

April 2022

Transportation Demand Management Planning Study

Final Submission

Prepared for the University of Waterloo
Sustainability Office



(University of Waterloo, n.d.)

Signal Consulting Group
200 University Avenue West
Waterloo, ON
N2L 3G1

April 21, 2022

Heather McDiarmid, Mat Thijssen
University of Waterloo
N2L 3G1

Re: Final Transportation Demand Management Planning Study

Dear Heather and Mat,

Signal Consulting Group is pleased to provide the University of Waterloo Sustainability Office with the final copy of the Transportation Demand Management Planning Study. The Study was prepared to examine the accessibility of sustainable modes of transportation and to examine the infrastructural and non-infrastructural barriers that hinder employee mode shift to more sustainable transportation choices as well as identify best practices from other institutions to encourage sustainable mode shift. The Study resulted in a series of recommended best practices that could be applied within the context of the University of Waterloo to encourage employees to use more sustainable modes of commuting.

Signal Consulting group would like to thank you and the University of Waterloo Sustainability Office for the opportunity to work on this Study. Should you have any questions or comments, please do not hesitate to reach out.

Thank you,

A handwritten signature in cursive script that reads "Kathryn Curry".

Kathryn Curry
Project Manager
Signal Consulting Group

Land Acknowledgement

We acknowledge that the University of Waterloo is located on the traditional territory of the Neutral, Anishinaabeg and Haudenosaunee peoples. The main campus is situated on the Haldimand Tract, the land granted to the Six Nations that includes six miles on each side of the Grand River. We recognize that active work towards reconciliation takes place across our campus through research, learning, and community building that is centralized within the Office of Indigenous Relations. that impact transportation demand behavior. The firm looks to create an innovative solution to the challenges the future will bring.

Acknowledgements

Signal Consulting Group would like to thank Heather McDiarmid, Mathew Thijssen, and the University of Waterloo Sustainability Office for providing us with this opportunity to research and examine barriers and opportunities regarding encouraging sustainable mode shift for employee commuters through the preparation of this Transportation Demand Management Planning Study. They provided a substantial amount of background information and data that we were able to use throughout the preparation of this Study. It was a pleasure to work with them and we hope that this Study will be beneficial towards understanding the barriers and opportunities employees face as well as during the preparation of Transportation Demand Management Plan for the University Campus.

We would also like to thank Dr. Clarence Woudsma for his support, guidance, and time throughout the project. His expertise in transportation, logistics, and Geographic Information System data provided insight into the project that was invaluable and contributed to the success of this project. As well, to Michael Drescher and Adam Skoyles for their assistance and administration of the Integrated Planning Project course.

Contents

1.0 Introduction	1
1.1 Purpose	1
1.2 Project Approach	2
2.0 Background Research & Literature Review	4
2.1 Policy Framework	4
2.1.1 Public Transportation System in Region of Waterloo	6
2.2 Summarization of Literature Review	7
2.2.1 Existing Programs at the University of Waterloo	10
2.3 Best Practices Review	11
3.0 Employee Journey Analysis	15
3.1 Background & Context	15
3.2 Current State	15
3.3 Methodology	15
3.4 Influence of Transportation Decisions	17
3.4.1 Individual Characteristics of the Traveller	17
3.4.2 Trip Characteristics	19
3.4.3 Characteristics of the Transport Facility	19

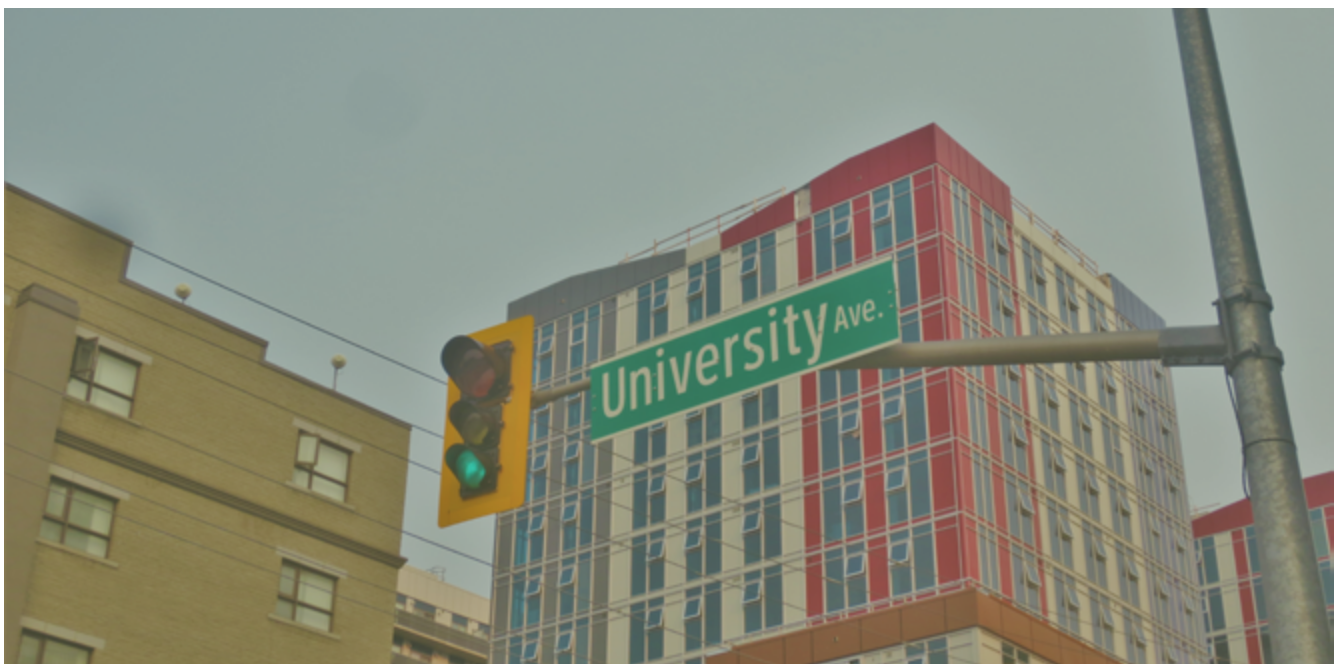
4.0 Employee Transportation Data Analysis	21
4.1 Methodology	21
4.2 Findings	22
4.2.1 Walkability	22
4.2.2 Cycling	23
4.2.3 Active Transportation Network	24
4.2.4 Bus Transit (GRT)	25
4.2.5 ION Light Rail Transit	27
4.2.6 Connectivity Network (Active Transportation & Transit)	28
5.0 Discussion & Analysis	29
5.1 Barriers	29
5.1.1 Non-Infrastructural Barriers to Sustainable Transportation	29
5.1.2 Infrastructural Barriers to Sustainable Transportation	31
5.2 Opportunities	33
5.3 Limitations & Assumptions	36
6.0 Recommendations	37
7.0 Conclusion	45
References	46
Appendix A: Best Practice Review	
Appendix B: Employee Postal Codes in Ontario Map	
Appendix C: Employee Postal Codes in Waterloo Map	

1.0 Introduction

The University of Waterloo has prepared a Climate and Energy Action Plan with the goal of achieving net zero emissions by 2050. As part of the roadmap to achieving net zero, the University has committed to reducing indirect emissions from commuting, including employee commuting (University of Waterloo, 2020). In 2019, 11.2% of the University's total absolute emissions came from employee commuting (University of Waterloo, n.d.a). In order to reduce these emissions, action item 41 from the campus' Shift Neutral plan commits to developing an institutional Transportation Demand Management Plan which would evaluate options and programs for supporting low carbon commuting (University of Waterloo, 2020). As a result, the University of Waterloo Sustainability Office has contracted Signal Consulting Group to prepare this Transportation Demand Management Planning Study which will be used to support the development of the University's Transportation Demand Management Plan.

1.1 Purpose

The purpose of this Study is twofold: one, to determine the accessibility of various regional sustainable transportation methods available to employees at the University of Waterloo and two, to identify the barriers preventing sustainable mode shift as well as the best practices for shifting transportation behaviour towards these sustainable commuting methods. This Study will be used for the preparation of a Transportation Demand Management Plan for the University of Waterloo.



1.2 Project Approach

The project approach followed the four stages that were outlined in the proposal: research and data compilation, data analysis and best practices, summarization of findings and the final deliverables.

Research & Data Compilation

During the first stage, the team researched and compiled data, academic literature as well as additional documents and materials to identify the factors that influence a commuter's mode choice. These factors were then applied within the context of the Region of Waterloo, specifically to the University of Waterloo. The initial research stage also included the research and preparation of an Employee Journey Analysis Memo, which reflects what we understand about individuals' travel behaviour, to identify barriers to sustainable transportation. This memo is based on our findings from various academic literature articles as well as the following key documents that informed the findings:

- The 2018 TravelWise Commuter Survey;
- The 2020 TravelWise Commuter Survey; and
- The "Opportunities for Increasing Sustainable Transportation Uptake by Employees at Waterloo" Report.

The Employee Journey Analysis memo is included in **Section 3.0** of this Study.

Data Analysis & Best Practices Scan

Next, various documentation and Geographic Information Systems (GIS) Data was compiled and reviewed to begin the second phase: Data Analysis and Best Practices Scan. In this phase, an industry and best practices scan was undertaken to identify and compare transportation demand management practices from other universities and institutions in order to determine the industry best practices for managing employee transportation behaviour. The Sustainability Tracking, Assessment & Rating System (STARS) was used to identify Universities with high sustainability ratings and ones that had Transportation Plans and those plans were then used to identify the best practices. The results of this Best Practice Scan are summarized in Section 2.3 below.

A geographic spatial analysis was also completed during this phase to examine current trends and accessibility to sustainable transportation methods, using data provided by the University of Waterloo Sustainability Office, open data sources and the University of Waterloo Geospatial Centre. Geoprocessing tools were used to assess the relationship between mode choice, distances, and the accessibility of transportation for employees. The results of this analysis are presented below in Section 4.0. The research from the first two phases was presented at the mid-term meeting and presentation on March 9, 2022.



(Roger Chen, 2022)

Summarization of Findings

The third phase consisted of summarizing the findings and creating visuals to summarize the data of the geospatial analysis. Suggestions from the mid-term presentation were considered at this time. The summarization of findings included examining the barriers to sustainable transportation that were identified through the research and employee journey analysis. This phase also reviewed the best practices scan, to identify potential transportation demand management (TDM) programs that the University could employ to help address some of the identified barriers. This analysis resulted in a series of five (5) recommendations that will be presented in **Section 6.0** below.

Final Deliverables

The information and analysis from the first three phases described above was used in the preparation of this final Study. This final deliverable report consists of;

- A summary of the policy frameworks and academic literature;
- The best practices scan;
- Employee journey analysis;
- GIS data analysis and maps
- Summary of the identified barriers and opportunities; and
- Final recommendations.

This information was presented to the client during a meeting on April 13, 2022.

2.0 Background Research & Literature Review

2.1 Policy Framework

The following policy context is intended to provide a summary overview of the planning policies that apply to the context of the University of Waterloo and is therefore not an exhaustive review for this Study. The policies outlined below provide support towards the creation of this Study and justification for sustainable transportation that looks to reduce the impact of greenhouse gas emissions, and the creation and implementation of transit networks that encourage the use of multimodal transportation for long term commuters within the Region of Waterloo and City of Kitchener.

Provincial Policy Statement (PPS), 2020

The Provincial Policy Statement (PPS) provides the efficient use of infrastructure (particularly public transit) as a key element of provincial policy (Sections 1.6.1, 1.6.3 and 1.6.7). These policy sections encourage transportation through energy efficiency and connectivity within and among transportation. With respect to transportation systems, section 1.6.7.4 promotes a land-use pattern, density and mix of uses that minimize the length and number of vehicle trips and support the current and future use of transit and active transportation. Section 1.8, supports energy conservation and efficiency strategies that help to improve air quality and reduce greenhouse gas emissions.

Growth Plan for the Greater Golden Horseshoe, 2019

Like the PPS, the Growth Plan supports sustainability, walkability and effective transportation use. Section 3.1 states that the transportation system for the Greater Golden Horseshoe Area (GGH) must be planned and managed for the safe and efficient movement of goods and people, and to reduce greenhouse gas emissions and other negative environmental impacts. Section 4.2, further supports this by recommending the reduction of the dependence on automobiles and supporting existing and planned transit and active transportation.

Region of Waterloo Official Plan (ROP), 2010

The Region of Waterloo Official Plan (ROP) provides relevant information about infrastructure needs and sustainable transportation modes within the region. Section 3 addresses the need to increase transportation opportunities for pedestrians, cyclists, and transit users. The ROP also supports providing a transportation demand management strategy/study that looks to reduce the total number of automobile trips by influencing people to adopt more sustainable travel choices when it comes to types of travel. In addition, Section 5 addresses Waterloo Region's infrastructure needs by planning and managing integrated, accessible, and safe multi-modal transportation systems that provide transportation choice and promote sustainability.

City of Kitchener Official Plan (OP), 2014

The City of Kitchener's Official Plan policies relevant to this study include Sections 3, 6, 7 and 13. Section 3 of the OP encourages minimized surface parking areas and discourages auto-oriented land uses through strategies of parking requirements, shared parking, parking process and other strategies. Similarly, Section 6 looks to increase accessible connectivity between places and various modes of transportation, while Section 7 provides a range of practices that promote sustainable development including, reducing greenhouse gas emissions, and creating complete, healthy, walkable, transit-supportive communities. To enhance sustainable transportation choices, Section 13.7.2 looks to reduce the need and demand for parking spaces and supply by encouraging various modes of travel.

University of Waterloo Campus Sustainability Report, 2021

The University of Waterloo Campus Sustainability report lays out direction and actions for the campus for shifting toward carbon neutrality by 2050. Their plan target is to have a 17.5% reduction by 2025 and a 35% reduction by 2030. The program describes 46 specific actions that help to achieve both short and long-term sustainability goals of the campus. The Campus Sustainability Report lists one of the goals to link transit and ridesharing to improve sustainable travel. In which the objective, has been tentatively complete, that by 2025 increase to 90 percent the proportion of sustainable commuting trips from a 2016 baseline of 85 percent.



(Roger Chen, 2022)

2.1.1 Public Transportation System in Region of Waterloo

Transportation Master Plan, 2018

The “Moving Forward” Region of Waterloo’s Transportation Master Plan, outlines the Region’s needs for active transportation (cycling and walking), public transit, and regional roads by the year 2041. The document’s vision is to create a Region that will be prosperous, and sustainable with viable transportation choices for people. It also encompasses five goals, with the following four relevant in the context of this study:

- Build a transportation network that supports all modes of travel;
- Develop a frequent transit network;
- Position region for new mobility; and
- Enhance inter-regional connections.

Grand River Transit Servicing Plan, 2017 - 2021

The Grand River Transit Servicing Plan identifies the transit network changes and service level improvements. The Plan addresses the “Service Improvement Plan & Ridership Growth Strategy”, which looks at completing the iXpress network of limited-stop bus routes. The Plan also aims to realign routes to form a grid shaped network, specifically with ION stations, and provide frequent service on high ridership routes to make ridership between different modes easier.

University of Waterloo Station & Route Implications

The new planned route buses have begun rolling out from the new bus platform at University of Waterloo Station, and the routes that will serve University of Waterloo Station include 201, 9, 13, 19, 30 and 31. This station connects University of Waterloo staff, students, faculty, and residents nearby to a mixed mode choices including Grand River Transit (GRT) Buses and ION light rail transit (LRT). Furthermore, this platform allows for easy access for commuters through the connection of GRT buses, ION LRT, and GO Transit.

2.2 Summarization of Literature Review

The “Opportunities for Increasing Sustainable Transportation Uptake by Employees at UWaterloo” 2018 report from SustainMobility evaluated three main factors in their literature review that influence sustainable transportation uptake: geographic location, transportation demand management policies, and infrastructure availability.

Table 1: “Opportunities for Increasing Sustainable Transportation Uptake by Employees at UWaterloo” 2018, Literature Review Summary

<i>Factor</i>	<i>Main Points</i>
Geographic Location	<ul style="list-style-type: none"> • Importance of convenient routes for sustainable transportation modes • Relationships between demographic characteristics and convenience can influence motivation to travel through sustainable modes • Proximity to transit, socioeconomic status and demography influence one’s mode choice • Varies based on geographic location (i.e., different cities/countries)
Transportation Demand Management (TDM) Policies	<ul style="list-style-type: none"> • Many companies do not promote multiple transportation modes • Integrated approach for TDM policy planning is most successful • Most successful policies restrict car use (e.g., limited available parking spots, charging parking fees, removing free parking)
Availability of Transportation Infrastructure	<ul style="list-style-type: none"> • Consider status and availability of transportation infrastructure • Transportation infrastructure (bike racks, sheds, secure public transit modes) can result in effectively increasing sustainable transportation uptake

With the 2018 findings considered, Signal performed an updated literature review that looked into recent writings that focused on those factors that influence sustainable transportation uptake. The review includes justification for previously found influences and added consideration of other concepts previously not mentioned. Determining motivators and deterrents towards choosing sustainable transportation, university and campus environments, contextual locations comparable to Waterloo, and employee demographics were emphasized where possible.

Geographic Location

In the context of Waterloo, literature shows that mid-sized cities have historically experienced low levels of transit ridership and high automobile dependence. Traffic congestion can be much less influential due to its lower residential densities, and it makes private automobiles more efficient (Collins & MacFarlane, 2018). To build on these findings, literature has shown that access and convenience from walking distance to bus stops, and reducing the number of transfers are significant to shifting modal choice (Allen & Farber, 2018).

Weather is a geographical and non-modifiable constraint that can prevent people from using sustainable methods of transportation. Waterloo experiences a continental climate, with four distinctive seasons, including relatively hot summers and long cold winters with snow. Though Waterloo cannot change the weather, constraints from the weather can be overcome through appropriate intervention (Klicnik & Dogra, 2019). Proper maintenance of sidewalks and diligent snow clearings, covered walking paths, rest stops, timing at crosswalks and intersections, and heated bus stops are a few strategies that can help mitigate the weather sensitivity when unfavourable (Klicnik & Dogra, 2019).

Transportation Demand Management (TDM) Policies

Similar to the 2018 review, one of the most influential and strong strategies to shifting travel mode choice is implementing policies to decrease attraction towards utilizing private automobile vehicles. TDM strategies include increasing parking rates and restrictions, and road tolls, which have been shown to strongly influence changing travel behaviour.

Strong links have been observed between pricing and transit ridership levels. Transit users place higher importance on saving money versus non-users, possibly due to the upfront costs of transit passes and fares, versus the more discrete car upkeep, insurance and parking fees of driving (Bozovic, Hinckson & Smith, 2021). In evaluating transit and automobile usage in Kingston, Ontario and Queen's University, one of the most commonly identified barriers to sustainable transportation was owning a Queen's parking permit. Employees who had invested in a parking permit had no justification to change their mode to public transit as these passes were sometimes difficult to obtain, and were issued for long-term periods (Collins & MacFarlane, 2018). Collins & MacFarlane (2018) found that those who did not own a parking permit were over two times more likely to shift to transit for commuting, versus those who owned a permit.

Additionally, parking supply has been shown to account for upwards of 92% of the variation for transit ridership in major Canadian cities, with the availability of surface parking adjacent to and within central business areas being a strong predictor for transit (Collins & MacFarlane, 2018).

Availability of Infrastructure

Transportation infrastructure availability and implementation, including bike racks and secure public transit modes were identified in the previous literature review. Since the release of the 2018 report, Waterloo's transportation and transit landscape has significantly changed as a result of the ION LRT operations that began in 2019. One study explained that mode choice can be more influential when transit systems and services change, and showed that having a new system entices new riders to change their attitudes on modal choice, and transition to using public transit after the introduction of a new rail line in Salt Lake City (Brown & Werner, 2008). When Kingston, Ontario introduced an express transit service, there was a shift amongst Queen's University employees in commuting patterns. Over three years, the year-round mode share for transit increased from 3.9% to 7% (Collins & MacFarelane, 2018).

Aside from transit, active transportation facilities can be underestimated when considering sustainable transportation infrastructure. Accessing walkability should have more emphasis on the quality of experience versus the availability of destinations (Bozovic, Stewart & Hinckson, 2021). In terms of cycling, there is a latent demand for bicycling, however in many cases, a large proportion of the public feel conditions are not safe enough to ride amongst existing automobiles (Cabral, Kim & Parkins, 2018). Respondents confirmed the importance of safety, stating they would cycle more if they felt safer on the road (Bozovic, Hinckson & Smith, 2021).

Analysis

With an updated review of the 2018 findings, Signal's review includes justification supporting previously found influences and added consideration of other concepts not previously mentioned. Pertaining to geography, the added factor of weather can deter many to use private automobiles versus sustainability modes. It is also evident that transportation demand management policies are very influential in modal choice, specifically surrounding parking fees, permits and availability for institutions like the University. Though the ION LRT is the most significant change within the sustainability transportation realm in Waterloo, it is important not to neglect cycling and walking facilities. Active transportation conditions should be considered through quality and experience, not exclusive to availability to destinations. It is important that the Sustainability Office continues to pursue current academic research and collect live data from staff, students and faculty for qualitative data.



