Evolution of dedicated cycling infrastructure in three Canadian cities: 2009 to 2022

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ABSTRACT

There has been a recent surge in cycling infrastructure implementation across Canada. Accurate cycling infrastructure implementation data are required to evaluate impact on safety and mobility. The objectives of this paper were to quantify the accuracy of municipal cycling infrastructure classification and cycling infrastructure installation dates, and to examine temporal trends in the implementation of on-road dedicated cycling infrastructure. We undertook this work in three Canadian cities; Vancouver, Calgary, and Toronto, from 2009-2022. Infrastructure classification accuracy was assessed using the Canadian Bikeway Comfort and Safety (Can-BICS) system, and implementation dates were verified using Google™ historical street view imagery and grey literature. Temporal trends in cycling infrastructure implementation were documented using the verified data. There were discrepancies in infrastructure classification resulting in underreporting in Toronto (8.8%) and Vancouver (8.3%) and overreporting in Calgary (1.7%). The most common misclassification was the municipality reporting the presence of a cycle track, when the infrastructure was a buffered painted lane. Agreement between municipal data and verified installation dates was only 42% in Calgary, 75% in Toronto, and 83% in Vancouver. Infrastructure doubled from 19.2 to 34.2 km/1,000 km roads in Vancouver, 18.7 to 40.2/1,000 km in Toronto, and 1.2 to 11/1000 km in Calgary over the study period. There was accelerated infrastructure implementation in Calgary and Toronto related to the onset of the COVID-19 pandemic. This study highlights and addresses data gaps necessary to examine accurate trends in implementation and to enable future longitudinal studies related to the impact of infrastructure on safety and mobility.

Introduction

Canadian municipalities are intensifying efforts to enhance active transportation infrastructure, for mobility, environmental, and health impacts (Gordon, 2018; Pucher & Buehler, 2017). Active transportation has the potential to alleviate transportation demands and align with broader environmental targets (Brand et al., 2021; Pucher et al., 2010). Consequently, many large Canadian cities have made considerable progress in building new bikeways and upgrading infrastructure to create active spaces for individuals of all ages and abilities (Pucher & Buehler, 2006).

Road safety remains a pressing public health concern given the immense human and economic burden (Cowle et al., 2022). For example, in Toronto, Ontario, 858 cyclists suffered injuries (812 major and 46 fatal injuries, respectively) between 2006 and 2023 (Toronto Police Service, 2023), with associated direct and indirect economic costs of more than $60 million per year (Toronto Public Health, 2012). In Canada, cycling injuries were estimated to cost $377 million CAD in 2018 (Parachute, 2022). The perceived risk of injury associated with cycling may also deter its adoption as an alternative transportation mode (Pucher & Buehler, 2017). Aligned with urban planning initiatives, the Vision Zero road safety strategy, launched in Sweden in 1997 and now adopted in cities globally, stands as a crucial guiding principle for road safety (Aboelata et al., 2017; Belin et al., 2012; Parachute, 2023). Vision Zero strives to eliminate all severe and fatal road transportation injuries while promoting healthy and equitable mobility for all. Unlike traditional approaches that place the burden of safety on road users, Vision Zero acknowledges human error and focuses on road system designs to prevent traffic deaths (Aboelata et al., 2017; Belin et al., 2012; Parachute, 2023). One of the key components in Vision Zero is the installation of cycling infrastructure to improve safety and encourage cycling as a sustainable transportation mode (City of Toronto, 2017).

All ages and abilities (AAA) cycling facilities are the benchmark in many Canadian cities and Vision Zero strategies, reflecting infrastructure that is well connected, safe, and comfortable for everyone (Laberee et al., 2023). AAA facilities include protected bike lanes, off-street paths and local street bikeways. Misclassification of cycling infrastructure and inaccurate installation dates can impede interjurisdictional comparisons and longitudinal studies (City of Vancouver, 2017; Ministry of Transportation and Infrastructure, 2019; Transportation Association of Canada, 2017). It is important to accurately determine what cycling infrastructure exists but also when and where it was installed, in order to effectively evaluate its effectiveness in terms of mobility and safety.

There have been previous studies verifying and evaluating cycling infrastructure data, including in Canada (Ferster et al., 2020, 2023; Nelson et al., 2021; Winters et al., 2022). Associations between infrastructure and cycling safety (Boss et al., 2018; Ravensbergen et al., 2020; Teschke et al., 2012), accessibility (Winters et al., 2018; Zhao et al., 2024), and demand (Assunçao-Denis & Tomalty, 2019; Berghoefer & Vollrath, 2023; Branion-Calles et al., 2019; Orvin et al., 2021; Tabascio et al., 2023), have been published. However, there are few empirical studies validating both municipality-reported data classification and implementation of bicycling infrastructure. To our knowledge, no study has subsequently used validated data to examine changes over time in cycling infrastructure across Canadian cities.

Accurate and longitudinal data are essential to the ongoing evaluation of both mobility and safety effects of municipal cycling infrastructure investments. The aim of cycling infrastructure is to encourage mode shift towards more sustainable forms of transportation, while ensuring safety. Therefore, our objectives were: to quantify the accuracy of and correct municipal cycling infrastructure classification; to quantify the accuracy of and correct municipal cycling infrastructure installation dates; and to examine temporal trends in the implementation of on-road dedicated cycling infrastructure using the verified data. We undertook this work in three Canadian cities; Vancouver, Calgary, and Toronto, for a 13 year period from 2009 to 2022.

Methods

Setting context

Population and roadway infrastructure for each of the study municipalities are described in Table 1. Vancouver had the highest population density with 5,758 individuals/km^2 and 84% of its roadways were local streets. Calgary had a population density of 1,583 individuals/km^2, 65% of its roadway network consisted of local streets, and, Toronto, the most populous municipality in the study, had a density of 4,434 individuals/ km^2, with 66% of its roadways being local streets.

Data Sources

Cycling network data were acquired from open data repositories maintained by the municipalities of Vancouver, Calgary, and Toronto in January 2023 (City of Calgary, 2023; City of Toronto, 2023; City of Vancouver, 2023) (Table 2).

Inclusion and Exclusion Criteria

Dedicated cycling infrastructure located on public roadways, specific cycling infrastructure classifications pertaining to painted lanes, buffered lanes, and cycle tracks were included in this study. To ensure methodological consistency and account for potential disparities in the inclusion of decommissioned infrastructure within municipal data, only infrastructure that was permanently installed and active at the end of 2023 was included.

Segments of cycling infrastructure categorized as off-street paths, shared roadways, or mixed-use paths were excluded from the analysis (Appendix A, Table A.2). Moreover, any segments classified as a temporary installation were removed. Duplicate entries with the same polyline coordinates were identified and removed. Only in Vancouver were local street bikeways (i.e. local streets that are shared by bicycles and cars, but with traffic calming elements) included in the descriptive analysis, as they comprise a large portion of cycling infrastructure in that city. In Toronto and Calgary, roadways with some features of local street bikeways vary greatly in form and have inconsistent nomenclature. Moreover, many do not satisfy the Can-BICS definition of local street bikeways, which require road treatments to reduce vehicle speed; therefore, these bikeways are not included in the Toronto and Calgary data.

Data collection and verification

Two researchers collected information on cycling infrastructure installation dates and classification independently. These data were then discussed at regular team meetings to ensure consistency and reach consensus. Municipal staff and researchers were consulted from each city when data were ambiguous. A verification process followed the identification of eligible segments from municipal data. Google™ imagery services and grey literature sources (municipal government briefs, construction notices, news articles, and posts from community organizations) were used to determine and verify infrastructure installation or modification during the study period (2009-2022). Original segments were examined and verified retrospectively using Google™ Street View and Google ™ Earth imagery to classify and date infrastructure installations and upgrades as painted lanes, buffered lanes, or cycle tracks. If imagery was not found, grey literature sources were further used to determine the classifications and dates of infrastructure installations or upgrades.

Objective 1: Accuracy and correction of infrastructure classification

Standardized classification criteria were applied across cities based on the Canadian Bikeway Comfort and Safety (Can-BICS) classification system (Winters et al., 2020), only for the categories cycle tracks and painted lanes. For this analysis, the Can-BICS painted lane classification was further subdivided into two distinct types: painted lanes and buffered lanes. This distinction facilitated a more detailed analysis of infrastructure trends and was influenced by previous research from Australia that observed an increased passing distance between motorists and cyclists when infrastructure consisted of buffered lanes compared with painted lanes (Nolan et al., 2021).

Three categories of infrastructure were considered including painted lanes, buffered lanes, and cycle tracks. Painted lanes were characterized by solid or dashed lines separating cyclists from vehicle travel lanes, accompanied by signs or pavement markings to distinguish them as cycling routes. Buffered lanes shared similar features but were distinguished by a wider painted area marked with diagonal or chevron patterns. Cycle tracks were defined based on the presence of a permanent vertical barriers such as bollards or raised curbs. In situations where different infrastructure was present on opposite sides of a roadway, the segment's classification was determined by the most protective element. Detailed information on the classification criteria is provided in Appendix A, Table A.3. Street imagery was used to review and confirm each segment's classification, with removal from the database of infrastructure consistent with the specified exclusion criteria.

The total length of each infrastructure type (length of a route measured along its central axis, in centreline-kilometers) at the end of each year was computed in R version 4.3.3 (R Core Team, 2023) using the sf package version 1.0-16 (Pebesma et al., 2024). This analysis provided comprehensive information on the lengths of bikeway types during the study period. The discrepancies in infrastructure classification between the municipal data and the verified data in the last year of the study (2022) was summarized by calculating the percent difference in kilometres by class. The misclassified infrastructure types were summarized overall by length (centreline-km), and percentage of infrastructure. The degree of misclassification was also assessed by year in terms of length (centreline-km) and percentage of infrastructure, in order to identify changes in misclassified infrastructure over time.

Objective 2: Accuracy and correction of installation dates

We documented the year of i) installation or ii) upgrade. An installation was defined as the introduction of dedicated cycling infrastructure on a roadway where no prior dedicated infrastructure existed within the study period. An upgrade was defined as the modification of existing dedicated cycling infrastructure, resulting in reclassification of the segment.

Implementation date accuracy was examined according to the year of installation. The discrepancies in implementation dates between the municipal data and the verified data were summarized by the percent of segments with dedicated cycling infrastructure from the verified data that matched the municipal data year and then within a ±1-year span.

Objective 3: Temporal trends in the implementation and upgrade of dedicated cycling infrastructure

The trends in installations and upgrades per 1000 centreline-km of roadway by year were tracked and reported for each city. The period between 2019 to 2022 was specifically examined to identify changes during the COVID-19 pandemic as cities responded to cycling demand across Canada with initiatives to enhance cycling infrastructure (Batomen et al., 2024; Canadian Institute for Health Information, 2022, 2023; Fischer & Winters, 2021). A secondary analysis involved examining where the bikeway installation/updates were located according to road type (i.e. arterial, collector, or local).

The percent change in installation and upgrades by infrastructure type was calculated by year, city, and road type. We also mapped the segments identifying the location of new installations and infrastructure since the COVID-19 pandemic in 2020. The code used to perform these analyses is available at https://rrwen.github.io/recovr-infracycle.

Results

Eligibility

As seen in Figure 1, from a total of 341.7 km (3,666 segments) in Vancouver's cycling network, 251.6 km (3,152 segments) were extracted by filtering for local street bikeways (Vancouver only), painted lanes, buffered lanes, and cycle tracks within the municipal data, and 247 km (3,117 segments) remained after verifying infrastructure classification. In Calgary from a total of 571.8 km (4,169 segments), 87.1 km (784 segments) met the eligibility criteria and 85 km (750 segments) remained after verification (details in Figures A.1-A-3).

Objective 1 Infrastructure classification verification

There were marked discrepancies in the cycling infrastructure classification between municipal data and verified data. We found more kilometres of roadway with cycling infrastructure than the municipality reported in both Toronto and Vancouver. In contrast, in Calgary not all of the municipally reported infrastructure was actually present based on our verification (Table 3). Table 4 portrays the classification error matrix of installed municipal reported cycling roadway infrastructure for each of the cities. The most common infrastructure misclassification in all cities was the municipality reporting the presence of a cycle track, when the infrastructure was actually a buffered painted lane by Can-BICS criteria. For example, half of the new cycle track distance reported by the city of Toronto was in fact painted and buffered lanes. Appendix B, Figure B.1. portrays the percent of misclassification by year and length of cycling infrastructure by city.

Objective 2: Installation dates verification

Installation years were verified for all segments, and showed that 66% of included segments in Vancouver, 8% in Calgary, and 41% in Toronto had dedicated cycling infrastructure established by 2009 or earlier. There was substantial variability in the accuracy of municipal data across the study cities. In Vancouver, among segments installed or updated during the study period, 83.3% accurately matched the municipal data installation years, and 97.2% were within a ±1-year range (Appendix B, Figure B.2). For Calgary, 42.1% of segments matched with the municipal data installation years, and 62.7% were accurate within ±1 year

(Appendix B, Figure B.3). Finally, in Toronto, among 188 eligible segments, 74.5% accurately matched with the municipal data installation years, and 78.2% were accurate within a ±1-year span (Appendix B, Figure B.4).

Objective 3: Trends in infrastructure installation

This verification of the data across years, and by infrastructure type, allowed us to track the growth in dedicated cycling infrastructure. There has been a substantial growth in dedicated on-road cycling infrastructure since 2009 across all three cities. Figure 2 illustrates the expansion of the cycling infrastructure across the cities. In 2009, Vancouver, Calgary, and Toronto had approximately 19 km, 1 km, and 18 km of cycling infrastructure per 1000 km of roadway, respectively. Local street bikeways made up more than half of Vancouver's cycling infrastructure at about 75 km per 1000 -km of total roadway. In 2009, cycle tracks represented 4% of Vancouver's dedicated on-road cycling infrastructure; no cycle tracks existed in Calgary or Toronto. This changed substantially by the end of the study period, with cycle tracks constituting 39.7% of Vancouver's, 30.9% of Calgary's, and 32.5% of Toronto's dedicated on-road cycling infrastructure (Figure 2). This increase in cycle tracks was partially driven by upgrades of existing painted lane infrastructure (Figure 3). This was particularly salient in Vancouver, which saw decreases in painted lanes since 2016, as these were upgraded to infrastructure that physically separated cyclists from traffic.

