Evaluating the future of interprovincial rail transit in Canada's Capital Region using accessibility and equity

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Ottawa-Gatineau sits on the traditional, ancestral, and unceded territory of the Algonquin Anishnaabe Nation. It is critical to recognize the historical, cultural, and spiritual significance of this area when planning for its future. Indigenous peoples of the area must be meaningful partners in planning for any expansion of public transit across the Ottawa River.

Executive Summary

Context

Canada's National Capital Region sits along the Ottawa River and includes parts of the provinces of Ontario and Quebec. The bi-provincial arrangement, which includes a powerful federal government presence, creates a complex governance framework in which public transit planning between the cities of Ottawa, Ontario and Gatineau, Quebec is fragmented. The region's public transit network is served by two separate agencies that do not closely coordinate planning and operations. This arrangement is detrimental to long term priorities to encourage a mode shift towards sustainable transportation, reduce greenhouse gas emissions, and encourage infill development.

Ottawa-Gatineau is undergoing a significant rail expansion with new extensions to the O-Train Confederation Line and Trillium Line underway. Gatineau is also planning its own at-grade Tramway that would connect suburbs in western Gatineau to downtown Ottawa using the Portage Bridge. This supervised research project examines whether the Gatineau Tramway is the most effective method of connecting the two cities by increasing accessibility to jobs and people.

Research and Policy Recommendations

Rail alignments are evaluated through an accessibility analysis, which explores how under construction, planned, and proposed rail expansions affect the average number of jobs and people that can be accessed between 30 and 60 minutes on public transport. General transit feed specification (GTFS) data is created to simulate these new lines, network analyses are performed using open-source routing software, and the impacts on people are assessed using 2016 and 2021 census data. The effects are then evaluated through an equity lens using a social disadvantage index.

The findings suggest that the Gatineau Tramway, as currently configured, is not the most efficient method of connecting Ottawa and Gatineau by rail. On a per-kilometre basis, extending the O-Train Trillium Line 2 across the William Commanda Bridge would increase average accessibility gains at a much higher rate. For the Tramway to more effectively promote accessibility, the route should continue further into Ottawa, closer to where people live and work. Alignments that do so include Bank St., the Rideau-Montreal corridor, and the Queen Elizabeth Driveway. This analysis also finds that the proposed downtown loop concept would do little to increase accessibility to jobs and people.

This research project provides important insights into the projected impacts of new rail investments that connect Ottawa and Gatineau, while underscoring the possible benefits of increased interprovincial public transit collaboration. Further technical studies are needed to assess the viability of corridors examined.

The results should make decision makers take pause and consider the best way forward for the region. Improving interprovincial transit connections between both sides of the Ottawa River can lead to important benefits that make life easier for residents, including those most dependent on public transit. The conclusions in this report imply the need for critical conversations about how to better connect the National Capital Region.

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Introduction

Canada's National Capital Region is a highly integrated metropolitan area [1]. The region sits on the border between the provinces of Ontario and Quebec, and is home to important political, economic, and cultural institutions. Residents of each province regularly travel across the Ottawa River to access employment, family, friends, social events, services, and other amenities. Its two largest municipalities, the City of Ottawa in Ontario, and the City of Gatineau in Quebec, operate their own separate public transit agencies: OC Transpo, and the Société de Transport de l'Outaouais (STO), respectively. These agencies are ultimately responsible to the governments of each city, leading to a metropolitan transit system that is uncoordinated and fragmented.

The region is currently undergoing a significant rapid transit expansion and plans are underway to connect the cities by rail. Multiple bridges and corridors exist that could connect Ottawa with Gatineau, but the key agencies and actors involved have so far been unable to embrace, plan, and execute a coordinated vision.

The lack of planning and coordination of public transit in Ottawa-Gatineau is a hindrance to the region's ability to promote a mode shift, spur infill development, and reduce greenhouse gas emissions. As the region finds itself at a crossroads between different options to connect the cities, this supervised research project asks the following questions:

- How do other multijurisdictional metropolitan areas promote transit integration and where does Ottawa-Gatineau fall short?
- What are the projected accessibility effects after O-Train Stage 2?
- Is an extension of Trillium Line 2 across the William Commanda an option actually worth discarding?
- Is the Gatineau Tramway the most effective method of connecting Ottawa and Gatineau by rail?
- How would accessibility change if the Gatineau Tramway was extended into a downtown loop?
- Do other extensions of the Gatineau Tramway into Ottawa make sense?

This is first done through a literature review that explores the shift towards planning for accessibility and equity. This is followed by a case study of how other interjurisdictional transportation agencies are governed and promote integration. Finally, time interval cumulative accessibility metrics are calculated by creating general-transit feed specification (GTFS) feeds of O-Train Trillium Line 2 and 4 (2023), O-Train Trillium Line 1 and 3 (2026), the Gatineau Tramway, the extension of Line 2 across the William Commanda Bridge, and extensions of the Gatineau Tramway further into Ottawa, including the proposed downtown transit loop.

The findings indicate that the Gatineau Tramway is less efficient at promoting accessibility than extending the O-Train Trillium Line 2 across the William Commanda Bridge. To justify the Tramway from an accessibility standpoint, the Gatineau Tramway should be extended further into Ottawa than is currently planned. Extending the Tramway down Bank St., the Rideau-Montreal corridor, or along the Queen Elizabeth Driveway (QED) would all increase the Tramway's accessibility gains per kilometre and should be further studied. The downtown loop concept provides little accessibility improvements and would represent a missed opportunity to integrate public transit in the National Capital Region. The opportunity to extend O-Train Line 2 across the William Commanda Bridge, either to Alexandre-Taché Boulevard, or to Lorrain Boulevard should not be dismissed as the accessibility gains from these extensions are significant and have very positive equity effects.

This supervised research project contributes to the understanding of transit investment in the Ottawa-Gatineau region by applying time interval cumulative accessibility metric to assess the gains of under construction, planned, and proposed rail alignments, and evaluating projects on the metropolitan level, rather than just the local level. This report serves to spark discussions about the future of interprovincial public transit expansion, while also serving as a counter-planning study to ensure that sound transportation investments that include equity considerations are being made in the National Capital Region.

Literature Review

Accessibility

Transportation planning has been undergoing a long-term shift from mobility focused measures to accessibility measures [2]. First put forward by Hansen [3], accessibility is defined as "the potential of opportunities for interaction". Accessibility differs from mobility, which measures the ability of movement between points [4]. Accessibility is a more dynamic metric than mobility as it recognizes that travel is a derived demand, provides a social perspective on transportation planning, incorporates the complex interaction between transportation and land use, and assesses the ease of reaching desired destinations [5]. Accessibility is the most comprehensive land use and transport measure with profound implications on travel behaviour, mode share equity, economic development, and the environment [6-10]. Despite extensive research in the academic literature, many transportation plans and investments are still being evaluated based on mobility metrics such as travel-time savings [9, 11].

Cumulative opportunity measures of accessibility are increasingly used to assess transportation investments [9, 12]. This is the most commonly used location-based accessibility measure [13]. The equation of traditional cumulative accessibility measures is:

$$TCA_{oT} = \sum_{d=1}^{n} P_d f(t_{od})$$

Where:
TCA_{oT} is the cumulative accessibility of the origin *o* within the travel time threshold *T;*
P_d is the number of opportunities (jobs or people) in the destination *d*;
t_{od} is the travel time (minutes) between origin *o* and destination *d*;
$f(t_{od})$ is the travel time impedance function, which is a binary variable dependent on whether the travel time between the origin and destination is higher (0) or lower (1) than the travel time threshold *T*.

The advantage of this measure, as compared to more complex gravity-based measures, is that it is simple to understand and communicate to decision makers and the public. Cumulative opportunity measures have also been found to be highly correlated with gravity-based measures [14] and have been found to be a reliable accessibility metric in the Canadian context [15]. To assess cumulative opportunity measures, studies commonly use a single travel time threshold that ranges between 30 and 60 minutes [9], and 8 AM has been found to be representative of relative accessibility over the course of the day [16].

The limitation of cumulative measures is that not all destinations are equally desirable, and it is susceptible to the modifiable temporal unit problem (MTUP) [12]. In this context, the MTUP refers to how biased results of an accessibility analysis can arise from departure times not lining up with transit vehicle arrival times, service level fluctuations across time [17, 18], and arbitrary travel-time cut-offs [12]. This can lead to different conclusions with important equity considerations. Researchers and practitioners have tried to mitigate this effect by calculating average accessibility for a range of departure times [6, 19, 20] or by using multiple travel time cut-offs [20]. The multiple sensitivity analyses can make research findings more complex, undercutting the main benefit of cumulative measures of accessibility [21].

To address the limitations of traditional cumulative opportunity measures of accessibility, Tomasiello, Herszenhut [21] proposes a new time interval cumulative accessibility metric. This metric calculates the mean number of opportunities that can be reached within a given travel time threshold. The benefit of this metric is that it retains the straightforward aspect of traditional cumulative opportunity measures while also providing a more nuanced understanding of land use and transportation measures by reducing bias from ad-hoc cut-offs and mitigates the boundary effect of the MTUP.

Equity

Assessing equity in land use and transportation systems can be difficult as there is no standard definition [22]. Horizontal equity, sometimes referred to as equality, refers to providing the same service levels across populations. On the other hand, vertical equity refers to providing more benefits to groups that are disadvantaged or have greater need [23]. Social equity goals are rarely translated into clearly specified, measurable objectives in North American transportation plans [24]. Cities and transit agencies grapple with the competing priorities of providing better service to existing riders, or attracting new riders by providing better service to areas with low transit mode share [25].

