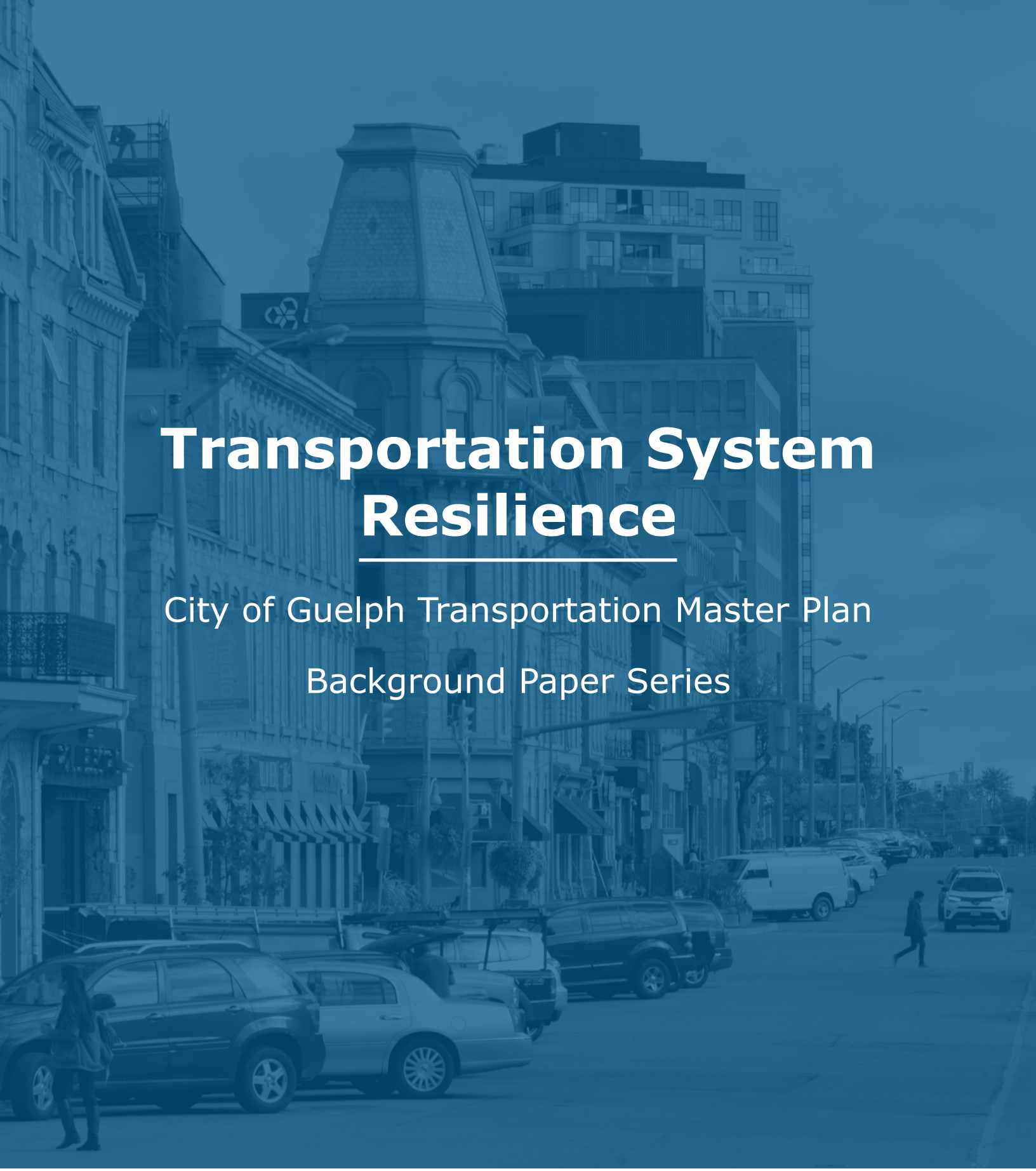

Transportation System Resilience

City of Guelph Transportation Master Plan

Background Paper Series

Transportation Master Plan

CITY OF Guelph

Making a Difference

Guelph Transportation Master Plan

Moving Guelph Forward

Guelph is growing and how we move around our city is changing. As a result, we are exploring transportation options to make our city move better in every way. Through the Transportation Master Plan (TMP) update, we will review all of the ways we move: walking, cycling, riding transit, driving, trucking, and using trains. Our goal is to ensure that we offer diverse travel options, have appropriate transportation capacity, and maintain a high quality of life for both existing and future residents and workers.

The updated TMP will look at transportation planning in Guelph beyond 2031. The main objectives of this update are:

- To ensure that the new plan builds upon current policies, including the Official Plan and other master plans that have been approved since 2005;
- To recommend new policies and guidelines that reflect the vision for our community and balance mobility, environment, and efficiency, while prioritizing safety and access for all travellers; and
- To explore how new, evolving technologies and travel services will shape the future of transportation in Guelph.