As illustrated in Figure 3, the growth in Toronto and Vancouver cycling infrastructure peaked in 2020 at the onset of the COVID-19 pandemic, with over 6 km and 1 km of new infrastructure per 1000 km of roadway installed respectively. Calgary's peak occurred in 2021, with over 1 km of new infrastructure built per 1000 km of roadway. For Calgary and Toronto, this growth of on-road cycling infrastructure was primarily attributable to the increase in cycle tracks (Figures 2 and 3).

Much of the increase in cycling infrastructure resulted from the introduction of cycle tracks on arterial roads. As seen in Appendix B, Figures B.5 to B.7, between 2019 to 2022, the length of or cycle tracks increased by about 45%, 83% and 300% in Vancouver, Calgary, and Toronto respectively. These trends in collector and local roads were evident throughout the entire study period.

In addition, a map of infrastructure – new and upgraded - following the onset of the pandemic is shown in Figure 4 to identify areas of change and to examine the connectivity of cycling infrastructure. In Vancouver, 4% of the existing infrastructure was upgraded and 8% was newly installed in the downtown area, in the central area, and in the east and western peripheries. Calgary had less than 1% upgraded, while 23% was newly installed in and closer to the downtown area. Finally, in Toronto 9% of infrastructure was upgraded and 24% was newly installed mostly in the downtown area with some changes in the central and eastern areas. As a result, seen in Figure 4 and Appendix B, Figures B.8 to B.10, the cycling infrastructure across cities does not have segments entirely connected to form a continuous route across the network.

Discussion

Accurate cycling infrastructure data are essential to evaluate its impact on safety and mobility, which is critical for effective planning. The objectives of this study were to compile and verify classification and implementation dates of on-road cycling infrastructure and then to describe the trends across Vancouver, Calgary, and Toronto from 2009 to 2022. Our study applied standardized criteria for classifying cycling infrastructure and leveraged grey literature and street view imagery services for verification. The updated dataset was then used to examine infrastructure implementation trends.

The degree of misclassification seemed to vary over time and by city. Verifying the municipal reports against historical street view imaging and other data, we found that cycling infrastructure was commonly misclassified in municipal sources compared with the standardized Can-BICS classification. Underestimates of the reported length of existing infrastructure by municipalities was as much as 19 km (8.8%) in Toronto for example. Importantly, what cities reported as separated cycle tracks – the safest infrastructure type (22), were in fact often buffered painted lines by Can-BICs criteria. Other studies confirm that inconsistency in cycling infrastructure classification is common (Ferster et al., 2020, 2023; Winters et al., 2022). For example, Ferster et al. analyzed municipal open data sources from 15 Canadian cities, and found an estimated accuracy of 76 ± 3% for presence or absence of infrastructure, and 69 ± 4% (by length) for infrastructure type (Ferster et al., 2020).

Installation dates of infrastructure are important in any evaluation of either mobility or safety effects. To our knowledge, no prior study has evaluated the accuracy of municipally-recorded installation dates for cycling infrastructure. We found varied agreement between municipal reports and verified dates, with 42% alignment in Calgary, 75% in Toronto, and 83% in Vancouver. Much municipal data does not accurately reflect when cycling infrastructure is implemented or upgraded. This new finding questions the use of unverified municipal installation date data in ongoing surveillance or in evaluation studies; for example, a pre-post study would be flawed if the implementation dates were erroneous.

When considering these data inaccuracies across cities, it must be acknowledged that these data are not collected primarily for research and evaluation purposes, but more for planning. Local practices and limited resources may therefore influence data collection as there may not have been an agenda to develop high quality evaluation studies. For example, installation date inconsistencies may exist within and across for a variety of reasons; the date may variably reflect the actual completion, the planned completion date, completion of one phase of a multi-phased project, or alternatively, the date of opening to riders. The municipalities have indicated that there is an increasing need for high quality evaluation studies to justify further cycling infrastructure implementation to policy makers and communities. The development of a guide for optimal data collection and documentation by municipal planners has been suggested in personal communication with several of the municipalities, to be developed in conjunction with the research team to facilitate robust evaluation.

By verifying and correcting the classification and installation dates of infrastructure type across the years, we were able to more accurately chart the growth in on-road dedicated cycling infrastructure. The consistent approach by which we have done this allows for comparisons across cities, something that is typically hampered by the differences in local practices around data collection and sharing. Our findings showed a growth in the cycling network across all three cities over the study period, with a shift towards protected cycling infrastructure. Roughly one-third of all infrastructure consisted of protected cycle tracks by the end of the study period. Toronto and Vancouver’s networks roughly doubled, while Calgary’s expanded eleven-fold, likely due to Calgary’s comparatively limited infrastructure before the pandemic.

Toronto's expansion peaked in 2020 when the city council approved the ActiveTO plan, to provide additional space for pedestrian and cycling to support physical activity during the pandemic (City of Toronto, 2020a). ActiveTO included the largest one-year expansion of on-road bike lanes in 2020 (City of Toronto, 2020b). The pandemic-driven increase in cycling infrastructure observed here aligns with trends in cities worldwide (Buehler & Pucher, 2022; Kraus & Koch, 2021; Rérat et al., 2022; Sunio & Mateo-Babiano, 2022). Buehler and Pucher's review of cycling research after COVID-19 (March 2020-January 2023) (Buehler & Pucher, 2024), found that expansions or bikeway network improvements accelerated during the pandemic, with a focus on protected bike lanes, traffic calming, slow streets, and car-free streets.

Calgary's infrastructure implementation also peaked after the start of pandemic in 2021, with a notable increase in separated infrastructure (Bike Calgary, 2022). In 2021, two major policy changes occurred in Calgary that may have contributed to the city's focus on safe active transportation, influenced by heightened awareness during the pandemic. The Calgary Transportation Plan was adapted to include network maps and network principles for safe and comfortable walking and wheeling (Bike Calgary, 2022). In addition, the City of Calgary adopted 40 km/h residential speed limits, accompanied by roadway design updates to achieve safer active transportation (Bike Calgary, 2022). In Vancouver, though cycle track installations rose slightly post-pandemic, the most significant increase occurred between 2012 and 2013 following the Transportation 2040 plan, which prioritized walking and cycling as top transportation goals (City of Vancouver, 2012, 2013).

There are ongoing challenges in several jurisdictions with cycling infrastructure expansion. In Vancouver, the plan to replace temporary cycling lanes in Stanley Park with permanent infrastructure has been delayed, and will face major budgetary challenges (McElroy, 2023). Legislation has recently been passed in Ontario, Bill 212, which proposes to remove new permanent cycling infrastructure along three major cycling corridors in Toronto (Legislative Assembly of Ontario, 2024). The Bill also states that provincial approval would be required for new bike lanes on any Ontario municipal road where a traffic lane was removed; thus overriding municipal governance (Legislative Assembly of Ontario, 2024). In Alberta, the Minister of Transportation called on municipalities to cancel plans to further build out bike lane networks and has blamed bike lanes for traffic congestion (Farrell, n.d.).These challenges are not aligned with public evidence and must be overcome in order to maintain and develop a functional cycling network and create a culture around sustainable transportation. Continued prioritization of motor vehicles over sustainable transportation options like walking, cycling, and public transportation may have deleterious human and environmental consequences (Sallis JF, 2016).

With the anticipation that increased ridership will continue, municipalities must take proactive steps to design active transportation networks that safely accommodate higher volumes. Cities have unique approaches to cycling infrastructure based on their specific characteristics and needs. For instance, we found that historically Vancouver has predominantly located cycling infrastructure on local roads, primarily on local street bikeways. In contrast, Calgary's infrastructure is more evenly distributed across arterial, collector, and local roads. Toronto, however, focuses most of its cycling infrastructure on arterial roadways. The variation in infrastructure observed across cities underscores the importance for city planners to have clear goals related to connectivity and to consider the importance of connecting people to the places they work, play, visit etc. This will guide the consideration of the mix of arterial versus local roadways with infrastructure when making the trade-off between equity and efficiency in cycling infrastructure (Bonsma-Fisher et al., 2024). The Toronto City Council recently adopted the Cycling Network 2025-27 Plan which emphasizes that arterial streets, those that connect numerous destinations and transit options, bring greater value to the cycling network compared with routes that primarily serve local neighbourhoods (Bonsma-Fisher et al., 2024; City of Toronto, 2024; Furth et al., 2016). Removing arterial roadways from the network can result in a fragmented and poorly connected system (Furth et al., 2016; Lin et al., 2024). This is essential to note, considering the Ontario's premier's recent statement that bicycle lanes should only be installed on secondary roads (Bond, 2024).

Our study, conducted within the Canadian context, offers valuable insights into cycling infrastructure installation and implications for evaluation. Key strengths of our research included the use of standardized criteria for classifying infrastructure and an enhanced approach to confirm changes over time, rather than relying solely on municipal reports. There were also limitations. The exclusion of temporary infrastructure could have obscured some spatial patterns especially around 2020; however, this choice means our study reflects the permanent infrastructure installed by each city to promote long-term cycling post-pandemic. Finally, given that each city updates its data at different times, some relevant details may not have been captured at the time of data acquisition in January and May of 2023. Consequently, there is a possibility that we did not fully capture all infrastructure in 2022, which may explain the small changes in infrastructure observed from 2021 to 2022.

Overall, the expansion of on-road cycling infrastructure over the past decade reflects the growing popularity of cycling as a mode of transportation (44), and investments in infrastructure have played a key role in supporting this upward trend (45). The insights from this study also set the stage for more in-depth research into cycling infrastructure trends, particularly as they relate to road safety and equity. Identifying how municipalities have responded to existing gaps in cycling networks, particularly in relation to factors such as population density and neighbourhood marginalization, is important to promote healthy and equitable mobility for all. This detailed exploration helps shed light on these factors in urban planning and may contribute to a better understanding of how cycling infrastructure is prioritized and implemented across municipalities.

Conclusions

This comprehensive evaluation of cycling infrastructure data accuracy and trends in implementation in Vancouver, Calgary, and Toronto from 2009 to 2022 has highlighted the need for more accurate data related to the classification and installation dates to facilitate high quality evaluations of the impact on mobility and safety. The study shows an expansion in dedicated on-road cycling networks, particularly in the form of cycle tracks, reflecting a conscious shift toward safer and more comfortable cycling facilities. The COVID-19 pandemic has notably spurred an upward trend in infrastructure development in response to changing mobility patterns and evolving public health needs. These trends may indicate a larger paradigm shift, reflecting efforts to embrace active transportation and to rethink the design of urban centers (Nikitas et al., 2021). Discrepancies and misclassifications within municipal cycling infrastructure data sources and the variable reliability of infrastructure implementation dates underscore that these data are not collected by municipalities for the purpose of evaluation or research, a common research challenge when repurposing data captured by administrative processes (Lezzoni, 1997). This highlights the need for standardized classifications for infrastructure and accurate implementation data to facilitate effective urban planning and policymaking. By investing in more inclusive and connected cycling networks that align with the Vision Zero road safety plan, municipalities can foster safer and more sustainable mobility in cities.

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Table 1: Population characteristics and municipal roadway classification coverage in Vancouver, Calgary, and Toronto (Canada), 2021/2022. Information downloaded from municipally maintained open datasets and 2021 Canadian census. Detailed methodology of calculations available in **Appendix A, Table A.1.**

	Measure	Vancouver[a]	Calgary[b]	Toronto[c]
Population characteristics 2021[d]	Population	662,248	1,306,784	2,794,356
	Area (km^2)	115	825.3	630.2
	Density (Pop. per km^2)	**5,758**	**1,583**	**4,434**
Municipal Roadways[e] 2022, centreline-kilometers*	Arterial	221.6	1,402.1	1153.7
	Collector	132.7	1331.9	767.1
	Local	1869.4	5197.3	3658.6
	Roadways, Total	**2,223.7**	**7,931.3**	**5,579.4**

a: Vancouver data from public streets (https://opendata.vancouver.ca/explore/dataset/public-streets/information, last updated July 24, 2023),
b: Calgary data from centreline (https://data.calgary.ca/Transportation-Transit/Street-Centreline/4dx8-rtm5, last updated July 1, 2023),
c: Toronto data from centreline (https://open.toronto.ca/dataset/toronto-centreline-tcl/, last updated May 3, 2023)
d: Census population data: https://www12.statcan.gc.ca/census-recensement/2021/dp-pd/prof/
e: Total centreline-km of public roadways in Vancouver, Calgary, and Toronto. Excluding highways, skeletal roads, and non-municipally operated roads. Local roadways denote residential streets and lanes

Table 2: Cycling infrastructure data sources for Vancouver, Calgary, and Toronto (Canada). Each data source represents cycling infrastructure installations, where each record represents a road segment with cycling infrastructure installed on it.

City	Source	Extraction Date	Years
Vancouver	https://opendata.vancouver.ca/explore/dataset/bikeways	January 2023	1984-2022
Calgary	https://data.calgary.ca/Transportation-Transit/Calgary-Bikeways/jjqk-9b73	January 2023	1999-2023
Toronto	https://open.toronto.ca/dataset/cycling-network/	January 2023	2001-2022

Table 3: Comparison of municipal-reported roadway cycling infrastructure lengths and verified bikeway infrastructure in Vancouver, Calgary and Toronto (Canada), 2022. Verified bikeway lengths available in Appendix B, **Table B.1**.