Using accessibility changes in the evaluation of transport projects instead of travel time savings has shown important equity benefits [26]. The use of accessibility changes increases the chances that transport projects serving disadvantaged population groups will score well in a business case.

In the Canadian context, Manaugh and El-Geneidy [27] applied changes in cumulative opportunity to evaluate proposed public transport projects in Montreal. Their analysis incorporated equity considerations by using a traffic analysis zone disadvantage index. Foth, Manaugh [28] put forward a commute to work social disadvantage indicator that includes median household income, unemployment rate, percentage of the population that has immigrated within the last 5 years, and percentage of households that spend more than 30% of income on rent.

Assessing transportation projects

Advances in data standardization and network routing software have allowed accessibility to increasingly be used in the evaluation of public transit projects. Accessibility is a superior metric than travel time savings or station catchment jobs data as it does a better job of predicting demand and can better analyze the effects of transit improvements to disadvantaged areas. Crucially, accessibility analyses allow for a more comprehensive network-based approach that corridor studies fail to capture. This is important to assess at the planning stage to properly understand local and regional impacts [29]. Evaluating the projected impacts of proposed transit investments is important to maximize the social benefit of these projects [29]. Accessibility has been used to assess the efficiency of individual rail corridors by dividing the change in person weighted accessibility per line by its length [30]. For other analyses with detailed cost estimates, this has been evaluated on a per dollar basis [31].

The introduction of General Transit Feed Specification (GTFS) data in 2006 standardized public transit scheduling and allowed for interfacing with routing platforms. Transit agencies release GTFS feeds with the most up to date schedules on a regular basis. From a user perspective, this data is the basis for route planning with popular apps, such as Google Maps. For accessibility analyses, GTFS data is used to create a network and travel-time matrix, which is then combined with land use data to generate accessibility counts. Creating GTFS simulations based on proposed project schedules has been used to evaluate projected cumulative accessibility to jobs for individual rapid transit projects [12, 20, 21] and at a larger scale for entire transportation master plans [27, 29].

These analyses do not reflect the possible changes in accessibility from bus route changes in response to the opening of a new rapid transit line. Transit operators do not provide detailed route changes years in advance of revenue service. Previous analyses have simply run the new GTFS feed on top of the existing network. This has the effect of inflating accessibility estimates [12, 31]. At the same time, the lack of service adjustments to promote bus-rail transfers deflates the estimate [32]. Further study is required to assess how these two effects counteract each other.

Case Study Background

What is now the National Capital Region has been a home and gathering space for Indigenous people as far back as 9,000 years ago. In the early 1800s, construction of the Rideau Canal and lumber trade led to significant population growth, and in 1857, Ottawa was named the capital of the united Province of Canada [33].

The National Capital Region contains seven municipalities across two provinces. Interprovincial trips represent nearly 10% of all travel during the morning rush hour with approximately 30% of these trips being taken by public transit. Almost 70% of interprovincial trips in the morning rush hour are from Quebec to Ontario [34]. These trips are largely motivated by employment, as Ottawa has 81% of jobs in the region. Gatineau's population is expected to grow at a slower pace than its job growth, while Ottawa's expected job growth is higher than its population growth [34]. This dynamic was previously expected to increase demand for interprovincial trips by all modes, although the long-term effects of COVID-19 and the shift to hybrid working arrangements will impact this.

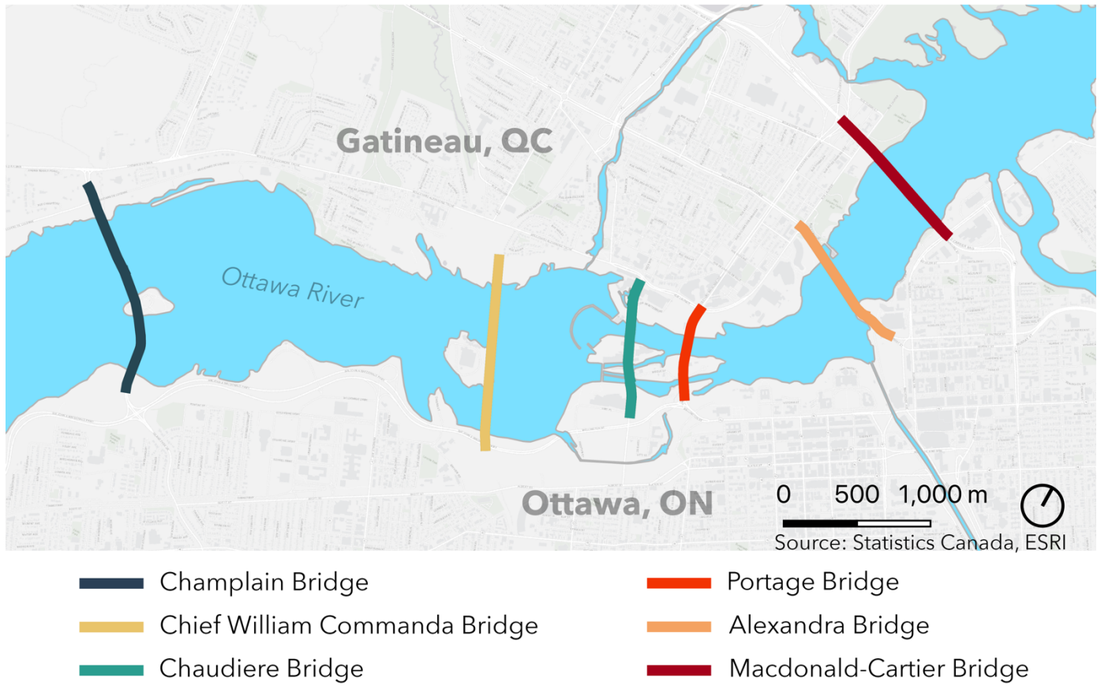

Figure 1 Interprovincial bridges between Ottawa and Gatineau

As figure 1 shows, the region has six active bridges between Ontario and Quebec. All of the bridges, except for the Chief William Commanda Bridge carry vehicular traffic. The Alexandra and Chaudiere bridges previously had rail tracks but have been converted to lanes for vehicles and active transportation. The Chief William Commanda Bridge is a former rail bridge that has recently been semi-permanently converted into an active transportation only bridge.

Planning in Ottawa-Gatineau is complex and involves many actors with diverse interests. Regarding multi-level governance in the region, a representative of the NCC stated, "It creates a unique situation insofar as integration and getting a cohesive approach to urban planning and urban design. It's not only difficult, but it's almost structured not to happen" [35]. For example, the City of Ottawa's 2013 Transportation Master Plan and NCC's *Interprovincial Transit Strategy for Canada's Capital Region* includes extending O-Train Line 2 directly across the William Commanda Bridge to Alexandre-Taché Blvd, but that corridor has since been rejected by the mayors of Ottawa and Gatineau as a viable rail connection and has converted to an active transportation bridge. Instead, Hull-Aylmer MP Greg Fergus proposed a Tramway in 2016 for West Gatineau [36], which the City of Gatineau, STO, and National Capital Commission eventually embraced. This plan has yet to be finalized or funded, and disagreements between actors persist. Despite an estimated additional cost of $500M, the STO and the City of Ottawa prefer the Tramway to enter downtown Ottawa in a tunnel under Sparks Street, only one block north of Ottawa's existing tunnel for the O-Train Confederation Line 1 [37, 38]. The National Capital Commission (NCC) prefers a route that runs at-grade along Wellington Street, a street whose future has been disputed between the City of Ottawa and NCC since it was closed following the winter 2022 occupation of downtown Ottawa [39].

Ottawa-Gatineau's lack of public transit integration and complex regional governance structures have been the subject of previous studies. Several plans in the early twentieth century recommended the establishment of a federal district encompassing Ottawa and Gatineau, but this encroachment on provincial jurisdiction proved unacceptable to Quebec [1]. Despite this, the federal government has continuously played a strong role in shaping the built form of the National Capital Region. The *Ottawa Improvement Commission Report* (1903), *Holt-Bennett Plan* (1915), and *Gréber Plan* (1950) all shaped the region's land use, transportation, and public spaces.

As figure 2 shows, the National Capital Region used to have an extensive rail network that spanned the two provinces at the William Commanda and Alexandra bridges. Until 1966, the Canadian Pacific Railway used the Alexandra Bridge for trains travelling to Montreal and Vancouver [40], and the William Commanda Bridge carried passenger rail until 1981 [41]. As Figure 3 shows, the Ottawa Electric Company sent streetcars to Hull along the Chaudiere Bridge, while the Hull Electric Company's streetcar network used the Alexandra Bridge until 1946.