This paper is part of a series of background papers intended to communicate information, key trends, and concepts. These will form the foundation of and set the strategic direction for our updated TMP. The papers are intended to support conversations in the community and within City Hall about how we plan for the future of mobility.

The series includes the following papers, which are all available at **guelph.ca/tmp**:

- **Transportation Technology and New Mobility Options**
- **The Changing Transportation System User**
- **Transportation and Building 21st Century Cities**
- **Road Safety**
- **Network Planning**
- **Transportation System Resilience**

Each of the background papers opens with an introductory primer on the topic before it examines key global trends, considers how these topics and trends are currently addressed in Guelph, and concludes with an analysis of the implications of that topic on planning Guelph's future transportation system.

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Transportation System Resilience: A Primer

In cities, resilience is the capacity of individuals, communities, institutions, businesses, and systems to survive, adapt, and grow in the face of *acute shocks* (short term disruptions) and *chronic stresses* (long term disruptions).[1] In essence, it is the ability of a city to constructively adapt and to thrive in the face of a challenge.

Transportation resilience is an increasingly important topic as the world faces the COVID-19 pandemic, an *acute shock* with a very significant impact. As lockdowns have been implemented in countries around the world, traffic volumes in urban centres dropped dramatically and transit systems have faced unprecedented drops in ridership. At the same time, demands for cycling and walking space have spiked.

COVID-19 is also generating *chronic stresses*, such as a deepening economic recession and potential long-term changes in travel behaviour. Entire economic sectors have been upended overnight, resulting in significantly reduced municipal revenues from taxes and user fees. At the same time, forced new habits like working from home and relying on online shopping are changing travel demand patterns in our communities.

As a result, transportation system resilience has never been more top of mind. Given that transportation networks make up such a significant proportion of the public realm, the ability to constructively adapt to the current shocks and long-term stresses in the transportation system will have a lasting and significant impact on our communities.

Transportation system resilience depends on four core elements:

1. **Diversity,** which means possessing a wide variety of elements with different functions to ensure that the system has different strengths to response to various shocks and stresses;
2. **Redundancy,** which means containing multiple components that can perform the same function and providing back-up systems when shocks and stresses affect the system;
3. **Flexibility and adaptive capacity,** which means possessing the ability to be easily modified in response to a disturbance caused by a shock or stress; and
4. **Capacity to reorganize,** which means having the ability to quickly adapt on its own, allowing the system to respond to shocks and stresses in real time.

This paper covers each of these core elements of resilience in more detail, starting with an explanation of what each element looks like in transportation within the following sections. The paper then covers best practices in resilient transportation planning from around the world, describes what aspects of transportation resilience exist in Guelph today, and concludes with some key takeaways about how to consider transportation resilience in Guelph in the future.

1 100 Resilient Cities, "What is Urban Resilience?" http://100resilientcities.org/resources/#section-1

Diversity

A transportation system is more resilient if it serves people with a range of characteristics using multiple modes. This means that a diverse system takes into account the wide range of traveller ages and abilities and provides appropriate infrastructure for all modes of travel. Having a transportation system that supports safe, affordable, and convenient travel by any mode helps satisfy the need for alternative transportation options in case a shock or disruption affects one or more modes.

Options are critical when circumstances change or unexpected disturbances arise, both for individual travellers (who may have physical disabilities or be experiencing financial hardship), and for the larger community (such as during a flood or major road closure).

Diversity in a transportation system is best supported by a land use pattern with a mix of land uses and densities that maximizes the opportunity for as many travellers as possible to meet their needs with short trips (i.e. within 2km or less). Short trips can usually be easily completed by users of any mode of transportation, presenting travellers with a broad range of mode choices to meet their needs.