City	Classification	Municipal	Verified	Difference
Vancouver	Painted and Buffered Lanes	43.8 km	46.7 km	+2.9 km (6.4%)
	Cycle Tracks	27.4 km	30.7 km	+3.3 km (11.4%)
	On-Road Infrastructure, Total	**71.2 km**	**77.4 km**	**+6.2 km (8.3%)**
Calgary	Painted and Buffered Lanes	57.0 km	60.3 km	+3.3 km (5.6%)
	Cycle Tracks	31.7 km	26.9 km	-4.8 km (16.4%)
	On-Road Infrastructure, Total	**88.7 km**	**87.2 km**	**-1.5 km (1.7%)**
Toronto	Painted and Buffered Lanes	131.5 km	151.4 km	+19.9 km (14.1%)
	Cycle Tracks	73.9 km	73.0 km	-0.9 km (1.2%)
	On-Road Infrastructure, Total	**205.4 km**	**224.4 km**	**+19.0 km (8.8%)**

Table 4: Classification error matrix of installed municipal reported cycling roadway infrastructure in Vancouver, Calgary and Toronto (Canada). Misclassification by year available in **Figure B.1.**

City	Municipal Classification	Cycle Track	Local Street Bikeway	Painted and Buffered lane	Shared Road	None
Vancouver	Painted and Buffered Lane (42.8 km)	.5 km (1.2%)	0	40.3 (94.2%)*	0	2 km (4.6%)
	Cycle Track (28.4 km)	10.5 (37.0%)*	0.7 km (2.5%)	9.7 km (34.2%)	0	7.5 km (26.4%)
Calgary	Painted and Buffered Lane (56.2 km)	0.5 km (0.9%)	0	55.6 (98.9%)*	0	.1 km (0.2%)
	Cycle Track (28.8 km)	22.8 km (79.2%)*	0	5.3 km (18.5%)	0	0.7 km (2.4%)
Toronto	Painted and Buffered Lane (130.5 km)	0.1 km (<0.1%)	0	130.2* (99.8%)	0	0.2 km (0.2%)
	Cycle Track (68.1 km)	33.0 (48.5%)*	0	34.2 km (50.2%)	0.9 km (1.3%)	0

*Correct classification

Figure 1: Flow diagram of inclusion criteria for bikeway segments in Vancouver, Calgary, and Toronto. This flowchart provides a high-level overview of the segment inclusions and exclusions for each municipality. Screened segments have been manually checked using Google Street View and grey literature to verify infrastructure type and installation/upgrade years. For detailed flow diagrams specific to each municipality, please refer to **Figures A.1 to A.3**. For details on excluded segments, refer to **Table A.2**.

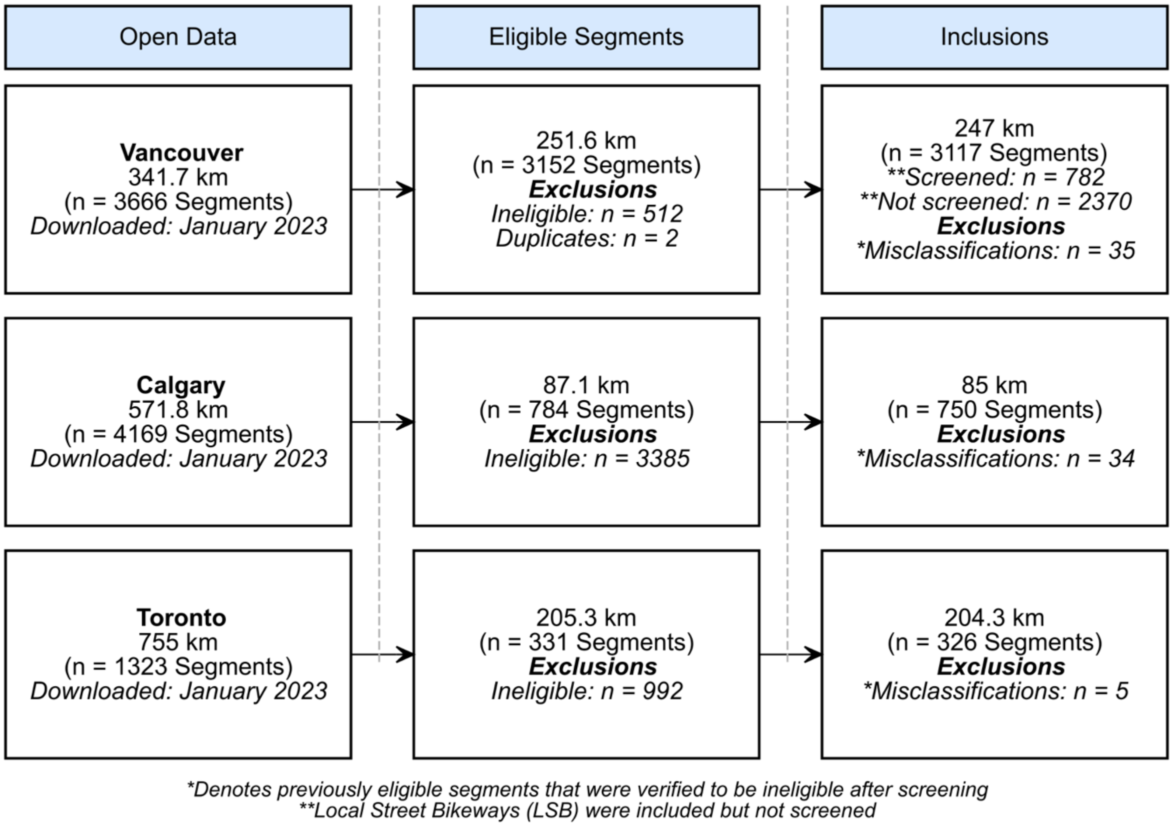


Figure 2: Changes in dedicated cycling infrastructure between 2009 and 2022 for Vancouver, Calgary, and Toronto based by infrastructure category. Assessed using roadway centreline-km, with infrastructure classifications determined by the most protective infrastructure classification present along each road segment. Local street bikeways were included for reference only in Vancouver as it was a majority of the cycling infrastructure. Different length ranges were used on the y-axis as the amount of cycling infrastructure varied greatly between each city.

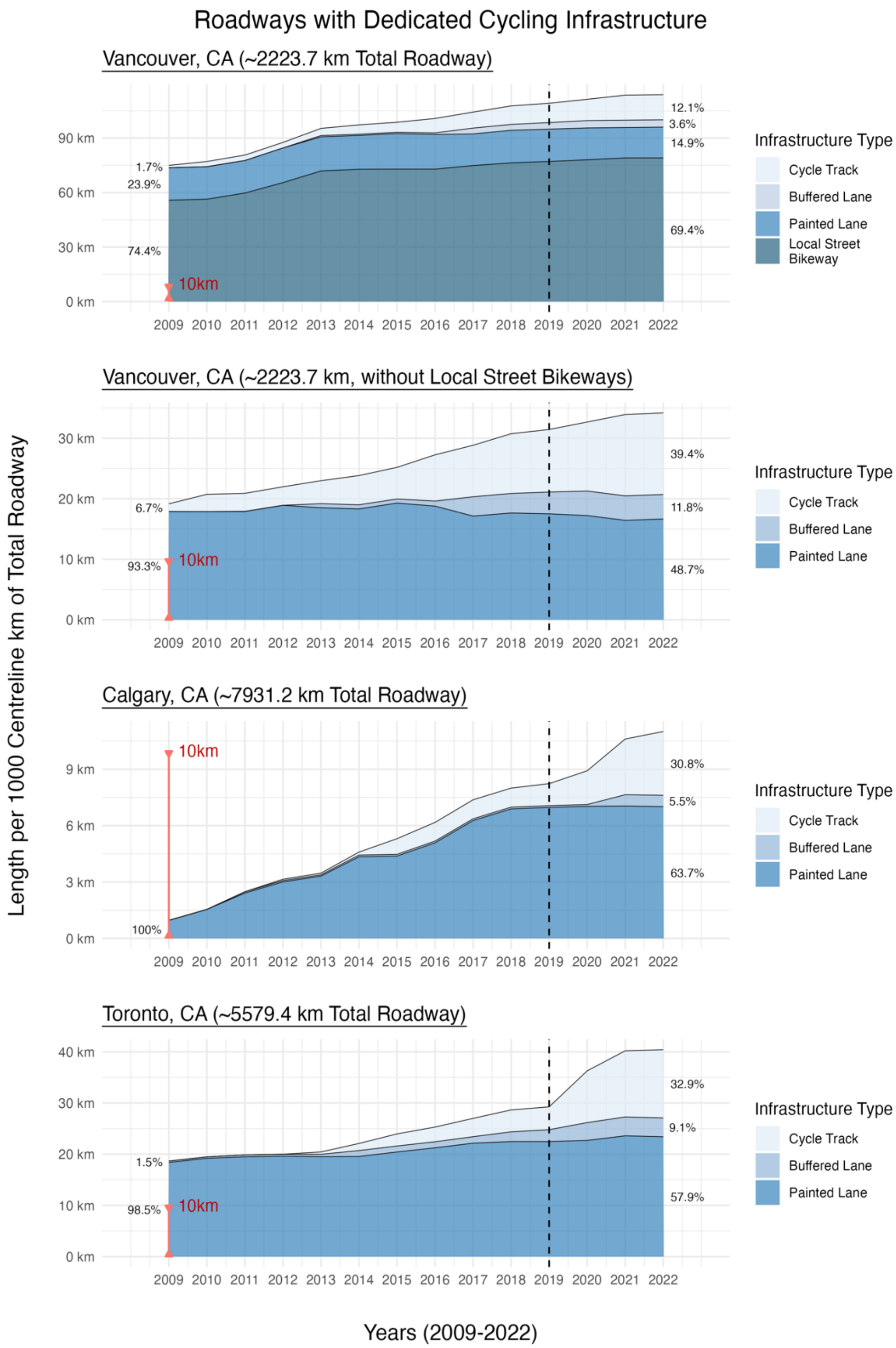


Figure 3: Yearly net change in cycle route infrastructure by municipality, standardized per 1000 centerline-km of roadway. The net change considers both the installation of new facilities, and the removal of existing infrastructure, such as when an existing facility is upgraded. This reflects the overall modifications made within each municipality over the course of the study period (2009-2022).

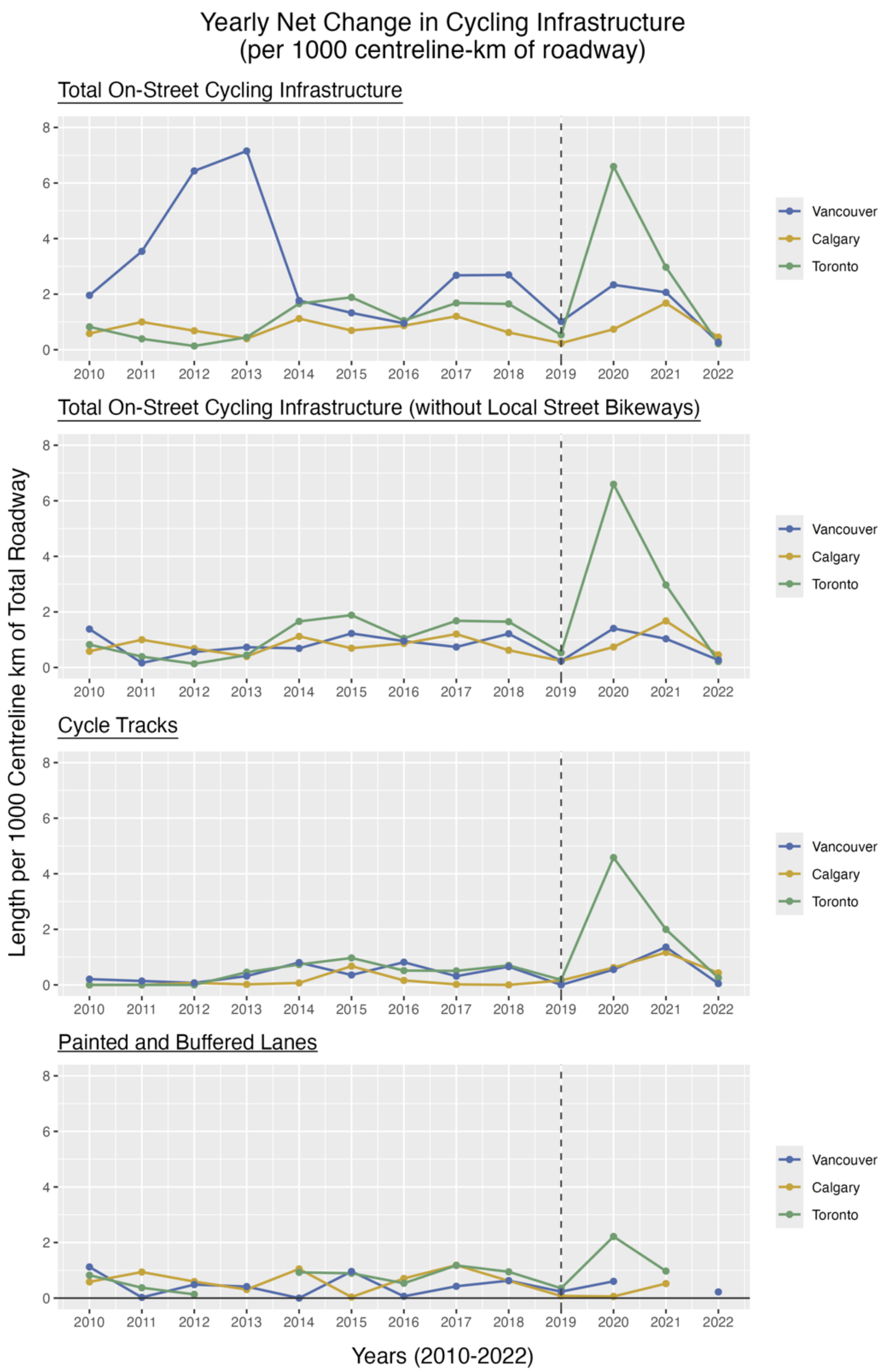
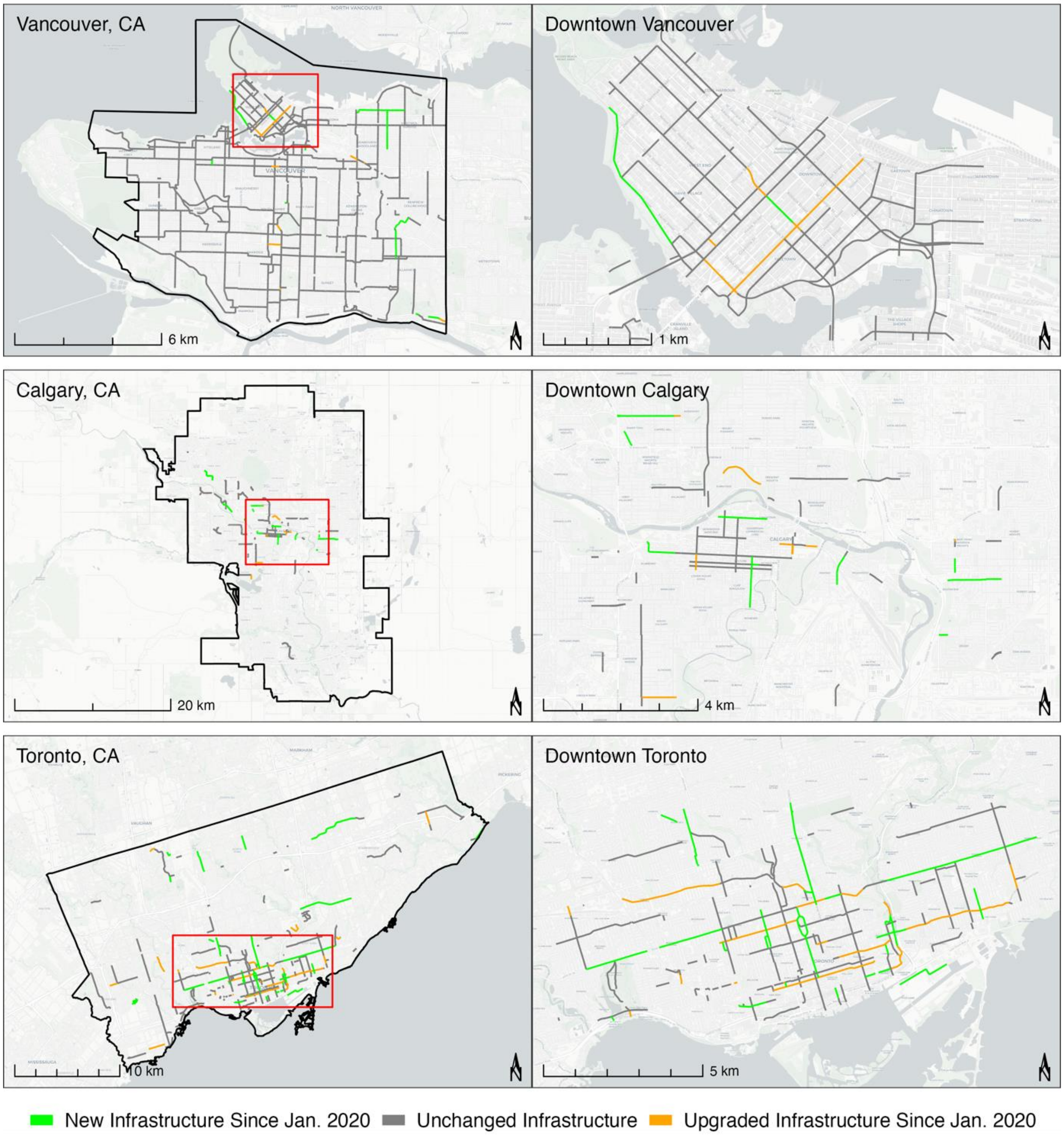