2.2.1 Existing Programs at the University of Waterloo

The University of Waterloo has a number of transportation demand management practices currently in place. A review of the University's website indicates a fairly robust set of practices including subsidized public transportation, bike facilities, carpooling, an emergency ride home program, carsharing, and electric vehicle (EV) charging stations (University of Waterloo, n.d.b).

Additionally, the University has a partnership with the GoTravelWise program, which administers the carpooling program, subsidized GRT passes, and an Emergency Ride Home program. Through TravelWise, employees also have access to see the cost of their commute by various transportation methods, the ability to search for carpools, and the ability to log their trips for a chance to win prizes. TravelWise offers a carpool matching program and the University offers preferential parking for formal carpools. The TravelWise Corporate Pass subsidizes 15% of the monthly transit pass so that employees only pay \$76.50 rather than the full \$90. The Emergency Ride Home program is for employees who walk, cycle, take transit or carpool which reimburses employees up to \$75 per trip for a maximum of 4 trips per year.

Bike facilities at the University include a bike maintenance centre, bike theft protection services, and bike boxes. Recently in 2021, the University opened a bike cage located near EV3 which secures up to 62 bikes. Undergraduate and graduate students, staff and faculty can pay \$10.00 per month to use this bike storage, and permits are available on a monthly, termly or yearly basis. The University also previously offered a bike-sharing program in the Spring and Fall of 2019. For electric vehicle charging, there are currently 13 EV charging stations on campus (Engineering 6 (3), South Campus Hall (2), East Campus 2 (3), East Campus 4 (3), and Needles Hall (2)) with 5 more charging stations in development (L Lot (3), and Plant Ops Lot (2)).

The current rate for a faculty/staff parking permit is \$42.94 per month (including tax), with motorcycle parking permits costing the same.



2.3 Best Practices Review

For the purpose of this Study, a review of best practices from other universities and non-institutional employers was undertaken to provide an understanding of what other institutions and workplaces were doing to shift employee behaviour towards more sustainable modes of commuting. The Best Practice Review looked at 13 Transportation Plans across ten universities, one government employer and one private company, including:

- University of British Columbia;
- Carleton University;
- Concordia University;
- Oregon State University;
- Tufts University;
- University of California Los Angeles;
- East Carolina University;
- University of New Hampshire;
- University of Pennsylvania;
- California State University Northridge;
- Government of Rhode Island; and
- Apple Inc.

For each institution, the Review identified preliminary background information including year the Plan was created, the employer, number of employees, location of institution, and the target group (i.e. employees, students). The review examined the parking framework (e.g., parking fees, pricing structures) to see how parking demand was dealt with, and then provided a summary of the Plan's purpose, goals and objectives and its proposed and current strategies and/or initiatives to shift travel behaviour. Finally, the applicability and relatability of the Plan and its initiatives were considered to the context of Waterloo and the University.



A copy of the Best Practice Review is attached as **Appendix A**.

Limitations

A report by the Community Transportation Association of America outlined TDM strategies for companies such as Amazon, Google, CVS, Meta, and Best Buy. However, the original source TDM documents for the companies listed in the report were not found during the research stage. It is likely that because these are private companies, their Plans are not public-facing documents.

Figure 1:
Current and Proposed Initiatives and Programs from Institutions in the Best Practice Review

	Carpool Systems	Carpool Incentive	Public Transit Subsidy	Guaranteed Ride Home	Clean Fuel Incentive	Marketing	Carsharing	Bike Facilities	Bikesharing	EV Charging	Bike Subsidy	Vanpooling	Flexible Parking	TDM Coordinator	Telework
University of Waterloo	✓	✓	✓	✓			✓	✓		✓					
University of British Columbia	✓	✓	✓	✓			✓	✓	✓	✓	✓		✓		
Carleton University	✓	○	○	○		○	✓	✓	✓	✓					✓
Concordia University	✓	✓				✓	✓	✓	✓	✓					○
Oregon State University	✓	✓	✓	✓		✓	✓	✓	○	✓		✓	○		○
Tufts University	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓			○
University of California Los Angeles	✓	✓	✓		✓			✓		✓	✓	✓	○	✓	✓
East Carolina University	✓	○	✓	○		○	✓	✓	○	✓			○	○	
University of New Hampshire	○		✓	✓			✓	○	✓	○			○		✓
University of Pennsylvania	✓	✓	✓				✓	✓	✓	✓	✓	✓	✓		
California State University Northridge	✓	✓	✓	✓	✓	○	○	✓		✓		✓		✓	✓
State of Rhode Island Government	○	○	○	○		○	○	○			○	○		○	○
Apple Inc.	✓		✓	✓		✓	✓	✓	✓		✓			✓	

 Current Practice
 Proposed Initiative

Findings

The Best Practice Review found a wide variety of strategies, initiatives and programs that were either currently in use or were proposed through the Transportation Plan. The most common programs were carpool systems and bike facilities, which all of the studied institutions currently provide or proposed to provide. Carpool systems included any form of carpool services, whether operated within the institution, or providing information to external carpooling systems available within the institution's location and area. Bike facilities was a broad category with amenities such as bike racks, lockers, cages, lanes, registration, wayfinding, and maintenance shops, shower facilities and buddy programs. Programs that were close in popularity included public transit subsidies, ride-sharing programs, carpool incentives, and electric vehicle (EV) charging facilities, which more than 10 employers provided or proposed. Other notable programs included: guaranteed ride home programs, clean fuel initiatives, marketing, bike-sharing, bike subsidies, vanpooling, flexible parking, TDM coordinators, and telework strategies.

One overarching initiative was the reduction of vehicular mobility on campus to encourage walking and cycling and improve safety. A couple of institutions implemented intra-campus shuttles or micromobility systems (shared bicycles, scooters, skateboards, etc.) to travel within campus to provide easier access to transit stops and to reduce intra-campus vehicular travel. Some offered shuttles to nearby neighbourhoods which had numerous employees. Tufts University offers a "Bike Buddies" program, which pairs less experienced cyclists with nearby and more experienced cyclists to improve the confidence of those who have reservations about cycling alone. Incentive-based programs were another trend in the review, and included both financial and reward (prize) based offerings. Incentives covered anything from sustainable transportation choices in general, to specific transportation modes including the offer to exchange a parking pass for a bike package worth \$450 (University of California Los Angeles), a bike commuter reimbursement program for up to \$240 annually (University of Pennsylvania), or a bike check which provides up to \$50 annually for expenses such as repairs, new helmet, etc. (Tufts University).

Analysis

Each institution has a unique geographical context which plays a role in the success of their TDM programs. As such, what works well in some cities, may not work as well in others. The University of Waterloo currently has a number of practices in place, many of which were also commonly found during the best practices review, such as carpool systems, public transit subsidy, guaranteed ride home program, and bike facilities.

One practice that could be effective at the University of Waterloo is the implementation of a TDM coordinator. While not an overly common practice found during the review, increasing awareness of practices was mentioned frequently, with some institutions designating a TDM coordinator to oversee sustainability programs and work with employees. A TDM coordinator can conduct a wide range of tasks which could consist of assisting employees with organizing and planning their commute, explaining the options of various commuting modes and incentives available, and organizing carpooling/vanpooling and bikesharing. The TDM coordinator could also provide additional support for increasing awareness and usage of sustainable transportation programs at the institution. Alternatively, Oregon State University is implementing an online commute platform, which brings all transactions and lays out all the commuting options in one place; Tufts University, and Concordia University have similar online systems.

Flexible or preferential parking was another potentially applicable best practice. There was wide variability on the implementation of such practices, which largely revolved around reducing the convenience of driving alone. These strategies, initiatives and programs include, but are not limited to:

- Parking cash-out;
- Increased parking rates;
- Flexible/pay-as-you-go parking;
- Reward system for commute modes other than driving alone;
- Preferential parking for carpool/vanpool/clean fuel vehicles;
- Discount parking rates for carpool/vanpool, low emission, or clean fuel vehicles;
- Designated carpool lots;
- Flexible work to allow for carpool/vanpool;
- “Park and Ride” employee lots; and
- “Park Once” system to reduce intra-campus travel during the day.

The parking programs discussed often worked in conjunction with each other and with other TDM programs, such as bike subsidies. A combination of these programs is most likely to be effective at the University of Waterloo. Based on the parking prices at other institutions, the University of Waterloo’s parking fee of \$38 per month is comparably low; Concordia University ranges from \$90 to \$285 per month and the University of British Columbia ranges from \$95.55 to \$103.35 per month. It is important to note that the parking system and fee structure varies between the institutions and their geographic locations, making it difficult to compare. Parking pricing is fairly site-specific and the University may choose to undertake a parking study to determine a more sustainable, or market-based, parking fee structure that would more accurately reflect the market and environmental costs.

Telework was another emerging trend mentioned within multiple institutions. For the University of Waterloo, while more than half of the employees live within the urban boundary of Kitchener-Waterloo (~62%), there is still a large proportion who live outside the city that would likely require some form of vehicular travel to reach campus. Providing policies for teleworking can help to reduce vehicular emissions by reducing trips to campus per week and flexible work hours can allow for a more adjustable schedule to support carpooling/vanpooling. Simply allowing for telework to occur a few times a week can still have a significant impact on reducing vehicle emissions.

Incentives may also be adaptable to the University of Waterloo context to help shift employee mode choice. Several incentives were identified throughout various institutions, including subsidies and/or reimbursements for bicycling, public transit subsidies, rewards programs for choosing more sustainable methods, and parking “cash-out” options, which give employees money towards transit passes in exchange for their parking pass. While the university currently works with Travelwise to subsidize the GRT transit passes, the best practices show that the subsidy offered is fairly low (15%) in comparison; Apple offers up to \$100 per month reimbursement, Tufts University proposed a 50% public transit subsidy, and California State University Northridge offers up to 60% subsidy for transit up to \$100. Also to note, the Corvallis Transit System, which services Oregon State University, is fareless and the University of New Hampshire also offers free public transit.

3.0 Employee Journey Analysis

3.1 Background & Context

Sustainable travel behaviour refers to the environmental, economic and social impacts that are reduced when users make a travel mode (Sunio and Schmocker, 2017). The promotion of such sustainable transportation modes mitigates the environmental effects of mobility and can have further positive effects on users (Esztergar-Kiss et al., 2021). As a result, understanding how individuals make mode choices is important and needs to be further investigated, to support sustainable mode choice. The following memo reflects what we understand about individuals' travel behaviour based on literature as well as the key documents listed in Section 3.3.

3.2 Current State

As reflected in the 2020 TravelWise Survey, over 66% of commuters at the University of Waterloo are staff and around 10% are faculty members. This is an increase from 37% and 7% in 2018. The 2018 TravelWise Survey results indicated contract part-time workers drove alone most frequently, while full-time employees made up the second highest of those who drive to work. Additionally, data identified from this survey indicated that sustainable transportation is used most by those aged 20-34. Lastly, the distance was found to be a significant factor in determining travel patterns. The average reported distance to work was 11.3 kilometres (km) and 68% of staff live within 10 km of the University.

3.3 Methodology

Understanding how individuals make mode choices is important and therefore must be further investigated, to support sustainable mode choice. The Employee Journey Analysis reflects what we understand about individuals' travel behaviour, based on our findings from various academic literature articles as well as the following key documents that informed the findings:

- The 2018 TravelWise Commuter Survey;
- The 2020 TravelWise Commuter Survey; and
- The “Opportunities for Increasing Sustainable Transportation Uptake by Employees at Waterloo” Report.

The work from the Employee Journey Analysis, helped the consulting team further investigate the wide range of employees at the University of Waterloo, and the factors that may influence individuals' mode choice during their commute to work.

The Employee Journey Analysis first identified three categories of influence (on mode choice), which included:

- The individual characteristics of the traveller;
- The trip characteristics; and
- Characteristics of transport facility.

Individual characteristics refer to factors such as income, car ownership, household structure, or attitude. Trip characteristics include factors such as trip purpose, time of day and whether it is an individual or group trip. Transport facility characteristics refer to factors such as travel time, cost, availability, reliability, comfort, safety and security (Ortuzar & Willumsen, 2011). The results found in Almarsi & Alraee (2013), find that the factors which significantly affect mode choice include total travel time cost, ownership and means of transport, distance and the age of the individual. The analysis focused on the following characteristics within the three different categories:

- Income;
- Employment Type;
- Household Structure;
- Employee Interest and Satisfaction;
- Individual or Group Trip;
- Weather;
- Geographic Location;
- Availability of Infrastructure; and
- Comfort.

3.4 Influence of Transportation Decisions

3.4.1 *Individual Characteristics of the Traveller*

Income

In The Opportunities for Increasing Sustainable Transportation Uptake by Employees at Uwaterloo Report (2018), it was found that there was a positive correlation between income and the drive-alone mode of transportation. As the income of employees increased, so did the likelihood to drive alone as their primary mode of transportation. This is consistent with literature research, where when an individual's income increases so does their disposable income. This provides the opportunity for employees to prioritize the convenience and social status of private automobile ownership (Flannelly & McLeod, 1989).

This is an important consideration when we are looking to shift these commuters to more sustainable modes. Understanding this income and convenience factor, we may want to look at policies and initiatives that focus on convenience, while also understanding what specific current policies and incentives at the University cause individuals to choose to drive over other modes. For example, the cost of a parking pass on campus versus a transit pass, proximity of parking lots versus proximity of transit stops to spaces of employment on campus.

Employment Type

According to the TravelWise Survey (2018), different position types can often experience different travel behaviour due to the consistency and flexibility needed for each. The survey found that contract part-time workers drove alone most frequently. The survey results are expected as contract-part time workers do not have as much of an obligation to be on campus as often. This allows for such workers to live further away from the university, however increasing their distance, and therefore may impact the availability and convenience of using sustainable modes compared to those who live closer. As the survey results show that permanent, full-time employees make up the second-highest of those who drive to work, these are the individuals- especially those living in close proximity to the university we can target for a shift in commuting mode.

Household Structure

The Opportunities for Increasing Sustainable Transportation Uptake by Employees at Uwaterloo Report (2018), looked to analyze the relationship between age and mode choice. The results did not determine a significant relationship; however, it suggests that other age-related factors such as family obligations or household structure can influence one's mode choice. For example, those who drove alone to work may be based on factors such as speed, comfort, and individual freedom, especially among those who may have competing family obligations such as dropping other family members off at alternative locations (Beirão & Cabral, 2007). This same notion is reflected in other literature where households with young children face a number of spatial and time constricts in meeting their travel needs (Dowling 2015, Schwanen, 2011; Wheatley, 2014). Accommodating things such as childcare, employment and

household responsibilities can restrict the time available for individuals to meet their own needs as well as their household's travel demands (Dowling, 2015).

According to The Opportunities for Increasing Sustainable Transportation Uptake by Employees at Uwaterloo Report (2018) report, most employees who had family obligations drove alone. Such information is significant as we need to understand how in some scenarios, driving is the most feasible option. However, implementing things such as a flex pass, for such employees can be useful in reducing the number of drive-alone scenarios, as individuals can drive alone only when necessary to meet such family obligations, but choose more sustainable modes for other days.

Employee Interest and Satisfaction

The 2018 TravelWise Survey asked respondents an open-ended question to identify if there were any programs, services or infrastructure changes that would encourage them to try using sustainable modes of transportation in their commute to campus. The top factors encouraging a different mode include:

- Better local transit routes;
- Better cycling/trails to work;
- Discounted transit passes; and
- Bike parking at the workplace.

The top factors encouraging a different mode that were within the University scope included:

- Bike parking at the workspace;
- Shower facilities at the workplace;
- Flex parking passes for the days that driving is needed;
- Dedicated carpool parking at the workplace; and
- An employer-provided shuttle to and from work.

Additionally, the majority of those who were very satisfied with their primary mode of transportation to work included those who walked, while the majority of those who were very unsatisfied and unsatisfied with their primary mode of transportation drove alone (2018 TravelWise Survey, 2018). Understanding such push factors are important in shaping new initiatives and improving current initiatives.

3.4.2 Trip Characteristics

Individual or Group Trips

According to the 2018 TravelWise Survey, 48% and 32% of those who used carpooling as a mode of transportation were satisfied or very satisfied with their primary mode of transportation. Additionally, one of the questions in the survey asked what method of travel employees used most often for their commute. Besides driving alone, carpooling was the second-highest mode of transportation. The design and development of carpooling services have been driven by the need to promote sustainability and improve the efficiency of the transport systems in urban areas (Mitropoulos et al., 2021). This helps to minimize negative impacts such as emissions, travelling costs and congestion while increasing passenger vehicle occupancy (Mitropoulos et al., 2021). Carpooling services combine the flexibility and speed of driving alone, with a reduced cost. For staff and faculty members who have similar hours, there is an opportunity to share a vehicle trip and split travel costs, such as gas and parking fees, with others who have similar time schedules. Understanding the positive satisfaction of current carpoolers as well as the benefits it brings, can help improve existing carpool initiatives.

Weather

Weather considerations are an important influence on active transportation, specifically cycling. Positive weather conditions are considered the most suitable for cyclists. This is when the greatest number of cyclists are reported to ride, such conditions include periods of warm temperature, low winds and the absence of precipitation (Mitchell, 2018). Additionally, negative conditions include the presence of rain, fog, snow, extreme temperatures, wind, and humidity. The presence of such conditions may also affect the number of those influenced to cycle during these types of days (Mitchell, 2018). In Waterloo, the warm season lasts for approximately 3.7 months from May to September, with an average daily high temperature above 20 degrees. The cold season lasts for 3.3 months from December to March with an average daily high below 3 degrees. A wet day is considered one with at least 1 mm of liquid or liquid-equivalent precipitation (WeatherSpark, n.d). The wet season in Waterloo lasts 7 months. Among the wet days, rain alone is most common for 10 months, whereas snow alone is most common for 1.9 months (WeatherSpark, n.d). As a result, walking and cycling do not always seem the most convenient or feasible throughout the entire year.

3.4.3 Characteristics of the Transport Facility

Geographic Location

Personal characteristics not only directly affect travel mode choice but can also affect the mode choice indirectly through longer-term choices. One long-term choice relates to one's residential location. This is a factor that affects the decision-making process as it influences a person's mobility, as it relates to constraints in their activity and travel pattern both in space and time (De Vos et al., 2015). Similarly, Esztergar-Kiss et al. (2021), highlight that travel time and distance are important parameters that influence mode choice. The Central Transit Corridor is the central spine that runs through the heart of the urban communities in Cambridge, Kitchener, and Waterloo. The ION is currently in place in this

Corridor to support the concentration of existing and planned residences and jobs (Region of Waterloo, 2013). Individuals who live in closer proximity have a bigger potential to shift modes. Understanding this is important as these are the commuters we would like to target in the transition to more sustainable modes of transportation. Based on the 2018 TravelWise Survey, the majority of employees at the university live within 0 to 10 km of the university. 19% of employees who live 0 to 5 km, and 1% living within 5 to 10 km of the university commute by walking. This is quite normal as people do not usually walk too far to reach their workplace. Of the survey respondents, 23% of employees who live within 0 to 15 km of the university commute by cycling, meaning this mode can be suggested for shorter trips. For public transport, the majority of those who use transit as a main mode of transportation live within 5 to 10 km of the university. The majority of those who live within 20 to 30 km of the university, chose to drive, which means that longer trips can be suggested by this mode.

Availability of Infrastructure

In developing TDM initiatives, it is important to consider the status and availability of infrastructure that supports such transportation modes, as well as the role it plays in influencing an individual's mode choice. Multiple studies show that the structure of road networks and the availability of transport infrastructure such as a road network are related to mode choice. The availability of an adequate road network provides high accessibility for travel and good connectivity, which provides greater opportunities for the use of sustainable modes of transportation such as biking, walking or public transport (Parthasarathi & Levinson, 2018; Ramezani & Pizzo, 2018; Chu & Nguyen, 2019). Additionally, higher-order transit individuals are willing to travel further to use it, thus, those who live within reasonable distances of the ION Central Transit Corridor should be encouraged to use it. Understanding where employees live in relation to their commute routes and the availability of infrastructure or lack thereof around them can help us to identify which groups of individuals we can encourage to use sustainable modes and the barriers they may face.

Comfort

According to Ye et al. (2020), comfort, preference are some of the factors that affect commuters and students. Comfort preference has a significant negative influence on the choice of public transport, while it has a significant positive impact on the choice of a private car for commuters. The Opportunities for Increasing Sustainable Transportation Uptake by Employees at Uwaterloo Report (2018) looked at the relationship between employees' demographics and mode choice, such as age. The results found that driving alone was the most prominent transportation choice across all ages, due to the convenient nature of driving.

4.0 Employee Transportation Data Analysis

4.1 Methodology

ArcGIS was used to conduct an employee transportation geospatial analysis, and visualize the data. Employee postal codes were first taken from the survey and geocoded using ArcMap, then were plotted on the map for visualization (ESRI, 2022). Similar research was conducted in the “Opportunities for Increasing Sustainable Transportation Uptake by employees at the University of Waterloo” report by SustainableMobility (2017). Different routes such as walkability network data, cycle lanes, Grand River Transit (GRT) and ION routes, and stops layers were obtained from the Region of Waterloo’s open public data, the City of Kitchener’s open public data, and the Geospatial Centre at the University of Waterloo, which were then added to the maps. University of Waterloo is identified as the centre point, with catchment areas set at 2, 5, 10 and 15 km from the University respectively. Inside each catchment area, the distance between employees and transportation infrastructure was analyzed and conducted using the Near Analysis tool to determine the likelihood of each individual to use a specific transportation mode based on their distance to it.

