0.2) | 9 (0.2) |
| Lacombe | 0 (0) | 0 (0) | 6.6 (0.3) | 0 (0) | 0.4 (0) | 7 (0.3) |
| Brooks | 0 (0) | 0 (0) | 0.8 (0) | 0 (0) | 0 (0) | 0.8 (0) |
| Camrose | 0 (0) | 0 (0) | 0.7 (0) | 0 (0) | 0 (0) | 0.7 (0) |
| Wetaskiwin | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |
| Lloydminster | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |
| British Columbia | | | | | | |
| Port Moody | 0.8 (0) | 12 (0.5) | 39.4 (1.5) | 3.3 (0.1) | 10.8 (0.4) | 66.3 (2.5) |
| Campbell River | 0 (0) | 0 (0) | 47.2 (0.3) | 0 (0) | 8.6 (0.1) | 55.8 (0.4) |
| Pitt Meadows | 0 (0) | 25.1 (0.3) | 14.3 (0.1) | 1.7 (0) | 8.5 (0.1) | 49.6 (0.5) |
| Langford | 0 (0) | 28.5 (0.7) | 16.9 (0.4) | 0 (0) | 0.9 (0) | 46.3 (1.1) |
| Vernon | 0 (0) | 1.6 (0) | 27.3 (0.2) | 0 (0) | 6.4 (0.1) | 35.2 (0.3) |
| Courtenay | 0 (0) | 0 (0) | 17.3 (0.5) | 0.4 (0) | 11.1 (0.3) | 28.9 (0.9) |
| Salmon Arm | 0 (0) | 0 (0) | 11.8 (0.1) | 0 (0) | 16.5 (0.1) | 28.3 (0.2) |
| Colwood | 0 (0) | 6.8 (0.4) | 10.7 (0.6) | 0 (0) | 0.3 (0) | 17.8 (1) |
| Penticton | 0 (0) | 6 (0.1) | 0.8 (0) | 0 (0) | 10.7 (0.2) | 17.5 (0.4) |
| Langley | 0 (0) | 5.6 (0.5) | 7.5 (0.7) | 0 (0) | 3.9 (0.4) | 17 (1.7) |
| Port Alberni | 0 (0) | 0 (0) | 9.9 (0.5) | 0 (0) | 1.2 (0.1) | 11.1 (0.5) |
| Cranbrook | 0 (0) | 0 (0) | 5 (0.2) | 0 (0) | 5.5 (0.2) | 10.5 (0.3) |
| Williams Lake | 0 (0) | 0 (0) | 6.2 (0.2) | 0 (0) | 0 (0) | 6.2 (0.2) |
| Nelson | 0 (0) | 0 (0) | 5.5 (0.3) | 0 (0) | 0 (0) | 5.5 (0.3) |
| Terrace | 0 (0) | 0 (0) | 2.4 (0) | 0 (0) | 2.7 (0) | 5.1 (0.1) |
| White Rock | 0 (0) | 4.2 (0.8) | 0 (0) | 0 (0) | 0.3 (0.1) | 4.5 (0.9) |
| Powell River | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 4.3 (0.1) | 4.3 (0.1) |
| Fort St. John | 0 (0) | 0 (0) | 3.2 (0.1) | 0 (0) | 0 (0) | 3.2 (0.1) |
| Parksville | 0 (0) | 0 (0) | 2.7 (0.2) | 0 (0) | 0.2 (0) | 3 (0.2) |
| Prince Rupert | 0 (0) | 0 (0) | 0.4 (0) | 0 (0) | 0 (0) | 0.4 (0) |
| Dawson Creek | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |

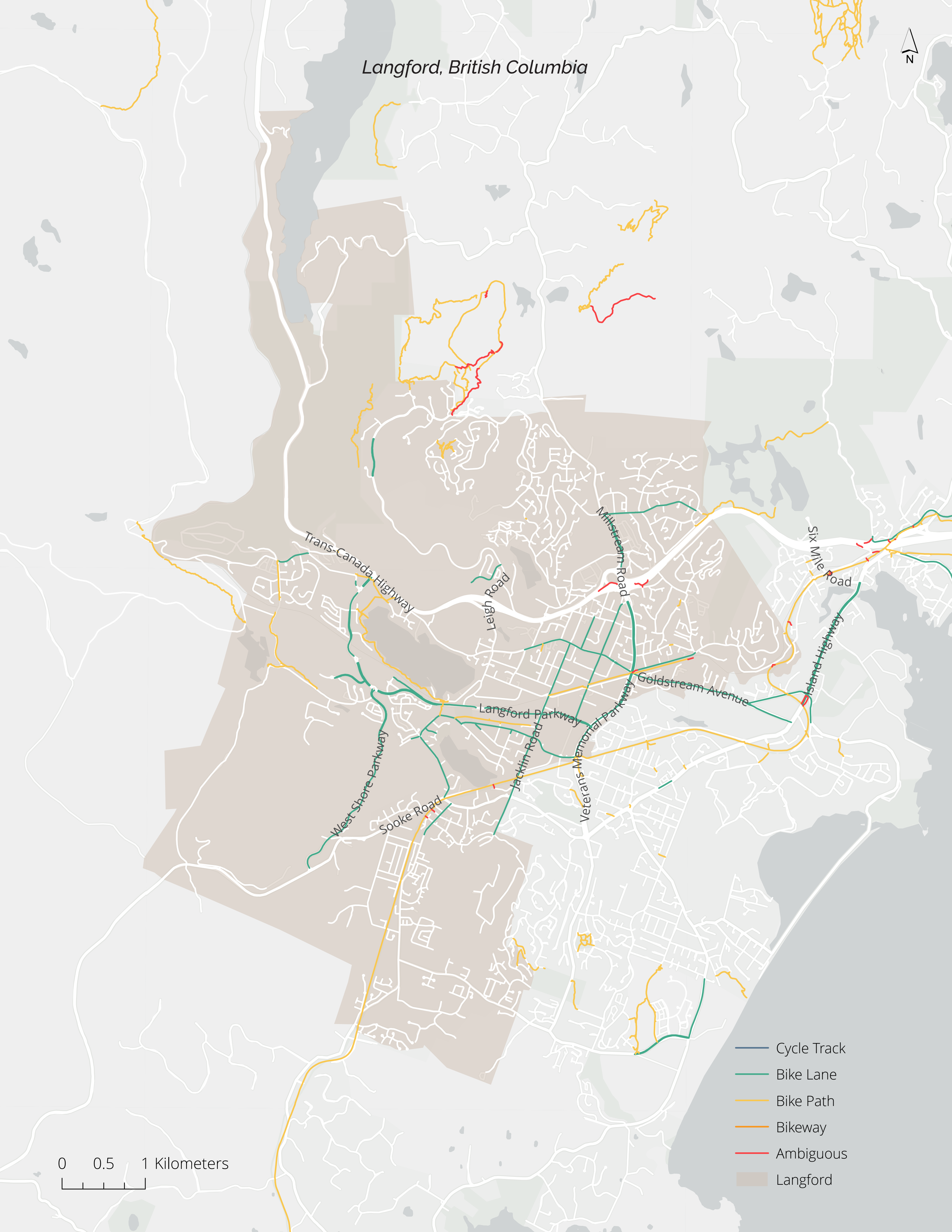
| City | Cycle Track | Bike Lane | Bike Path | Bikeway | Ambiguous | Total |
|---|---|---|---|---|---|---|
| Manitoba | | | | | | |
| Brandon | 0 (0) | 0 (0) | 8.2 (0.1) | 0 (0) | 33.3 (0.4) | 41.5 (0.5) |
| Steinbach | 0 (0) | 0 (0) | 10.5 (0.4) | 0 (0) | 0 (0) | 10.5 (0.4) |
| Winkler | 0 (0) | 0 (0) | 2.4 (0.1) | 0 (0) | 2.4 (0.1) | 4.8 (0.3) |
| Selkirk | 0 (0) | 0 (0) | 2.6 (0.1) | 0 (0) | 0 (0) | 2.6 (0.1) |
| Portage la Prairie | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |
| Thompson | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |
| Saskatchewan | | | | | | |
| Moose Jaw | 0 (0) | 0 (0) | 30.4 (0.6) | 0 (0) | 0 (0) | 30.4 (0.6) |
| Prince Albert | 0 (0) | 0 (0) | 22 (0.3) | 0 (0) | 0 (0) | 22 (0.3) |
| Swift Current | 0 (0) | 0 (0) | 15.2 (0.5) | 0 (0) | 0 (0) | 15.2 (0.5) |
| North Battleford | 0 (0) | 0 (0) | 14 (0.4) | 0 (0) | 0 (0) | 14 (0.4) |
| Estevan | 0 (0) | 0 (0) | 8.1 (0.4) | 0 (0) | 0 (0) | 8.1 (0.4) |
| Yorkton | 0 (0) | 1.1 (0) | 4.3 (0.1) | 0 (0) | 0 (0) | 5.4 (0.1) |
| Weyburn | 0 (0) | 0 (0) | 3.2 (0.2) | 0 (0) | 0.9 (0) | 4.1 (0.2) |
| Warman | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |

**Density is kilometres of bike infrastructure per square kilometre.*

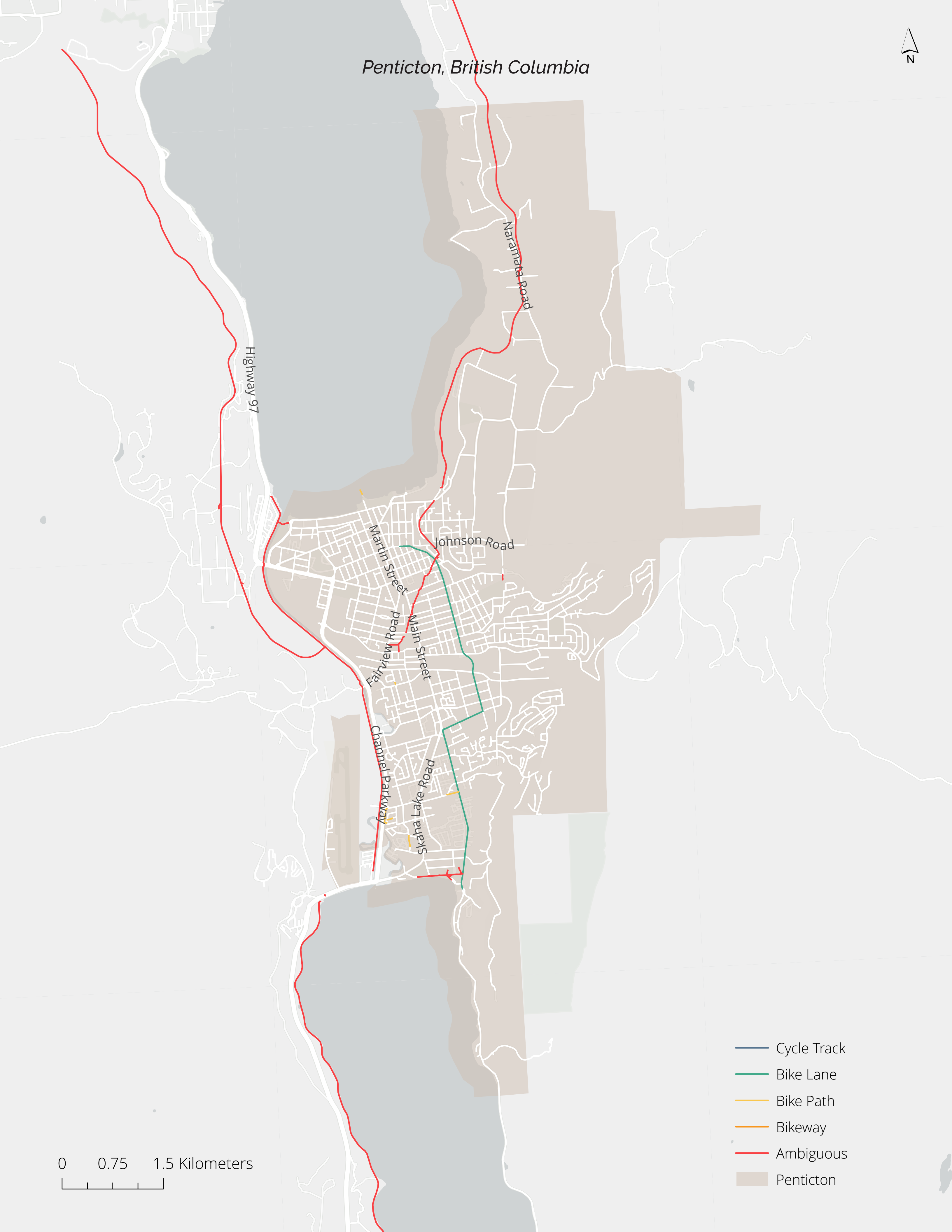
## Appendix 8: Examples of Maps Generated through the Infrastructure Audit