Figure 4: Changes in Dedicated On-Street Infrastructure Since January 2020 for Vancouver, Calgary, and Toronto with Municipal Boundaries. Basemap from OpenStreetMap and Carto (Positron).



Supplementary Files

APPENDIX A: DETAILED METHODOLOGY

Table A.1: Calculation and Processing of Bikeway Data for the Cities of Vancouver, Calgary, and Toronto.

Census Populations: Data Source: Statistics Canada (2021): https://www12.statcan.gc.ca/census-recensement/2021/dp-pd/prof/index.cfm?Lang=E
Vancouver Street Centreline Calculation Methods **Data Source(s):** 2 Source Files Public Streets (Last Updated July 24, 2023): https://opendata.vancouver.ca/explore/dataset/public-streets/information/?location=16,49.24772,-123.19169 - Filter: From public streets (n=17,032), select where streetuse != Closed (n=17,028) Lanes (Last Updated June 13, 2022): https://opendata.vancouver.ca/explore/dataset/lanes/information/?location=15,49.24423,-123.1524 - Include all: (n=7,842) **Length Calculations:** Calculate Geometry Attributes – Geodesic Length (km) in ArcGIS Pro 3.0.1 **Classifications:** Arterial Road: [from Public Streets – Filtered] streetuse == "Arterial" Collector Road: [from Public Streets – Filtered] streetuse == "Collector", "Secondary Arterial"* Local Road: [from Public Streets – Filtered] streetuse == "Residential", "Leased", "Recreational", [from Lanes] all-included (*) The classification of secondary arterial roads as part of the collector category was determined through a random evaluation of several secondary arterial roads. These roads were frequently situated within residential areas, featured residential driveways, included a median divider with no additional lane markings, and hosted community facilities such as schools, recreational areas, and community centers. This decision helped maintain consistent classification practices across municipalities.
Vancouver Routes Centreline Calculation Methods **Data Source(s):** 1 Source File Vancouver Bikeways (Downloaded May 2023): https://opendata.vancouver.ca/explore/dataset/bikeways/information - Include all: (n = 3666) **Length Calculations:** Calculate Geometry Attributes – Geodesic Length (km) in ArcGIS Pro 3.0.1 **Classifications:** Cycle Track: Bikeway Type == "Protected Bike Lanes" & Subtype != "OSB", "OSS"

Painted Lane: Bikeway Type == “Painted Lanes” Off Street, Path: Bikeway Type == “Protected Bike Lanes” & Subtype == “OSB”, “OSS” On Street, Shared: Bikeway Type == “Shared Lanes”, “Local Street”
Calgary Street Centreline Calculation Methods Street Definitions: https://www.calgary.ca/planning/transportation/road-classification.html **Data Source(s):** 1 Source Files Calgary Centreline: Last Updated July 1, 2023 (from: https://data.calgary.ca/Transportation-Transit/Street-Centreline/4dx8-rtm5) - Filter: From Calgary Centreline (n=115,948), select where ctp_class != Skeletal Roads & Ownership != Private (n=87, 463) **Length Calculations:** Calculate Geometry Attributes – Geodesic Length (km) in ArcGIS Pro 3.0.1 **Classifications:** [From Calgary Centreline – Filtered] Arterial Road: ctp_class == "Arterial Street", "Industrial Arterial", "Local Arterial", "Parkway", "Urban Boulevard" Collector Road: ctp_class == "Neighbourhood Boulevard", "Collector", "Primary Collector" Local Road: ctp_class == "Access Route", "Residential Street", "Activity Center Street", "Historic Road Allowance", "Lanes (Alleys)", "Industrial Street"
Calgary Routes Centreline Calculation Methods **Data Source(s):** 2 Source Files Calgary Bikeways (Downloaded January 2023): https://data.calgary.ca/Transportation-Transit/Calgary-Bikeways/jjqk-9b73 - Filter: From Calgary Bikeways (n = 4170), select where bicycle_cl != “DECOMISSIONED”, “TEMPORARY” (n = 4161) Calgary Parks Pathways (Last Updated August 2023): https://data.calgary.ca/Recreation-and-Culture/Parks-Pathways/qndb-27qm - Filter: From Calgary Parks Pathways (n=15, 828) select where life_cycle != PLANNED, maintained begins with “CALGARY”, material != TO BE IDENTIFIED (n = 15, 828) **Length Calculations:** Calculate Geometry Attributes – Geodesic Length (km) in ArcGIS Pro 3.0.1 **Classifications:** Cycle Track: [from Calgary Bikeways – Filtered] bike_cl == "Cycle Track" Painted Lane: [from Calgary Bikeways – Filtered] bike_cl == "Bicycle Lane" On street Bikeway: [from Calgary Bikeways – Filtered] bike_cl == "Neighbourhood Greenway", "On-Street Bikeway", "On-Street BIkeway", "Shared Lane" Off-street paths: [from Calgary Parks Pathways – Filtered] include all

Toronto Street Centreline Calculation Methods
Definitions: https://www.toronto.ca/services-payments/streets-parking-transportation/traffic-management/road-classification-system/about-the-road-classification-system/

Data Source(s): 1 File
Toronto Centreline: Last Updated May 3, 2023 (from: https://open.toronto.ca/dataset/toronto-centreline-tcl/)

- Filter: From Toronto Centreline (n = 70,974), select where Jurisdi37 == "CITY OF TORONTO", Feature36 != "Collector Ramp", "Busway", "Creek/Tributary", "Expressway", "Expressway Ramp", "Ferry Route", "Geostatistical Line", "Hydro Line", "Major Railway", "Major Shoreline", "Minor Railway", "Minor Shoreline (Landlocked)", "Pending", "River", "Trail", "Walkway" (n – 45, 639)

Length Calculations: Calculate Geometry Attributes – Geodesic Length (km) in ArcGIS Pro 3.0.1

Classifications:
[From Toronto Centreline – Filtered]
Arterial Road: FEATURE36 == "Major Arterial", "Major Arterial Ramp", "Minor Arterial", "Minor Arterial Ramp"
Collector Road: FEATURE36 == "Collector"
Local Road: FEATURE36 == "Access Road", "Other", "Laneway", "Local"

Toronto Routes Centreline Calculation Methods

Data Source(s): 1 Source Files
Toronto Bikeways (Downloaded January 2023): https://open.toronto.ca/dataset/cycling-network/

- Include all (n = 1323)

Length Calculations: Calculate Geometry Attributes – Geodesic Length (km) in ArcGIS Pro 3.0.1

Classifications:
[From Toronto Bikeways]
Cycle Track: INFRA_H20 == "Bi-Directional Cycle Track", "Cycle Track", "Cycle Track - Contraflow"
Painted Lane: INFRA_H20 == "Bike Lane", "Bike Lane - Buffered", "Bike Lane - Contraflow"
On street Bikeway: INFRA_H20 == "Sharrows - Arterial - Connector", "Sharrows - Wayfinding", "Signed Route (No Pavement Markings)", "Park Road", "Sharrows"
Off-street paths: INFRA_H20 == "Multi-Use Trail", "Multi-Use Trail - Boulevard", "Multi-Use Trail - Connector", "Multi-Use Trail - Entrance", "Multi-Use Trail - Existing Connector"

Table A.2: Excluded Segment Counts and Roadway Lengths by Infrastructure Type and Road Classification for Vancouver, Calgary, and Toronto (Canada). Each entry denotes the infrastructure type and road classification for that type. Lengths are measured in roadway centreline-km. Totals are calculated for each city above the total. Geodesic lengths calculated in R version 4.3.3 using the sf package version 1.0-16.

Excluded Segment Counts and Lengths by Infrastructure Type and Road Classification
Measured by centreline-km of roadway

City	Type	Class	Segments	Length
Calgary	On-Street Bikeway		2889	437.4 km
	Neighbourhood Greenway		358	23.8 km
	Shared Lane		115	18.7 km
	DECOMMISSIONED		3	2.8 km
	Cycle Track		30	2.4 km
	Bicycle Lane		14	0.6 km
	TEMPORARY		6	0.5 km
	Cycle Track	Neighbourhood Boulevard	2	0.5 km
	On-Street Bikeway	Collector	1	0 km
	On-Street Bikeway	Arterial Street	1	0 km
	TOTAL		**3419**	**486.7 km**
Toronto	Multi-Use Trail		330	289.3 km
	Signed Route (No Pavement Markings)		215	100 km
	Multi-Use Trail - Boulevard		44	37.9 km
	Sharrows - Wayfinding		97	37.4 km
	Multi-Use Trail - Entrance		179	26.2 km
	Park Road		34	22 km
	Sharrows		55	21.5 km
	Multi-Use Trail - Existing Connector		18	9.5 km
	Sharrows - Arterial - Connector		10	3.3 km
	Multi-Use Trail - Connector		10	2.7 km
	Bike Lane	Major Arterial	2	0.6 km
	Bike Lane - Contraflow	Local	1	0.2 km
	Bike Lane	Minor Arterial	1	0.1 km
	Bi-Directional Cycle Track	Local	1	0.1 km
	TOTAL		**997**	**550.8 km**
Vancouver	Protected Bike Lanes	Off-street	317	72.7 km
	Shared Lanes	Arterial	109	8.7 km
	Shared Lanes	Residential	11	3.1 km
	Shared Lanes	Collector	36	2.8 km
	Shared Lanes	Sec Arterial	38	2.6 km
	Protected Bike Lanes	Lane	8	1.4 km
	Protected Bike Lanes	Arterial	8	1.3 km
	Protected Bike Lanes	Residential	12	0.7 km
	Painted Lanes	Arterial	2	0.6 km
	Protected Bike Lanes	Sec Arterial	2	0.4 km
	Painted Lanes	Residential	2	0.2 km
	Painted Lanes	Lane	1	0.1 km
	Painted Lanes	Sec Arterial	1	0.1 km
	Local Street	Off-street	1	0.1 km
	Local Street	Residential	1	0 km
	TOTAL		**549**	**94.7 km**

Table A.3: Detailed Criteria for Classifying Infrastructure.

Overview of Steps

Infrastructure Classification Steps:

- Classify dedicated on-street cycling infrastructure types as either a painted lane, buffered painted lane, or cycle track based on the criteria listed below. Where dedicated on-street cycling infrastructure is absent for a specific segment, the segment will be classified as a shared road, and excluded if it did not receive a subsequent upgrade to a dedicated cycling infrastructure type. Where the cycling facility is located >10 m from a roadway or is denoted for shared use with pedestrians, the segment will be excluded.
- If differing infrastructure types exist on either side of the road, categorize the segment based on the most protective element of dedicated cycling infrastructure: Cycle Track (most protective) > Buffered Painted Lane > Painted Lane > Shared Road.
- When different infrastructure types are observed along one side of a roadway segment, the classification will rely on the predominant infrastructure type present along the majority of the route, with infrastructure present at intersections excluded from consideration.

Criteria for Painted Lane, Modified from Can-BICS (15)**:**

A cycling facility can be considered a painted bike lane if the design is consistent with the following features:

1. Lane Demarcation: Solid or dashed lane line(s).
    a. Lane may be solid or dashed on the travel lane side.
2. Route Signage and Pavement Markings: Lane must include either of the following at the site or between the site and nearest intersection (≤ 250 m from the site):
    a. Bicycle symbols painted on the road (reserved lane diamond optional).
    b. Reserved lane sign (for bicycles) or bicycle symbols on signs (cycling route wayfinding signs).
    c. Shoulders lacking any bicycle stencils or signage as outlined above are considered ‘paved shoulders’ and should not be considered cycling infrastructure.
3. Auto parking prohibited: Curbside motor vehicle parking is prohibited with 'no parking' or 'no stopping' signs or equivalent pavement markings.
    a. Only applicable to painted bike lanes adjacent to the curb, without a designated parking lane.