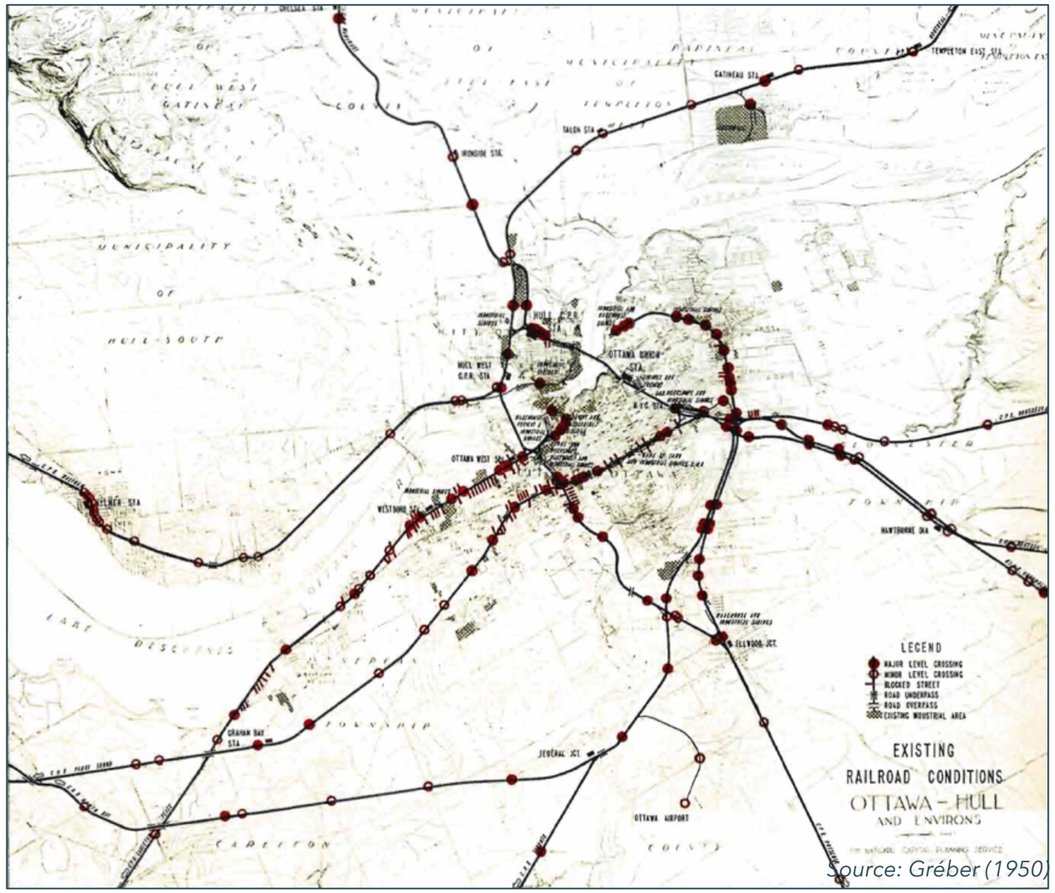

Figure 2 Former railway map of Ottawa-Gatineau [42]

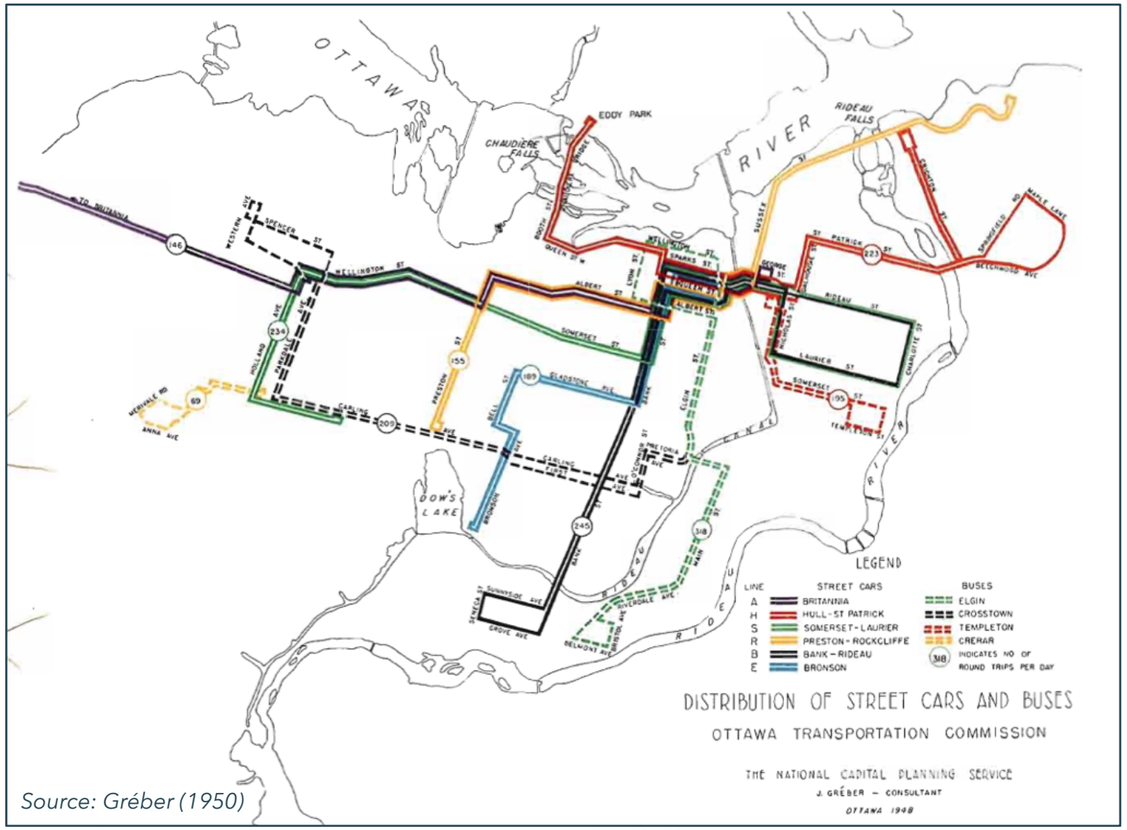

Figure 3 Ottawa Transportation Commission network map (1948) [42]

By 1966, the *Gréber Plan*'s bold vision for the capital was being implemented. Downtown Ottawa's Union Station was closed for a new main train station at Tremblay Road, and rail lines were converted into highways, "scenic parkways", multi-use pathways, and Ottawa's Transitway BRT system. The insistence on removing rail from the city extended to the streetcar network, where Gréber stressed the urgency in removing the line connecting Ottawa's Wellington St. to Hull [42]. The last streetcar in Ottawa ran in 1959, with bus service becoming the main public transit mode in the region. Greber's influence on Ottawa's land use and transportation cannot be overstated. His plan involved the razing of the working-class neighbourhood of LeBreton Flats, the removal of industry from the city, and creation of large government employment hubs. The creation of the greenbelt, which was an attempt to contain urban sprawl, was ultimately undermined by the construction of highways that fueled the growth of exurbs. As evidenced by the distribution of jobs and people in figures 4 and 5, Ottawa is characterized by its inner core, greenbelt, and exurban communities. Outside of the urban boundary are many rural communities that receive very limited public transit service.