Fort Saskatchewan, Alberta
N
Highway 825
259 Avenue NE
Highway 37
Highway 15
Manning Drive NE
Veterans Way
99 Avenue
112 Street
94 Street
Southfort Drive
Highway 21
0
0.75
1.5 Kilometers
Cycle Track
Bike Lane
Bike Path
Bikeway
Ambiguous
Fort Saskatchewan

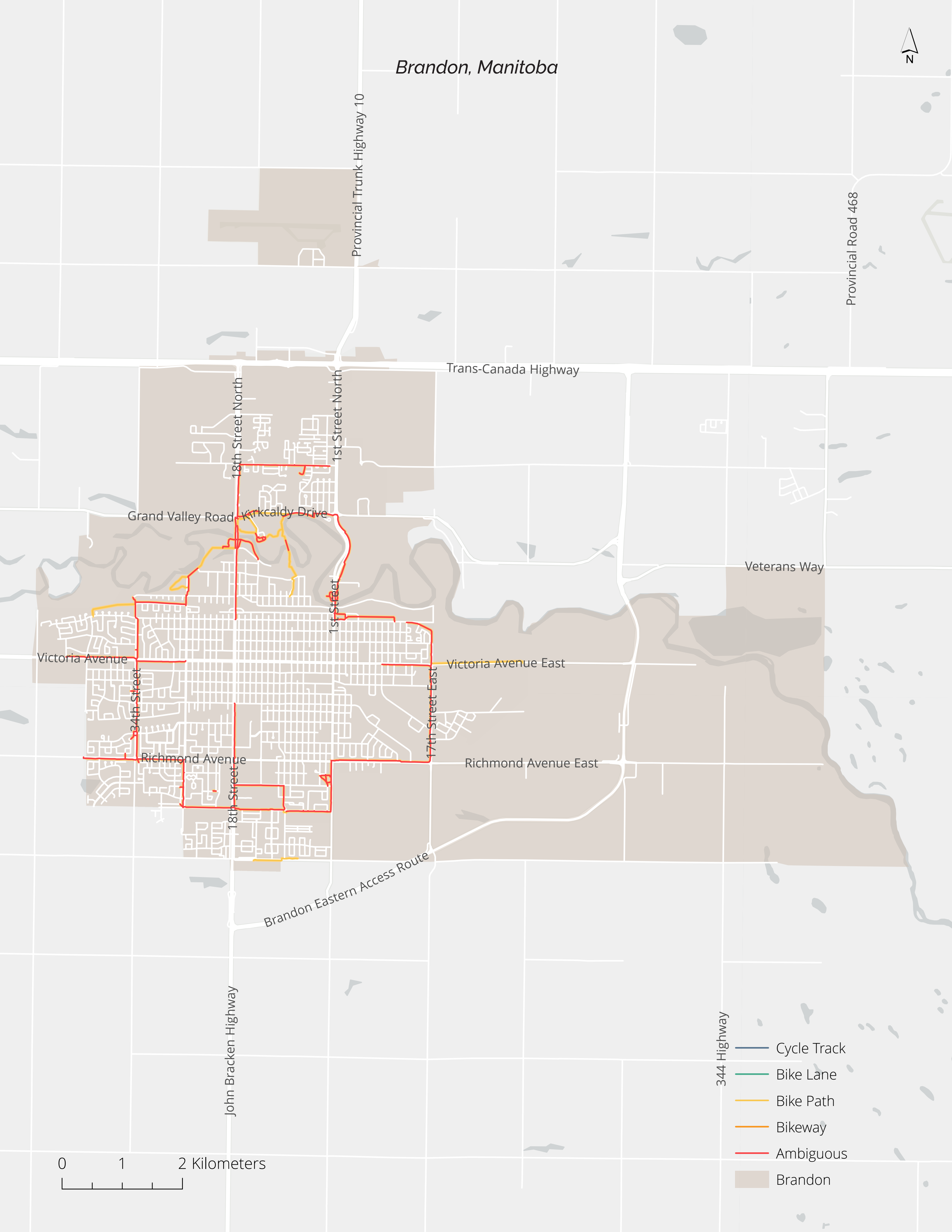

Spruce Grove, Alberta
Yellowhead Highway
Grove Drive
Jennifer Heil Way
Calahoo Road
Century Road
Pioneer Road
Parkland Highway
Golden Spike Road
79 Avenue
Highway 628
Cycle Track
Bike Lane
Bike Path
Bikeway
Ambiguous
Spruce Grove
0
0.5
1 Kilometers