Criteria for Buffered Painted Lane:

A cycling facility can be considered a buffered bike lane if the design is consistent with the following features of a painted lane, in addition to:

1. Lane Demarcation: Solid lines
   a. Lane must be buffered on the travel lane side and may be unbuffered or buffered on parking lane side (if parking is available).
   b. The buffered delineation measures a minimum width of 1 foot (> 30 centimeters) and exhibits diagonal striping or chevron markings.

Criteria for Cycle Track from Can-BICS (15)**:**

A cycling facility can be considered a cycle track if the design is consistent with the following features:

1. Physical Separation: The cycle track is physically separated from the roadway (the portion of the road that vehicles can travel) and this **separation has a vertical component.**
   a. Where automobile parking is the physical separation, permanent vertical elements such as bollards, a curb, raised median, planter boxes, or street furniture (e.g., bike share station) must also be present along the street segment (the area between intersections).
   b. Where bollards provide the physical separation, bollard spacing must be ≤ 6 m (about the length of a passenger car/truck), otherwise, consider the facility a 'painted bike lane' (roadway lane designated for cyclists without physical separation).
   c. The facility may bend-in toward the roadway upstream of the intersection, an unprotected distance not exceeding 10 m (about two car lengths), otherwise, consider the facility a 'painted bike lane'.
   d. If the facility is located between automobile parking and a travel lane, regardless of the physical separation used, consider the facility a 'painted bike lane'.
2. Right-of-Way: Part of the road and located ≤10 m from the roadway (i.e., street buffer width cannot exceed ten metres).

Table A.3: Definition of Installation, Upgrade, and Installation Period.

Definition of a New Installation

- A new installation refers to the introduction of dedicated on-street cycling infrastructure on a road where no prior dedicated on-street cycling infrastructure existed within the period of interest (2009-2022).
- In cases where dedicated on-street cycling infrastructure is already in place at the beginning of the study period, the installation year will be designated as the first year of the study period (2009).

Definition of an Upgrade

- An upgrade refers to the modification of a segment with existing dedicated on-street cycling infrastructure, resulting in a different classification. This study considers potential classifications as either a cycle track, buffered painted lane, or painted lane. While commonly associated with the installation of more protective infrastructure, this definition is not limited to such cases.

Determining an Installation Period:

- An installation period refers to a specific year, a time range within a year, or a precise date when a bikeway undergoing modifications that meet the criteria of a new installation or upgrade becomes available for cyclists to use.
    - An installation period can be confirmed visually through historical imagery or through written sources such as construction notices, policy documents, news articles, or other forms of grey literature. When utilizing historical imagery to ascertain the installation period, a time range is defined between the most recent image displaying the previous infrastructure and the earliest image featuring the new cycling infrastructure.
    - In cases where ambiguity between different sources arises, (1) priority will be given to sources that provide direct confirmation of completion, such as completion notices, news articles announcing cycling route openings, or imagery, over those that suggest intended, planned, or approximate dates, (2) if this criterion is met and there remains ambiguity, the installation period will be defined as the most recent or earliest date or time range when a bikeway was accessible for use by cyclists. All other factors considered, the source with the greatest precision will take precedence.

Figure A.1: Segment Inclusion Criteria for Vancouver.

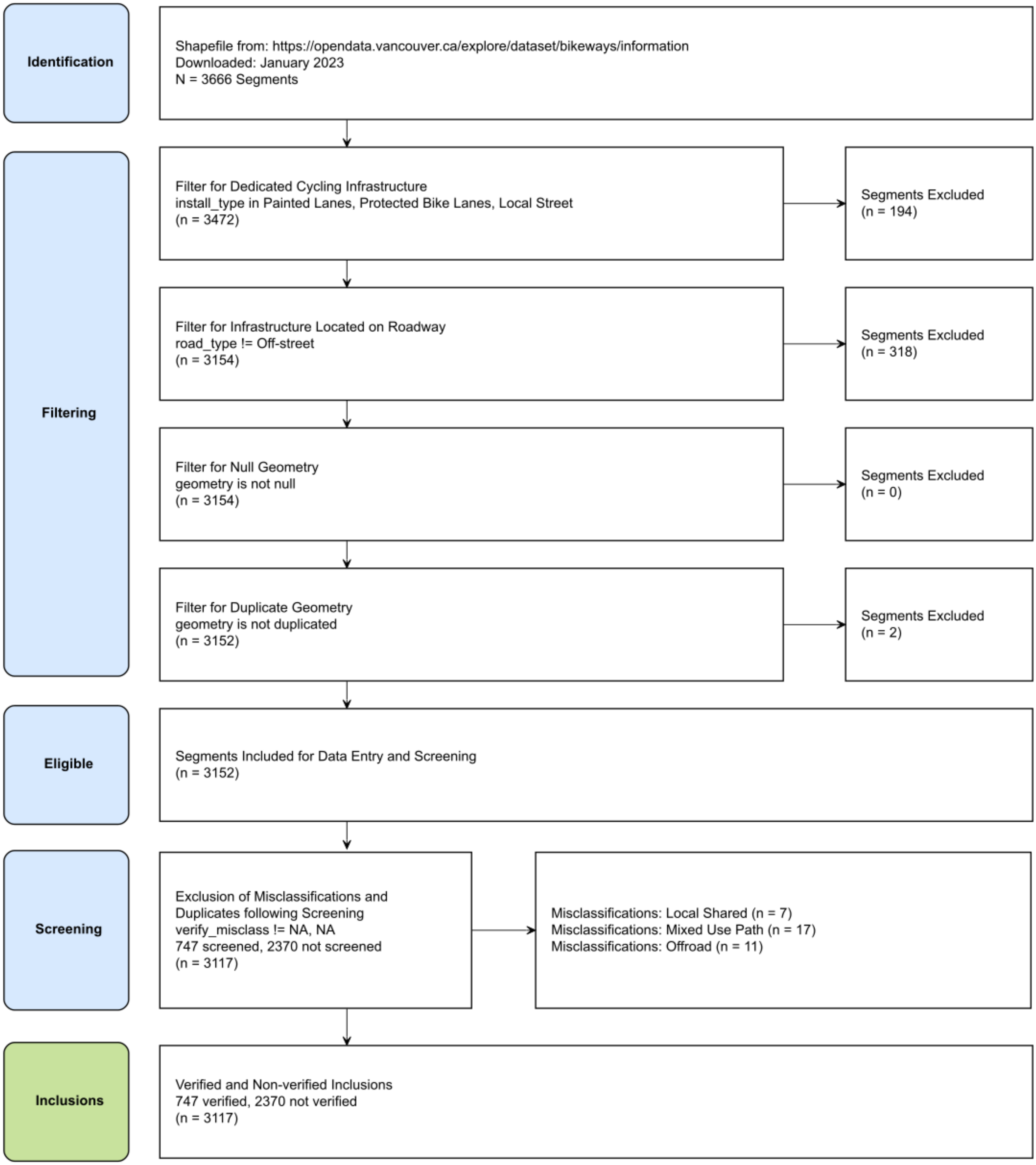


Figure A.2: Segment Inclusion Criteria for Calgary.

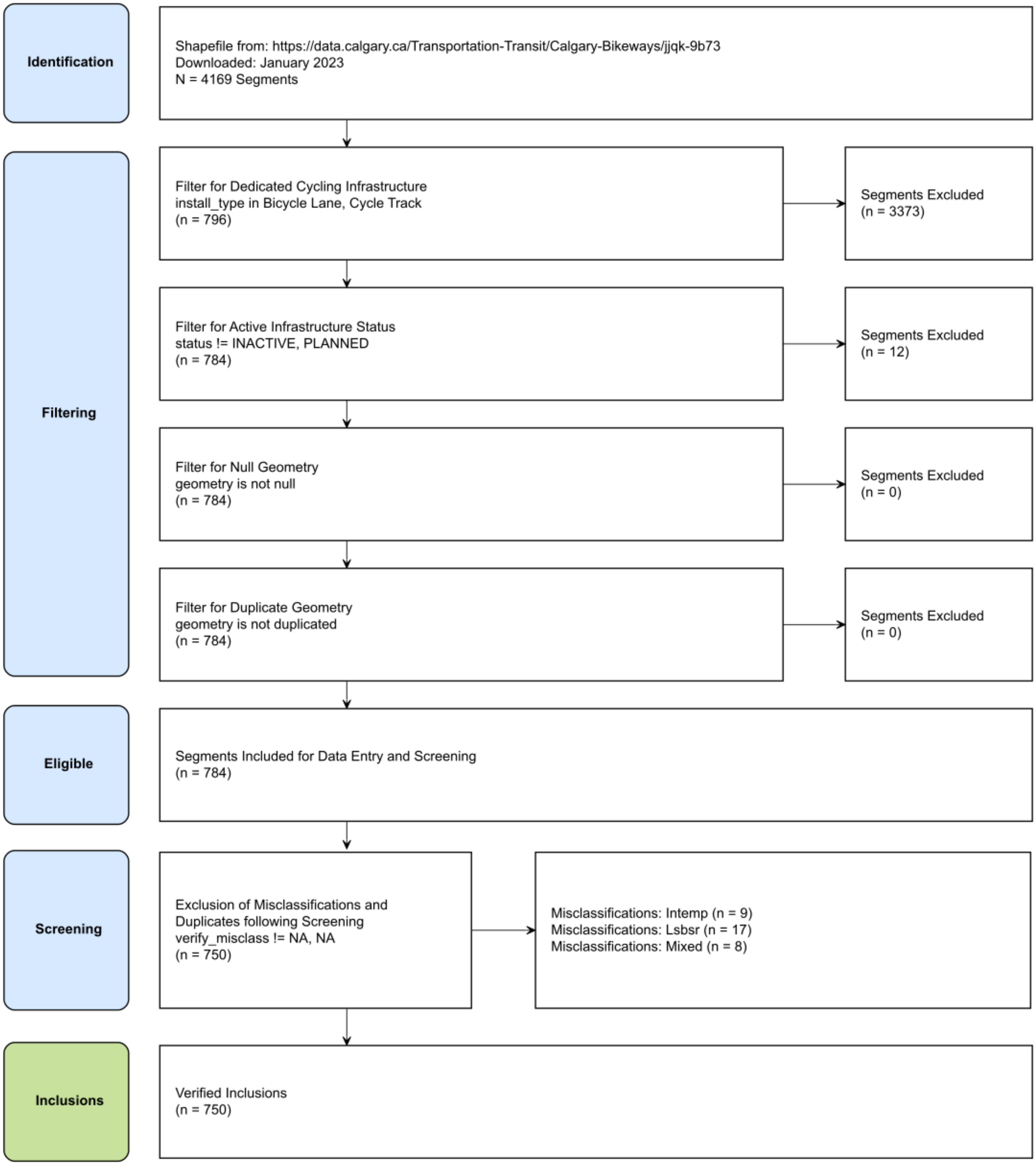
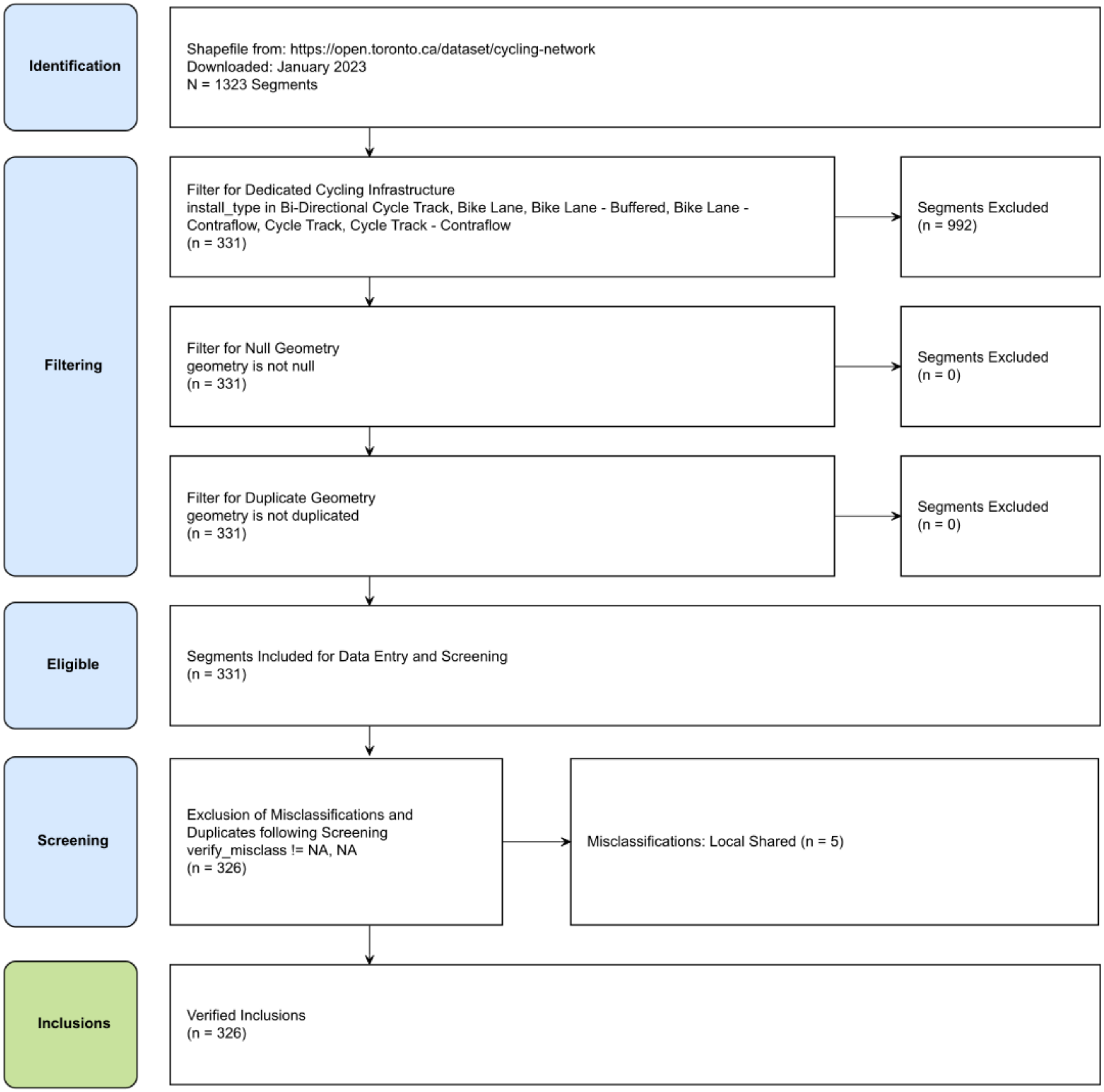


Figure A.3: Segment Inclusion Criteria for Toronto.