Also noted in the original data, it was determined that there is a threshold of 400 m from a GRT stop, 600 m distance from bike paths, and 200 m distance from walkability networks for people to use each mode (2017). Additionally, a threshold of 1 km (1000 m) was established for the distance from ION stops. Geocoded postal codes for employees further than 15 km from the University were recorded, but an analysis of transportation infrastructure was not conducted due to regional differences in transportation infrastructure.

The research conducted in this analysis is intended to provide an updated version of this spatial research, with similarities in the way research was conducted and analyzed. As convenience is a factor in commuting choice, an additional analysis was undertaken to assess the number of bus transfers employees need to reach the university, either needing one and two bus commutes. This analysis was conducted by first identifying all the buses that had stops at the University of Waterloo to find the people within one bus ride, then identifying bus routes within the GRT system that intersected with bus routes that had stops at the University campus.

A connectivity network analysis was completed for both active transportation (Walkability and Cycling) and transit networks using the Network Analysis tool in ArcGIS. Infrastructural data was layered, creating a complete network connecting to the University. This was further examined to determine infrastructural barriers and insights for opportunities.

4.2 Findings

4.2.1 Walkability

While most employees have access to sidewalks or some form of walking network, realistically only those who live in the nearby vicinity to the University are the most likely to walk to work. For the purpose of this Study, it was determined that it was reasonable for the average person at a 2 km radius from the University, 98% of the employees located in that radius have access to walkability networks within 200 metres (m). An examination of the percentage of employees within 2, 5, and 10 km with access to walkability networks is shown in Table 2, and postal codes without access to walkability networks is shown in Figure 2.

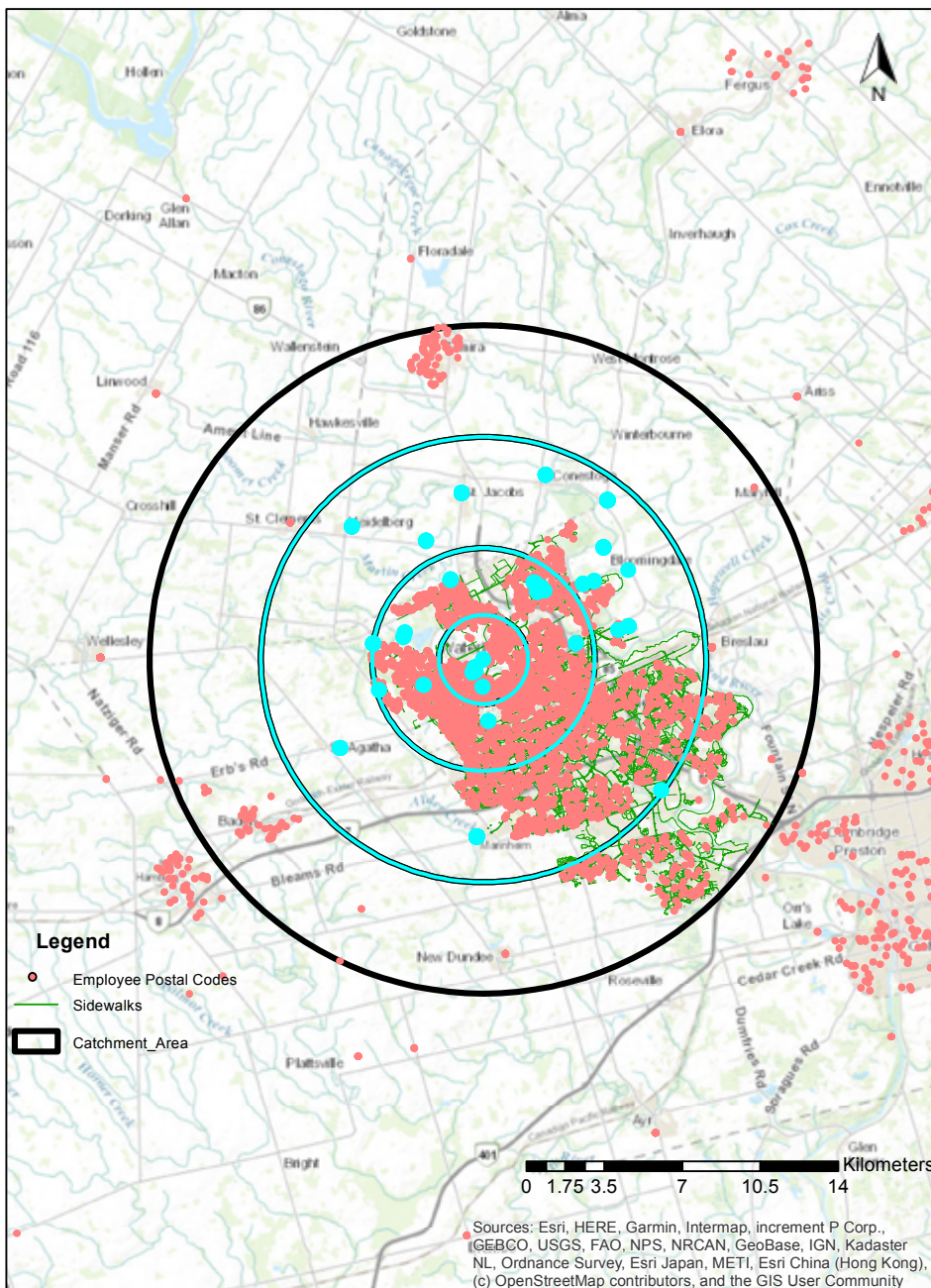


Figure 2: Employee postal codes in 2, 5, 10 km catchments from the University of Waterloo that do not have access to sidewalks and walkability networks within 200 m

Table 2: Percentage of employees in 2, 5, 10 km catchments from the University of Waterloo with access to sidewalks and walkability networks within 200 m

Catchment Area from the University (km)	% of Employees With Access to Walkability (within 200 m)
2	98.06
5	98.73
10	97.13
15	N/A

4.2.2 Cycling

When considering accessibility of cycling infrastructure, the data analysis showed that 93% of employees within the 2 km radius had access to bike lanes within 600 m. Looking within a larger radius of 15 km, 76% of employees had access to cycling trails within 600 m, as shown on Table 3 below. Postal codes without access to cycling networks is shown in Figure 3.

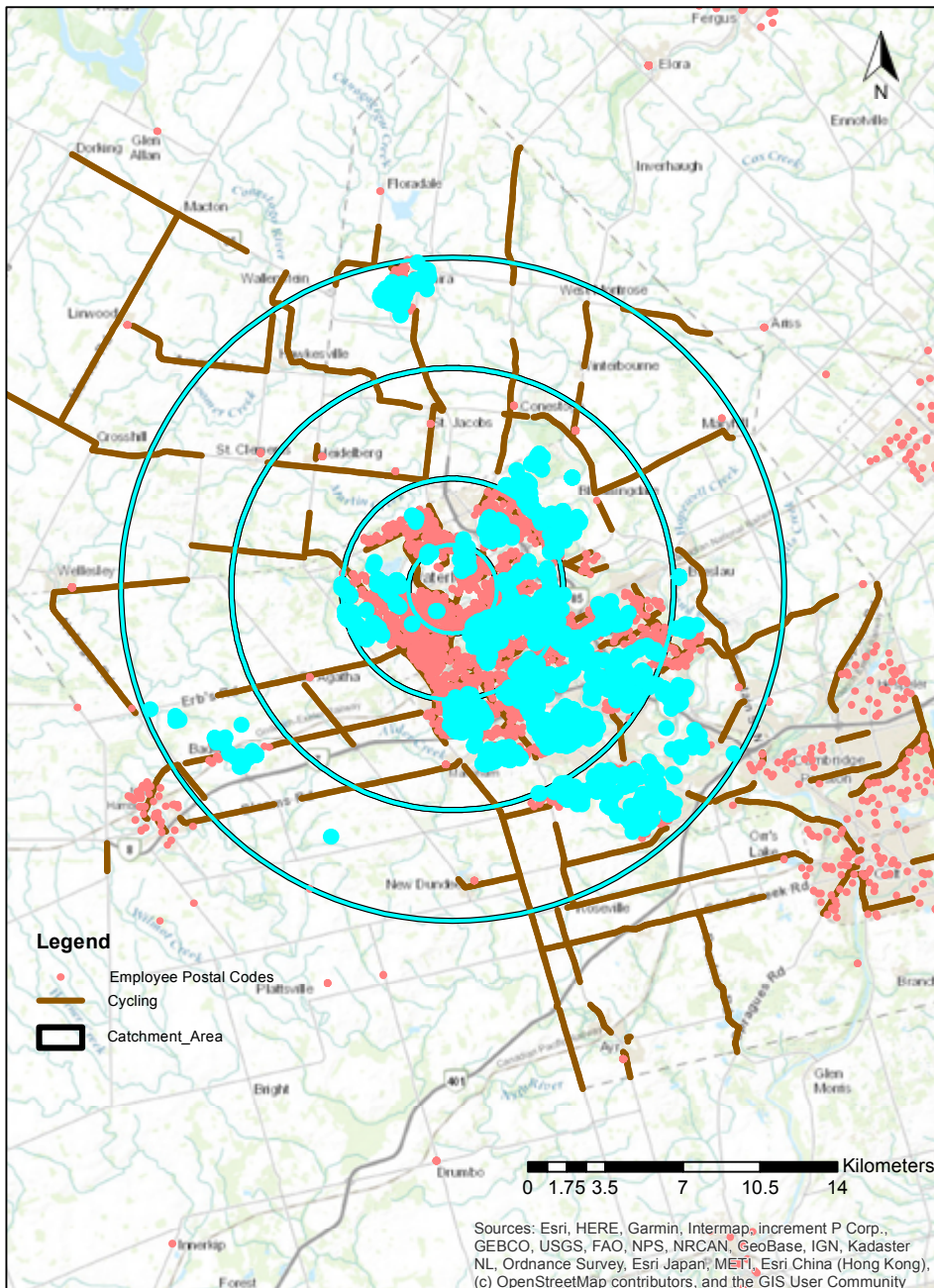


Figure 3: Employee postal codes in 2, 5, 10, 15 km catchments from the University of Waterloo that do not have access to cycling networks within 600 m

Table 3: Percentage of employees in catchment areas from the University of Waterloo with access to cycling networks within 600 m

Catchment Area from the University (km)	% of Employees With Access to Bike Lanes (within 600 m)
2	92.83
5	77.31
10	69.06
15	66.17

4.2.3 Active Transportation Network

A connectivity network was created for active transportation networks within 5 km of the University. This contained both Sidewalk and Cycling data that provides a continuous network to the University. From this analysis, around 28% (1,061 out of 3852) of employees within the 5 km catchment area had access to the active transportation network within 200 m. This number is significant as it shows that though employees within the catchment area may have access to walking and cycling networks independently, they don't necessarily have access to a complete network. The postal codes within 200 m to the active transportation network is shown in Figure 4.

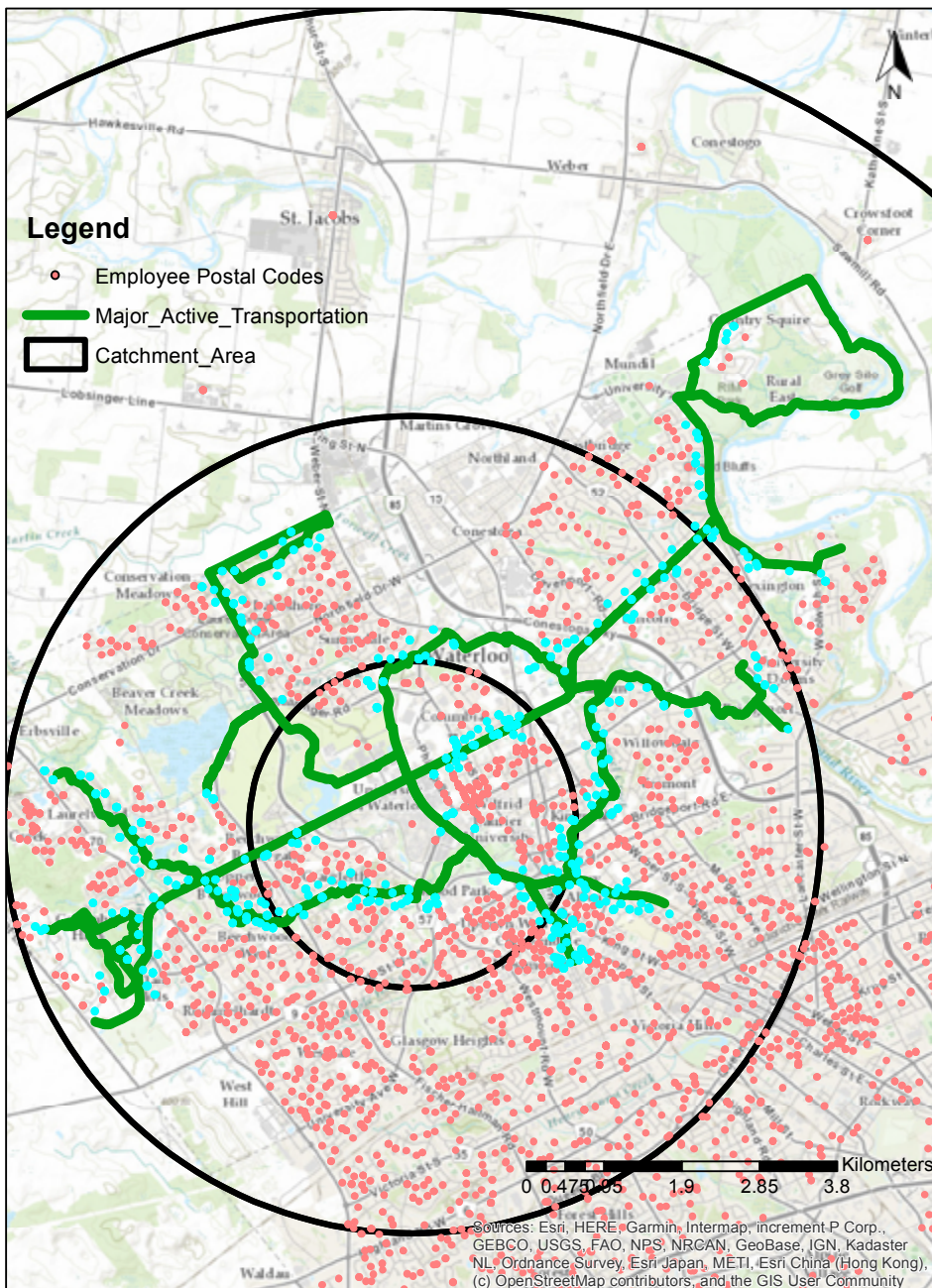


Figure 4: Employee postal codes that have access to the active transportation networks within 200 m to the University of Waterloo

4.2.4 Bus Transit (GRT)

When examining access to bus public transit, the majority of employees had access to a bus stop within 400 m, which is the equivalent of a 5 minute walk. The percentage of employees with access to GRT stops within a 2, 5, 10 and 15 km catchment area of the University are identified below in Table 4, and postal codes without access to GRT stops are shown in Figure 5. The map shows that there is a cluster of employees without access to GRT stops near the western portion of Waterloo campus, especially as you reach the 5 km to 15 km catchment area.

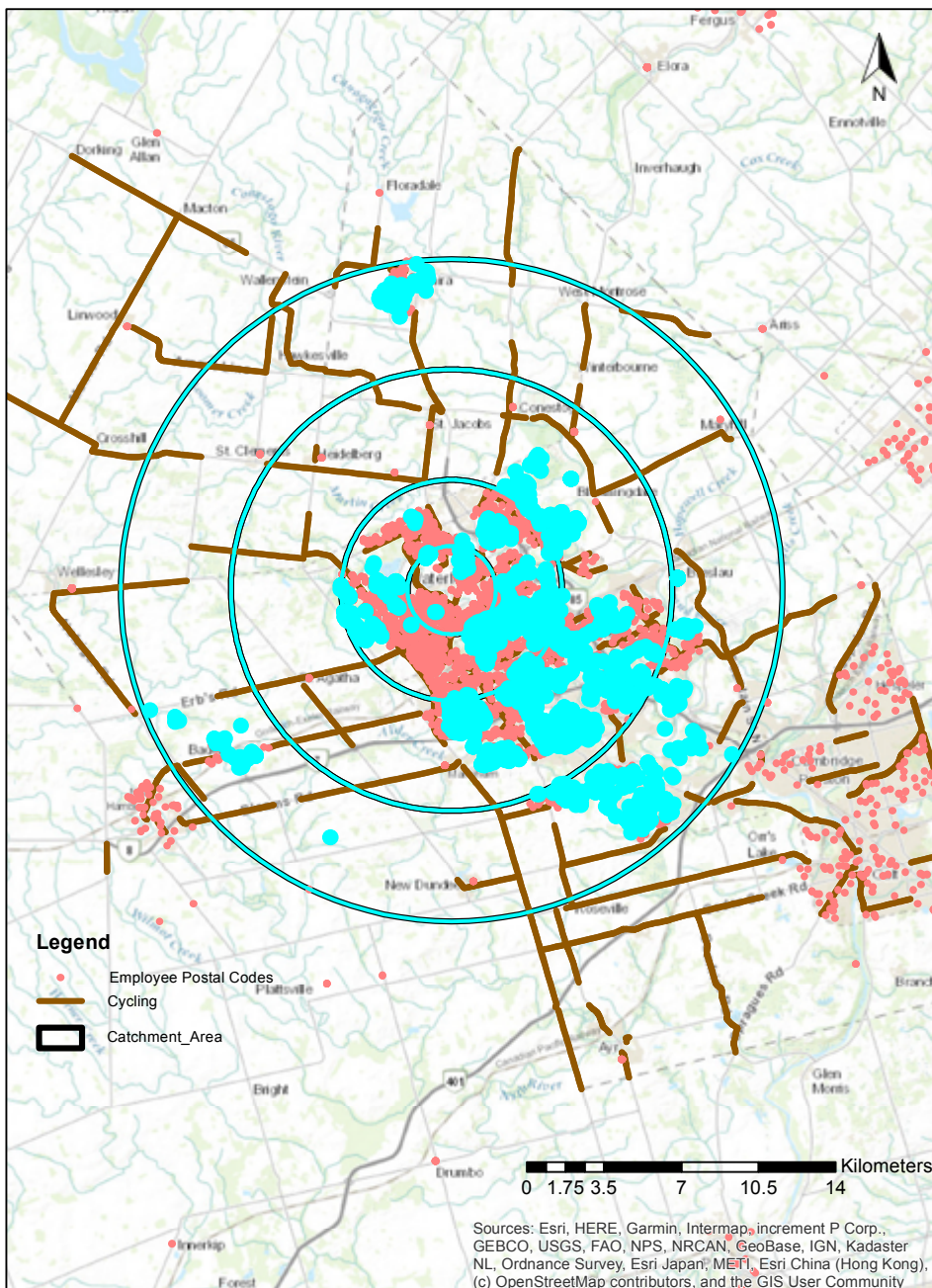


Figure 5: Employee postal codes in 2, 5, 10, 15 km catchments from the University of Waterloo that do not have access to cycling networks within 600 m

Table 4: Percentage of employees in catchment areas from the University of Waterloo with access to GRT stops within 400 m

Catchment Area from the University (km)	% of Employees With Access to GRT Stops (within 400 m)
2	94.62
5	92.63
10	89.74
15	87.18

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

GRT Bus Route Convenience & Ease of Access (Transfers)

To determine the accessibility of the GRT bus transit service, an analysis was conducted using GRT bus routes and employee postal codes. Convenience is a major factor when considering commuting methods. The more an individual has to transfer during their commute, the less convenient the trip is. This makes other commuting modes, such as driving, seen as being much more convenient. Thus, it is important to identify how many employees would require one bus and how many would require two buses to commute to the University of Waterloo.

109 GRT bus routes run across Waterloo Region, with 14 of these routes containing a direct stop at the University of Waterloo. The average person will walk up to 400 m to a bus stop which is the distance used to determine the number of employees within walking distance to a bus route. The analysis showed that 2,724 employees were within walking distance of a bus stop (400 m) that provided a route with direct access to the University of Waterloo campus.

Of the estimated 6,003 employees that live within the Region of Waterloo, approximately 45% of employees require one bus to reach campus. The analysis found that 4,761 employees were within 400 m of a bus stop that would allow them to commute to the University of Waterloo with two buses or less. From this analysis, it is estimated that 79% of University employees within the Region of Waterloo have access to campus within a maximum of two buses (one transfer).