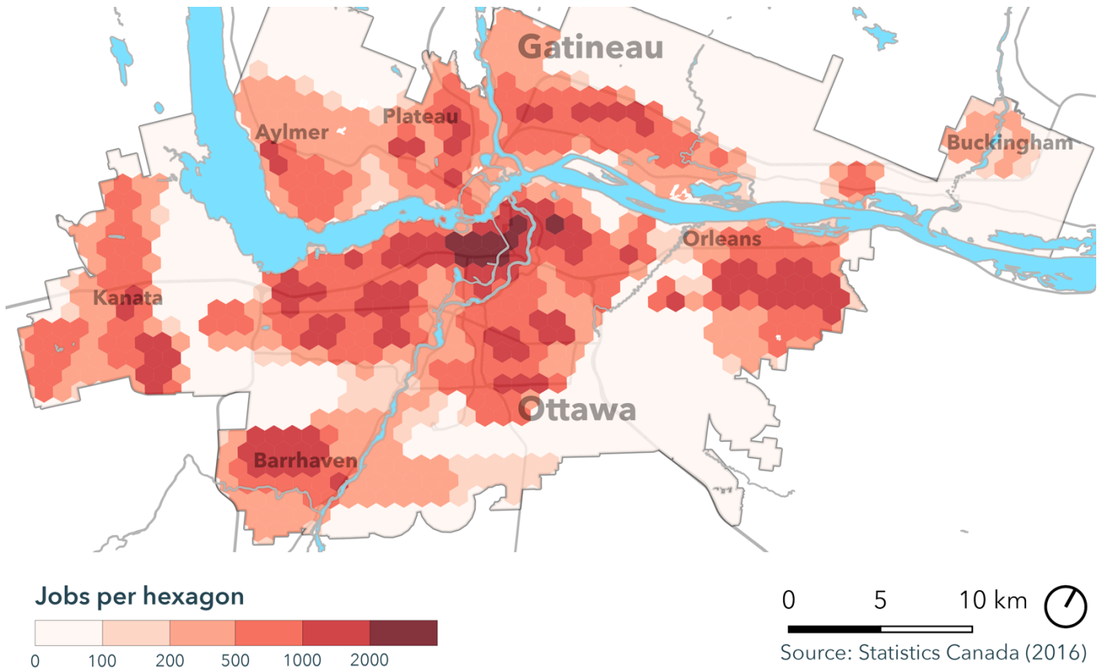

Figure 4 Jobs distribution in urban Ottawa-Gatineau

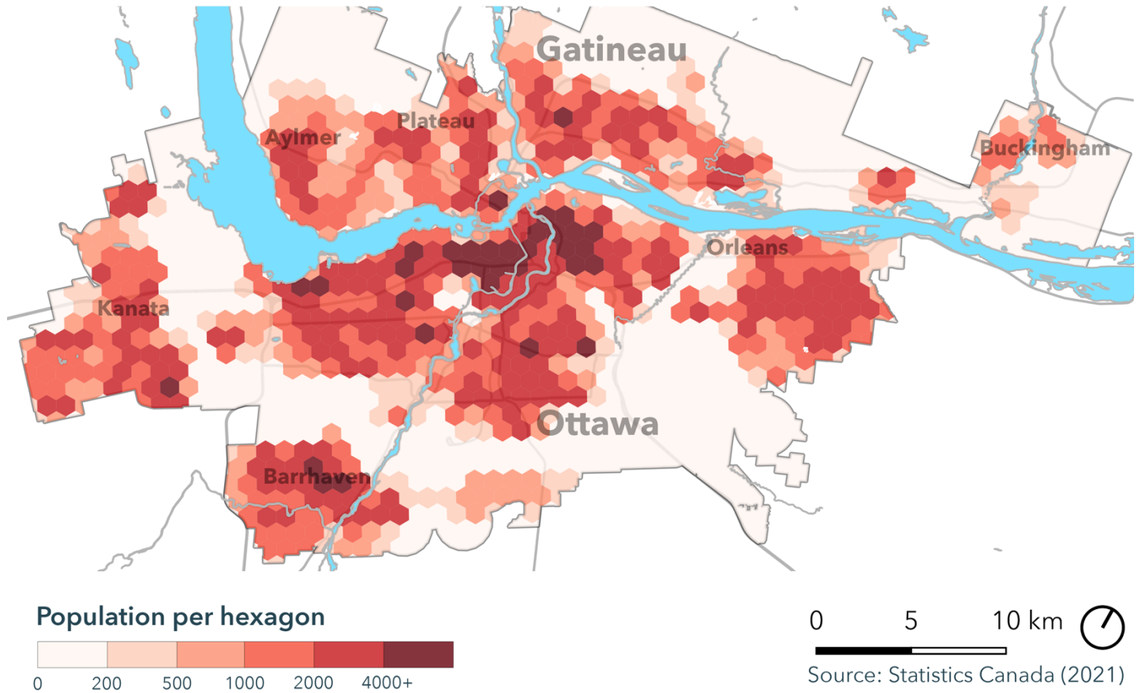

Figure 5 Population distribution in Ottawa-Gatineau

Today, OC Transpo and the STO are governed by each city's municipal government. OC Transpo falls under the City of Ottawa's Transit Commission, which is composed of nine city councillors and the mayor of the city serving as an ex-officio member. The Transit Commission has wide ranging responsibilities that include budget approval, directing transit related policies and programs, and operations. One of its 22 delegated responsibilities is to "Provide direction and guidance with respect to the operation of interprovincial public transit and co-ordination with the Société de transport de l'Outaouais ("STO")." [43]. The city previously had unelected citizen representation on the commission but these roles were removed in 2022 [44].

The STO is a public corporation governed by a seven-member board of directors. Five of these members are city councillors appointed from the City of Gatineau and two citizen members, one a regular transit user, and one a paratransit user [45]. The STO's board is responsible for administrative, policy, and technical decisions for the agency [46]. The STO's strategic plan includes a vision statement that notes that "Achieving this vision relies on the integrated planning of public transit systems and the related services offered, based on a metropolitan perspective that encompasses all the surrounding communities, including Ottawa [47]".

As of June 2023, the only all-day OC Transpo bus that serves Gatineau is route 85. Routes 15, 61, 63, 66, and 75 provide peak service to Gatineau, but all terminate on the Island of Hull. The STO's service to Ontario is much more robust as 10 all-day routes, and 22 peak routes terminate in downtown Ottawa. 1 all-day route and 2 peak-only routes serve Tunney's Pasture Station in Ottawa's west end. As Figure 6 shows, no STO routes travel east of King Edward Ave. or south of Scott St. Neither agency provides any through running of service, which means that transit riders must often transfer to cross the Ottawa River, especially outside of peak hours.

Interprovincial network
June 2023

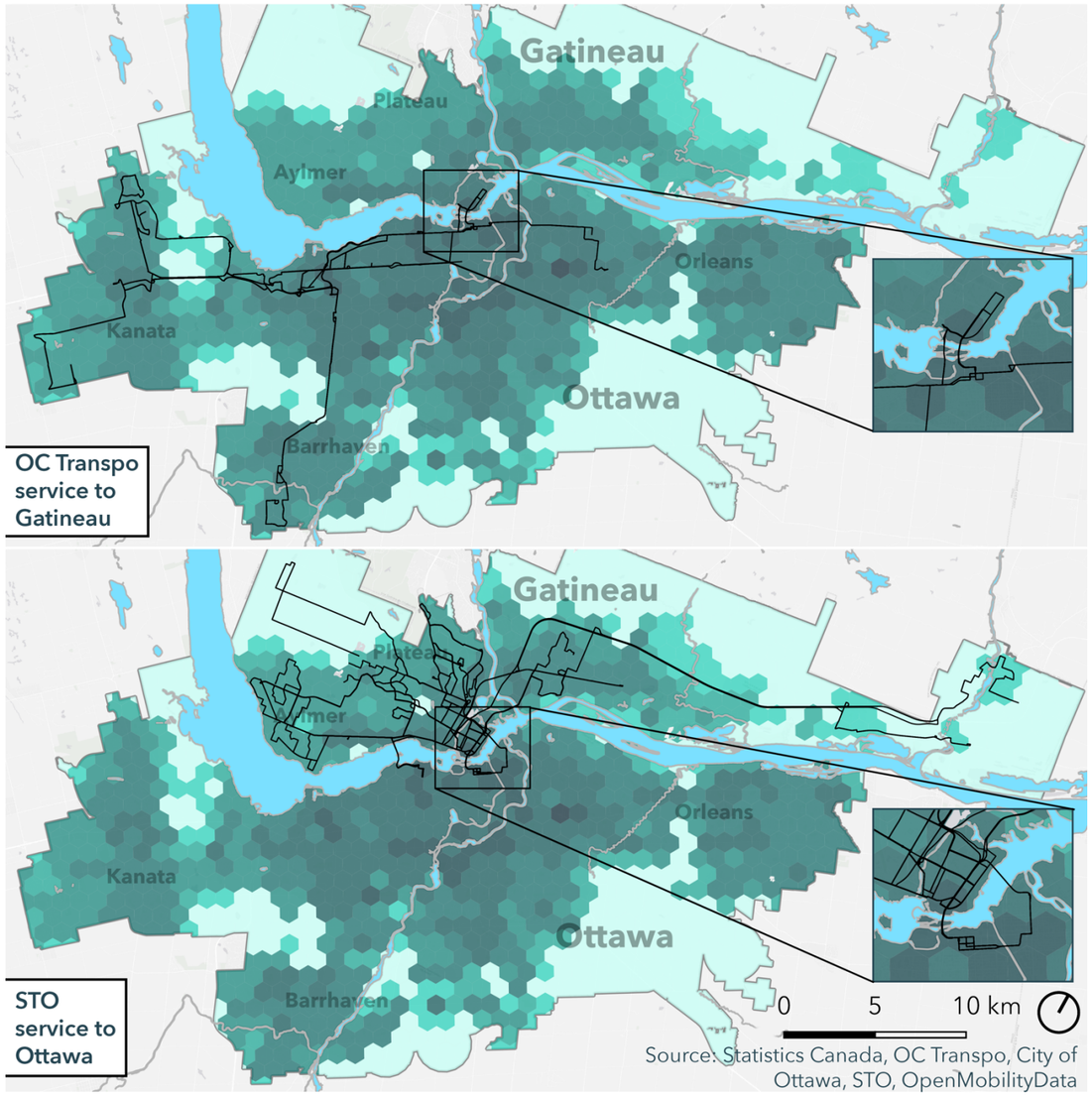

Figure 6

Past jurisdictional disagreements have stifled increased transit integration. An interprovincial BRT plan in the late 1970s fell apart due to complicated planning, jurisdictional, and funding matters [48]. The City of Ottawa pushed forward with its own BRT system that opened in 1983. Proposals to create a single transit agency for the region have been rejected and opposed by both transit agencies and municipal governments [49]. The lack of a formal governance structure to facilitate transit coordination does not mean that collaboration does not happen. The cities occasionally come to agreement, such as the decision to align transfers in downtown Ottawa for the opening of the O-Train Confederation Line 1 [50]. Technical guidelines, best practices, transportation forecasting, and data collection are also shared at the TRANS Committee, which includes the NCC, City of Gatineau, City of Ottawa, OC Transpo, and STO.

While each municipal government and transit agency acknowledges the importance of a regional approach, the governance of the entire network is ultimately fragmented so that planning and operations decisions are made at the municipal level. This can be detrimental to the residents of the region as the system does not have a singular fare card or policy, wayfinding is not uniform, through running of service is almost non-existent, and transfers between the systems are often required to cross the Ottawa River [51]. Previous studies have argued that higher levels of government should intervene to mitigate the effects of a dysfunctional metropolitan governance of transportation [1].

The NCC is the best example of a higher level of government intervening in interprovincial planning in the National Capital Region. In the last quarter century, the NCC has developed Confederation Boulevard between Ottawa and Gatineau, and its planning and oversight of the region's extensive multi-use pathway represents the emergence of multi-level governance in the region [52] [35]. Despite this, the NCC does not currently play a role in providing public transit, except for seasonal shuttles.