APPENDIX B: SUPPLEMENTARY RESULTS

Figure B.1: Percent of infrastructure length misclassified by verified classification by year, with length of misclassified segments.

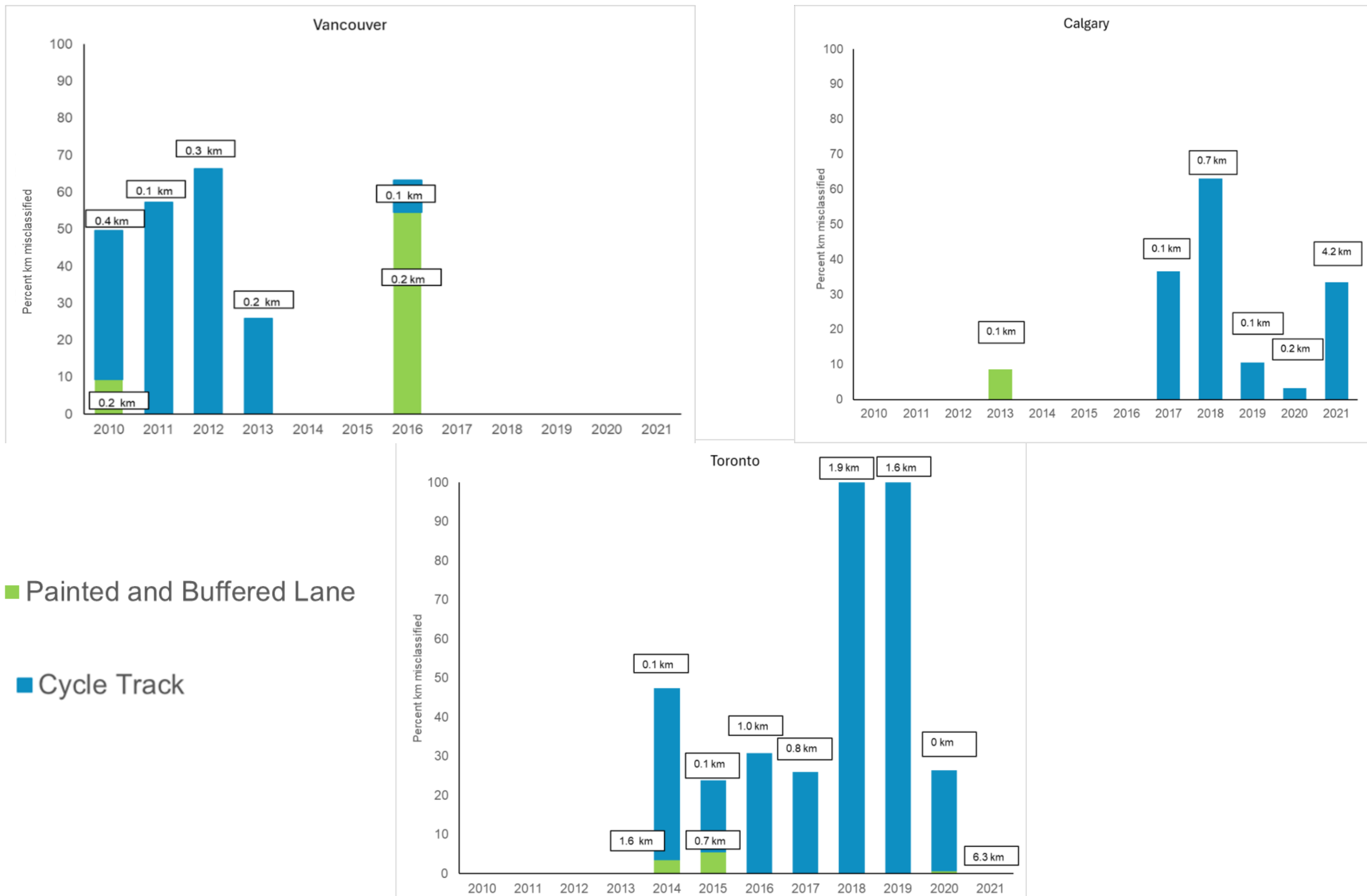


Figure B.2: A comparative analysis between municipal data and verified data on the installation years for cycling infrastructure in Vancouver, CA. Any data where a city provided and verified installation years were missing or the verified year occurred earlier or equal to the start of the study period (2009) has been excluded from analysis, yielding n=251 segments. The graph shows that 83.3% of the included segments had the correct installation year as per the city's data, and 97.2% were accurate within a range of ±1 year.

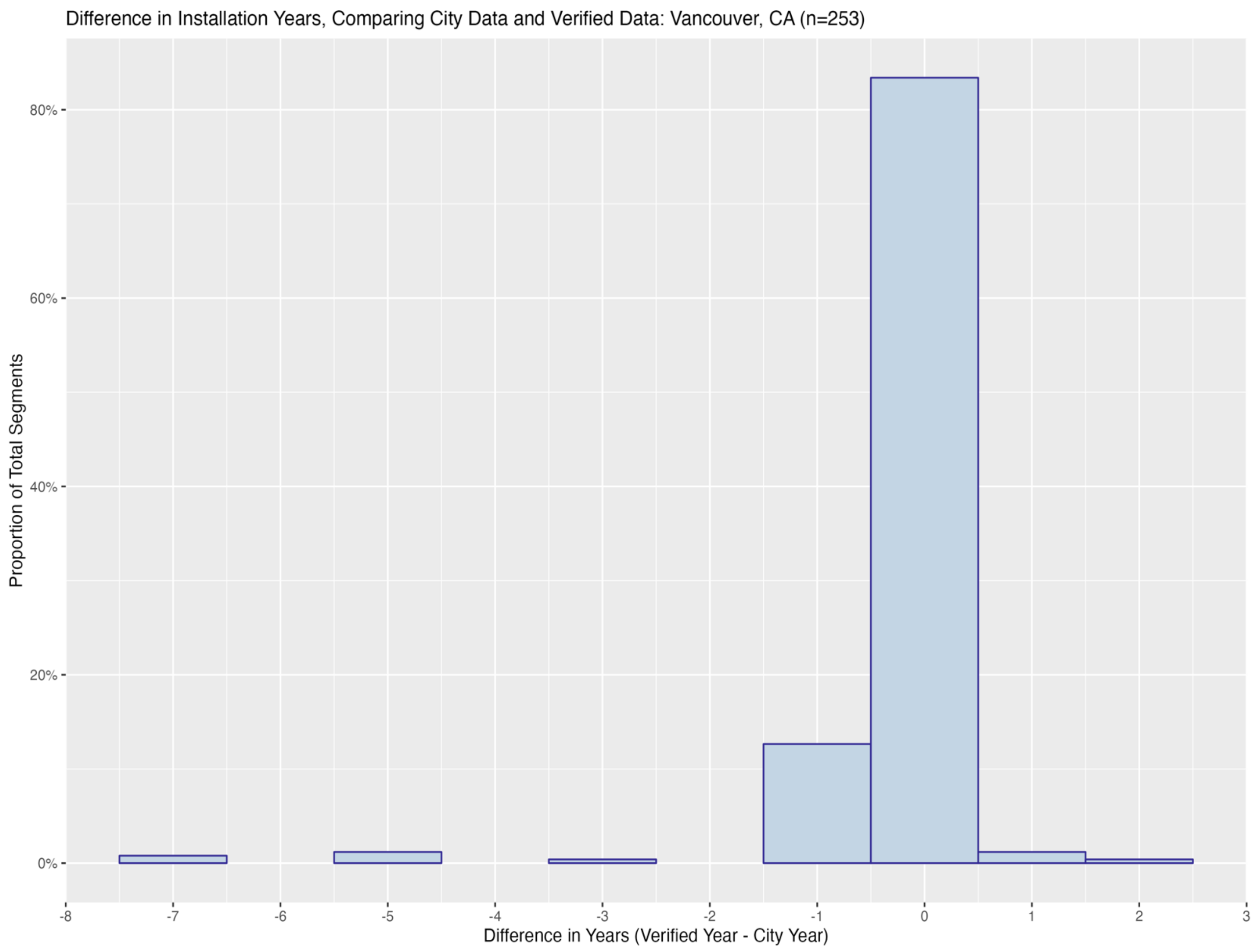


Figure B.3: A comparative analysis between municipal data and verified data on the installation years for cycling infrastructure in Calgary, CA. Any data where a city provided and verified installation years were missing or the verified year occurred earlier or equal to the start of the study period (2009) has been excluded from analysis, yielding n=668 segments. The graph shows that 42.1% of the included segments had the correct installation year as per the city's data, and 62.7% were accurate within a range of ±1 year.

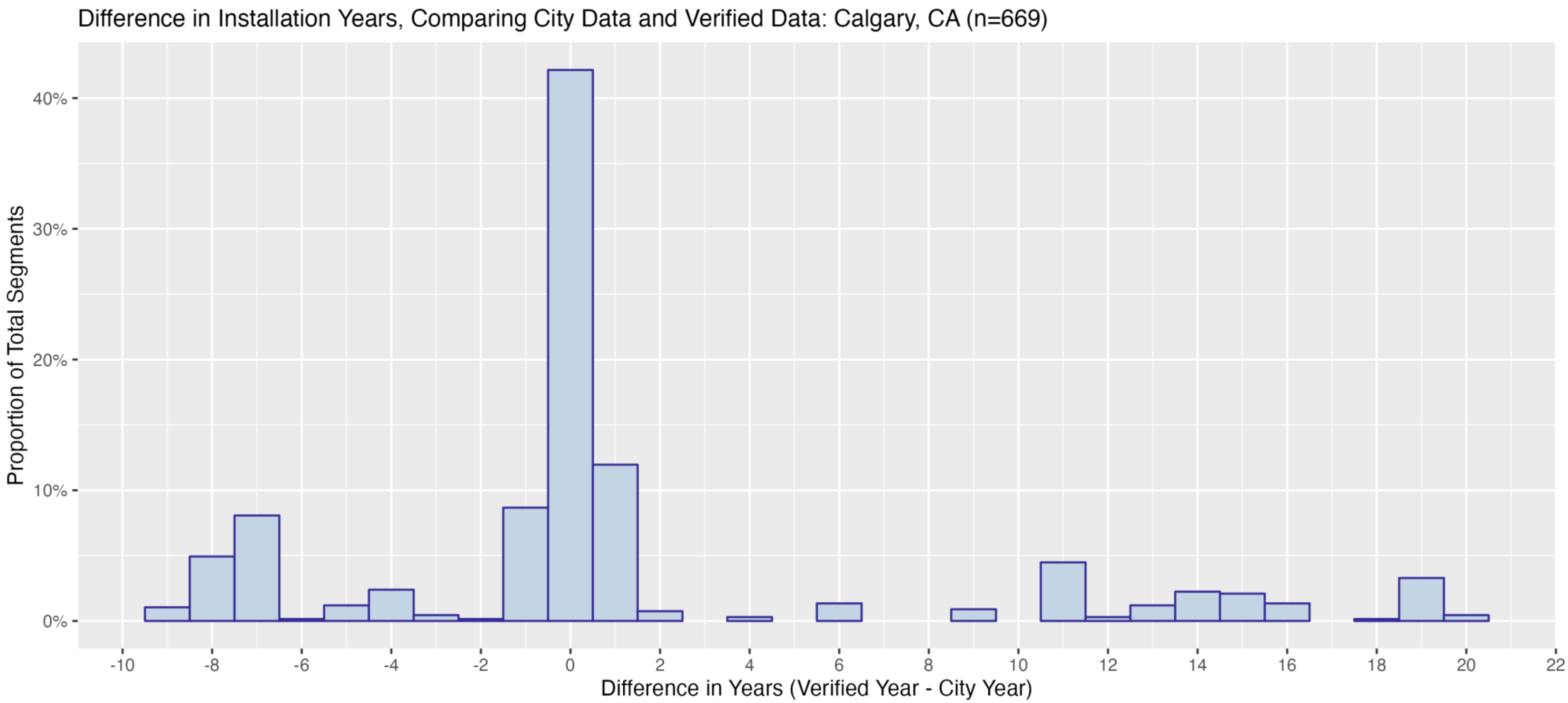


Figure B.4: A comparative analysis between municipal data and verified data on the installation years for cycling infrastructure in Toronto, CA. Any data where a city provided and verified installation years were missing or the verified year occurred earlier or equal to the start of the study period (2009) has been excluded from analysis, yielding n=188 segments. The graph shows that 74.5% of the included segments had the correct installation year as per the city's data, and 78.2% were accurate within a range of ±1 year.