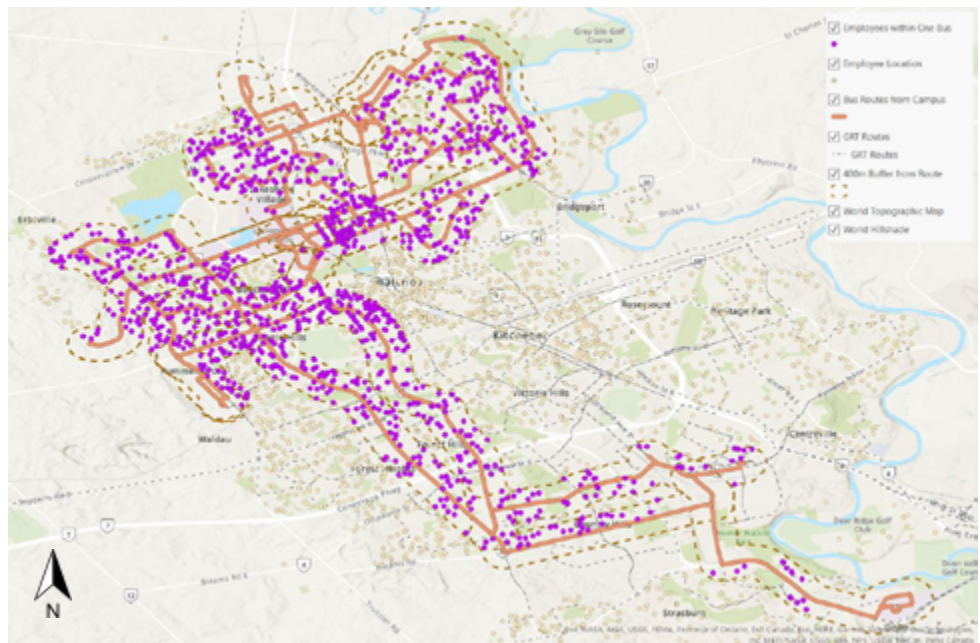


Figure 6 (top): Postal Codes Requiring One Bus Service to Reach University of Waterloo

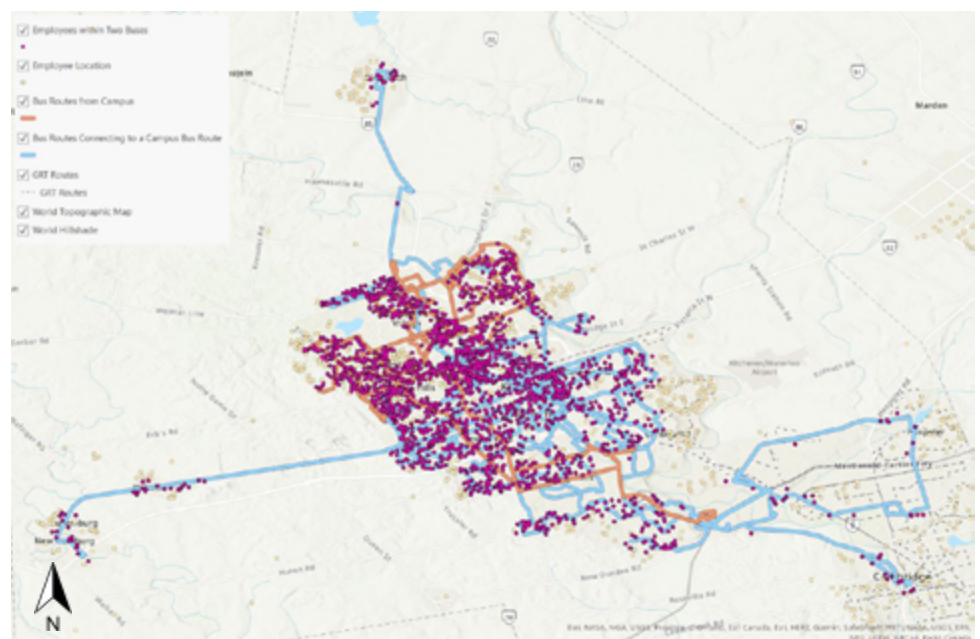


Figure 7 (bottom): Postal Codes Requiring Two Bus Services to Reach University of Waterloo

4.2.5 ION Light Rail Transit

Because the ION LRT operates on a limited path, there are a large number of employees who do not have direct access to an ION station. When analyzing the data, a larger access distance of 1000 m (~10-12 min walk) was used as studies show people are much more willing to travel further to utilize higher orders of transit. Within 2 km of the university, 60% of employees had access to an ION station, while within a 15 km radius, 30% of employees had access to an ION stop within 1000 m, as shown in Table 5 below. For all the employees within the Urban Boundary of KW, only 26% of them would have access to an ION station within 1000 m.

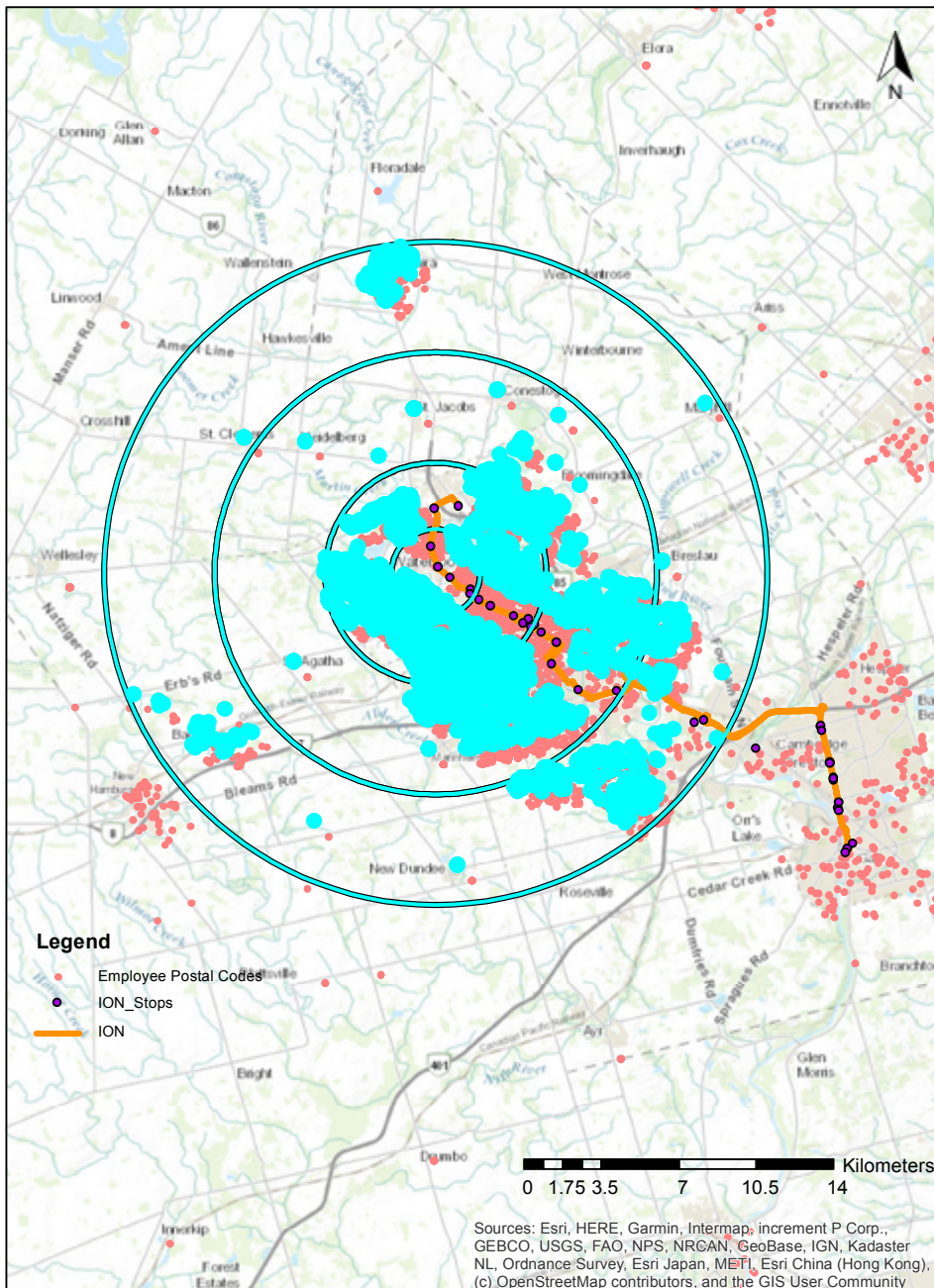


Figure 8: Employee postal codes in 2, 5, 10, 15 km catchments from the University of Waterloo that do not have access to an ION station within 1000 m

Table 5: Percentage of employees in catchment areas from the University of Waterloo with access to an ION station within 1000 m

Catchment Area from the University (km)	% of Employees With Access to ION Station (within 1000 m)
2	60.01
5	36.32
10	31.92
15	29.22

4.2.6 Connectivity Network (Active Transportation & Transit)

With the GRT bus stop and ION station data, a second connectivity network was created for the sustainable transportation networks within the region including sidewalk, cycling, and bus and ION routes. The data analysis found that around 64% (5520 out of 8657) of employees within Waterloo Region had access to this network within 400 m. This technically means that the majority of employees living within the region have some form of access to a sustainable transportation mode. However, timings to reach the university varies on a large scale.

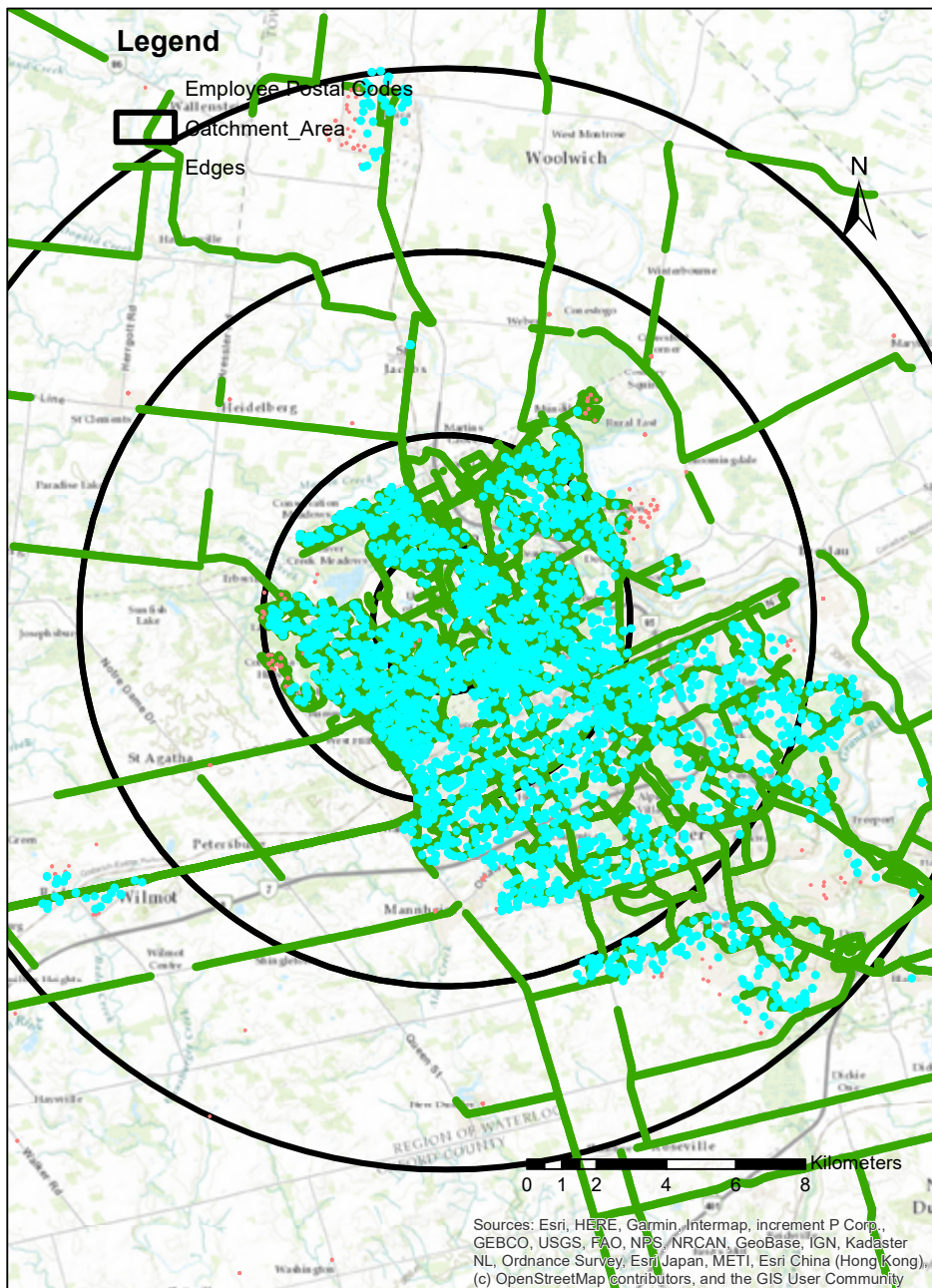


Figure 9: Employee postal codes that have access to the connectivity network within 400 m to the University of Waterloo

5.0 Discussion & Analysis

5.1 Barriers

It is important to first determine the factors influencing employee travel behaviour in order to be able to shift their behaviour towards more sustainable methods. While considering the barriers to sustainable transportation, the Travelwise 2018 survey showed that the top three reasons employees' decide to drive were: convenience and comfort, efficiency, and personal trips before, during or after work.

Understanding the barriers that influence people's modal choice is crucial to establishing the recommendations and further realizing how to shift employee modal choice to more sustainable modes effectively. From the research within the Employee Journey Analysis, literature review, best practices, and the surveys provided, our team identified three primary categories of influence: individual characteristics of the traveler, characteristics of the trip, and characteristics of the transport facility. These influences can be also categorized into non-infrastructural (characteristics of the individual traveler and characteristics of the trip), and infrastructural barriers (characteristics of the transport facilities).

5.1.1 Non-infrastructural Barriers to Sustainable Transportation

Individual Characteristics of the Traveller

The barriers relating to the characteristics of the traveler include income, employment type, household structure, employee interest and satisfaction, and lack of awareness.

Income

Research found there was a positive correlation between income and driving. The higher an employee's income, the higher the amount of disposable income and the likelihood and ability to drive alone as their primary mode of transportation. Having a higher disposable income can also encourage the prioritization of convenience, leading to more single occupant vehicle (SOV) trips.

Employee Type

The TravelWise Survey (2018) showed that different employee types can often have different travel behaviours due to the consistency and flexibility needed for each job type. The survey found that contract part-time workers drove alone more frequently as they don't have as much of an obligation to be on campus as often. Permanent full-time employees made up the second highest numbers of those who drove to work.

Household Structure

Household structure can influence the kinds of trips and obligations employees may make before, during, and after work. Many employees in the Travelwise survey cited family obligations and other personal trips as reasons for choosing private automobiles as their primary modal choice. A review of the literature found those who drove alone often made their modal decision based on factors such as speed, comfort, and individual freedom, especially among those who have family obligations such as dropping other family members off at alternative locations (Beirão & Cabral, 2007). Accommodating trips involving childcare, employment and household responsibilities can restrict the time available for individuals to meet their own needs, as well as their households travel demands (Dowling, 2015).

Employee Interest & Satisfaction

Employee interest, satisfaction and awareness can refer to one's perception of Waterloo. These factors can vary based on one's personal values, perception and interests. One's comfort and perception on how safe it is in navigating active transportation facilities, includes walking and cycling networks, as well as transit, for their specific demographic. Additionally, employee awareness was also found to be important in establishing common knowledge to the sustainable transportation networks available (e.g., knowing what bus routes to take to reach the destination). Employee awareness extends to knowledge of the programs and incentives available to them. The 2018 survey found that there was a large portion of respondents who were not previously aware of the TravelWise programs offered at the University of Waterloo, and can further imply that they may be unaware of the other sustainability programs that the University offers.

Characteristics of the Trip

Trip barriers for the characteristics of the trip include factors such as weather, commute time and costs. can influence the kinds of trips and obligations employees may make before, during, and after work.

Weather

Weather plays a role in commuter mode choice, especially in Canada. The Region of Waterloo experiences a continental four-season climate, with cold winters and hot summers. As a result, walking and cycling do not always seem the most convenient or feasible throughout the entire year, resulting in many people opting to drive.

Commute Time

It is largely perceived that the commute time by car is significantly faster than walking and cycling. A part of this perception is tied to how one experiences these trips and the lack of awareness surrounding the first and last mile of the commute. When considering walking or cycling, the perception is from the time leaving the home to reach their building of employment. However, with driving, commuters often only consider the time taken to travel in the vehicle and not the time spent walking between the vehicle and their destination. In the case of Waterloo, most of the parking lots are located around the edge of campus meaning that many employees incur a fair amount of travel time between the vehicle and their office building.

Financial Costs

Financial costs and fees are another non-infrastructure barrier related to the trip, especially with regard to parking costs. Compared to other institutions, the price per month for a faculty parking pass is comparatively low at the University of Waterloo and is highly subsidized. This can stand as a large barrier to encouraging sustainable mode shift.

Additionally, as mentioned before within the income and employment type barriers, some may value time over cost savings. In this case, many may feel that the cost of parking is justified for increased convenience and efficiency, versus trying to save money by another mode like walking or cycling. The parking permits are offered to faculty and staff as a monthly fee, either to be paid in office or by payroll deduction. With the option of paying through payroll deduction, the parking permit charge is much more convenient to pay, does not come directly out of the employee's pocket, and can be easily forgotten about. Therefore, through this structure, it can be very easy for employees to continuously use and pay for parking. Similarly, by offering a monthly pass, the University encourages driving as employees paying for the pass on a monthly basis will want to get their money's worth.

5.1.2 Infrastructural Barriers to Sustainable Transportation

Characteristics of the Transport Facility

Lastly, characteristics of transport facilities were considered under infrastructural barriers which included geographic location of employee households and availability of infrastructure.

Geographic Location of Employees

When considering geographic location, the distribution of employees geographically is important to consider. During the evaluation of the postal code data provided, it was found that only around 62% of employees live within the Kitchener-Waterloo urban area, with the remainder distributed between the rural areas and other towns and cities. Outside of the Greater Toronto Hamilton Area (GTHA), there are concentrations of employees in towns and cities nearby Kitchener-Waterloo (K-W), including Cambridge (~224), Guelph (~215), Elmira (~73), Stratford (~57), London (~56), and Fergus (~20). This geographic distribution of employees presents a barrier as a significant number of employees live outside the buffer where walking, cycling or public transit are feasible.

Availability of Infrastructure

When examining the availability of infrastructure, the focus was on access to sidewalks, bike lanes, and to transit. All three of these factors affected how likely individuals were to shift to these more sustainable modes of transportation. The next portion of the infrastructural barriers will focus on the employees within the K-W urban area and the availability of infrastructure.

Walkability

The data analysis showed that lack of access to walkability networks was not a barrier in the case of the University of Waterloo as over 98% of employees had access to these networks. However, in the case of walkability, distance tends to be the larger barrier that might prevent these employees from walking as there is a limited distance that is feasible to consider walking to work (approximately 2 km). Other barriers outside of distance include whether the walking networks are well connected, if the walk is enjoyable or safe, and if the infrastructure is adequate and maintained (i.e. narrow sidewalks along large, busy roads, properly lit and snow clearance).

Cycling

Factors such as the maintenance of the lanes and trails, safety, and connectivity of the networks impact whether commuters use these systems as when these factors are inadequate, it makes it more challenging or tedious to the user. A bike ridership survey by the City of Edmonton in 2014 found that there is a latent demand for cycling and more people would like to cycle, but feel that the conditions are not safe enough. Safety concerns that were identified within this study included heavy motorized traffic, poor winter maintenance, lanes not being well lit, and a lack of driver awareness of cyclists.

Public transportation

While the number of employees within Waterloo region that have access to public transportation is quite high, further analysis was conducted into the percentage of employees who only required 1 bus and the percentage of employees who required 2 buses to commute to the University of Waterloo. The results of the analysis found that 45% of employees within Waterloo Region require only one bus to reach the university, whereas 79% of employees require 2 or less buses to reach campus. The number of transfers required to reach a destination can highly influence one's mode choice. A commuting survey done at McGill University found that trip satisfaction declines by 32% when a rider must transfer at least two times, and transfers between bus routes, and between a bus and a higher order (for example the LRT), also negatively affected trip satisfaction (Grisé, & El-Geneidy, 2019).

Due to the limited route of the new ION LRT, there are a large number of employees who do not have direct access to an ION stop. When the LRT is extended into Cambridge, this may improve as it will ideally provide those in Cambridge quick and timely access to the University of Waterloo.

5.2 Opportunities

Vanpooling

One opportunity the University could implement would be a vanpooling system. Similar to carpooling, a vanpool is a larger vehicle (i.e. a van) that would allow more passengers to drive together. A vanpool would be ideal for groups of employees in towns and cities located outside Kitchener-Waterloo, such as Guelph, Cambridge, Elmira, and London, that have a substantial number of employees (>50). Vanpooling would work similarly to carpooling and could be operated with similar benefits (i.e. preferential parking).