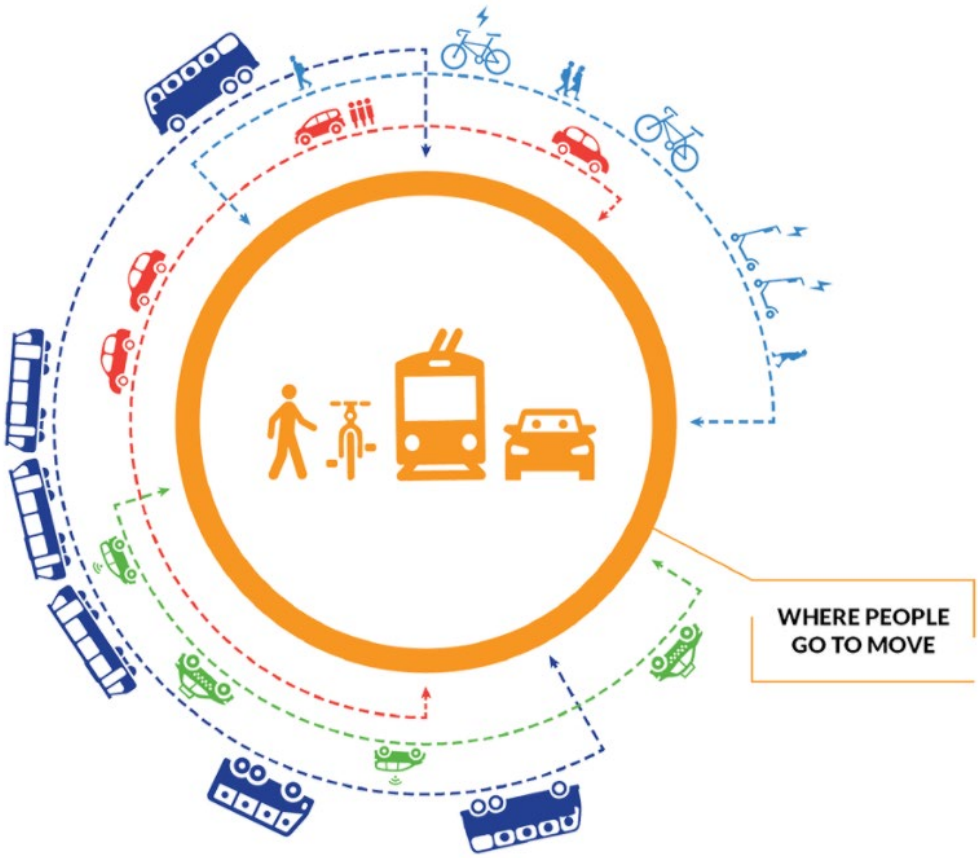

Figure 1: A multimodal transportation system can provide the kind of transportation option diversity that characterizes a resilient system. Image Source: Shared Use Mobility Centre

Figure 2: Dunsmuir Street in Vancouver supports safe and comfortable travel by all modes. Image Source: Paul Krueger.

Redundancy

A system with back-ups or parallel options for critical elements minimizes the impacts caused by failures or breaks. A redundant transportation system provides back-up linkages or alternate facilities for critical elements. Greater redundancy in a transportation system can be achieved by supporting multimodal streets. Providing reliable transportation alternatives means that residents will have more options available to access goods and services if one mode or a certain route is not available to them.

Redundancy can also be achieved by having multiple corridors that can connect parts of the city and multiple access points into communities. Grid road networks are redundant by nature since they create a system of parallel street and transit routes that are more resistant to localized network issues.

Redundancy of access is a critical consideration for emergency planning. When natural disasters like forest fires or floods engulf a community, having multiple routes for escape can be a matter of life or death. In communities with only one way out, residents can become trapped in the long queues formed by others fleeing the area or they may lack accessible options for escape.

Adding elements of redundancy may require some trade-offs with efficiency in a transportation system. However, prioritizing efficiency above all other attributes can leave a transportation system vulnerable to major disruptions if there is a major issue within the network.

Flexibility and Adaptive Capacity

A transportation system has flexibility and adaptive capacity when it can be easily adjusted by planners and decision-makers in response to stresses and longer term disruptive trends. This element of resilience is often most evident in the design of streets. Streets that can be used for multiple purposes and easily "rearranged" to serve different purposes are more resilient than streets that require costly transformation projects each time to achieve the same result. Street design based on the principles of flexibility and adaptive capacity typically minimizes the use of fixed barriers and boundaries. Elements of flexibility and adaptive capacity are also emphasized when municipalities plan streets for impending changes such as climate change and emerging technologies.

Tying transportation system budgets to the achievement of specific transportation objectives rather than to the completion of specific actions or projects could help municipalities maximize the potential benefits of flexibility and adaptive capacity in their transportation systems. This would allow municipalities to keep tweaking their transportation solutions until they achieve their objective. However, to be effective, this approach would require on-going monitoring and management of conditions so that municipalities could change their strategy and approach in response to travel demands and conditions over time.

Capacity to Reorganize

The capacity to reorganize is evident when the components of a transportation system have the ability to adapt on their own in real time to surrounding conditions. Street designs with non-permanent features where users behave collectively to allow different modes to co-exist in the same space are an example of the capacity to reorganize. Other examples include smart technology with "detect and adapt" capabilities (such as select traffic signal systems) and traveller information systems that empower travellers to decide which mode to use or when to start their trip.

As cities around the world are finding ways to respond to an increasing range of challenges such as growing populations, increased congestion, and climate change, many have prioritized ensuring transportation resilience. Embedding elements of resilience into the transportation system helps municipalities prepare, adapt, and transform in the face of adversity. This section identifies some trends and best practices from various communities as they relate to the four elements of resilience introduced in the previous section.