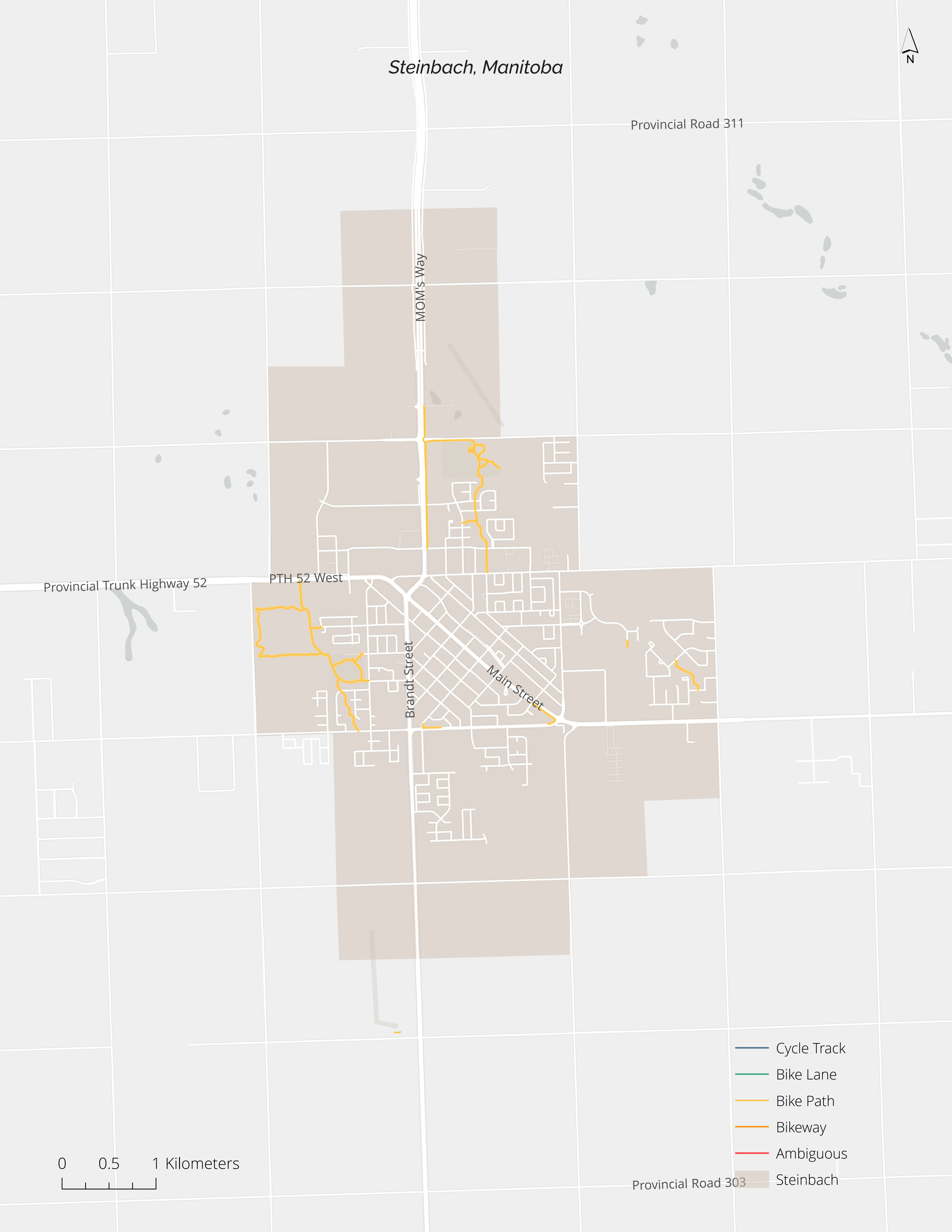
Langford, British Columbia
N
Trans-Canada Highway
Leigh Road
Millstream Road
Six Mile Road
Island Highway
Goldstream Avenue
Langford Parkway
Veterans Memorial Parkway
Jacklin Road
West Shore Parkway
Sooke Road
0
0.5
1 Kilometers
Cycle Track
Bike Lane
Bike Path
Bikeway
Ambiguous
Langford