Flexwork / Telework

Flexible work (flexwork) and telework are other opportunities that other institutions have employed to reduce emissions. Flexwork allows for employees to have flexible work hours which can help improve the convenience of carpooling and other sustainable transportation methods. The rigidity of set work hours means that driving may be the only option if they have other commitments (i.e. dropping off or picking up kids from bus stops) that do not align with public transit or carpooling timing. Telework would allow for employees to work from home some day(s) a week which would save their commuting emissions and ideally contribute to fewer vehicles on the road during peak commuting hours. While not viable for all employment positions, the option for some employees to work remotely could cut down on the emissions coming to campus on a given day.

Parking

There are a number of opportunities with parking to encourage commuting mode shift. One opportunity is the implementation of a pay-as-you-go or flexible parking permit system. When parking permits are charged monthly, people are encouraged to continue driving for the full month to maximize the permit usage. Implementing pay-as-you-go or flexible parking may encourage more employees to take alternative transportation modes more frequently. Increasing the parking permit fees is another opportunity to help shift mode behaviour; right now the permit costs are fairly low in comparison to other institutions and a more market-based rate that factors in the environmental and social costs of driving could help to encourage other forms of transportation. Research into surrounding monthly parking lot fees was undertaken through the HonkMobile App and the following rates were found:

Address	Type	Monthly Fee
250 Lester Street	Covered	\$99.00
201 Lester Street	Garage	\$99.00
203 Lester Street	Garage	\$99.00
251 & 253 Lester Street	Covered	\$99.00
137 University Avenue	Uncovered	\$75.00
255 Sunview Street	Garage	\$120.00
261 Lester Street	Covered	\$99.00
208 Sunview Street	Garage	\$99.00
239 Albert Street	Uncovered	\$125.00
The Hub	Underground Parking Garage	\$130.00
388 Philip Street	Uncovered	\$100.00
383 Albert Street	Uncovered	\$125.00

Table 6: Parking Lot monthly fees for addresses near the University of Waterloo

A parking study could be undertaken to better understand the true cost of driving and parking to accurately price the parking spaces. While the University currently offers preferential parking for carpooling, further expanding the program to offer more spots in prime locations such as:

- Preferential parking spaces for vanpooling, plug-in hybrid vehicles, EV or hybrid vehicles;
- Implement dedicated parking lots for carpool/vanpool;
- Offer financial incentives through reduced-cost parking permits for carpooling, vanpooling, and low to no emission vehicles (e.g., electric, hybrid, motorcycles); and
- Implement a parking permit cash-out system, allow parking passes to be “cashed-out” and reward sustainable choices.

Public Transit Subsidy

The University of Waterloo currently offers a 15% savings on public monthly transit passes through TravelWise. However, as many other institutions offer greater discounts, further increasing the subsidy to lower the cost of the transit pass could prove beneficial to encouraging employees to take more sustainable modes of transportation. Tufts University offers a 35-40% subsidy (depending on campus) and proposed a 50% subsidy, California State University Northridge offers a subsidy of up to 60% for transit up to \$100, and Apple Inc. offers up to \$100 per month reimbursement.

TDM Coordinator

One opportunity available would be to implement a Transportation Demand Management (TDM) Coordinator position at the University. While not very prominent across institutions yet, the benefits of a TDM Coordinator are plentiful. They can work with employees to come up with individualized commute plans, implement marketing campaigns to increase awareness of the TDM programs available, coordinate carpooling and vanpooling (including identifying clusters of employees that could carpool/vanpool and reaching out to gauge interest), and track the progress and use of the programs to identify any gaps or improvements to further improve their efficiency and usage.

Marketing

In the 2018 survey, almost half of the respondents (43%) indicated that they had not previously heard of or been aware of TravelWise. To improve awareness of the programs that the school and TravelWise offer, marketing programs could be employed. Marketing and bringing awareness to the available programs is an important aspect of ensuring the success of these programs as if employees do not know they exist, they do not know all the options they have for commuting and will generally stick with their status quo. A TDM coordinator or other dedicated employee(s) could undertake this role.

Shuttle Service

Another opportunity is identifying neighbourhoods within Waterloo which contain a high concentration of employees and offering a shuttle service to reduce the number of single-occupancy vehicle trips. Apple Inc. and the University of Pennsylvania offer shuttle services to nearby neighbourhoods with high quantities of employees. The University of Waterloo could identify neighbourhoods with high numbers of employees that could benefit from a shuttle service and reach out to gauge interest.



(Roger Chen, 2022)

Public Transit Subsidy

The University of Waterloo currently offers a 15% savings on public monthly transit passes through TravelWise. However, as many other institutions offer greater discounts, further increasing the subsidy to lower the cost of the transit pass could prove beneficial to encouraging employees to take more sustainable modes of transportation. Tufts University offers a 35-40% subsidy (depending on campus) and proposed a 50% subsidy, California State University Northridge offers a subsidy of up to 60% for transit up to \$100, and Apple Inc. offers up to \$100 per month reimbursement.

Bike Facilities

The school has a number of existing bike facilities. However, building on the existing services with other identified needs from the 2018 survey as well as the information found in the research, there is an opportunity for rounding out the cycling infrastructure on campus.

One opportunity is the inclusion of shower and locker facilities which was a suggestion from the 2018 survey as well as found in other institutions. Installing more covered bicycle parking was another commonly found bike facility to encourage the use of cycling to campus as the cover helps to protect the bicycles from the elements. Bike wayfinding off-campus was another comment from the 2018 survey that could be implemented by creating a map available to employees with the cycling infrastructure available across Kitchener-Waterloo (i.e. bike lanes, bike paths/trails, etc.).

One program found during the research that was offered by Tufts University was the “Bike Buddies” program. The program paired employees who were hesitant about or less confident in cycling with employees who were more experienced cyclists to encourage more employees to commute via cycling. Incentives to encourage cycling are another opportunity as some institutions offer reimbursements for bicycle-related fees such as protective gear or maintenance. One institution also offered four “rainy day” parking passes a year to cyclists who use cycling as their primary method of transportation; however, they were located in California and the applicability of this method may be limited as Ontario’s four-season climate presents challenges for cycling year-round.

Bikesharing

In the Spring and Fall of 2019 the University offered a bikesharing program called “Dropbike”. Investigating the success and drawbacks of the program could be beneficial to looking into the possible continuation, expansion or iteration of the Dropbike program. Exploring new technology and other forms of light-weight transportation such as scooters to improve micromobility on campus and assist with addressing the first and last mile aspect of the commute.

5.3 Limitations & Assumptions

There were multiple limitations and assumptions made throughout the duration of the Study. The first limitation was the duration of the project, with having only four months to provide a full report with recommendations. The timeline limited the team's ability to provide further in-depth analysis, interpretation, and findings for the scope of work. For the analysis, interpretation of data and the research aspect of the project, further analyses were not conducted due to the time constraint. As not all possible analyses were conducted, it is possible that there may be additional information yet to be determined that could have impacted the final recommendations in this report. By having a longer time frame, the team potentially could have identified more cities with similar geographical context in terms of population, land use and geographical location to have more comparisons of data analysis and research.

Another limitation faced was the data; specifically the restrictions of the survey data, selection biases and Google Mapsestic. The privacy of survey data from the University of Waterloo was a limitation, as the raw survey results were not accessible due to privacy circumstances. Therefore, certain factors and relationships were not considered and may have skewed the survey data results that were provided. This can also influence the outcome of the GIS analysis, impacting the interpretations of the findings.

Thirdly, there is the possibility of selection biases for data. This study was undertaken to gather and analyze as much hard data as possible and present it in a standard form to facilitate comparison. Each data set was assessed and as most of them were unique, the focus of data analysis for this study was based largely on employee commuting behaviors within the urban boundary. By not limiting data analysis to within the urban boundary, it may have helped better identify potential gaps.

The fourth limitation is associated with the use of Google Maps travel time data versus more conventional forms of travel data. While Google Maps data provides the benefit of quality of both in timescales at which the data is available and in the level of disaggregation of trip level data, there is little research available to confirm the accuracy of the data to actual travel conditions. In fact, the underlying methods used for calculating predictive travel times are not known.

The last limiting factor was COVID-19. With the pandemic, there were a lot of changes in regards to the working environment and scenario (i.e., stay-at-home orders, remote working, reduced commuting, etc.) During this time, there was a shift to working from home which would have impacted the survey responses and data gathered during the pandemic. One assumption for this study that was requested is that the Transportation Demand Management Plan would be based on a pre- and post-COVID normal. Because of this, the most data that was analyzed for the Study was gathered prior to the pandemic (2018), meaning the majority of the information used was limited and outdated.

6.0 Recommendations

Based on the research and analysis completed for the Study, five recommendations are proposed for the University of Waterloo to encourage sustainable modal shift within the employee demographic.

Recommendation #1: Parking

The first recommendation is to adjust the university's current parking system, both financially and organizationally. One of the main barriers for sustainable mode shift is the convenience of driving. Driving is generally considered to be more comfortable and faster than alternative modes of transportation. At the University of Waterloo, the low cost of parking and the monthly permits both contribute to the appeal of driving to campus. The University of Waterloo charges \$38 plus tax (\$42.94) per month for parking which is low in comparison to the University of British Columbia where the cost of a monthly parking pass is \$103.55 and Concordia University where the permit price ranges from \$70 to \$285 per month. Monthly parking permits make it easy to trap employees into renewing their passes due to the limited availability, and encourage people to drive so they get their money's worth within that month-long permit period.

To make driving less convenient, other institutions have employed a number of methods, including:

- A "parking cash-out" system where employees cash in their parking pass for some form of reimbursement/financial incentive (i.e. "sustainable transportation allowance", a specified reimbursement instead of free or subsidized parking). UCLA offers an Earn-A-Bike Program in which they provide a free \$450 bicycle package in exchange for their parking permit.
- Increased parking rates to account for the actual cost of parking including maintaining the parking lots, as well as the environmental and social costs. Costs can also be based on the fair market values well as comparables in the area. In this case, nearby monthly parking costs range from \$75 to \$130, with the majority of private parking lots sitting around \$99 to \$100 per month for a space.
- A flexible or "pay-as-you-go" parking system where parking is based on a daily rate in order to avoid trapping employees into paying for a month at a time and encourage switching up commuting methods.
- A rewards system for employees who commute by modes other than driving alone.
- Offering preferential parking for carpools, vanpools, and clean fuel or low emission vehicles. Introducing a Commuter Parking Pass for employees outside of a specified geographic range of the University who would likely rely on a vehicle to commute to and from campus which would offer a discounted parking rate so that employees who live further away pay less than those who live close by.

- Offering discounted rates for carpooling or vanpooling permits to encourage high occupancy vehicle trips.
- Offering discount parking rates for low emission (motorcycle) or clean fuel vehicles.
- Providing designated carpool/vanpool lots closer to campus.
- Flexible work to allow for carpooling/vanpooling.
- “Park and Ride” Employee Lots.
- “Park Once” system to reduce intra-campus travel during the day.

For the University of Waterloo, increased parking rates, flexible or “pay-as-you-go” parking, and preferential parking are recommended as a starting point, however a parking study should be conducted in order to further examine these options and to determine a recommended parking rate that would account for the actual cost of parking as well as the environmental and social costs of driving. In the interim, a parking increase could be justified based on surrounding monthly parking rates which range from \$75 to \$130 per month.

Considerations:

- Some solutions easy to implement in the short term/interim
- Complexity of determining the actual cost of parking
- Many options to choose from

Barriers Addressed

- (vary based on program):*
- Convenience
 - Low cost of parking or subsidized parking
 - Weather

Implemented at:

- University of British Columbia
- University of California Los Angeles
- California State University Northridge

Recommendation #2: Increasing the Public Transit Subsidy

The second recommendation is to increase the existing public transit subsidy for employees. While University employees are currently offered a 15% subsidy for monthly GRT passes through TravelWise, other institutions offer upwards of 40 to 60% subsidies, or a reimbursement up to a certain amount. For example Apple, offers a transit reimbursement for up to \$100 per month. When comparing it to other institutions, the existing subsidy offered by the University of Waterloo is relatively low. The University of Sherbrooke in Quebec offers a \$50 subsidy so that employee's only pay around \$20 per month (Université de Sherbrooke, n.d.).

One major consideration for public transit subsidies is with the Canadian income tax laws, if an employer covers the cost (either partially or fully) of public transit passes for an employee, it counts as a taxable benefit and as a result would be shown on the employee's T4 as taxable income. This tends to be undesirable for many employees. An alternate solution to the University directly increasing the subsidy could include collaboration with the Region of Waterloo and TravelWise to increase their public transit subsidy either for all employers or just the University of Waterloo (i.e. by increasing the University's membership fees to accommodate the increased subsidy). Lowering the cost of public transit for employees, coupled with the previous recommendation of raising the price of parking, would help make public transit more attractive to employees from a cost perspective.

Considerations:

- Require collaboration with the Region/ GRT/TravelWise to determine feasibility
- Income tax/taxable benefit considerations
- Could be minimally complex to implement and could occur quickly

Barriers Addressed:

- Cost of parking versus cost of public transit
- Convenience

Implemented at:

- University of British Columbia (Okanagan Campus)
- Carleton University (proposed)
- University of Sherbrooke

Recommendation #3: Shuttle Service

The third recommendation is to implement a shuttle system between neighbourhoods with a high concentration of employees and the campus. This suggestion mainly stems from the 2018 TravelWise survey, where the respondents suggested a shuttle could be a good program to encourage using sustainable modes. Identifying gaps within the existing bus system where there is a high concentration of University employees and implementing a shuttle system could reduce the number of individual vehicle trips. Alternatively, a vanpooling system could be set up for smaller-scale shuttle operations in K-W, as well as within other cities and towns nearby that have high concentrations of employees such as the Greater Toronto Area (GTA) (Figure 10).

Guelph is another area with a significant concentration of employees (214 employees) that could benefit from high-occupancy travel systems such as a vanpool or shuttle service (Figure 11). Guelph is approximately 34 km from the University of Waterloo and has no direct link to the Region of Waterloo transportation system other than by road. It takes approximately 40 minutes to drive to the University of Waterloo campus from Guelph. With the current VIA Rail schedule, the only train from Guelph to Kitchener is at 6:50 pm, which is not feasible for employees commuting for regular work hours. The GO Bus route from Guelph to the University takes approximately 1 hour and 40 minutes. These lengthened times can impede household obligations.

Another potential nearby location is Elmira which is 15 km away from the University and has approximately 71 university employees (Figure 12). The University of Waterloo is approximately a 20-minute drive from Elmira.

Elmira does have access to the GRT system. The GRT Route 21 connects Elmira to the University of Waterloo, however the trip takes around 48 minutes and includes a transfer from the bus to the ION (overall time varies based on connection times). It may be valuable for the University to investigate implementing a shuttle system between neighbourhoods and nearby towns with high concentrations of University employees and determine the demand for this service.

It is recognized that not all employees work similar hours, and there may not be high enough demand for it to be a feasible service. However, this exercise can still be beneficial for identifying employees in similar geographic areas that would be interested in higher occupancy travel, and promote other forms of commuting such as carpooling or vanpooling.

Recommendation #3: Shuttle Service

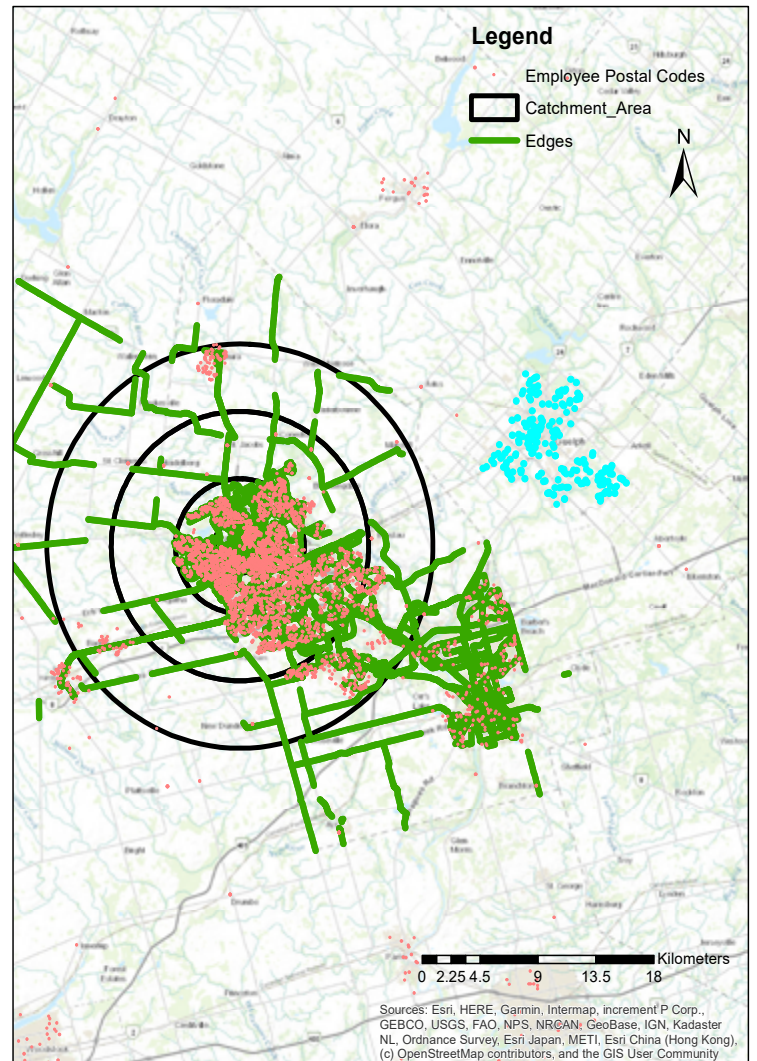
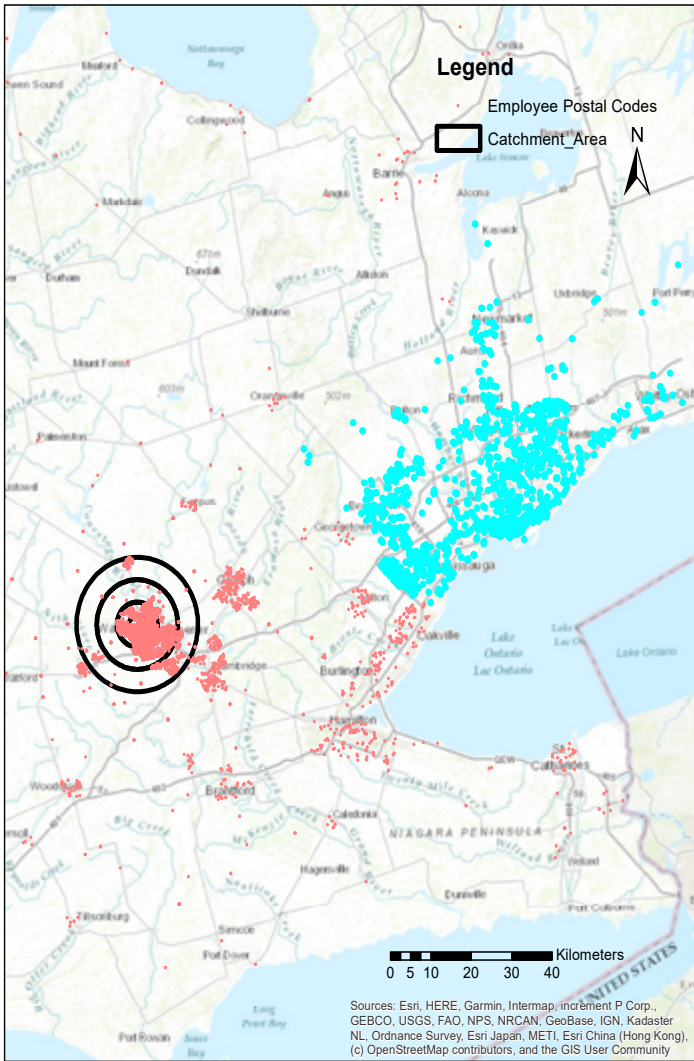
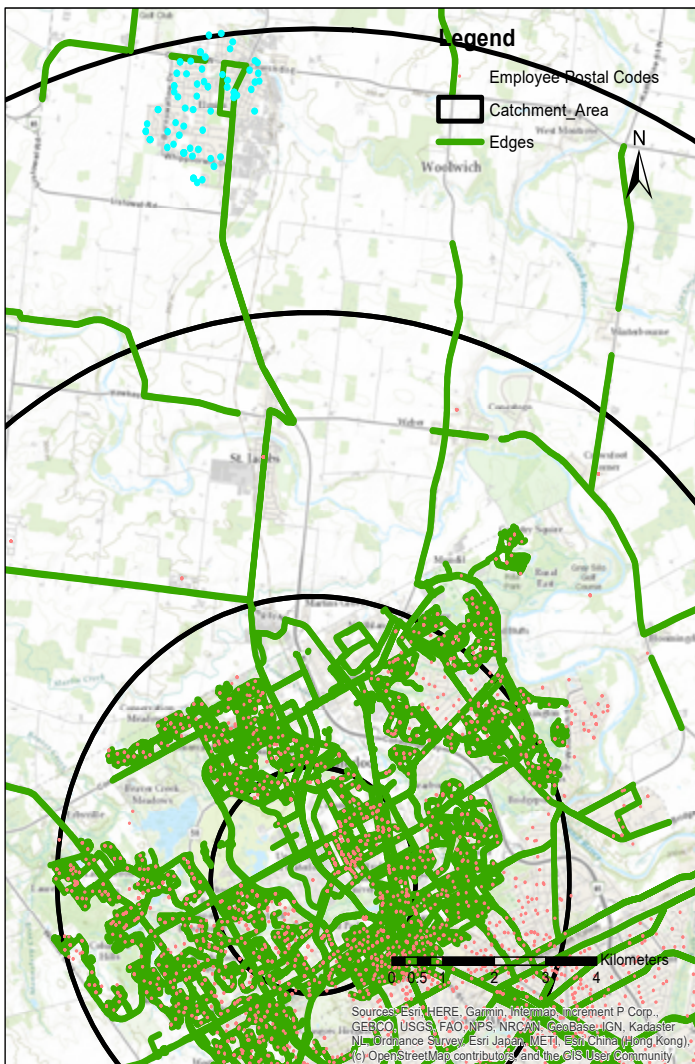


Figure 10: University of Waterloo Employee postal codes in the Greater Toronto Area

Figure 11: University of Waterloo Employee postal codes in Guelph, ON



Considerations:

- Feasibility and costs (e.g., employees to run service, operating and capital costs for shuttle/vanpool service)
- Geographic distribution of employees and route determination

Barriers Addressed:

- Geographic location
- Convenience
- Weather

Implemented at:

- University of British Columbia
- University of Pennsylvania
- Apple Inc.