Diversity

A "complete streets" approach to street design is one way transportation planners and engineering are building diversity into transportation systems. Context-sensitive complete streets are designed to enable safe and convenient travel for users of all modes. The approach brings balance to the allocation of road space and serves a greater diversity of users in comparison to the car-oriented streets of the past.

Guidelines and standards for complete streets have become a common feature in many jurisdictions around the world, including London, Edmonton, Calgary, Toronto, and Saskatoon in Canada. The National Association of City Transportation

Trends in Transportation System Resilience

Officials (NACTO), an association of major North American cities and transit agencies, also provides guidance on complete street design using case studies and best practices from around the world.

And guidelines are taking the unique needs of different users into account more often. Increasingly, design guidelines for cycling facilities are recognizing that cycling facilities must serve more than seasoned commuter cyclists. In response, cities are developing guidelines for facilities that serve a broader group of cyclists, such as the City of Vancouver's *All Ages and Abilities Cycling Routes Design Guidelines*.

The same principles also apply to pedestrian facilities. In Ontario, the *Accessibility for Ontarians with Disabilities Act (AODA)* contains provisions for requiring municipalities to build pedestrian facilities that accommodate a more diverse group of users, including those with physical disabilities and visual impairments.

Documents like multimodal level of service (MMLOS) guidelines are also ensuring that all modes are being considered in transportation planning, design, and operational decisions. In Canada, MMLOS guidelines are already in effect in Ottawa, Halifax, and York Region. A provincial set of MMLOS guidelines is expected to be published within the next 5 years to support all Ontario municipalities.

MMLOS guidelines support diversity by improving the level of service experienced by a broader range of travellers.

Transportation Demand Management (TDM) is another tool municipalities use to improve the diversity of modes in transportation. TDM is a series of educational programs, awareness campaigns, incentives, and disincentives to influence mode choice, spread out travel demands, reduce trip lengths, or eliminate trips altogether. Examples of TDM measures include:

- Encouraging work from home arrangements;
- Encouraging off-peak travel via flexible workday policies;
- Improving transit services to key employment nodes;
- Improving active transportation facilities to key employment nodes;
- Requiring site-specific TDM elements as a condition of development;
- Using feed to manage parking demand fees; and
- Implementing congestion pricing.

Most municipalities today have dedicated resources to TDM programming. Municipalities often partner with workplaces and other organizations to implement certain TMD measures.

Figure 3: Implementing measures like the King Street Transit Priority Corridor in Toronto helps improve transportation system resilience. Image Source: Vadim Rodnev / Shutterstock.com

The *diversity* of transportation options has also grown in recent years. Today, people in many cities have access to micromobility, microtransit, ride-hailing, shared mobility options, and more. Discussed in greater depth in the *Transportation Technology and New Mobility Options* background paper, these emerging forms of mobility contribute to a more diverse transportation system. However, decision-makers need to have appropriate policies and methods of enforcement to ensure safety, affordability, and accessibility for the users of these options.

Redundancy

Redundancy is a key feature in the transportation systems of many cities for both emergency preparedness and day-to-day operational issues. Redundancy is critical for emergency preparedness but it also offers alternative options for travellers when there is congestion, when their trip may be affected by a collision or construction delay, or when their regular route is temporarily unavailable due to road closures. These more mundane events are an inevitable part of transportation and require mitigation to prevent daily network failures.

Redundancy in transportation systems is not always obvious at first glance. In New York City, subway lines have double tracks in order to accommodate local and express service. However, this design also provides redundancy if one track is incapacitated. In Vancouver, redundancy is built below the SkyTrain, with parallel bike paths running underneath the elevated tracks.

In Toronto, Highway 401 utilizes the Express-Collector Lane System. In this system, the collector and express lanes are separate from each other, providing a built-in alternative route if one set of lanes is closed due to an incident. There are also permanently marked exits onto secondary highways along Highway 401 as part of the Emergency Detour Route network.

Figure 4: Following an initial pilot project, Argyle Street in Halifax was permanently redesigned as a " lexible street." The street remains open to tra ic, but can be closed to allow for outdoor concerts, festivals, and other events. Image source: Paul McKinnon via Shutterstock.com.

And GO Train routes roughly paralleling Highway 401 offer an alternative mode of travel for people travelling between municipalities in the Greater Toronto Area (GTA).

Flexibility and Adaptive Capacity

Temporary measures to reallocate road space, often referred to as "tactical urbanism," are one example of how communities can incorporate flexibility and adaptive capacity into their transportation networks. Tactical urbanism interventions are temporary and relatively inexpensive, allowing communities to experiment with potential street designs and identify the best solution for their specific challenges. The inexpensive and moveable materials used for tactical urbanism can also be used to respond to different needs over time. In Canada, many cities have implemented tactical urbanism interventions, including Vancouver, Toronto, Mississauga, Winnipeg, and Edmonton.