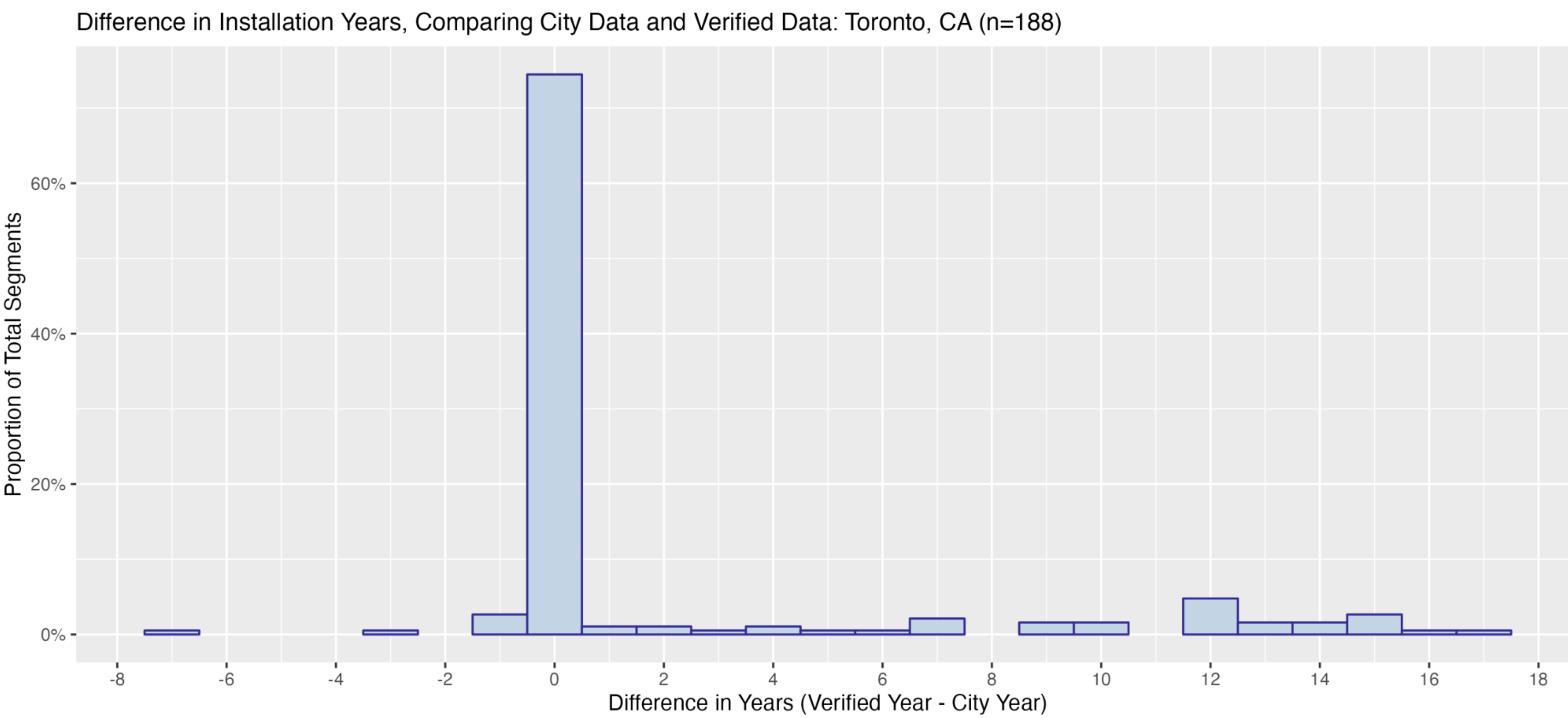


Figure B.5: Changes in dedicated cycling infrastructure between 2009 and 2022 for the Municipality of Vancouver, CA by (A) roadway classification, and (B) infrastructure distribution within each road class. Assessed using roadway centreline-km, with infrastructure classification determined by the most protective element present along each road segment.

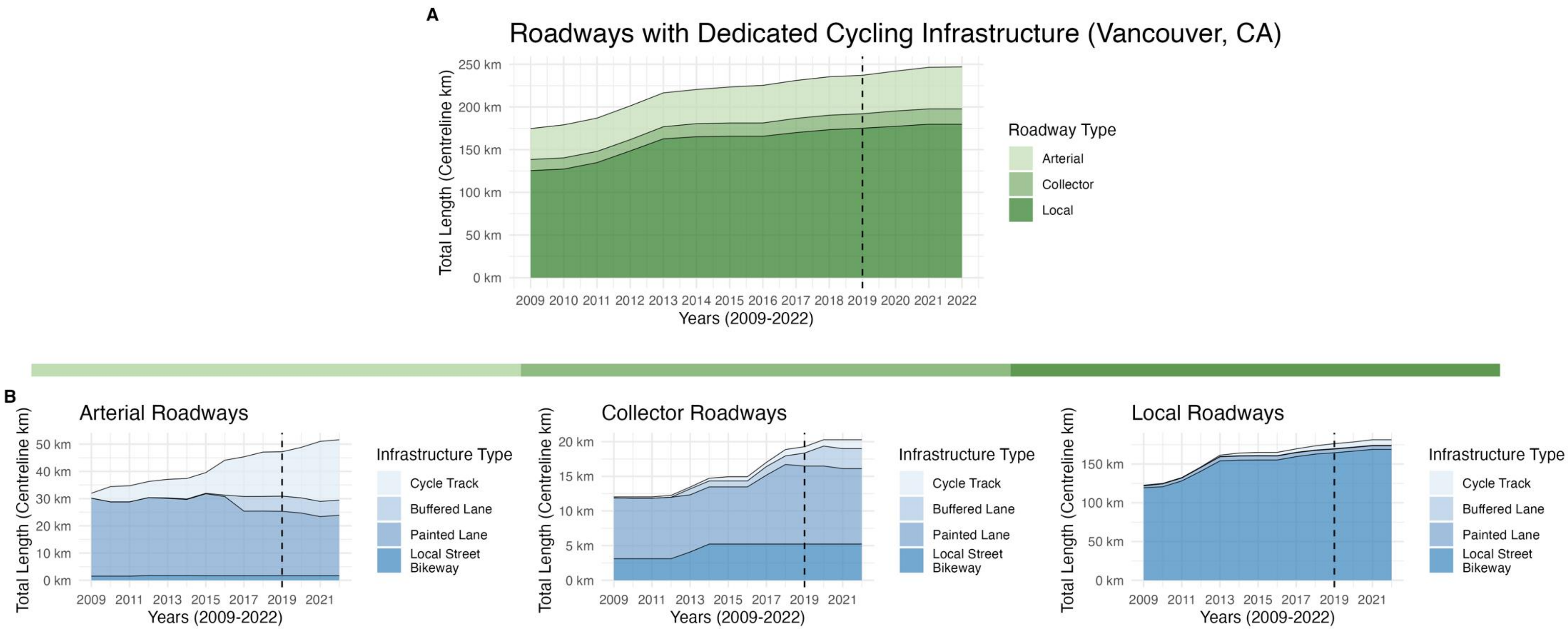


Figure B.6: Changes in dedicated cycling infrastructure between 2009 and 2022 for the Municipality of Calgary, CA by (A) roadway classification, and (B) infrastructure distribution within each road class. Assessed using roadway centreline-km, with infrastructure classification determined by the most protective element present along each road segment.

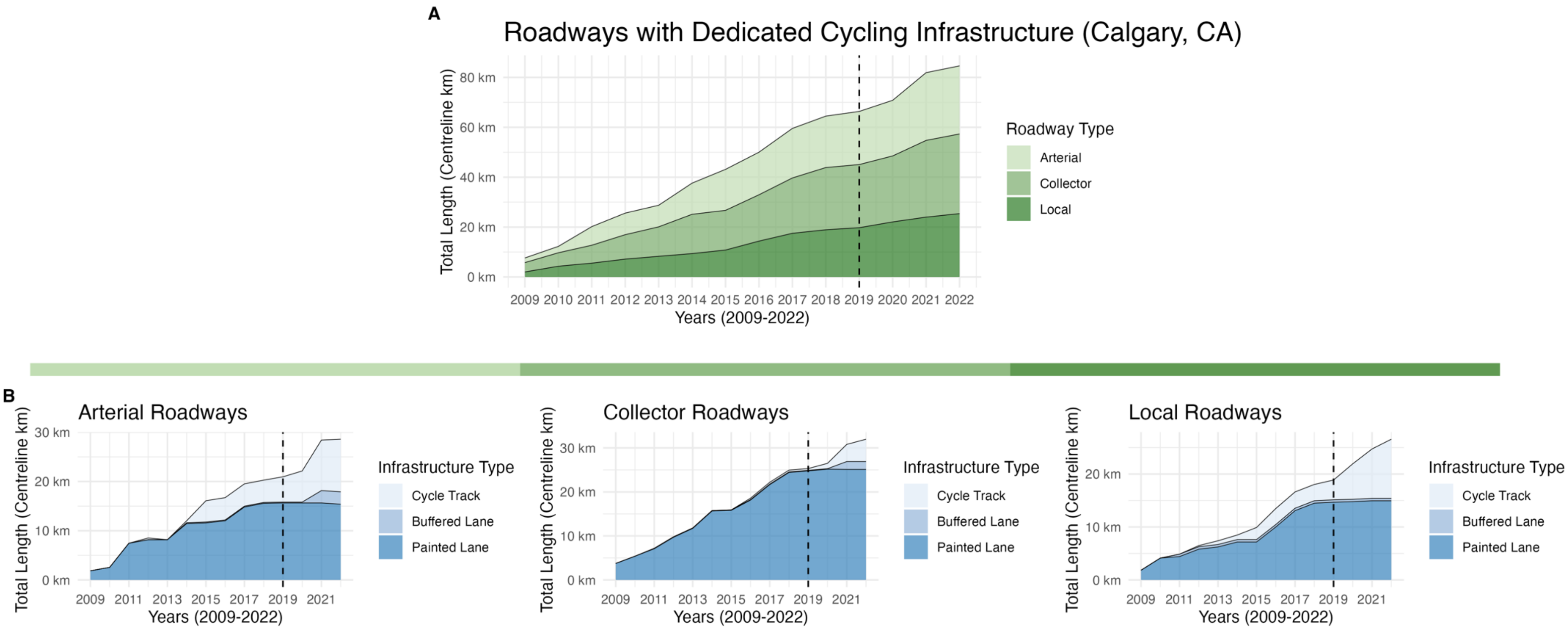


Figure B.7: Changes in dedicated cycling infrastructure between 2009 and 2022 for the Municipality of Toronto, CA by (A) roadway classification, and (B) infrastructure distribution within each road class. Assessed using roadway centreline-km, with infrastructure classification determined by the most protective element present along each road segment.

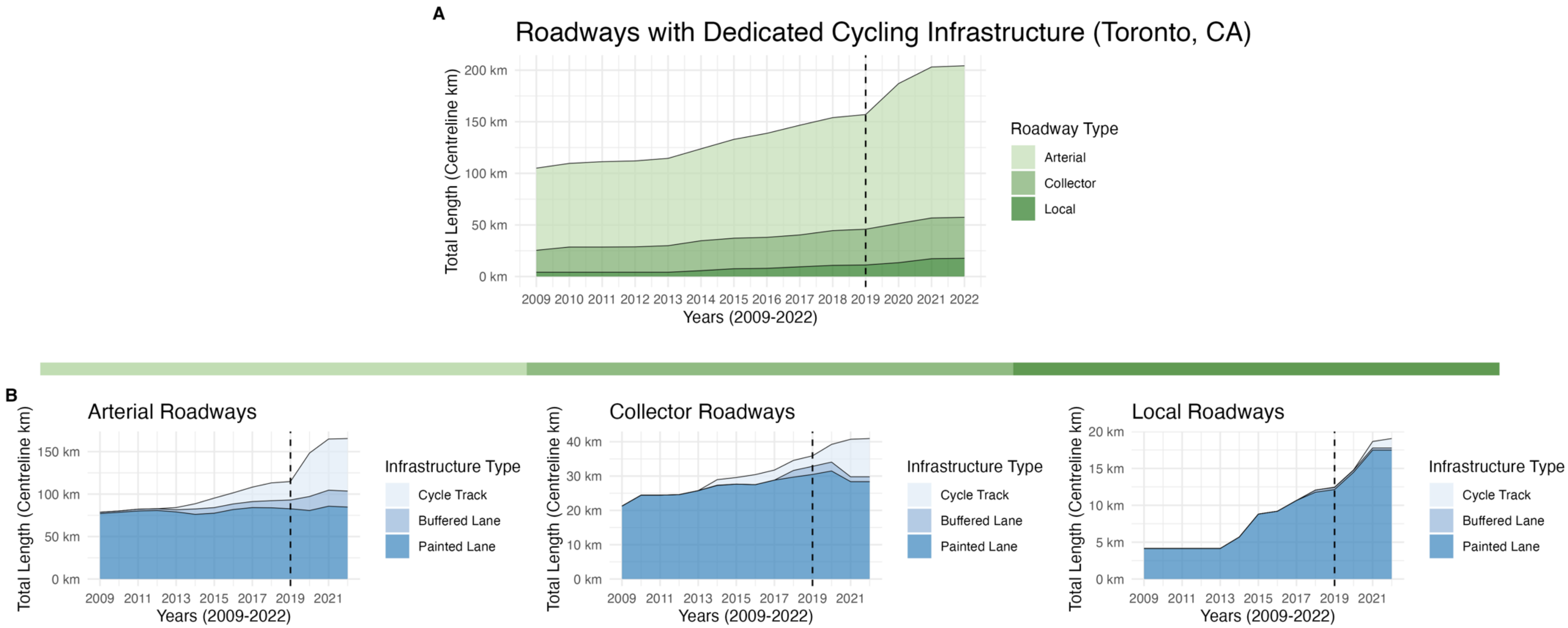


Figure B.8: Enlarged Map. Changes in Dedicated On-Street Cycling Infrastructure Between 2020-2021 for the Municipality of Vancouver, CA. New installations of dedicated infrastructure are denoted in green, upgrades from a previous dedicated infrastructure type are denoted in orange. Basemap from OpenStreetMap and Carto (Positron).