Figure 12: University of Waterloo Employee postal codes in Elmira, ON

Recommendation #4: TDM Coordinator

The fourth recommendation is to have a Transportation Demand Management (TDM) Coordinator position at the University. The TDM Coordinator would play a number of roles, most centrally being in charge of the programs. This Coordinator would function as the administrator of the TDM programs and initiatives, and would track the use of the programs in order to identify gaps and opportunities, collect further feedback from commuters, and propose adjustments where needed. The coordinator could also work to increase awareness of the University's TDM programs through marketing and promotion, organize carpools and vanpools arrangements for employees that live nearby each other, and work with employees to organize individualized travel plans. The coordinator could also work with outside agencies such as TravelWise to further improve the programs and offerings. As noted in the 2018 Report, the TDM programs are most successful when there is an integrated approach to implementation, involving multiple programs. Having a TDM coordinator in charge of overseeing all the programs would provide the opportunity to integrate the programs in order to maximize the success of the programs.

The City of Oakville prepared a Transportation Demand Management Plan in 2016 for the Oakville Green development, a large-scale commercial development that will have a significant number of employees (WSP & MMM Group, 2016). As part of the Plan, they identify the need for a TDM coordinator as a part of the TDM Strategy in order to be successful as the coordinator will be responsible for administering and promoting the programs to employees. Appendix A to the Oakville Green Transportation Demand Management Plan includes a detailed Roles and Responsibilities outline for the TDM Coordinator position which could be used as a starting point for the University of Waterloo.

Considerations:

- Costs of having a dedicated person
- Consistent evaluations of new opportunities as well as gaps within the TDM programs
- Dedicated individual to increase awareness of programs

Barriers Addressed:

- Lack of Awareness
- Geographic Location
- Time

Implemented at:

- California State University Northridge
- East Carolina University (proposed)
- Apple Inc.
- City of Oakville (Oakville Green)

Recommendation #5: Flexwork / Teleworking

The fifth recommendation is to implement workplace policies to support flexible work and teleworking arrangements for employees. Flexible working, or flexwork, would allow employees to have a more adjustable start and end time to their workday, providing them more time to get to work, and the flexibility to tend to obligations, such as having to drop off and pick-up their kids from school, that may be preventing them from using alternative modes of transportation in the interest of being on time. Allowing flexwork would not only allow more flexibility for using public transit, but also for carpooling where people may start at different times and therefore have to currently drive alone.

The University could additionally implement policies to permit teleworking for applicable employees to allow them work from home a few days a week. While the majority of employees are within the Kitchener-Waterloo Urban Area, there are still approximately 38% of employees who are living outside of the urban area, most of whom would require a vehicle to commute. By offering the ability for employees who are able to do their jobs remotely the opportunity to telework/telecommute, the overall number of trips to campus in general would be reduced, and this would help towards reducing total emissions generated from employee commuting.

Considerations:

- Feasibility (certain equipment, resources only available on-campus)
- Social Equity (only certain jobs will be applicable for these programs)

Barriers Addressed:

- Weather
- Convenience
- Household Structure/Family Obligations

Implemented at:

- Carleton University
- University of New Hampshire
- University of California Los Angeles

7.0 Conclusion

This Study looked to determine accessibility of sustainable transportation systems for employees, identify infrastructural and non-infrastructural barriers to sustainable transportation from an employee perspective, and identify transportation demand management best practices from other institutions that could be applied in the context of Waterloo. The information found through research and analysis was then used to inform the recommendations that are set out in **Section 6.0** above. This Study will be used for the preparation of the Transportation Demand Management Plan by the University of Waterloo. While this study identified a number of barriers, opportunities and recommendations, there is still room for further research and analysis to assist the campus with reaching its goals of net zero emissions by 2050.



References

- Allen, J., & Farber, S. (2018). How time-use and transportation barriers limit on-campus participation of university students. *Travel, Behaviour & Society*, 13, 174–182.
<https://doi.org/10.1016/j.tbs.2018.08.003>
- Beirao, Gabriela, Cabral, J. (2007). Understanding attitudes towards public transport and private car: A qualitative study. *Transport Policy*, Volume 14, Issue 6, pp 478-489.
- Bozovic, T., Stewart, T., Hinckson, E., & Smith, M. (2021). Clearing the path to transcend barriers to walking: Analysis of associations between perceptions and walking behaviour. *Transportation Research. Part F, Traffic Psychology and Behaviour*, 77, 197–208.
<https://doi.org/10.1016/j.trf.2021.01.003>
- Cabral, L., Kim, A. M., & Parkins, J. R. (2018). Bicycle ridership and intention in a northern, low-cycling city. *Travel, Behaviour & Society*, 13, 165–173.
<https://doi.org/10.1016/j.tbs.2018.08.005>
- Climate and Average Weather Year Round in Waterloo Canada. Retrieved 18 April 2022, from <https://weatherspark.com/y/19227/Average-Weather-in-Waterloo-Canada-Year-Round>
- City of Kitchener. (2014). Official Plan. Retrieved from <https://www.kitchener.ca/en/development-and-construction/official-plan.aspx>
- Collins, P. A., & MacFarlane, R. (2018). Evaluating the determinants of switching to public transit in an automobile-oriented mid-sized Canadian city: A longitudinal analysis. *Transportation Research Part A: Policy and Practice*, 118, 682–695.
<https://doi.org/10.1016/j.tra.2018.10.014>
- Cuttleriwala, I., Milicic, K., Fernandes, S., Unia, R., & Bhardwaj, L. (2018). *Opportunities for Increasing Sustainable Transportation Uptake by Employees at UWaterloo*.

- De Vos, J., Mokhtarian, P.L., Schwanen, T. *et al.* (2015). Travel mode choice and travel satisfaction: bridging the gap between decision utility and experienced utility. *Transportation* 43, 771–796. <https://doi.org/10.1007/s11116-015-9619-9>
- Dowling, R. (2015). Chapter 35: Parents, children and automobility: Trends, challenges and opportunities. In R. Hickman, M. Givoni, & D. Banister (Eds.), *Handbook on transport and development* (pp. 526–538).
- ESRI. (2018). ArcGIS Online Geocoding Service. Retrieved March 31, 2018, from <https://geocode.arcgis.com/arcgis/index.html>
- Essam, A., & Sadi, A. (2013). Factors affecting mode choice of work trips in developing cities—Gaza as a case study. *Journal of Transportation Technologies*
- Esztergár-Kiss, D., Shulha, Y., Aba, A., & Tettamanti, T. (2021). Promoting sustainable mode choice for commuting supported by persuasive strategies. *Sustainable Cities And Society*, 74, 103264. doi: 10.1016/j.scs.2021.103264
- Flannelly, K. J., & McLeod, M. S. (1989). A multivariate analysis of socioeconomic and attitudinal factors predicting commuters' mode of travel. *Bulletin of the Psychonomic Society*, 27(1), 64–66. <https://doi.org/10.3758/BF03329899>
- G. Piazza, S. Bracco, F. Delfino, S. Siri. (2021). Optimal design of electric mobility services for a Local Energy Community, *Sustainable Energy, Grids and Networks*, 10.1016/j.segan.2021.100440, 26, (100440).
- Grand River Transit. (2017). University of Waterloo Station. Retrieved from <https://www.grt.ca/en/about-grt/university-of-waterloo-station.aspx>
- Klicnik, I., & Dogra, S. (2019). Perspectives on Active Transportation in a Mid-Sized Age-Friendly City: “You Stay Home.” *International Journal of Environmental Research and Public Health*, 16(24), 4916–. <https://doi.org/10.3390/ijerph16244916>

- M. C.Chu, L. X. Nguyen, T. T. Ton, and N. Huynh. (2019). "Assessment of motorcycle ownership, use, and potential changes due to transportation policies in Ho Chi Minh city, Vietnam," *Journal of Transportation Engineering Part A System*, vol. 145, no. 12, pp. 1–11.
- Mitchell, J. (2018). Cycling in a Changing Climate: An Examination of the Effects of Weather and Climate Change on Cycling Frequencies in Southern Ontario. Retrieved from https://uwspace.uwaterloo.ca/bitstream/handle/10012/13024/Mitchell_Jacob.pdf?sequence=5&isAllowed=y
- Mitropoulos, L., Kortsari, A., & Ayfantopoulou, G. (2021). Factors Affecting Drivers to Participate in a Carpooling to Public Transport Service. *Sustainability*, 13(16), 9129. Doi: 10.3390/su13169129
- Ontario.(2020). A Place to Grow: Growth plan for the Greater Golden Horseshoe. Retrieved from <https://www.ontario.ca/document/place-grow-growth-plan-greater-golden-horseshoe>
- Ontario.(2020). Provincial Policy Statement. Retrieved from <https://www.ontario.ca/page/provincial-policy-statement-2020>
- Parthasarathi, P and D. Levinson.(2018). "Network structure and the journey to work: an intra-metropolitan analysis," *Transportation Research Part A: Policy and Practice*, vol. 118, pp. 292–304.
- Region of Waterloo. (2018). Transportation Master Plan. Retrieved from <https://www.regionofwaterloo.ca/en/exploring-the-region/transportation-master-plan.aspx>
- Region of Waterloo. (2013). The Region of Waterloo Central Transit Corridor: Community Building Strategy.

- Region of Waterloo. (2015). The Region Of Waterloo Official Plan. Retrieved from <https://www.regionofwaterloo.ca/en/regional-government/land-use-planning.aspx#Regional-Official-Plan>
- Ramezani, Pizzo, and Deakin. (2018). "An integrated assessment of factors affecting modal choice: towards a better understanding of the causal effects of built environment," *Transportation*, vol. 45, no. 5, pp. 1351–1387.
- Schwanen, T. (2011). Car use and gender: The case of dual-earner families in Utrecht, The Netherlands. In K. Lucas, E. Blumenberg, & R. Weinberger (Eds.), *Auto motives: Understanding car use behaviours* (pp. 39–62). Bingley: Emerald Group.
- Sunio, V., & Schmöcker, J. D. (2017). Can we promote sustainable travel behavior through mobile apps? Evaluation and review of evidence. *International journal of sustainable transportation*, 11(8), 553-566.
- SustainMobility. (2018). Opportunities for Increasing Sustainable Transportation Uptake by Employees at UWaterloo. *University of Waterloo*.
- TravelWise. (2018). *2018 Commuting Report: University of Waterloo*.
- TravelWise, (2020). *2020 TravelWise Commuter Survey*.
- TravelWise, (2018). *2018 TravelWise Commuter Survey*.
- University of Waterloo. (2021). Environmental Sustainability Report. Retrieved from <https://uwaterloo.ca/sustainability/our-progress>
- Université de Sherbrooke. (n.d.). Transport en commun pour le personnel. Retrieved April 17, 2022, from <https://www.usherbrooke.ca/developpement-durable/mobilite/personnel#acc-3102-571>

University of Waterloo. (2020). *Shift: Neutral*. Retrieved April 6, 2022, from https://uwaterloo.ca/sustainability/sites/ca.sustainability/files/uploads/files/shift_neutral_final_aoda.pdf

University of Waterloo. (n.d.a). *Climate and Energy Data*. Retrieved April 6, 2022, from <https://uwaterloo.ca/sustainability/about/reporting/climate-and-energy-data>

University of Waterloo. (n.d.b). *Transportation*. Retrieved April 6, 2022, from <https://uwaterloo.ca/sustainability/projects-and-initiatives/transportation>

Willumsen, L. G. (2002). *Modelling transport*. Wiley.

Wheatley, D. (2014). Travel-to-work and subjective well-being: A study of UK dual career households. *Journal of Transport Geography*, 39, 187–196.
doi:10.1016/j.jtrangeo.2014.07.009

WSP, & MMM Group. (2016). *Transportation Demand Management Plan Oakville Green Life Sciences And Technology District. Town Of Oakville*. Retrieved April 17, 2022, from <https://www.oakville.ca/assets/2011%20planning/da-13250601-tdm.pdf>

Appendix A

Best Practice Review

Best Practices Review

Table of Contents

Transportation Plans	1
UBC Transportation Plan	1
Carleton University Transportation Strategy	3
Oregon State University Transportation Plan	5
Oregon State University 2030 Sustainable Transportation Strategy	6
Tufts University Transportation Demand Management Plan	8
East Carolina University Comprehensive Master Plan: Transportation Plan	10
University of California, Los Angeles – Sustainable Transportation Plan	12
University of New Hampshire – Transportation Policy Review and Update	14
Sustainability Plans with Transportation Policies	15
University of Pennsylvania Climate and Sustainability Action Plan 3.0	15
CSUN Sustainability Plan, 2013-2023	17
Concordia Sustainable Action Plan	19
Non-University Employee Transportation Plans	21
Rhode Island State Employee Transportation Guide Plan	21
Private Sector Employers with Transportation Demand Management (TDM) Strategies	22
Apple Inc.	22

Transportation Plans

UBC Transportation Plan

<u>Employer:</u>	The University of British Columbia (UBC)
<u>Date of Plan:</u>	2014
<u>Cost of Parking Space:</u>	\$95.55-\$103.35/month
<u>Location:</u>	Vancouver Grey Point Campus, Vancouver, British Columbia
<u>Number of Employees:</u>	16,343
<u>Who the plan is for?</u>	All employees and students

Summary of Plan:

The purpose of UBC's Transportation Plan is to provide long-term strategic guidance for campus planning, specifically with regard to transportation. Their Plan focuses on on-campus transportation and identifying gaps within their existing policy framework related to transportation in order to provide new policies and actions to achieve their long-term targets. The plan looks to improve transportation options and influence individuals' travel behaviour through implementation of the Plan.

TDM Initiatives/Strategies:

The targets of the UBC Plan include increasing sustainable travel (walking, cycling, transit), reducing single occupant vehicle (SOV) travel to and from UBC, and maintaining daily private automobile traffic at or less than 1997 levels. The relevant policies and actions set out in the plan to reach these targets include:

- Walking
 - Prohibiting travel through pedestrian core by UBC vehicles;
 - Promoting non-automobile travel by improving the pedestrian and cycling network;
 - Improve road, pathway and intersections to make alternative modes of transportation more convenient;
 - Improve campus pedestrian-friendliness by improving illumination, installing raised crosswalks, median islands, flashing lights, audible and tactile indicators;
 - Apply traffic calming principles to increase pedestrian friendliness; and
 - Expand the network of weather-protected walking routes across campus.
- Cycling
 - Ensure bike lanes on all major roads on campus;
 - Increase driver awareness of cyclists through signage, road markings and promotional campaigns;
 - Cover a minimum of 25% of UBC's bicycle racks;
 - Create and end of trip facilities plan for secure bicycle parking and amenities;
 - Increase end-of-trip facilities for cyclists through the requirement for all new academic buildings and mixed-use hubs to provide lockers, showers and covered secure bicycle storage in scale with the facility's floorspace;

- o Prioritize investments into improving route mapping, markings, more bike racks and secure parking; and
- o Develop a map to show the cycling network, to, from and around the campus.
- Transit
 - o Support TransLink initiatives to increase accessibility of transit to the campus from elsewhere in the Lower Mainland;
 - o Work with TransLink to increase the routes of the community shuttle and to better locate stops and shelters to better serve the campus;
 - o Encourage TransLink to use clean fuel vehicles for community shuttles; and
 - o Provide safe, accessible, weather-protected, convenient and attractive transit facilities.
- Driving
 - o Encourage shift from SOV to carpooling/vanpooling;
 - o Adopt policies that favor higher occupancy vehicles (HOV);
 - o Maintain measures to encourage carpooling (e.g. transferrable parking passes);
 - o Reduce the need to travel off campus by providing broader range of services on campus for daily convenience, social and recreational needs;
 - o Index minimum daily parking prices to transit fares;
 - o Continue to reduce the amount of commuter parking;
 - o Expand care sharing parking location across campus to meet demand; and
 - o Expand electric vehicle charging stations.

Parking on Campus:

Parking spots on the UBC Vancouver Campus range from \$95.55 to \$103.35 per month, depending on the length of the permit term. Parking space rentals are available in various durations, from 1 day (\$14) to 30 days (\$103.35) to a year (\$1,146.60) and the longer the duration of the permit, the cheaper the space is.

Discussion:

The UBC Vancouver Campus is located along the fringe of the City and separated from the built-up area of Vancouver by a forested area with five arterial roads providing access to the campus. The campus has been designed to support a complete academic and residential community on the campus and houses, housing just under half the student population in on-campus housing. The location of the site separate from the built-up area means that they have had to improve public transit access to assist with shifting travel behaviour to and from UBC. As a result, the walking and cycling recommendations are largely based on switching on-campus travel modes as opposed to targeting those who commute.

Current Practices in Place:

- Bike Share
- Bike Wayfinding
- Cycling Maps around Campus and Vancouver
- Slow Cycling Zones on Campus
- Bike Lockers and Cages
- Bike Maintenance

- Try an E-Bike Program
- Pedestrian Priority Zones
- Designated Carpool Lots
- Carpooling Services
- Emergency Ride Home Program
- Carsharing
- Allowing multiple vehicles to be registered against a parking permit
- Cheaper rates for motorcycles as lower impact vehicles.

Summary:

The UBC Plan provides some good strategies and initiatives for travel behaviour shift that can be adapted to fit within the Waterloo context, however the location of the UBC campus on the outskirts on the city means that alternative methods of commuting rely more so on transit and carpooling as walking and cycling is less desirable due to the distance from off-campus residences.

Carleton University Transportation Strategy

<u>Employer:</u>	Carleton University
<u>Date of Plan:</u>	2019
<u>Cost of Parking Space:</u>	\$59-\$134/month
<u>Location:</u>	Ottawa, Ontario
<u>Number of Employees:</u>	5,328
<u>Who the plan is for?</u>	All employees and students

Summary of Plan:

The purpose of the Strategy is to address the transportation challenges and opportunities that the University is expecting to experience within the next five (5) years. A part of this was creating transportation demand management policies and recommendations to reduce reliance on single occupancy vehicles.

Initiatives/Strategies:

The University's Transportation Strategy sets out recommendations for various aspects of transportation including active travel, parking, and transit. The relevant recommendations are as follows:

- Active Travel
 - Short-term (0-5 years)
 - Provide dedicated cycling facilities including amenities such as sheltered bike racks, secure bike lockers and shower facilities.
 - Marketing of current bike services
 - Improve pedestrian crossings in front of LRT station
 - Raised crosswalk in front of LRT platform
 - Connect to surrounding active travel facilities

- Re-purpose of local campus road (Library Road) for pedestrians/cyclists and prohibit general vehicle travel.
 - o Long-term (5+ years)
 - Pedestrian tunnel extensions
 - Re-purposing of Campus Ave (heavily travelled road) for pedestrians and cyclists and limit use of vehicles to shuttles, and service and emergency vehicles only.
 - Crossrides at Campus Accesses
- Parking
 - o Short-term (0-5 years)
 - Increasing parking costs to reduce demand (costs are lower than comparables across the city)
 - Shuttle van service for those with accessibility needs
 - Additional transportation Demand Management strategies recommended:
 - Implementation of an Employee Transit Pass Program
 - Telecommuting and Flextime program
 - Carpool and Guaranteed Ride Home Program
 - Additional EV Charging
 - Marketing
 - New Cycling Facilities
 - o Long-term (5+ years)
 - Autonomous shuttle service

Parking on Campus:

The cost of a parking space in the Staff/Faculty Permit Areas at Carleton University ranges from \$59 to \$134 dollars per month. The cost of a parking space depends on the lot which the permit is issued for. It appears that the more expensive spaces are located within a parking garage (\$74-\$134) whereas standard, outdoor parking spaces were cheaper (\$59-\$71).

Discussion:

The Carleton University Transportation Plan is more focused on accommodating growth and the changes that are planned within the next five years than transportation mode shift. However, there was a small section dedicated to transportation demand management to change travel behaviour within parking strategies. The location of the campus within the City as well as the presence of the LRT makes Carleton University comparable to the University of Waterloo.