The introduction of the NCC's Transit Office represents a significant step in potentially overcoming this governance challenge. The crown corporation's *Long-Term Integrated Interprovincial Crossings Plan for the National Capital Region* notes that the West Gatineau Tramway project and proposed downtown loop "present an opportunity to initiate further discussions around governance of interprovincial transportation and regional mobility" [34]. This report examines the varying levels of transportation governance models that could be employed in Ottawa-Gatineau but stops short of recommending one. Crucially, any regional transportation agency would likely require significant collaboration between Ontario and Quebec as both OC Transpo and the STO are governed by municipal governments, which fall under provincial jurisdiction.

Finding a solution to this multijurisdictional issue is currently relevant as the region is undertaking a significant expansion of its public transit network. The 12.5 km phase 1 of the O-Train Confederation Line 1 opened in 2019. At expected completion of phase 2 in 2026, the Confederation Line will run 39.5 km from Trim Station in the eastern suburb of Orleans, split at Lincoln Fields Station, and terminate at Moodie Station in the West, and Algonquin Station to the South. To differentiate between the two termini, the Algonquin Station route is to be named Line 1 and the Moodie Station route is to be named Line 3.

At the same time as this east-west light rail expansion, the diesel-powered O-Train Trillium Line is being lengthened and upgraded with new grade separations and infill stations. This line first opened in 2001 as a 5 station, 8 km pilot project on a former Canadian Pacific Railway corridor. The City of Ottawa purchased the corridor and the William Commanda Bridge (then the Prince of Wales Bridge) for approximately $11 million [53]. The success of the pilot project led to full implementation, a $60 million upgrade in 2015 [54], and now a $1.6 billion expansion that will include a shuttle service to Ottawa International Airport [55]. Service south to Limebank Station will assume the name of Line 2, and the shuttle service between the airport and South Keys Station will be named Line 4. At the time of this writing, the upgraded Trillium Line is expected to enter service in the fall of 2023. Expansion of Line 2 north to Gatineau across the William Commanda Bridge was included in Ottawa's *2013 Transportation Master Plan* but the bridge has since been converted to an active transportation connection [53, 56, 57].

In 2013, the STO began service on their own BRT system, called Rapibus, that extends from Station Taché-UQO to Station Labrosse [58]. After serving the Rapibus corridor, many routes serve downtown Ottawa. A 2.8 km north-eastern extension to Station Lorrain is expected to open in the fall of 2023 with a further extension to boulevard de l'Aéroport currently being studied [59]. The Rapibus corridor runs just beside a single track of rail owned by Genesee & Wyoming and directly connects to the William Commanda Bridge.

In 2018, Gatineau unveiled plans for a 24.4-kilometre light rail line that would connect the western suburbs of Aylmer and the Plateau neighbourhoods with downtown Ottawa. Initial plans included two connections, one using the William Commanda Bridge, and the other using the Alexandra Bridge [60]. In 2019, City of Ottawa staff concluded that using the William Commanda Bridge as a main rail connection between the two cities would overcrowd Bayview Station, a station which had only just re-opened as an O-Train hub that same year [53]. After further study, revised plans proposed only one crossing at the Portage Bridge [61]. After initially proposing scenarios that included BRT along parts of the corridor, the STO has indicated that an all-tram scenario with a tunnel under Sparks Street in downtown Ottawa is its preferred alignment. The agency remains open to the option of running trams at-grade on Wellington Street in downtown Ottawa [62]

Transit Line	Length	New Stations	Status
O-Train Trillium Line 2 Pilot Project	8 km	5	Revenue service (2001), upgraded (2015), closed (2020)
Stage 1: O-Train Confederation Line	12.5 km	13	Revenue service (2019)
Stage 2: O-Train Trillium Line 2 and 4	16 km upgrade of Line 2	8	Under construction (2023)
Stage 2: Confederation Line 1 and 3	27 km extension of Line 1	16	Under construction (2026)
Gatineau Tramway	24.4 km	37	Planning and Design
Downtown Loop Tramway Extension	2.6 km extension	3	Early planning
QED Tramway Extension	6.5 km extension	9	No formal proposal
Montreal Station Tramway Extension	9.7 km extension	14	No formal proposal
Bank St. Tramway Extension	6.8 km extension	8	No formal proposal
O-Train Line 2 Commanda Extension to Alexandre-Taché Blvd	1.8 km extension	1	Proposal (in City of Ottawa's 2013 *Transportation Master Plan*
O-Train Line 2 Commanda Extension to Lorrain Blvd	16.5 km extension	11	Proposal (in 2013 *Interprovincial Strategy for Canada's Capital Region*)

Table 1: Completed, under construction, and proposed rail transit expansions in Ottawa-Gatineau

In August of 2021, the NCC indicated its support for an at-grade alignment on Wellington Street [39]. The NCC prefers this option as it aligns with its long-term plans and is a more affordable and technically sound option than a second downtown transit tunnel [63]. An at-grade alignment on Wellington Street has also sparked renewed interest in the idea of a transit loop between the two downtowns. The original concept, as put forward in the 2013 *Interprovincial Transit Strategy for Canada's Capital Region*, proposed that the loop be a complementary service to major commuting routes, and not be a rail crossing between the cities [64]. But in 2020, a plan created by a former NCC board member, and endorsed by former politicians, business leaders, and developers has publicly argued that the Gatineau Tramway, and pending replacement of the Alexandra Bridge, is the perfect opportunity to construct a downtown rail loop between the two cities. This idea was swiftly endorsed by the head of the NCC in an op-ed, and references to a downtown loop began appearing in NCC planning documents regarding the Tramway, seemingly without any public consultation or technical analysis [65] [39]. The continued development of the interprovincial transit loop is considered a long term strategy for the NCC [34]. The *2013 Interprovincial Transit Strategy for Canada's Capital Region* no longer appears on the NCC's website.

Planned transit projects such as the Baseline BRT, Rapibus extensions, Stage 3 of the Confederation Line, and Carling LRT were not included in this analysis as they do not serve both provinces and are thus outside of the scope of this analysis. The projected accessibility effects of implementing rapid transit on these corridors warrants further study.

Governance Case Studies

The governance of public transit affects outcomes as an organization's structure and board composition influences decision making [66]. Despite this influence, Marsden and Reardon [67] note that questions of governance, including context, power, resources, and legitimacy are largely being ignored in the transportation literature.

The presence of externalities that transcend boundaries, opportunity for economies of scale, and administrative uniformity have been identified as reasons for higher-level government involvement in regional transportation planning [68]. In most metropolitan areas, which sit in only one sub-national jurisdiction, this intervention usually comes from the provincial or state government. In the Canadian context, regional special purpose bodies (RSPB) have been created to better integrate regional transportation and land use planning in three Canadian metropolitan areas. Metrolinx in the Greater Toronto and Hamilton Area and TransLink in Metro Vancouver operate as RPSBs with unelected corporate boards, while the Autorité régionale de transport métropolitain (ARTM) employs a hybrid model with appointed and elected members of the board [69]. Advocates of RSPBs note that these agencies promote regional coordination, specialization, and equity, while critics argue that they can be undemocratic and unaccountable [70].

While the degree of provincial authority over transportation RSPBs in Canada differs, provincial governments are all strongly involved in some capacity [71]. Metrolinx is an agent of the Government of Ontario, its CEO and board are appointed by the provincial government, and its directives are issued from the Ontario Minister of Transportation [72]. The ARTM's authority is derived from the Government of Quebec and the Communauté métropolitaine de Montréal (CMM). The provincial government appoints the president of the board and six members, the CMM appoints three experts, and five mayors from local governments sit on the board [69]. TransLink represents a more locally driven RSPB as its authority is not that of an agent of the provincial government. It derives organizational directives, budgetary approval, and selection of board members from its Mayor's Council [71]. The importance and influence of multiple provincial governments in the creation of RSPBs is undoubtedly a challenge in Ottawa-Gatineau where two provincial governments are involved. The models employed by Metrolinx, TransLink, and the ARTM show that diverse governance models are available that incorporate different levels of provincial and local authority, political accountability, and operational autonomy.

Ottawa is not alone in its experience as a metropolitan area transcending sub-national boundaries. In the USA, several public transit agencies operate across interstate borders with many agencies existing as interstate compacts between state level governments. For transportation planning, these interstate compacts have proven necessary as metropolitan areas continue to expand across state lines [73]. For example, the Washington Metropolitan Area Transit Administration (WMATA), which is responsible for planning, developing, financing, and operating transit facilities in the Washington, D.C. metropolitan area has a 16-member board, with equal representation from Virginia, Maryland, the District of Columbia, and the U.S. federal government. Similar models have also been employed in Philadelphia with the Delaware River Port Authority, which has an equal number of commissioners from Pennsylvania and New Jersey, and in Kansas City with the Kansas City Area Transportation Authority, where commissioners are shared between Kansas and Missouri.

Source: WMATA

Figure 7 WMATA Metro Map [74]

Inter-state compacts range in their financing schemes. Some, especially those whose primary role is to operate public transit, are dependent on government subsidy. Others, such as the Port Authority of New York and New Jersey, which operates the PATH system, are self-financing through rents, tolls, fees, and facilities [75]. [75] The transfer of service from local levels towards intergovernmental service delivery has largely been considered a success, which has allowed for the scope of cooperation between jurisdictions to expand [76].