Flexibility and adaptive capacity is also evident in the design of the aptly named "flexible streets." Flexible streets are streets that can be easily repurposed in response to different demands at different times of day or of the year. A common design for flexible streets has sidewalks on both sides of a roadway but no traditional curb, allowing the entire cross-section of the street to become a space only for active transportation users or pedestrians during special events.

Flexible streets have been popular in Europe prior to being more frequently utilized in North American design. Flexible streets are typically seen in urban cores or in "main street" environments. Today, there are several flexible streets in municipalities across Canada, including:

- Argyle Street in Halifax
- Saint-Catherine Street in Montreal
- Dundas Street in London
- Queens Quay in Toronto
- Stephen Avenue in Calgary

Figure 5: The recently reconstructed Dundas Place in London, Ontario, is an example of a "flexible street" that can be adapted quickly to different uses. Image Source: City of London.

The repurposed use of curbside space for patios or parklettes during the summer months is another example of incorporating flexibility into streets that is popular in many cities.

Many cities are also using flexibility and adaptive capacity to respond to the long-term disruptions imposed by climate change. Methods for this include:

- Prioritizing space and infrastructure for modes of transportation that produce low or no emissions;
- Increasing urban tree canopies; and
- Managing the effects that the growing number of impermeable surfaces have on water quality, flood potential, and groundwater recharge (particularly in light of increased frequency of major rainfall events).

With respect to water management in particular, municipalities across North America are increasingly implementing low impact development (LID) techniques to mimic natural processes and manage stormwater as close to its source as possible. These techniques help manage flooding, protect water quality, and protect aquatic habitats. Within the transportation network, LID techniques may appear within the right-of-way in the form of:

- permeable pavements;
- bio-retention swales or rain gardens;
- infiltrating trenches;
- tree box filters, which also support the urban forest; or
- use of native species for landscaping.

Preparing existing streets for the transition to electric and autonomous vehicles (EVs and AVs, respectively) is another example of flexibility and adaptive capacity. With anticipated widespread adoption of these technologies in the near future, many municipal, provincial, state, and federal governments are prioritizing the development of EV- and AV-supportive policies and infrastructure (such as on-route charging stations) in preparation for their arrival. To learn more about electric and autonomous vehicles, please refer to the *Transportation Technology and New Mobility Options* background paper.

Capacity to Reorganize

A transportation system's capacity to reorganize can be supported by infrastructure that allows the system to change in response to real-time conditions. "Slow streets" (or Woonerfs, as they are known in Dutch) are an example of a street design with a built-in capacity to reorganize.

These streets are shared by pedestrians, cyclists, and motorists with minimal physical separation through the combination of placemaking and speed management. Slow streets blur the boundary between pedestrian space and the roadway, allowing pedestrians and cyclists to use any part of the street. This environment forces cars to slow down to a "walking speed" and enables the entire street to become part of the public realm. The recently transformed Bear Street in Banff is an example of this street design.

Figure 6: This bioswale in the median of Grange Avenue in Greendale, Wisconsin, adds visual interest while also providing flood storage, filtering run-off, and supporting local pollinator populations. Source: Aaron Volkening

Figure 7: Bear Street, Banff, Alberta. Source: City of Banff

Innovative transportation technologies can also support a transportation system's capacity to reorganize traffic in response to real-time conditions. Traffic signal systems that update signal timing in response to real-time congestion are an example of this. Many cities today incorporate various elements of smart transportation system technologies that are self-adaptive to current conditions. Specific technologies and innovations are discussed in more detail in the *Transportation Technology and New Mobility Options* background paper.

Traveller information systems are another form of technology that supports a system's capacity to reorganize by enabling groups of people to make different decisions.

Widely used variable message signs on highways and signs indicating parking availability at entrances to parking lots are low-tech approaches that provide travellers with valuable information to help them make trip-related decisions. Services like Google Maps and Waze offer travellers in many communities around the world real-time information to help inform route choices, mode choices, departure time, and more. More transit systems are also offering real-time schedule information on status and arrival times through the use of GPS-enabled transit vehicles. All of these options enable the transportation system to react in real time.

Case Study: Technology, Big Data, and Transportation System Resilience

Numerous emerging smart cities technologies are poised to improve a street's capacity to reorganize, especially when it comes to highly demanded curb space. The high profile Sidewalk Labs proposal for the Quayside community on the eastern waterfront of Downtown Toronto was the most ambitious and expansive vision in Canada for smart city technology. Although the project proposal was withdrawn in May 2020 for a diverse variety of reasons, it offered a glimpse into the possibilities for a transportation system with a higher capacity to reorganize. Proposed plans for this community incorporated a vast array of sensors to collect enormous amounts of real-time data, which would feed into a mobility management system. In turn, the system would have coordinated travel modes, traffic signals and street infrastructure. Adaptive traffic signals would have had the ability to give intersection priority to pedestrians and cyclists who need more time to cross safely, or to transit vehicles running behind schedule. Dynamic curbs would offer flexible pick-up/drop-off zones that could provide ride-hail passenger loading zones during rush-hour and quickly become public spaces during low-traffic periods.[2]

Though the vision of Sidewalk Labs was never realized, some of the proposed concepts could be useful in improving the resilience of future transportation systems.