Current Practices in Place:

- U-Pass program
- City's Rideshare Carpool Program
- Ottawa Ride Match
- Carsharing through ZipCar and VRTUCar
- Bike sharing (Right Bike Share)
- Bike Repair Station

- EV Charging

Summary:

The University's Transportation Plan is focused more on accommodating changes and growth that will occur over the next five years. Commuting methods were not directly discussed, however there was a small section on the Campus' existing TDM strategies and some proposed TDMs that could be implemented to assist with demand. Increased parking prices, telework/flexible work time, additional EV charging stations, and marketing the TDMs are some strategies that could work well for University of Waterloo.

Oregon State University Transportation Plan

Employer: Oregon State University (OSU)

Date of Plan: 2018

Cost of Parking Space: \$10 to \$48.33/month

Location: Corvallis, Oregon, U.S.A

Number of Employees: 9,414

Who the plan is for? All campus users

Summary of Plan:

The purpose of the Transportation Plan for OSU is to establish a vision for the transportation systems over the long-term and guide actions to manage and improve transportation facilities and services for all on campus. Key goals of the plan include improving accessibility and walkability, and providing and encouraging sustainable transportation options with the intent of achieving a multimodal transportation system with prioritized modes and minimal modal conflict.

Initiatives/Strategies:

The initiatives and strategies set out in the OSU Transportation Plan are based on established modal priorities, from highest to lowest priority: Pedestrian, Bicycle/Skateboard, Beaver Bus/Transit, Service/Delivery, Private Motor Vehicle. The Beaver bus is an intra-campus shuttle. Relevant initiatives and strategies employed by OSU as set out in their Transportation Plan include:

- Provide space for bicyclists travelling in the same direction to safely overtake one another;
- Provide dedicated space for bicycle use, separate from pedestrian facilities and buffered from motor vehicles;
- Provide comfortable (low stress), high quality facilities for cyclists at all ability levels;
- Avoid actions with the motor vehicle parking system that lead to increased rates of commuting alone to the campus, such as overbuilding or underpricing parking;
- Participate in rideshare programs and implement other incentives to encourage and support carpooling, vanpooling, and other ridesharing opportunities;

- Regularly encourage the campus community to use active transportation and transit for access to and circulating on campus;
- Coordinate OSU site improvements to connect with city, county, and other off-campus facilities to provide benefits to the campus community, adjacent neighborhoods, and the surrounding communities;
- Provide bicycle parking to serve demand in locations that promote appropriate use, support the campus aesthetic, respect special designations, and minimize pedestrian conflicts;
- Provide amenities (lighting, sidewalks, benches, planters, courtyards, quads, transit stops/shelters, bike racks, recycling receptacles, etc.) that support and encourage pedestrian and bicycle use and a vibrant campus environment.

The OSU Campus also has a Transportation Options program which employs strategies to provide options to commuting students and employees in order to reduce dependence on SOV travel. This has evolved into a TDM Strategy which is examined in another section below.

Parking on Campus:

Parking on Campus is based on the Zone the permit is issued for. Parking passes for Zone A, which is the closest parking areas, are \$48.33 per month, whereas Zone B costs \$32.50 per month, and Zone C, which are the furthest away from the main area, costs \$10 per month. Carpool permits are the same prices however, split across the people involved in the carpool; and an annual vanpool permit costs \$50.

Discussion:

Similar to the Carleton University Plan, the OSU Transportation Plan deals primarily with accommodating growth and planning to make the campus more multimodal and accessible, however they do focus a bit more on improving sustainability. There does not appear to be much to reduce SOV trips and improve sustainability.

Current Practices in Place:

See “Oregon State University 2030 Sustainable Transportation Strategy” Section for current practices at the University.

Summary:

The Transportation Plan is largely about accommodating growth and setting out a long-term vision for the transportation system within the University. While this document was useful in terms of improving accessibility and safety to encourage more multimodal transportation, the subsequent Sustainable TDM Strategy is anticipated to be more applicable for the purposes of the University of Waterloo TDMPS.

Oregon State University 2030 Sustainable Transportation Strategy

Employer: Oregon State University (OSU)

Date of Plan: 2020

<u>Cost of Parking Space:</u>	See above
<u>Location:</u>	Corvallis, Oregon, U.S.A
<u>Number of Employees:</u>	9,414
<u>Who the plan is for?</u>	All campus users

Summary of Plan:

This Plan follows the 2018 Transportation Plan and the recommendations of the report are grounded in the best practices of transportation demand management.

Initiatives/Strategies:

The relevant initiatives and strategies recommended in this Sustainable Transportation Strategy include:

- Pay-as-you-go parking – daily parking system that supports flexibility and choice (doesn't lock you into a monthly permit)
- Online Commute Platform – develop a commute platform that brings all transactions together into one site (daily parking, flexible carpooling, transit, biking, and incentives)
- Commute incentives – introduce a system to reward commuters for daily trips other than by driving alone
- Flexible carpooling – create a flexible carpool program to match riders, manage incentives and access preferred parking
- Remote work – update the University's telecommute policy to make remote work a flexible daily option for as many employees as possible
- Increase CTS Service – Seek expanded service on select Corvallis Transit System (CTS) routes to campus by working with the City
- Monroe Corridor Redesign – collaborate with the city to redesign, fund and reconstruct a portion of NW Monroe Avenue to improve pedestrian, bicycle and transit operations and safety
- Neighbourhood Bikeways – partner with City to develop select neighbourhood bikeways that connect to University, including the improvement of crossing treatments to make travel safer
- Shared Micromobility – implement a robust, reliable system of shared bicycles, scooters, and/or other micromobility devices to provide last-mile connections to transit, replace driving trips across campus, and facilitate access to nearby destinations
- Bike parking – provide more secure bicycle parking on campus to meet growing demand and create a comprehensive bike parking management program.
- Car-free Campus Core – limit personal vehicle access to the campus core to prioritize pedestrians and bicyclists, as described in the OSU Transportation Plan.

Parking on Campus:

See above section "Oregon State University Transportation Plan".

Discussion:

This Strategy came as a result of the 2018 Transportation Plan to implement TDM initiatives to improve sustainability and shift travel behaviour. There was significant consultation and survey work completed to identify barriers that can be addressed to assist with shifting mode choice.

Current Practices in Place:

- Carpooling
- Vanpooling
- Carsharing
- Skateboard parking
- Bicycle parking
- Bike lockers
- Electric Vehicle Parking and Charging
- Beaver Bus (intra-campus shuttle)
- Employee Transportation Guide
- Emergency Ride Home
- City Transit System is fareless

Summary:

The TDM strategies set out in this Strategy are a result of identified barriers and gaps within the context of Oregon State University. Many of these strategies could be adapted to fit within the University of Waterloo context, specifically the initiatives that reduce the desirability of SOV travel such as flexible parking and carpooling, car-free campus core, and commuter incentives.

Tufts University Transportation Demand Management Plan

<u>Employer:</u>	Tufts University
<u>Date of Plan:</u>	2015
<u>Cost of Parking Space:</u>	\$38/month
<u>Location:</u>	Medford, Massachusetts, U.S.A
<u>Number of Employees:</u>	Over 4,000
<u>Who the plan is for?</u>	Faculty, staff, and students

Summary of Plan:

The purpose of the Plan is to develop specific transportation demand management programs to address all modes of transportation and to create a set of strategies to address escalating challenges related to transportation and mobility demands. The Plan examined the existing TDM programs they had in place as well as the results of a 2014 transportation survey to come up with a TDM strategy.

Initiatives/Strategies:

Relevant strategies recommended in this Plan include:

- Restructure parking rates and invest revenues into TDM programs;
- Install bicycle lanes connecting to campus;
- Implement 50% subsidy for staff and faculty T-Pass program;
- Install additional secure bike parking at the on-campus hub station;
- Create policy for telecommuting/telelecturing;
- Work with City to upgrade bus stops;
- Offer a \$20/month bicycle reimbursement benefit;
- Develop a personalized Employee MyCommute intranet site;
- Increase awareness of TDM programs;
- Increase staff and faculty enrollment in pre-tax T-Pass deduction;
- Incentivize vanpools/carpools;
- Develop a “Bike Buddies” Program to encourage bicycle commuting;
 - Bike Buddies would pair experienced cyclists with less experienced cyclists for those who may have safety concerns
 - Can also implement women-specific ride to campus
- Install frontloading bike racks on campus shuttles;
- Introduce High Occupancy Vehicle (HOV) ridesharing permit;
- Provide information on non-SOV transportation options for inter-campus travel; and
- Increase number of EV charging stations.

Parking on Campus:

The cost for a parking space for Faculty and Staff is \$38 per month.

Discussion:

Part of their research noted that there was a low awareness of many of the existing programs they offered. Employee awareness of the TDM programs is a key factor in having them become successful. The University of Waterloo currently has a number of TDM strategies in place, however the level of awareness of the programs is currently unknown. Increasing awareness of these programs may play a key role in shifting travel behaviour.

Current Practices in Place:

- Campus Shuttle
- Safe Ride Service
- Carsharing
- Lyft Program
- Emergency Ride Home Program
- Electric Car Owner Benefits (free charging)
- “A Better Commute” incentive – rewards for sustainable transportation choices
- Bike Check – up to \$50 reimbursements per year for expenses such as bike repair, new helmet, etc.
- Carpool Subsidy
- Public Transit Subsidies
- Vanpool Subsidy

- GoMassCommute tool – tracks commute and rewards
- Commuting Brochures
- Bikesharing (through BlueBikes)
- Bike parking
- Bike repair shop
- Bicycle benefits (discounts at nearby shops)

Summary:

The purpose of the Tufts University TDM Plan is to identify the strategies necessary to achieve the Universities TDM goals. The Plan outlines the existing TDM programs and proposed additional ones based on further research. Increasing awareness of TDM programs may help to shift mode choices.

East Carolina University Comprehensive Master Plan: Transportation Plan

Employer: East Carolina University (ECU)

Date of Plan: 2012

Cost of Parking Space: \$210-\$720/year

Location: Greenville, North Carolina, U.S.A

Number of Employees: 3,649

Who the plan is for? All employees and students

Summary of Plan:

The purpose of this Plan is to provide the University with a strategy to accommodate the current and future transportation requirements. It also looks to provide solutions to improve sustainability and will present recommendations for TDM programs. The anticipated growth of the University will strain the already limited parking availability, which is one of the reasons for this study.

Initiatives/Strategies:

The initiatives and strategies set out in the University’s Transportation Plan that are relevant to the context of the University of Waterloo include:

- Work with the city to improve sidewalks in the neighborhoods surrounding the University that are not included in the “Bicycle and Pedestrian Master Plan”
- Expand existing bikeshare program
- Adopt complete street policies
- End-of-Trip facilities for cyclists (showers, personal lockers, secure bicycle parking)
- Provide covered bicycle parking where possible, including under eaves/overhangs of buildings, in parking decks and in covered bike lockers
- Promote bicycle options as an alternative to driving
- Install bus shelters at major transit stops
- Continue to expand focus from student-centric transit service to the entire campus community

- Continue to develop a web-based transit portal that shows the location of all buses
- Adopt a “Park Once” philosophy to cut down on intra-campus vehicle trips during the day

Specific TDM policies include:

- Safe Ride (existing) – direct transit service for late-night transportation needs
- ZipCar – carsharing (existing)
- Faculty/Staff Rideshare (existing)
- Examine viability of park and ride lots for employees
- Encourage ride-sharing by offering priority parking spaces and aggressively promoting the program
- Expand carsharing service
- Further develop bicycle loan program
- Support people who use alternative by offering a Guaranteed Ride Home and occasional parking vouchers and or pay-as-you-go parking
- Develop ‘Parking Cash-Out’ or a ‘Transportation Allowance’ that rewards sustainable choices while retaining a social equity policy
- Continue working with GREAT and other operators to offer the East Carolina University community free or discounted travel on local buses and trains.
- Provide a full-time TDM Coordinator dedicated to helping commuters learn about alternatives and to promoting alternative modes
- Consider ways to promote the full range of transportation options during employee and student orientation
- Offer Individualized Travel Marketing – giving people details on alternatives available for their own commute – in a ‘marketing campaign’ style and/or for orientation

Parking on Campus:

Parking on the ECU campus is based on an annual cost ranging from \$210 per year (\$17.50/month) for basic parking spaces to \$720 per year (\$60/month) for a space in a parking garage.

Discussion:

The University’s research showed that currently, even during peak periods, a large number of spaces remained unused (1294 out of 8,304). However, they anticipate that as the University grows, these spots will be quickly used up and additional will be needed, leading to the need for alternative commuting measures. Like the University of Waterloo, many operational improvements to transit systems have already been enacted. Further encouragement towards the use of public transit could include increasing transit subsidies to make it more desirable.

Current Practices in Place:

- Transit on-Demand
- Bike Racks
- Bikesharing (Coming Soon)
- Carsharing
- Rideshare

- Safe Ride

Summary:

The purpose of this Plan is to identify strategies to assist with growth and parking constraints and while it does offer methods to shift commuting habits, it's focus is more on accommodating growth than reducing emissions. However, it does offer some TDM strategies that could be adopted to fit the needs of the University of Waterloo such as having a TDM coordinator, expanding existing services, and offering individualized travel marketing.

University of California, Los Angeles – Sustainable Transportation Plan

Employer: University of California, Los Angeles (UCLA)

Date of Plan: 2014

Cost of Parking Space: varies

Location: Los Angeles, California, U.S.A

Number of Employees: 42,000

Who the plan is for? All employees and students

Summary of Plan:

The purpose of the UCLA Sustainable Transportation Plan is to enact the goals and objectives of the University with regard to sustainable transportation and reducing greenhouse gas emissions. The Plan, while focusing on non-parking aspects of transportation, recognizes the importance of providing parking for commuters and visitors and acknowledges that parking policy is a critical piece of demand management.

Initiatives/Strategies:

Initiatives and strategies set out in the UCLA Sustainable Transportation Plan which are relevant to the University of Waterloo context include:

- Alternative Fuels & Smart Management
 - Providing EV chargers, compressed natural gas stations, and a hydrogen station;
 - Right-sizing vehicle fleet (i.e. blend car-sharing technology with alternative fuel vehicles in a pool of fleet vehicles, rather than individual departments each having their own traditional ICE vehicle(s))
- Flexible Parking
 - Working to identify which new technologies and parking price models give customers the greatest flexibility in using multiple commute modes, thereby encouraging customers to use sustainable transportation more often while also allowing them to drive and park conveniently when needed.
- Advocacy Support
 - Rail transit system expansion – advocate and participate in the planning process of the expansion to better serve the campus

- o bus transit route and service expansion – participate in route planning were possible to advocate for areas which are not served or are underserved.
- Active transportation
 - o Traffic calming
 - o “Bike-ification” – improving the campus for a safer, more bike-friendly environment
 - o Pedestrian prioritization

Parking on Campus:

Faculty and Staff parking permits at UCLA are broken down by UCLA Benefits (Eligible and Ineligible) and Non-UCLA then further broken down by: “yellow”, “blue”, “x”, “night and weekend”, and “weekend only”. The UCLA Benefits-Eligible category also has “two-person carpool”, “three-person carpool”, “four-person carpool” and “clean fuel”, as permit options. The least expensive to most expensive parking options were the carpool options (\$26-\$72/month), followed by the clean fuel, then yellow zones, then blue and finally X as the most expensive (\$157/month). A map showing the location of these various parking areas/zones was not available. The parking spaces for those without benefits or Non-UCLA ranged from \$441 per quarter to \$1,053 per quarter.

Discussion:

As UCLA is located in one of the most traffic congested cities in the United States, there is a strong need to shift away from SOV travel in order to reduce emissions. The traffic congestion also likely makes commuting less desirable which helps to support the shift towards other travel modes. The combination of TDM and parking policies is applicable in the University of Waterloo context as there are a number of employees located outside of the City for which non-vehicular travel (i.e. cycling, or public transit) may not be feasible.

Current Practices in Place:

- Commuter service to help with planning your commute
- Subsidized public transit
- Telework
- Carpool services
- Bike racks and lockers
- Bike Shop
- Commuter Passport which offers access to shower facilities on campus
- Earn-A-Bike program (receive a free \$450 bicycle package in exchange for their parking permit) – employee and grad students only
- Vanpool

Summary:

The UCLA Sustainable Transportation Plan aims to shift travel behaviour and towards more sustainable transportation choices in order to reduce emissions, similar to the goals of the University of Waterloo. The initiatives to reduce of SOV travel through flexible parking policies can be adapted to fit within the context of the University of Waterloo

University of New Hampshire – Transportation Policy Review and Update

<u>Employer:</u>	University of New Hampshire (UNH)
<u>Date of Plan:</u>	2019
<u>Cost of Parking Space:</u>	\$75
<u>Location:</u>	Durham, New Hampshire, U.S.A.
<u>Number of Employees:</u>	4,000
<u>Who the plan is for?</u>	All employees and students

Summary of Plan:

The purpose of this Report is to update an existing TDM based approach which was adopted in 2003 (15 years prior to this report). The update is to look at the successful policies from the 2003 policy, reaffirm the core principles and move forward with refreshed strategies. Changes since the 2003 plan include significant campus growth and improvements to transportation systems. This Report is also intended to address current transportation issues such as reducing private vehicle demand and strengthening walking and biking mode choices.

Initiatives/Strategies:

Initiatives and strategies recommended within this report that are relevant to the Waterloo context include:

- Reduce UNH fleet vehicle emission, internal combustion engine use (ICE) and dependence
 - Reduce the need for fleet SOV use through changes in practices and procedures
 - Move toward alternative fuel vehicles such as EV and, where appropriate, departmental bikes
- Move the UNH commuter parking permit price system closer to sustainable/market-based pricing
 - Remove price caps on parking for faculty parking permits
 - Consider moving towards pay-per-use as opposed to unlimited use permit for some or all user categories
- Moped and Motorcycle accommodation
 - Implement a permit system and parking area to accommodate growth of these motorized transportation methods
- EV infrastructure to accommodate growing demand/expectations
- Support of transportation service partners such as Amtrak and ZipCar and other services that can provide alternatives to private vehicle use
- Bike and shared vehicle culture and accommodation (bike share, departmental bikes, shared personal transit vehicles)

Parking on Campus:

The website for University of New Hampshire states that faculty and staff parking permits are \$75, however it appears that the permits are for the duration of the academic year (September to the following August) and are the same price at whichever point during the term the permit is purchased.

Discussion:

Like many of the Transportation Plans assessed in this Best Practices Review, this Report has more to do with accommodating growth and demand than identifying ways to reduce commuter emissions. However, one of the most important unfinished items from the 2003 report was parking permit price calibration with market and environmental costs. This strategy could be adapted to fit within the context of the University of Waterloo to give a more accurate pricing structure to the actual cost of driving and parking.

Current Practices in Place:

- Free transit for employees and students
- Carpooling
- Ridesharing
- Carsharing
- Guaranteed Ride Home Program
- Bicycle racks on buses
- Bikeshare
- EV charging station
- Electrified University's fleet
- Telework

Summary:

The Report provided a review and update of the 2003 policies, adapting them to fit within the current context and address the present challenges. Much of the recommendations has to do with parking pricing as well as working on increasing the transit ridership. While they are still working to implement many of the initiatives and strategies, the adjustment of parking pricing structure is one that could be well adapted for the University of Waterloo.

Sustainability Plans with Transportation Policies

University of Pennsylvania Climate and Sustainability Action Plan 3.0

<u>Employer:</u>	University of Pennsylvania (UPenn)
<u>Date of Plan:</u>	2019
<u>Cost of Parking Space:</u>	\$129.97-\$213.83/month
<u>Location:</u>	Philadelphia, Pennsylvania, U.S.A.

Number of Employees: 18,000

Who the plan is for? All employees and students

Summary of Plan:

The purpose of this Sustainability Action Plan is to integrate sustainability into all aspects of the University including in academics, research as well as within the community and built environment. This is the third edition of the Action Plan. One aspect of the Plan is Transportation for which their mission is to encourage more sustainable transportation options as well as prioritize a pedestrian and cyclist-friendly campus and promote safety. Key focuses are on alternative transportation programs, improving energy efficiency of parking facilities and minimizing environmental impacts of the Penn Transit fleet.

Initiatives/Strategies:

Strategies set out in the report to reach their goals include:

- Promoting incentive programs for alternative transportation, integrating services with other transit providers, and influencing local transportation systems;
- Promoting a pedestrian friendly and safe campus in support of the City's Vision Zero efforts;
- Enhancing the University's bicycle policies and coordinating initiatives with the greater Philadelphia bike community; and
- Improving energy efficiency in parking operation including infrastructure upgrades, lighting retrofits, and adding four new electric charging stations.

Programs, strategies and initiatives that have been implemented through previous editions of this plan include:

- Discounted pre-tax travel subsidies for public transit;
- Ensuring public transit stops are never more than a five-minute walk from any part of campus;
- Increased supply of EV charging stations;
- Adopted Green Garage Standards during recent parking garage renovations;
- Bike Commuter Expense Reimbursement Program;
- Adding new and improved bike racks across campus;

Parking on Campus:

The Staff and Faculty parking varies based on the parking lot and they are broken down into Prime Rate 1, Campus Rate 2, and River Fields priced at \$129.97, \$203.83, and \$213.83 per month, respectively.