A formal multi-jurisdictional governance arrangement with representation from multiple parties is not a prerequisite for integrating public transit across borders. New York State's Metropolitan Transportation Authority (MTA) operates its Metro North commuter rail line into Connecticut under contract from the Connecticut Department of Transportation. Similar agreements have been put in place in the Öresund region surrounding Copenhagen, Denmark. Regional rail in southern Sweden serves several stations in Copenhagen. The network is owned, planned, and managed by six regional Swedish governments and operations are contracted out to a private third party operator [77]. Previous attempts at coordinating a joint service with both Swedish and Danish operators ran into financial disputes between the two countries [78].

In some cases, such as in the Upper Rhine Valley Area, positive results in cross-border services have been achieved through greater municipal and regional autonomy. National governments have ceded influence through the introduction of Eurodistricts that coordinate planning between cities [79]. The decentralization of decision making has produced positive recent results as Basel and Strasbourg both extended their tramways across national borders [80]. In the tri-national area surrounding Basel, Switzerland, cross-border transit service has been driven by the influence of the central city [81]. The Swiss government has provided financing for tram lines into France and Germany because doing so is seen as in the interest of Basel. This has been done in the absence of a cross-border public transit governing body with its own budget [82]. Just north of Basel, the Compagnie des Transports Strasbourgeouis expanded Strasbourg, France's tram system into the German city of Kehl in 2017. While there are regular meetings between the political leadership of both cities, the operations of the system falls under Strasbourg's control [83]. The costs for the project were split at the mid-point of the bridge connecting the two cities on the Rhine. Additional funding for the project came from various levels of government, as well as INTERREG, an EU Policy that promotes cross-border integration.

These case studies illustrate the different approaches various governments have taken to improve cross-border transit integration. What is common to many of the approaches is an acknowledgement that improved integration is beneficial for the region. What differs is the degree of local autonomy, higher government influence, funding authorities, and degree of operational integration. The challenge for the National Capital Region has been and will be to find a compromise that is acceptable to such a large and diverse group of stakeholders.

Figure 8 Basel, Switzerland operates a tri-national tramway into Germany and France [84]

Methodology

Using Geographic Information Systems (GIS), Ottawa's urban boundary and the boundaries of the City of Gatineau were combined and divided into a hexagon grid, with each hexagon measuring a diameter of 1 km. The use of a hexagon grid is important as it creates a uniform grid that reduces distortion that can arrive from irregularly sized and shaped census tracts (CTs) and dissemination areas (DAs). A hexagon grid was chosen over a rectangular grid as it more suitable for network analyses [85]. The hexagon grid was intersected with 2016 census tract level job location data and socioeconomic data at the DA level from 2021. Demographic data was distributed proportionally based on the percentage of the area that each hexagon occupied within a CT or DA.

Census data was used to create a social disadvantage index. This is a composite, normalized index that equally weights the percentage of residents that have immigrated in the past 5 years, the percentage of households that are spending above 30% of their income on rent, the average median income, and the unemployment rate. Figure 9 shows how social disadvantage is distributed across Ottawa-Gatineau. To create deciles, a population per hexagon threshold of 200 was used to exclude the greenbelt other very sparsely populated areas of the city.

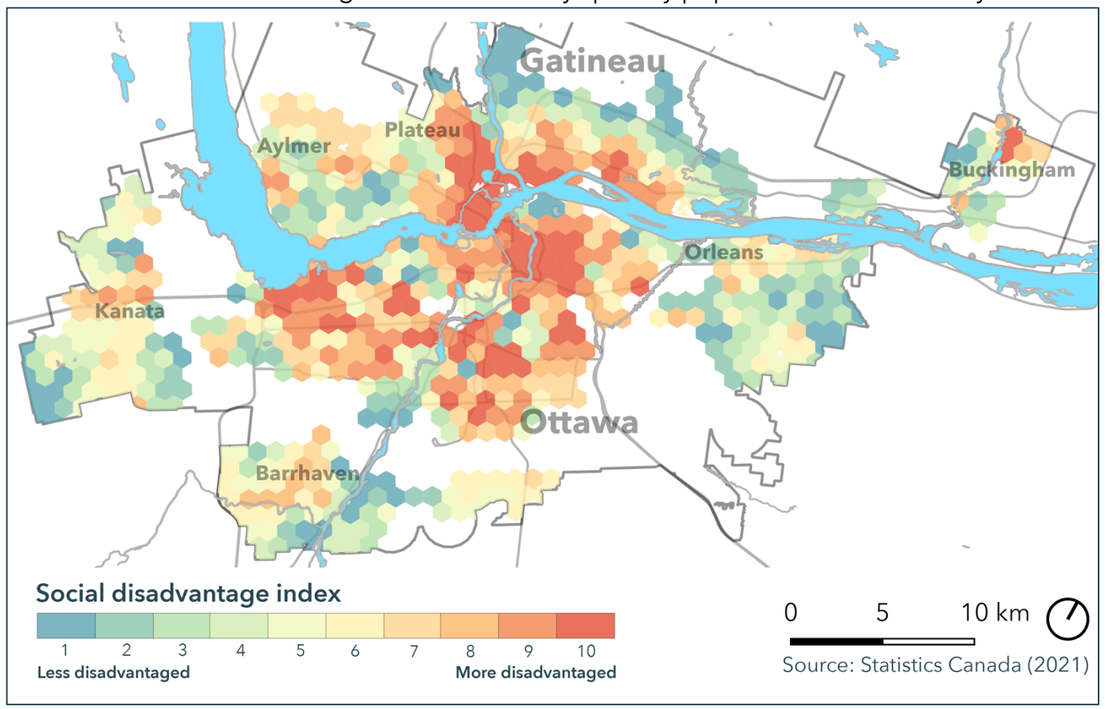

Figure 9 Spatial distribution of social disadvantage index

To generate the projected future public transit networks, new GTFS files were created to simulate the completion of the second stage of the O-Train construction. This includes the Trillium Line 2 and 4 and Confederation Line 1 and 3 expansions. Station locations were retrieved from the Open Ottawa data portal and their centroid locations were input into IBI Transit Data Tools. To simulate the Stage 2 network, route patterns corresponding to projected headways, travel times, dwell times, layover times, and cycle times were created [86]. These specifications were taken from project agreements for the weekday AM peak at 8 AM. This constant time has been found to be representative of the relative accessibility over the course of a day [16].

Line	Headways
Trillium Line 2 and 4 (and proposed extensions to Gatineau)	12 minutes
Confederation Line 1 and 3 Extension	2:45 between Lincoln Fields and Blair
Gatineau Tramway (and proposed extensions into Ottawa)	2:30 between Saint-Raymond and Ottawa, 5 minutes on Aylmer and Plateau branches

Table 2 Headway assumptions

The result of this initial step is a simulation of the O-Train network after the Trillium Line re-opens in 2023 and the Confederation Line extension enters service in 2026. The network does not include expected modifications to the bus network.

After the Stage 2 network was created, GTFS feeds of planned or proposed transit corridors were created. Because these projects are still in the planning phases, detailed service plans do not yet exist. In the case of the Gatineau Tramway, major decisions on the exact alignment, station locations, and how it will integrate into downtown Ottawa have yet to be made. For this analysis, the STO's favoured All-Tram concept was selected. This plan features light rail vehicles serving downtown Ottawa from two branches: one in Aylmer, and one in the Plateau neighbourhood. The analysis also uses the Wellington Street route as opposed to the Sparks Street Tunnel, as this alignment is preferred by the National Capital Commission [39]. An average speed, including stops, of 22.5 km/h was used for the route, which is the midpoint of the estimated speed range laid out by the STO [87]. This estimated speed is in line with similar Canadian at-grade LRT projects such as Toronto's Finch West LRT, which is expected to have an average speed of 20-21 km/h [88]. For extensions of the Trillium Line 2 into Gatineau, and the Gatineau Tramway further into Ottawa, the average speeds and headways of the original lines were maintained.

To generate accessibility counts, a travel time matrix is first needed. This matrix calculated the travel time from each hexagon to every other hexagon, for every minute of the 8 AM hour, at the 50th percentile. This was done using r5r, an open-source multimodal routing package developed in R [89]. Accessibility was calculated using time interval cumulative accessibility metric, as proposed by Tomasiello, Herszenhut [21]. This metric builds upon the traditional cumulative accessibility equation by using the average number of opportunities accessible within a time range. For this study, a time interval of 30 to 60 minutes was used as it provides a nearly 15 minute buffer surrounding Ottawa-Gatineau's average public transit commute time in 2016 [90]. The equation for time interval, cumulative accessibility is:

$$ICA_{oI} = mean(\{TCA_{oT} \forall T \in I\})$$
$$I = [T_{min}, T_{max}]$$

Where:
ICA_{oI} is the average cumulative accessibility of the origin o within the travel time interval I;
TCA_{oT} is the traditional cumulative accessibility equation;
I is a minute-by-minute distribution of travel time cutoffs within a given time interval between T_{min} and T_{max};

As such, the results should be interpreted as the average number opportunities accessible at the origin between 30 and 60 minutes at the 8 AM hour.

To assess the cumulative impact on the residents of Ottawa-Gatineau, the accessibility impacts were weighted by population of origin. To allow for comparisons between transit lines, results were standardized on a per kilometre basis. The use of per kilometre comparisons is imperfect as it discounts real life details such as the potential need for bridge work, new grade separations, and other engineering considerations that are outside of the scope of this study.

The changes in accessibility to jobs and people were evaluated through an equity lens by using a commute to work social indicator that combines median household income, unemployment rate, percentage of the population that has immigrated within the last 5 years, and percentage of households that spend more than 30% of their income on rent [28]. It should be noted that not all residents of a socially disadvantaged area are necessarily disadvantaged. Similarly, disadvantaged individuals and households can and do live in areas that are generally more socially advantaged.