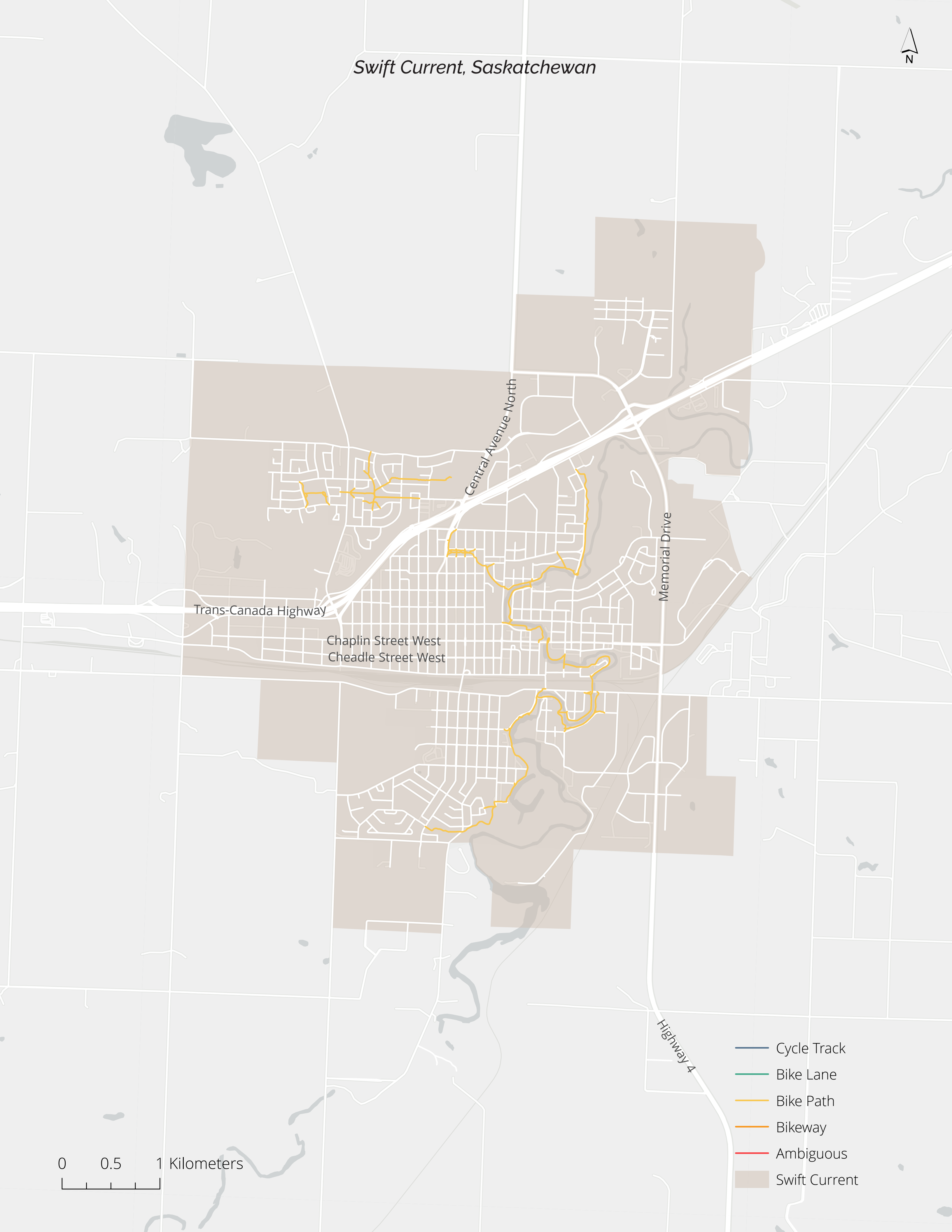
Penticton, British Columbia
N
Highway 97
Naramata Road
Johnson Road
Martin Street
Main Street
Fairview Road
Channel Parkway
Skaha Lake Road
Cycle Track
Bike Lane
Bike Path
Bikeway
Ambiguous
Penticton
0
0.75
1.5 Kilometers



Brandon, Manitoba
N
Provincial Trunk Highway 10
Provincial Road 468
Trans-Canada Highway
18th Street North
1st Street North
Grand Valley Road
Kirkcaldy Drive
Veterans Way
1st Street
Victoria Avenue
Victoria Avenue East
34th Street
17th Street East
Richmond Avenue
Richmond Avenue East
18th Street
Brandon Eastern Access Route
John Bracken Highway
344 Highway
Cycle Track
Bike Lane
Bike Path
Bikeway
Ambiguous
Brandon
0
1
2 Kilometers



Steinbach, Manitoba
Provincial Road 311
MOM's Way
Provincial Trunk Highway 52
PTH 52 West
Brandt Street
Main Street
Provincial Road 303
N
0 0.5 1 Kilometers
Cycle Track
Bike Lane
Bike Path
Bikeway
Ambiguous
Steinbach



Swift Current, Saskatchewan
N
Central Avenue North
Memorial Drive
Trans-Canada Highway
Chaplin Street West
Cheadle Street West
Highway 4
Cycle Track
Bike Lane
Bike Path
Bikeway
Ambiguous
Swift Current
0
0.5
1 Kilometers

## Appendix 9: Examples of Google Street View of Random Points


Langford, BC


Langford, BC


Colwood, BC


Langford, BC

Colwood, BC


Port Moody, BC


Port Moody, BC


Cranbrook, BC


Brandon, MB


Brandon, MB


Swift Current, SK


Moose Jaw, SK


Moose Jaw, SK


Leduc, AB


Spruce Grove, AB


Spruce Grove, AB


Spruce Grove, AB


Fort Saskatchewan, AB


Fort Saskatchewan, AB


Fort Saskatchewan, AB