Discussion:

While this is a Sustainability Action Plan and not specifically a Transportation Plan, the intentions of this Plan, specifically the transportation section, is similar to the goals of the University of Waterloo's climate action plan and the TDMPS in that it looks toward alternative transportation modes for commuting.

Current Practices in Place:

- Free UPenn Transit Services
- City Public Transit Subsidy
- Commuter Benefits (Up to \$280/month of commuter fare costs may be paid for through pre-tax payroll deductions)
- Penn Buses
- Penn Shuttles
- Loop through University City (LUCY) Bus – free of charge
- Rideshare
- Carpool
- Vanpool
- Carpool parking discounts (25% to 75%)
- Occasional Parking (provides discounted parking to those who only drive occasionally)
- Bike Commuter Expense Reimbursement Program (up to \$240 annually)
- Bike Share
- Bike Repair Stations
- Bike Registration
- Locker Rentals
- City Bike Routes Map

Summary:

The intention of the Sustainability Action Plan to shift travel behaviours to alternative transportation methods to reduce emission is similar to the goals of the University of Waterloo's TDM Planning Study. Multiple editions of the Action Plan has resulted in many initiatives already being enacted with some additional methods proposed as a result of monitoring and further research. The current strategies in place at the University of Pennsylvania provide a good example of the types of initiatives that could be put in place at the University of Waterloo.

CSUN Sustainability Plan, 2013-2023

<u>Employer:</u>	California State University Northridge (CSUN)
<u>Date of Plan:</u>	2013
<u>Cost of Parking Space:</u>	\$10.23-\$47.38/month
<u>Location:</u>	Los Angeles, California, U.S.A.
<u>Number of Employees:</u>	Over 4,000
<u>Who the plan is for?</u>	All employees and students

Summary of Plan:

California State University, Northridge has historically been a leader in alternative energy technology. CSUN has declared sustainability as a priority for the campus and this Plan is a direct response to that declaration. While the Plan focuses on many different aspects of

sustainability, the Transport section will be examined for the purpose of this review. The main issues they have identified are to: reduce total number of commuting miles, reduce use of SOV for commuting, and reduce emissions associated with vehicle use on campus.

Initiatives/Strategies:

Relevant initiatives and strategies set out in the CSUN Sustainability Plan include:

- Increase opportunities to live closer to campus for faculty and staff;
- Offer incentives or programs to encourage employees to live close to campus and reduce weekly commuting miles;
- Expand funding structure to support alternative modes of transportation;
- Expand the hours of shuttle service to Metrolink station;
- Implement a car-sharing program;
- Develop preferential parking for carpools, vanpools, motorcycles and high-efficiency vehicles;
- Continue and expand financial incentives for using alternative means of transportation;
- Improve infrastructure for bicycle parking by increasing overall capacity and replacing existing with safer types;
- Establish a bike shop or rental program;
- Establish an education program to provide information on availability, safety, and rules of operation on all available modes of transportation on campus;
- Coordinate efforts on campus with government agencies to support alternative transportation modes, such as improving and expanding bus lines and improving sidewalks around the campus;
- Study feasibility of permitting purchase of transit passes and van-pool passes under pre-tax Commute Choice benefits;
- Install more electric vehicle chargers including solar-powered chargers;
- Discourage traffic through campus;
- Implement pilot programs for alternative transportation days;
- Purchase electric, hybrid, or non-motorized vehicles to replace existing fleet where feasible, otherwise choose smaller gasoline-powered vehicles; and
- Conduct bi-annual surveys for travel behaviour.

Parking on Campus:

Parking the California State University Northridge Campus varies or faculty and staff is varied based on type of vehicle space, motorcycle spaces are cheaper than standard spaces, as well as by lot, ranging from \$10.23 to \$16.92 per month for motorcycles to \$15.39 to \$47.38 per month for standard spaces.

Discussion:

The issues identified for the purpose of taking action are similar to those set out by the University of Waterloo. The age of the Plan (2013) does present some challenges for adaptation from the standpoint of evolution of alternative transportation modes in the last 10 years. However, it also provides the opportunity to see if the strategies have been successfully implemented.

Current Practices in Place:

- Transportation Coordinator
- Vanpool
- Public Transit Subsidy (up to 60% up to \$100/month)
- Employee Bicycle Program
 - up to 4 “rainy day” permits a year
 - Bicycle Compounds (sheltered parking location)
- Carpool and HOV Parking Program
- Campus Shuttles to nearby neighbourhoods and Metrolink
- Compressed workweek/Telecommuting
- Guaranteed Emergency Ride Home Program
- EV Charging Stations
- Clean Air Parking Spaces (CAPS) Program – preferential parking

Summary:

CSUN provides numerous programs for both students and employees with regard to encouraging commuter mode shift to reduce emissions. While the Plan is older (2013), there are strategies that can be adapted to fit the Waterloo context, as well as the current practices that implement those strategies. The similarities in the goals of the Plan with Waterloo’s indicate these best practices may be ideal for adaptation.

Concordia Sustainable Action Plan

<u>Employer:</u>	Concordia University
<u>Date of Plan:</u>	2020
<u>Cost of Parking Space:</u>	\$70-\$285/month
<u>Location:</u>	Montreal, Quebec
<u>Number of Employees:</u>	6,722
<u>Who the plan is for?</u>	All employees and students

Summary of Plan:

The 2020 Concordia University Sustainable Action Plan focuses on a vision of sustainability across all facets of the University in the years to come. The document is meant to function like a living document and be amended every so often with new information. While no specific transportation section, there are transportation policies for improving sustainability.

Initiatives/Strategies:

Relevant policies/strategies/initiatives set out in the Concordia Sustainable Action Plan include:

- 15% rebate on an annual BIXI bike sharing membership;
- Secure indoor bicycle parking facility;

- Faculty and staff travelling for work to nearby cities (Ottawa, Toronto, Quebec City) are encouraged to travel by train and will be reimbursed for their business-class train travel regardless of comparative airline costs;
- Evaluate demand for secure bicycle parking, outdoor bicycle parking and free-service bicycle repair stations, and increase these services as needed;
- Provide twice-annual bicycle awareness and training events on both campuses and promote safe cycling practices and resources through regular communications;
- Favour electric vehicles when purchasing new vehicles for our campus fleet;
- Install 82 additional electric parking spots at both campuses and create incentives to use electric vehicles;
- Encourage options for our staff to work remotely in recognizing the benefits to our carbon footprint as well as to public health, employee wellness and accessibility;

Parking on Campus:

Concordia University has two campuses: Loyola and SGW. Employee parking at the Loyola Campus is \$95 per month however, for carpool parking permits they are only \$70 per month. Parking at the SGW Campus ranges from \$156 to \$285 per month.

Discussion:

According to their 2020 Plan, 93% of students and 84% of employees use more sustainable transportation methods as their primary form of commuting (i.e. walking, cycling, and public transportation). The high percentage of employees already using sustainable transportation methods as their primary mode of commuting indicates that the practices of Concordia University should be examined when considering what TDM strategies to implement.

Current Practices in Place:

- Bikeshare – Concordia discount
- Carsharing
- EV Charging Stations
- Secure Bicycle Parking
- Campus Shuttle
- Bicycle shower facilities
- Flying Less Concordia (reducing academic flying emissions)
- Online commute planner

Summary:

The high percentage of employees and students who currently use sustainable transportation methods to commute to and from campus is positive, however based on the current practices in place, the mode choice may not be solely due to initiatives and TDM strategies rather than the culture and/or built environment of Montreal, which encourages more sustainable transportation overall. The best practices from Concordia should still be examined and adapted to fit within the Waterloo context where possible.

Non-University Employee Transportation Plans

Rhode Island State Employee Transportation Guide Plan

<u>Employer:</u>	State of Rhode Island Government
<u>Date of Plan:</u>	2013
<u>Cost of Parking Space:</u>	N/A
<u>Location:</u>	Rhode Island, U.S.A.
<u>Number of Employees:</u>	14,058
<u>Who the plan is for?</u>	All State employees

Summary of Plan:

The State of Rhode Island prepared an Employee Transportation Guide in order to reduce the vehicle miles traveled (VMT) in commuting to work. The Plan looks to reduce SOV commuting and encourage alternate forms of travel. The Plan was developed in response to parking shortages and the desire to reduce SOV trips in order to reduce the VMTs.

Initiatives/Strategies:

Initiatives and strategies proposed in the Rhode Island Guide that could be adapted to fit the context of the University of Waterloo include:

- Transit
 - Parking cash-out – commuter benefit that offers up to \$185/month instead of free or subsidized parking at work.
 - Employee transit benefits
 - In-site transit pass sales or distribution
- Carpooling
 - Ride-matching (either third party or internal database)
 - Free and/or preferential parking
 - Parking cash-out
 - Reward programs (i.e. prize drawings)
- Vanpooling
 - Ride-matching
 - Preferential parking
 - Parking cash-out
- Bicycling and Walking
 - Safe and secure storage for bicycles
 - Shower and locker facilities
 - Parking cash-out
- Alternative Work Schedules – compressed work week
- Telework
- Live near work – employers provide new employees with information on areas that have reduced commute times or are near transit lines

- Commuter choice tax benefits
- On-site information centre
- Guaranteed ride home
- On-site facilities (i.e. showers, lockers, safe bike storage, transit stop improvements, etc.)

Discussion:

As the Plan was commissioned by the State and will be a governmental project, the scope of work that they can do and what they can affect is greater than that of the University of Waterloo and therefore not all strategies may be able to be applied. The goal to reduce VMT and SOV trips is similar to the goals of TDMPS and the strategies set out could be useful in the context of Waterloo.

Current Practices in Place:

Practices currently in place were not able to be found. This may be due to it not being a public facing document.

Summary:

The Rhode Island State Employee Transportation Guide Plan was prepared in response to parking constraints and the desire to reduce VMT and SOV trips. There were a number of recommended strategies that could be applied to the context of Waterloo, however, some may not be possible due to the limited power the University has compared to the State government.

Private Sector Employers with Transportation Demand Management (TDM) Strategies

Research into private sector employers has been conducted. While a report by the Community Transportation Association of America (CTAA) has been found which outlines TDM strategies for companies such as Amazon, Google, CVS, Meta, and Best Buy, the individual TDM documents for these companies were not found during the research. It is likely that as these are private companies their Plans are not public-facing documents.

Apple Inc.

A document outlining some of the TDM initiatives employed by Apple Inc. was located. TDM programs employed by Apple included:

- Apple Transit – free commuter coaches and shuttles to various neighbourhoods
- Ride-Share – online tool to match riders with drivers from similar locales
- Bicycling – numerous initiatives including bike to work day, discounts on select cycling products, program to match experienced cyclists with beginners, bike facilities such as racks, lockers, bike pumps, shower facilities, and monthly maintenance vendor.
- Walking – headquarters is nearby many residential neighbourhoods and the built environment is designed to accommodate active transportation such as walking and cycling

- Public Transit – stations and stops nearby the campus
- Marketing and Communications – comprehensive website available to Apple employees detailing alternative transportation options
- TDM Support Services
- Transit Subsidy – up to \$100/month for employees who take public transit two or more days a week. Covers the full price of monthly transit pass
- Bike Subsidy – \$20/month subsidy for bike improvements, maintenance, storage, or towards purchase of bicycle
- Campus Bike Share
- Intercampus Shuttle – on-request, fixed-route intercampus shuttles from 7am to 7pm
- Lunch Shuttle – provides transportation between Apple buildings and campus cafes between 11am and 2pm
- Commuter Club – opt-in program to stay up to date on schedules, new service, events and programs
- Commuter Expert Program – provides an opportunity to meet other employees who are using same alternative mode who can “mentor” them about the commuting method.
- Emergency Ride Home
- Campus Car – carsharing
- On-site Services – provided much of what employees may need on site during the day such as food options, coffee bars, fitness centres, concierge service, onsite car wash service, haircuts, ATMs, dry cleaning, shower facilities, postal kiosks, and produce deliveries.

References:

- Apple Inc. (n.d.). *Alves Cafe Transportation TDM Overview*. Retrieved from: https://cupertino.granicus.com/MetaViewer.php?view_id=14&clip_id=1311&meta_id=72139
- California State University Northridge. (2013). *CSUN Sustainability Plan, 2013-2023*. Retrieved from: https://www.csun.edu/sites/default/files/CSUN_Sust_Plan-m.pdf
- California State University Northridge. (2013). *Parking Fees/Refunds Schedule Academic Year 2021/2022*. Retrieved from: <https://www.csun.edu/sites/default/files/Parking%20Fees%20Fall%202019%20-%20Spring%202020%20Matrix%20-%20FINAL.pdf>
- Carleton University. (2019). *Carleton University Transportation Strategy*. Retrieved from: <https://carleton.ca/transportationplan/wp-content/uploads/Carleton-University-Transportation-Strategy-2019.pdf>
- Carleton University. (n.d.). *Staff and Faculty Permit Rates*. Retrieved from: <https://carleton.ca/parking/staff-and-faculty-permit-rates/>
- Community Transportation Association of America. (2012). *Profiles of Employer Sponsored Transportation Programs*. Retrieved from: <https://www.yumpu.com/en/document/read/7089572/profiles-of-employer-sponsored-transportation-programs>
- Concordia University. (2020). *Concordia Sustainable Action Plan*. Retrieved from: <https://www.concordia.ca/content/dam/concordia/services/sustainability/docs/Hub/plans/Sustainability-Action-Plan-Community-Version.pdf>
- Concordia University. (n.d.). *Parking on SGW Campus*. Retrieved from: <https://www.concordia.ca/maps/parking/sgw-campus.html>
- Concordia University. (n.d.). *Parking on Loyola Campus*. Retrieved from: <https://www.concordia.ca/maps/parking/loyola-campus.html>
- East Carolina University. (2012). *East Carolina University Comprehensive Master Plan: Transportation Plan*. Retrieved from: https://masterplan.ecu.edu/wp-content/pv-uploads/sites/29/2017/07/ECU_final_transportation_master_plan-2.pdf
- East Carolina University. (n.d.). *2021-2022 Staff/Faculty Parking Registration Information*. Retrieved from: <https://parking.ecu.edu/faculty-staff-2021-22/>

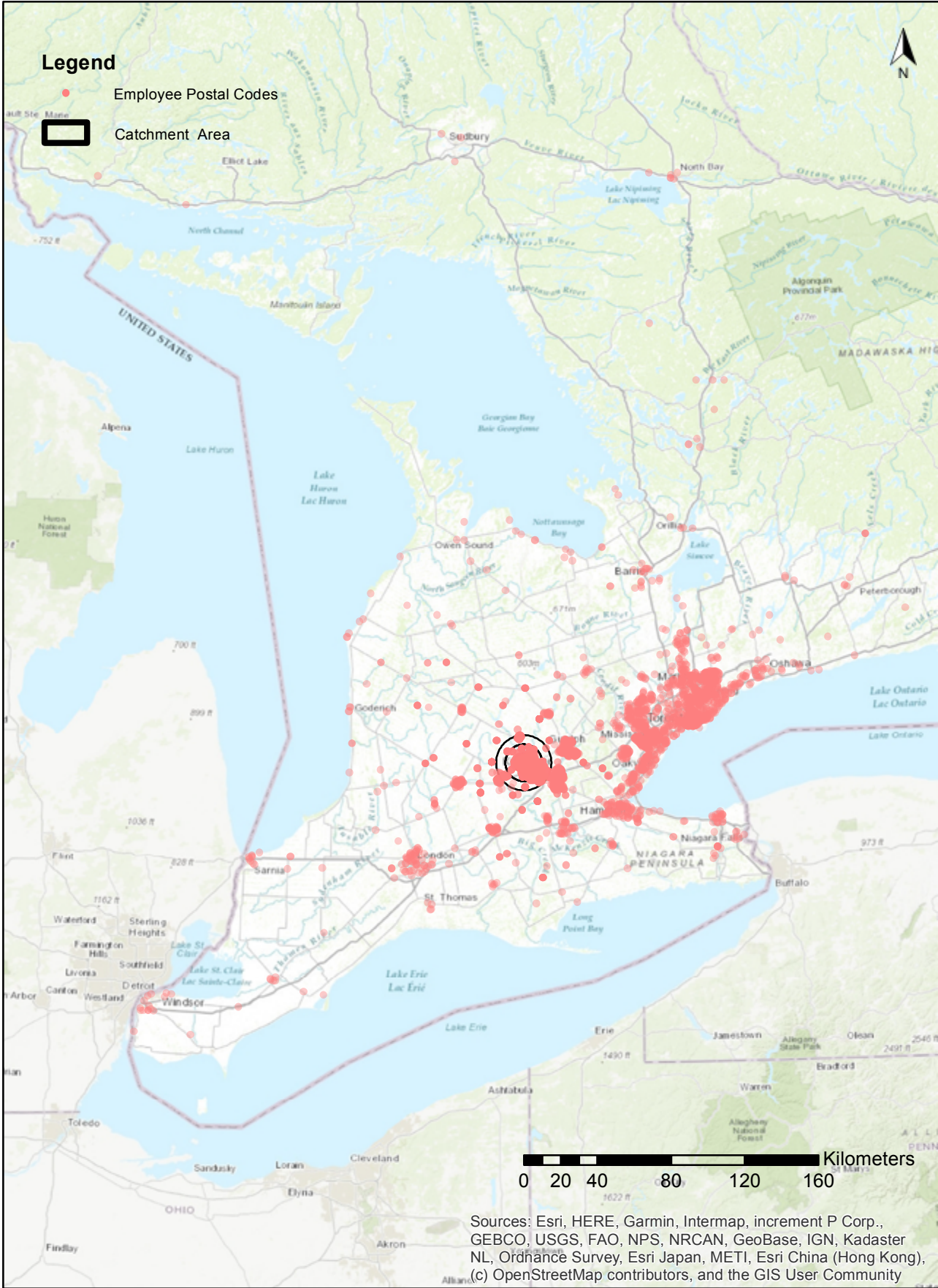
- Government of Rhode Island. (2013). *Rhode Island State Employee Transportation Guide Plan*. Retrieved from: http://www.planning.ri.gov/documents/mpo/State_Employee_Commuting_Plan_22013_Draft.pdf
- NECN. (2018). *Rhode Island Reports High Number of State Employees*. Retrieved from: <https://www.necn.com/news/local/rhode-island/rhode-island-reports-high-number-of-state-employees/242696/>
- Oregon State University. (2020). *Oregon State University 2030 Sustainable Transportation Strategy*. Retrieved from: <https://transportation.oregonstate.edu/sites/transportation.oregonstate.edu/files/2030-sustainable-transportation-strategy.pdf>
- Oregon State University. (2018). *Oregon State University Transportation Plan*. Retrieved from: <https://oregonstate.app.box.com/s/mseqk4whuinnkyb8gw7dczuiz4go9458>
- Oregon State University. (n.d.). *Permit Types*. Retrieved from: <https://transportation.oregonstate.edu/parking/parking-rates/permit-types>
- Tufts University. (2015). *Tufts University Transportation Demand Management Plan*. Retrieved from: <https://sustainability.tufts.edu/wp-content/uploads/TDM-Report-April-2015.pdf>
- Tufts University. (n.d.). *Parking Permits*. Retrieved from: <https://access.tufts.edu/parking-permits>
- University of British Columbia. (2014). *UBC Transportation Plan Vancouver Campus*. Retrieved from: https://planning.ubc.ca/sites/default/files/2019-11/PLANS_UBC_TransportationPlan.pdf
- University of British Columbia. (n.d.). *Permits & rates*. Retrieved from: <https://parking.ubc.ca/permits-rates>
- University of California Los Angeles. (2014). *University of California, Los Angeles – Sustainable Transportation Plan*. Retrieved from: <https://www.sustain.ucla.edu/wp-content/uploads/STP-Report-FINAL-v3.pdf>
- University of California Los Angeles. (n.d.). *UCLA Parking Rates and Fees*. Retrieved from: <https://www.transportation.ucla.edu/campus-parking/ucla-parking-rates-and-fees>
- University of New Hampshire. (2019). *University of New Hampshire - Transportation Policy Review and Update*. Retrieved from: <https://unh.app.box.com/s/oo8prre596vs50kmsmokadz03k69uj7z>
- University of New Hampshire. (n.d.). *Permit Prices and Refund Policy*. Retrieved from: <https://www.unh.edu/transportation/parking/permits/permit-prices-refund-policy>

University of Pennsylvania. (2019). *University of Pennsylvania Climate and Sustainability Action Plan 3.0*. Retrieved from:
https://www.sustainability.upenn.edu/sites/default/files/CSAP_3_Final%2010%2031%202019_1.pdf

University of Pennsylvania. (n.d.). *2021-2022 Parking Rates*. Retrieved from:
<https://cms.business-services.upenn.edu/transportation/permits-passes/parking-permits/2021-2022-parking-rates.html>

Appendix B

Employee Postal Codes in Ontario Map



Appendix C

Employee Postal Codes in Waterloo, Ontario Map