Results

When it opens in the fall of 2023, the Trillium Line is projected to provide small accessibility gains relative to other rail alignments considered in this analysis, as shown in figure 10. After 2026, the Confederation Line 1 and 3 expansion is estimated to increase accessibility to jobs by 8.5% in Ottawa-Gatineau. Out of all the rail alignments examined, this figure is by far the largest, which is encouraging as this project is well underway. When looking to future transit expansion, what stands out is that extending Line 2 across the William Commanda Bridge to Alexandre-Taché Boulevard would generate accessibility gains comparable to the entire O-Train Trillium Line 2 and 4 expansion.

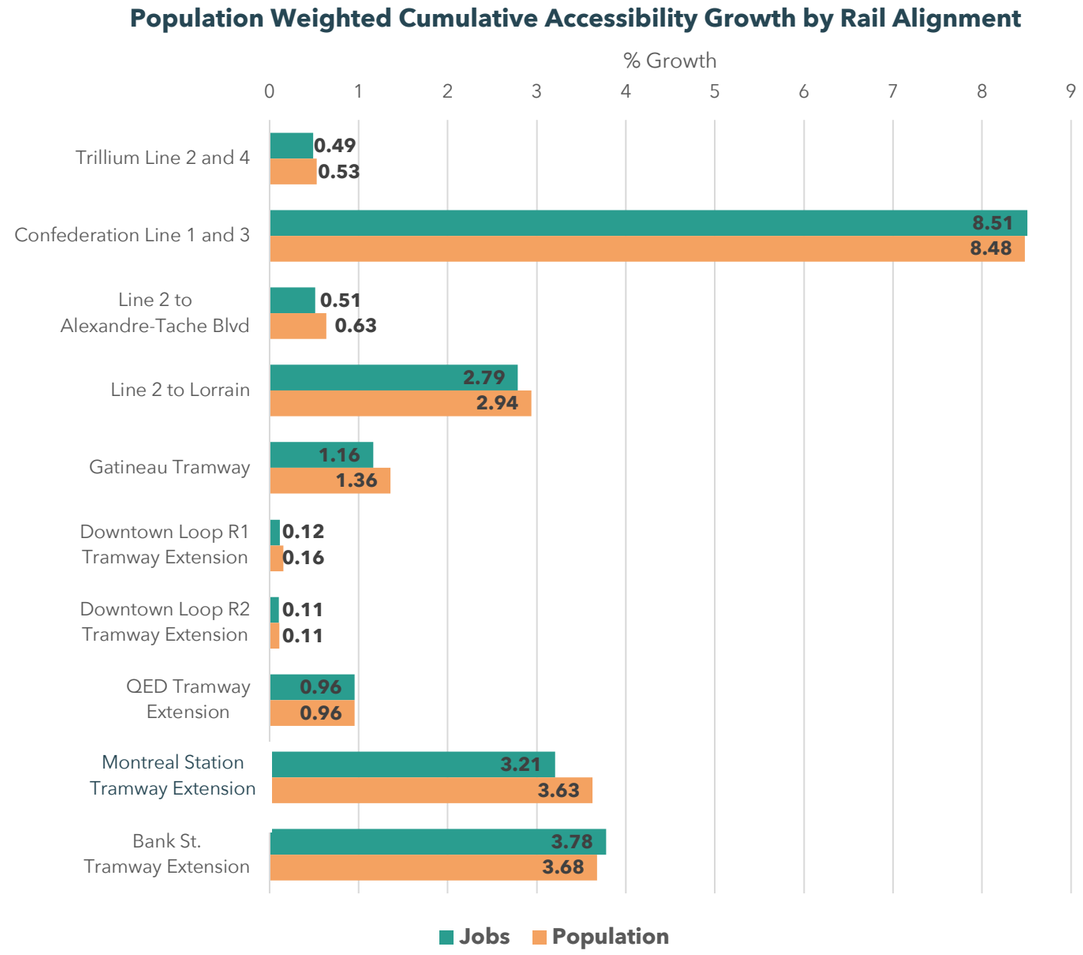

Figure 10

The Gatineau Tramway project is projected to only increase accessibility to jobs by 1.16%. If the tramway were to be extended into a downtown loop configuration, accessibility would only slightly increase. Much higher accessibility gains can be achieved by extending the Gatineau Tramway further into Ottawa, where jobs and people are located. This analysis looked at three corridors: the Queen Elizabeth Driveway, the Rideau-Montreal corridor, and Bank St. While this list is not comprehensive and other corridors are possible, the findings suggest that the accessibility gains from extending the Tramway further into Ottawa would be significant.

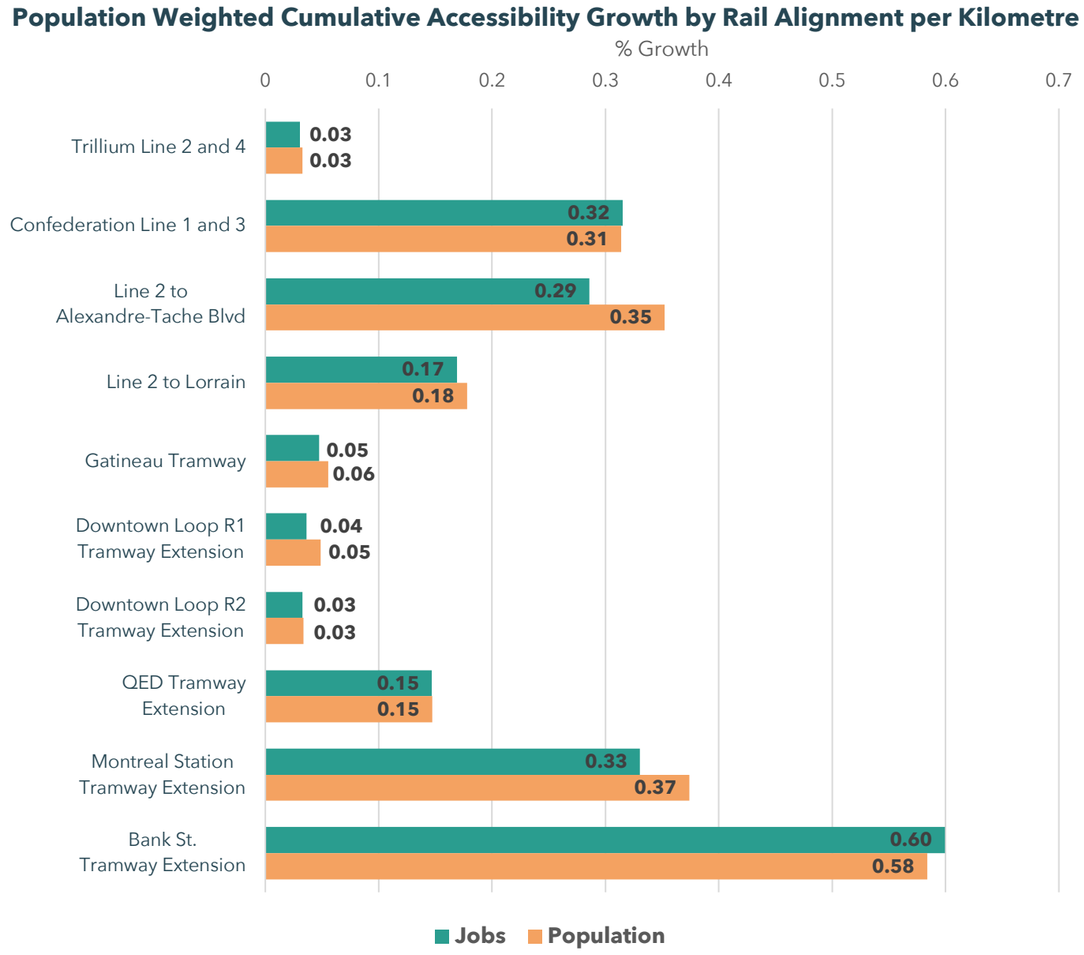

Figure 11

As figure 11 shows, when the accessibility gains are standardized by kilometre, a 6.8 km Bank St. leg of the Tramway would have the highest per kilometre accessibility growth. The Line 2 and 4 expansions are the lowest, which reflects the reality that the southern part of the route travels largely through sparsely populated parts of the city. The per kilometre gains from the Gatineau Tramway are the second lowest overall and configuring it as a downtown loop provides only a small boost to accessibility.

What stands out from figure 11 is that extending O-Train Line 2 across the William Commanda Bridge scores significantly higher than the Gatineau Tramway. An extension to Alexandre-Taché Boulevard would increase cumulative accessibility by 0.29% per kilometre, and a further extension along the Rapibus corridor to Lorrain Boulevard would increase cumulative accessibility by 0.17% per kilometre.

From an equity perspective, tables 3 and 4 show how the cumulative accessibility increases are distributed across deciles of the social disadvantage index. The Bank St. and Rideau-Montreal corridors score very well with high growth projected for more disadvantaged areas of the region. What's also evident is that the Confederation Line 1 and 3 extension is projected to have positive equity effects.