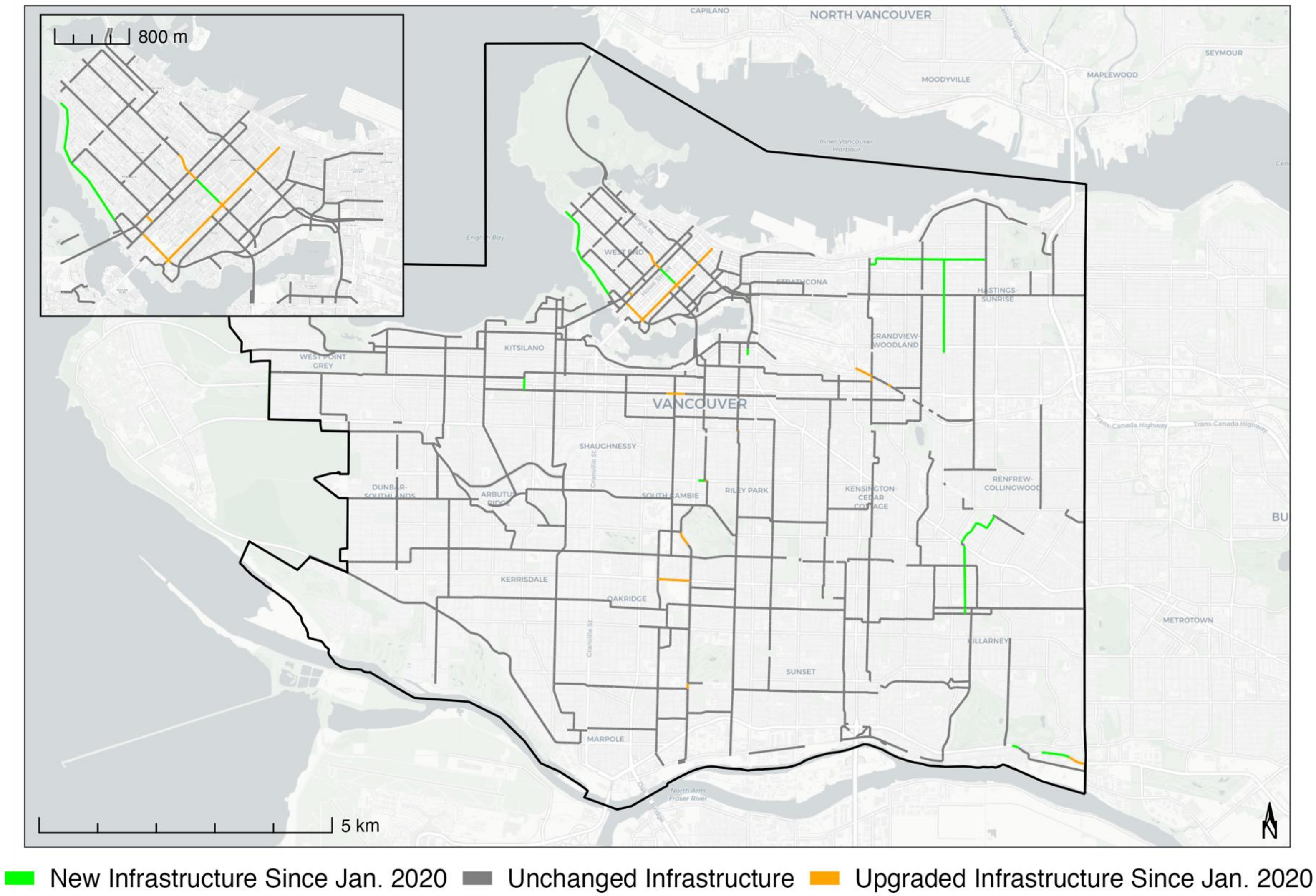


Figure B.9: Enlarged Map. Changes in Dedicated On-Street Cycling Infrastructure Between 2020-2022 for the Municipality of Calgary, CA. New installations of dedicated infrastructure are denoted in green, upgrades of dedicated infrastructure are denoted in orange. Basemap from OpenStreetMap and Carto (Positron).

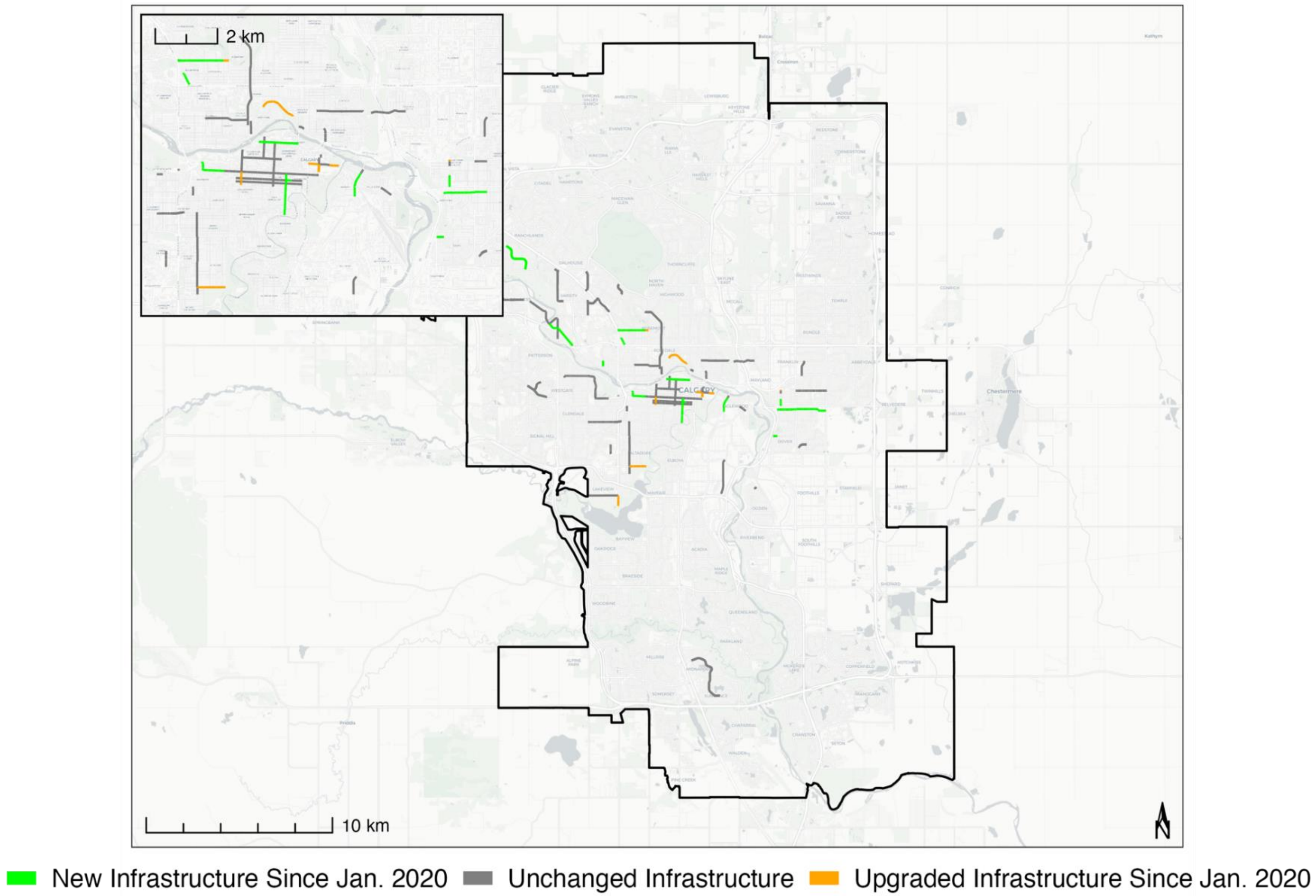


Figure B.10: Enlarged Map. Changes in Dedicated On-Street Infrastructure Between 2020-2022 for the Municipality of Toronto, CA. New installations of dedicated infrastructure are denoted in green, upgrades of dedicated infrastructure are denoted in orange. Basemap from OpenStreetMap and Carto (Positron).

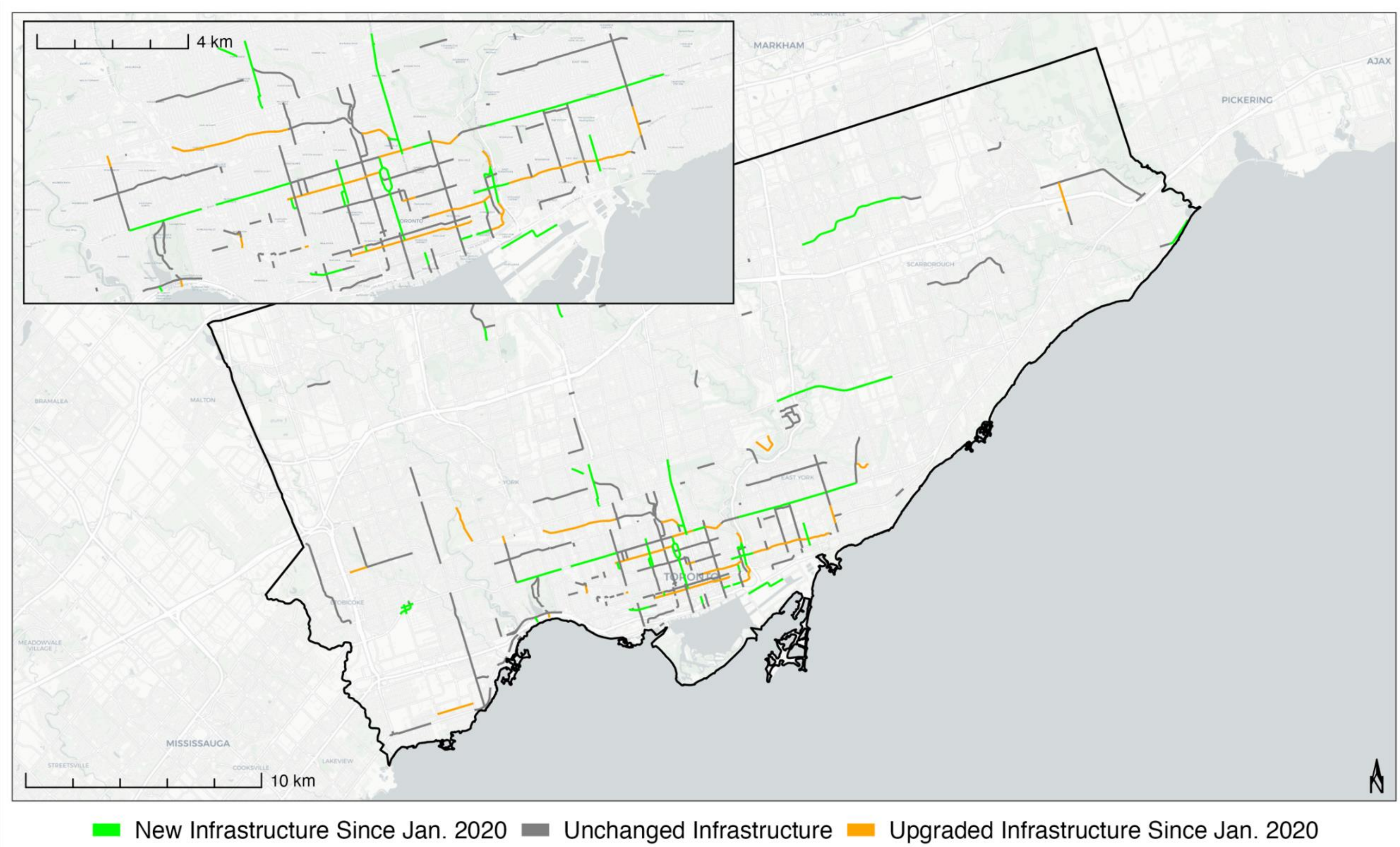


Table B.1: Total Length of Dedicated On-Street Cycling Infrastructure between 2009 and 2022, for Vancouver, Calgary, and Toronto (Canada). Each entry denotes the aggregated length of infrastructure existing at the conclusion the calendar year. Lengths are measured in roadway centreline-km, with cycling infrastructure classified according to the side of the road featuring the most protective element. Rows noted in light red denote infrastructure changes following the start of the COVID-19 pandemic. Geodesic lengths calculated in R version 4.3.3 using the sf package version 1.0-16.

Total Length of Roadways with Dedicated Cycling Infrastructure by Year (2009-2022)
Measured by centreline-km of roadway

	Vancouver					**Calgary**					**Toronto**				
Year	PL	BUF	CT	**TOTAL**	Change	PL	BUF	CT	**TOTAL**	Change	PL	BUF	CT	**TOTAL**	Change
2009	39.80	0.00	2.84	**42.64**		7.62	0.00	0.00	**7.62**		102.57	1.56	0.00	**104.13**	
2010	39.78	0.00	6.33	**46.11**	3.47	12.26	0.00	0.00	**12.26**	4.64	107.17	1.56	0.00	**108.73**	4.60
2011	39.84	0.00	6.64	**46.48**	0.37	19.15	0.55	0.00	**19.70**	7.44	108.72	2.08	0.00	**110.80**	2.07
2012	42.41	0.00	6.80	**49.21**	2.73	23.86	0.55	0.56	**24.97**	5.27	109.47	2.08	0.00	**111.55**	0.75
2013	41.82	1.50	8.76	**52.08**	2.87	26.30	0.55	0.70	**27.55**	2.58	108.95	2.54	2.55	**114.04**	2.49
2014	41.41	1.50	11.37	**54.28**	2.20	34.45	0.73	1.25	**36.43**	8.88	109.13	6.42	7.75	**123.30**	9.26
2015	43.54	1.50	12.30	**57.34**	3.06	34.75	0.73	6.61	**42.09**	5.66	113.99	6.55	13.16	**133.70**	10.40
2016	42.43	1.85	17.66	**61.94**	4.60	40.33	0.74	7.88	**48.95**	6.86	118.57	6.55	16.03	**141.15**	7.45
2017	38.77	7.09	19.60	**65.46**	3.52	49.73	0.74	8.03	**58.50**	9.55	123.60	6.55	19.44	**149.59**	8.44
2018	39.90	7.18	22.63	**69.71**	4.25	54.66	0.74	8.03	**63.43**	4.93	126.08	10.08	22.62	**158.78**	9.19
2019	39.59	8.00	23.67	**71.26**	1.55	55.28	0.74	9.28	**65.30**	1.87	126.07	12.45	23.63	**162.15**	3.37
2020	38.96	9.00	26.04	**74.00**	2.74	55.76	0.74	14.23	**70.73**	5.43	127.38	18.85	55.11	**201.34**	39.19
2021	37.19	9.00	30.58	**76.77**	2.77	55.87	4.76	23.50	**84.13**	13.40	132.35	20.03	70.82	**223.20**	21.86
2022	37.69	9.00	30.68	**77.37**	0.60	55.58	4.76	26.93	**87.27**	3.14	131.34	20.03	73.01	**224.38**	1.18