2 Sidewalk Toronto, "Mobility." https://www.sidewalktoronto.ca/innovations/mobility/

Transportation System Resilience and the COVID-19 Pandemic

In March 2020, the World Health Organization officially declared the growing number of COVID-19 outbreaks as a pandemic. As a result, lockdowns, isolation requirements, and social distancing measures were implemented in communities around the world. Since then, many cities have experienced historically unprecedented levels of unemployment, abandonment of public spaces, and a dramatic reduction in commuting trips as more people began to work from home. The immediate impacts of COVID-19 on transportation systems were rapid and very consequential. Cities and countries around the world were challenged to adapt to the new reality while continuing to provide convenient mobility options and ensuring public safety.

But the longer-term impacts of the pandemic on transportation systems might also be significant. COVID-19 has the potential to permanently change commuting patterns and the future of transportation. This offers communities the opportunity to avoid reverting back to "normal." Instead, cities could emerge from the pandemic with transformed transportation systems that are more resilient to shocks and stresses.

This section discusses general changes in driving, transit, cycling, and walking as a result of the pandemic that have been observed so far and the potential impacts these changes may have on the future of our cities.

Driving

Due to enforced lockdown measures, a shift to working from home for many workers, and significant disruptions to the economy, there has been a notable decrease in traffic congestion. Benefits of these changes include fewer car accidents, improved air quality, reduced noise pollution, and reduced greenhouse gas (GHG)

emission. Demands for parking space in employment centres and shopping areas has also declined, with many lots sitting empty. However, falling demand for parking has severely reduced municipal revenues from parking fees, which is likely to affect future municipal budgets, at least in the short-term future.

At the same time, demand for more deliveries (and thus for more short-term loading space along the curb) has increased as more people have had to rely on online shopping. The growing popularity of online shopping may last beyond the pandemic as more people become comfortable shopping online or grow accustomed to the convenience offered by online shopping. If this is true, the number of trips for retail purposes may not rebound to pre-COVID-19 levels.

Work from home arrangements are likely to continue for many months into the future as communities try to avoid subsequent waves of the virus while a vaccine is being developed. And as companies and employees become increasingly comfortable with working from home, these arrangements may become more permanent for a significant number of people who previously commuted to work. Eliminating a portion of commutes from pre-pandemic levels could translate into reduced congestion and slower traffic growth, especially during the peak periods.

However, there is the potential that traffic could grow beyond pre-pandemic levels and vehicle ownership could rise. Public transit and shared mobility options, which were used by many as an alternative to driving a personal vehicle for longer trips, may become less attractive as people remain concerned about potential exposure to the virus. In the long-term, this scenario could eliminate all of the short-term benefits gained from a drop in traffic volumes from the last several months.

Transit

With commuting at historically low levels and widespread fears of infection, transit has seen a significant decrease in ridership. This has also resulted in a significantly reduced farebox revenue, which has major implications for municipal budgets.

Throughout the pandemic, most transit agencies have continued to provide service for those who needed to travel, including many essential workers. Public transit systems around the world have taken significant measures to help make transit safe for both riders and operators, including:

- **Discouraging non-essential travel;**
- **Frequently disinfecting and cleaning vehicles, stations, and**

other high-contact areas;

- **Implementing staggered seat spacing policies and reducing the capacity of each transit vehicle;**
- **Constructing shields and barriers for operators;**
- **Enforcing rear door boarding and face covering policies for all passengers;**
- **Changing fare policies (which resulted in free transit in some cities) to minimize interactions between operators and customers; and**
- **Developing customer awareness about cleaning protocols and social distancing**.

The demands of the pandemics have significantly challenged transit system operations. Many systems have had to reduce service frequency on certain routes due to declining ridership. Some have even temporarily shut down transit service completely. At the same time, transit systems have had to increase frequencies on some routes despite declining ridership to maintain social distancing in each vehicle or to better serve essential workers traveling to their places of employment.

It is unclear when people will feel comfortable returning to transit. Returning to pre-pandemic ridership levels may take months or years, even after the pandemic subsides. But transit systems are continuing to struggle with the conflicting demands created by the pandemic. Low ridership means that operational budgets for transit have been significantly affected. At the same time, transit systems are sometimes having to increase operations to ensure the health and safety of all those on board. In response to this conundrum, governments have recently been providing emergency funding to try and support struggling transit systems.

Cycling

Cycling has become a more popular activity during the pandemic. Stuck at home for long periods of time, many people have discovered cycling for the first time as a form of recreation that allows them to maintain social distancing. For some, cycling became a form of exercise during a time when fitness facilities and group sports were no longer available. For people without cars, cycling offered a more affordable way of completing essential trips that didn't require the use of transit.

In response to these demands, many cities around the world quickly implemented temporary measures to reallocate unused street space to cyclists. Temporary pop-up cycling lanes have been implemented in cities all over the world including in New York City, Denver, Paris, Berlin, Bogota, Milan, Winnipeg, Calgary, Vancouver, and Montreal. Due to their popularity, mayors and city planners in a number

of these cities have publicly committed to making these changes permanent, making the COVID-19 pandemic a turning point for urban transformation. In France, the government has even offered bicycle repair subsidies to encourage people to keep cycling post-lockdown.[3]

Considered an essential service in many jurisdictions, bike shops have remained open in many communities throughout the pandemic. Many have noted a sharp increase in bike sales during the pandemic, resulting in temporary bicycle "shortages."[4] These new behaviour patterns could influence how people move around cities in the future, especially if they have access to safe infrastructure for cycling.

Walking

Like cycling, walking became a common form of recreation during the pandemic-related lockdowns. With all non-essential travel discouraged, many people also grew to depend on walking to get to shops and services close to their homes.

In response, many cities have expanded their pedestrian spaces to accommodate more activity and allow for social distancing. Some have introduced one-way sidewalks to make social distancing easier while others have closed parking or traffic lanes and expanded the pedestrian realm into the roadway using temporary materials.

Several cities in North America, including Seattle, Halifax, Vancouver, and Montreal, have also implemented "slow streets" on several local streets in their network. Slow streets use temporary materials to create traffic calming measures and only permit local vehicle traffic in order to maintain a safe environment for active transportation users. Slow streets support social distancing by allowing pedestrians to walk on the roadway if sidewalk space is not sufficient to pass others safely.

As with cycling, having more travellers used to walking may result in long-term changes in how people choose to move through cities once the pandemic is over.

3 BBC News, April 30, 2020, "Coronavirus: France offers subsidy to tempt lockdown cyclists." https://www.bbc.com/news/world-europe-52483684

4 CTV News, June 14, 2020, "Pandemic leads to a bicycle boom, and shortage, around world." https://www.ctvnews.ca/world/pandemic-leads-to-a-bicycle-boom-and-shortage-around-world-1.4983596

Next Steps

Though the tragic consequences of the COVID-19 pandemic on our communities cannot be understated, there have been some positive transportation-related outcomes from the changes that the pandemic has forced on our cities. A dramatic reduction in driving and increased use of active transportation throughout the pandemic have improved air quality, reduced the number of transportation-related accidents, and encouraged healthier habits.

There are now opportunities to make some of these positive changes more permanent. Many temporary active transportation facilities have proven the value of investment in active transportation infrastructure. This could lead to more space being allocated for cycling and walking on more streets. As working from home is likely to become a new normal, cities could see a long-term shift in commuting patterns, which may result in reduced vehicular traffic on our streets. Transit will continue to be challenged to balance the provision of adequate and reliable service with budget shortfalls from a dramatic loss of fare revenue. But transit must continue to be a key part of our transportation system since many people, including a significant portion of essential workers who have enabled our communities to get through the last several months, rely on transit to be able to participate in the economy.

With regards to transportation, COVID-19 has shown that cities can benefit from better data collection (especially real-time data) to be able to respond to changes in demand. The pandemic has also highlighted the need for flexibility and agility in transportation infrastructure as well as in the decision-making processes to allow cities to respond quickly to changing situations.

Figure 8: The Woolwich Street temporary bike lane project was an example of temporarily "rearranging" the street in Guelph. Image Source: Morgan Boyco

Transportation System Resilience in Guelph Today

Guelph actively incorporates elements of resilience into transportation planning. This section highlights examples of each core element of a resilient system that exist in our city's transportation system today.

Diversity

Guelph has five modal transportation networks – a goods movement network, a road network for cars, a bus-based public transit network, a cycling network, and a pedestrian network. Guelph's extensive trail system makes up portions of both the cycling and the pedestrian networks.

Guelph is incorporating complete street philosophies into our transportation system. Complete streets design principles have been introduced into transportation planning in Guelph through the *2014 Guelph Downtown Streetscape Manual and Built Form Standards*. Recent improvements to the intersection of Gordon Street and Stone Road that provide a dedicated space for cyclists are an example of a design that better supports transportation diversity. The Guelph Official Plan also has a number of goals, objectives, and policies to direct transit-supportive development, ensuring that new growth in the city is not car-centric.

Guelph has a Transportation Demand Management (TDM) program that recommends TDM elements as a condition for new development, organizes

educational campaigns and promotions for sustainable transportation, and partners with employers and institutions to develop TDM programs.

Providing accessible service is also a key component of a resilient system that supports diversity. Guelph Transit offers Mobility Services, a specialized shared-ride service that offers accessible door-to-door service for eligible users within the city. Mobility Services use wheelchair-accessible buses and contracted taxi vehicles to serve its users. Guelph also provides guidance for the planning, design, and re-design of transportation infrastructure through the *City of Guelph Corporate Accessibility Policy and Procedure* and the *2015 Facility Accessibility Design Manual*.

Redundancy

A grid-based network of streets covers much of Guelph. Multiple bridge crossings and two access points to Highway 401 offer some redundancy of access into different parts of the city. However, some neighbourhoods have limited opportunities to access Guelph's arterial road network without having to cross or connect to a major highway, which may be affected by major congestion or delay on any given day.

Flexibility and Adaptive Capacity

Guelph has implemented tactical urbanism interventions in the past, including the temporary bike lanes on Woolwich Street, as shown in **Figure 8.**

Guelph's *2014 Guelph Downtown Streetscape Manual and Built Form Standards* designate several corridors in Downtown Guelph as Flexible Streets and provide standards for their re-design in the future. These include Wyndham Street, Macdonell Street, Quebec Street, and Douglas Street. Carden Street is an existing example of flexible street design in Guelph.

In terms of street design that is resilient to climate change, the City was an early adopter of Low Impact Development (LID) techniques, recommending the use of LID Best Management Practices (BMPs) through the *2012 Stormwater Management Master Plan*.

Figure 9 - The Carden Street transformation in Guelph provided the street with opportunities for flexibility and adaptive capacity. The street is shown from 2009 on top and 2019 on the bottom. Image source: Google.

Additionally, the City of Guelph has a long history of environmental stewardship, including implementing concerted efforts to mitigate climate change by reducing greenhouse gas (GHG) emissions. The community's support for and the City's commitment to sustainability are evidenced through various high-level policies and strategies, including the City's *Strategic Plan, 2018 Guelph Community Plan, 2018 Official Plan, and Community Energy Initiative (CEI).* Guelph's various commitments to electrification are discussed in the *Transportation Technology and New Mobility Options* background paper.

Capacity to Reorganize

Guelph Transit currently offers real-time trip planning through Google Maps, which uses data from buses equipped with GPS.

Guelph Transit is also developing an in-house trip planner for its customers.

The City's traffic engineering group is currently organizing pilot programs to review data collection products that could enable the city to make better informed real-time operational decisions. If the pilots are successful, the City may proceed with a wider-scale implementation of these technologies.

Real-time footage from traffic cameras of intersections in Guelph's vicinity is available to the public, but only on provincial highways. The feed from these cameras is managed by the Ministry of Transportation of Ontario.

Moving Guelph Forward: Transportation System Resilience

In light of the global COVID-19 pandemic, ensuring resilience in our communities is more important than ever. A resilient transportation system is able to adapt and thrive in the face of both short- and long-term disruptions. To do this, the transportation system needs to incorporate elements of diversity, redundancy, flexibility, adaptive capacity, and the capacity to reorganize.

Significant challenges like growing populations, increasing congestion, and climate change will continue to test our transportation systems long after an effective vaccine for COVID-19 has been developed. It is important to prepare for this inevitability by implementing solutions that will improve the resilience of transportation systems while also meeting the specific needs of our communities.

Based on the trends, best practices, and existing conditions outlined in this paper, the following is a list of key takeaways about transportation resilience in practice:

- Cities that prioritize multimodalism and consider the needs of a wide variety of users create more resilient transportation systems. These transportation systems tend to be more diverse and flexible to shocks or stresses than car-centric ones.
- Providing redundancy in a transportation system is critical for emergency preparedness as well as for offering everyday travellers a back-up option in case of day-to-day operational issues.
- Resilient streets are those that are designed to be flexible in purpose and adaptable to anticipated future challenges like climate change or emerging technologies. Luckily, with creative solutions that often use temporary materials, many existing streets of all kinds have the capacity to adapt to new conditions.
- Resilient transportation systems can self-adapt and rearrange themselves with the right designs and technologies. Access to accurate real-time data allows systems to respond to changes in current conditions.
- The COVID-19 pandemic has both acted as an acute shock and generated chronic stresses on our transportation systems. Many people have changed their transportation habits in response to the pandemic. As things slowly go back to normal, cities have an opportunity to make some of the positive pandemic-related changes that improve transportation resilience a more permanent part of their transportation systems.

What do you think?

What future challenges might affect Guelph's transportation system? What does a resilient transportation system look like to you? What should Guelph do to ensure transportation resilience in our city for years to come?

Let us know! Visit guelph.ca/tmp to learn more about the transportation topics and trends informing the development of our Transportation Master Plan and to find out how you can have your say on Moving Guelph Forward.

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