	Social disadvantage decile									
	Less disadvantaged ←									→ More disadvantaged
	1	2	3	4	5	6	7	8	9	10
Trillium Line 2 and 4	1%	0%	0%	15%	35%	3%	2%	3%	1%	2%
Confederation Line 1 and 3	8%	3%	10%	7%	10%	9%	8%	19%	25%	22%
Line 2 to Alexandre-Tache Blvd	1%	2%	1%	4%	2%	2%	3%	91%	33%	32%
Line 2 to Lorrain	5%	13%	4%	8%	4%	22%	22%	19%	16%	38%
Gatineau Tramway	1%	5%	6%	5%	5%	3%	2%	33%	2%	4%
Downtown Loop R1 Tramway Extension	0%	1%	3%	0%	2%	3%	1%	-3%	5%	6%
Downtown Loop R2 Tramway Extension	0%	7%	7%	2%	2%	1%	1%	4%	1%	13%
QED Tramway Extension	0%	1%	3%	3%	0%	14%	2%	10%	4%	11%
Montreal Station Tramway Extension	13%	7%	15%	8%	5%	11%	17%	21%	22%	32%
Bank St. Tramway Extension	3%	13%	32%	18%	2%	36%	22%	40%	35%	56%

Table 3 Cumulative accessibility to jobs gains per kilometre of rail across social disadvantage index

	Social disadvantage decile									
	Less disadvantaged									More disadvantaged
	1	2	3	4	5	6	7	8	9	10
Trillium Line 2 and 4	1%	0%	0%	24%	48%	4%	2%	3%	1%	1%
Confederation Line 1 and 3	7%	3%	9%	7%	11%	9%	8%	19%	22%	22%
Line 2 to Alexandre-Tache Blvd	1%	3%	1%	4%	3%	2%	5%	96%	38%	37%
Line 2 to Lorrain	5%	12%	4%	7%	4%	24%	22%	19%	15%	39%
Gatineau Tramway	2%	4%	5%	5%	4%	3%	2%	54%	2%	5%
Downtown Loop R1 Tramway Extension	0%	1%	3%	0%	3%	3%	2%	-2%	6%	7%
Downtown Loop R2 Tramway Extension	0%	5%	6%	2%	1%	1%	1%	3%	0%	15%
QED Tramway Extension	0%	1%	3%	2%	1%	15%	2%	9%	4%	10%
Montreal Station Tramway Extension	12%	8%	17%	9%	5%	11%	17%	22%	21%	36%
Bank St. Tramway Extension	1%	5%	13%	7%	1%	13%	9%	16%	15%	22%

Table 4 Cumulative accessibility to people gains per kilometre of rail across social disadvantage index

Projected Accessibility Changes from O-Train Trillium Line 2 and 4

relative to the June 2023 network

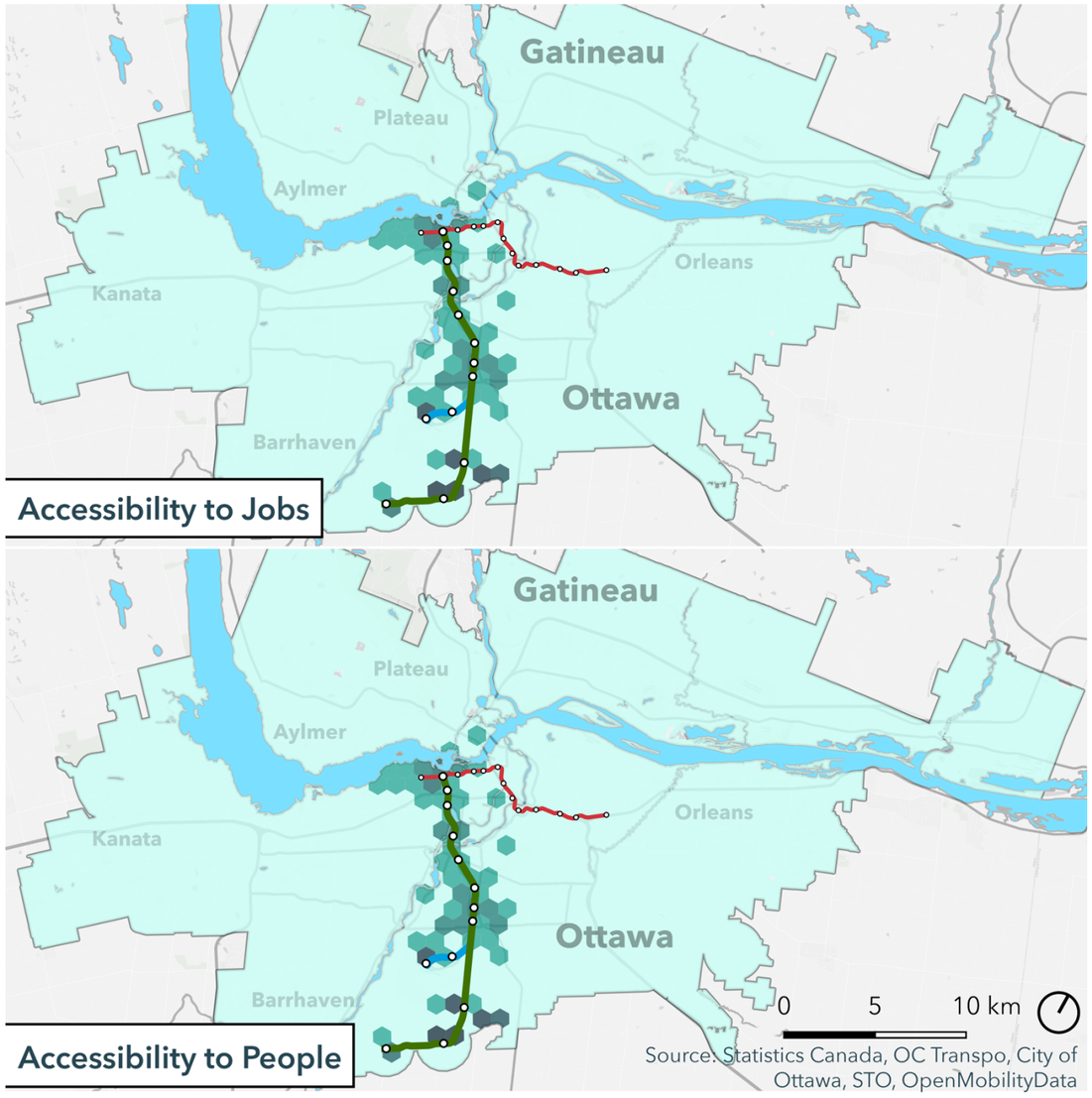

Figure 12

The completion of the O-Train Trillium Line construction, which will see the expansion and re-opening of Line 2, as well as the introduction of Line 4 to the airport, will provide modest and concentrated accessibility benefits surrounding the line. Areas that are currently not served by rapid transit or the R2 replacement bus service will benefit the most. For example, in multiple hexagons surrounding Bowesville Station, the average jobs accessible between 30 and 60 minutes on public transit will more than triple and the average population accessible between 30 and 60 minutes will more than quadruple. The population in these locations is currently very low, and the large accessibility gains emphasize the opportunity in densifying these new station catchments as transit-oriented developments. Other areas of high accessibility growth from the completion of the Trillium Line project include Ottawa International Airport, Leitrim Park and Ride, and Bayview Station.

The Trillium Line 2 and 4 project will have a relatively positive effect on equity. The bulk of the accessibility growth falls to areas of the city that are in the middle of the social disadvantage index. Small, but positive changes are projected for areas of the city that are more disadvantaged.

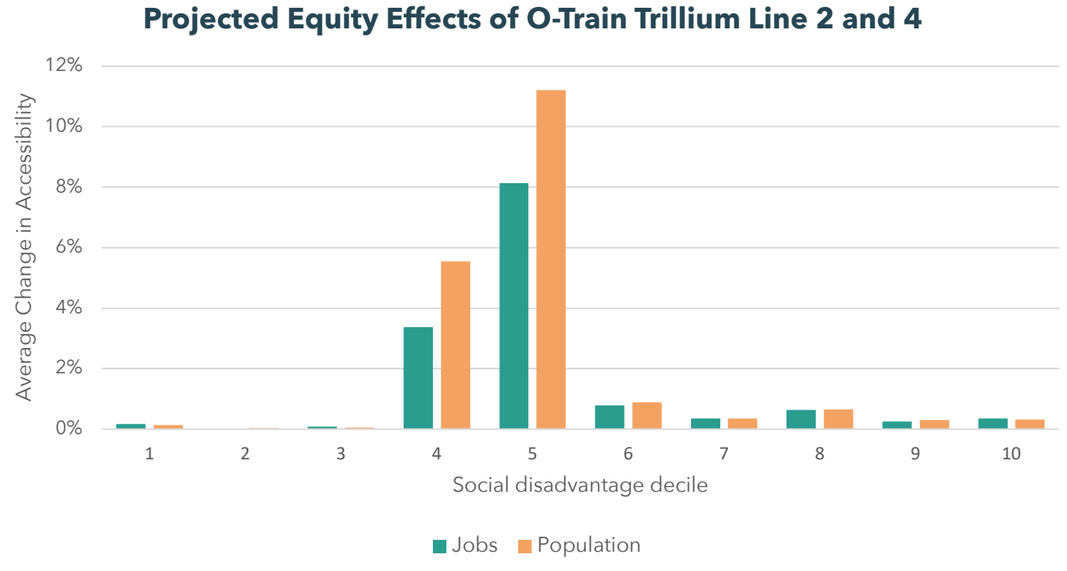

Figure 13

Projected Accessibility Changes from O-Train Confederation Line 1 and 3
relative to the projected network after Trillium Line 2 and 4 opens

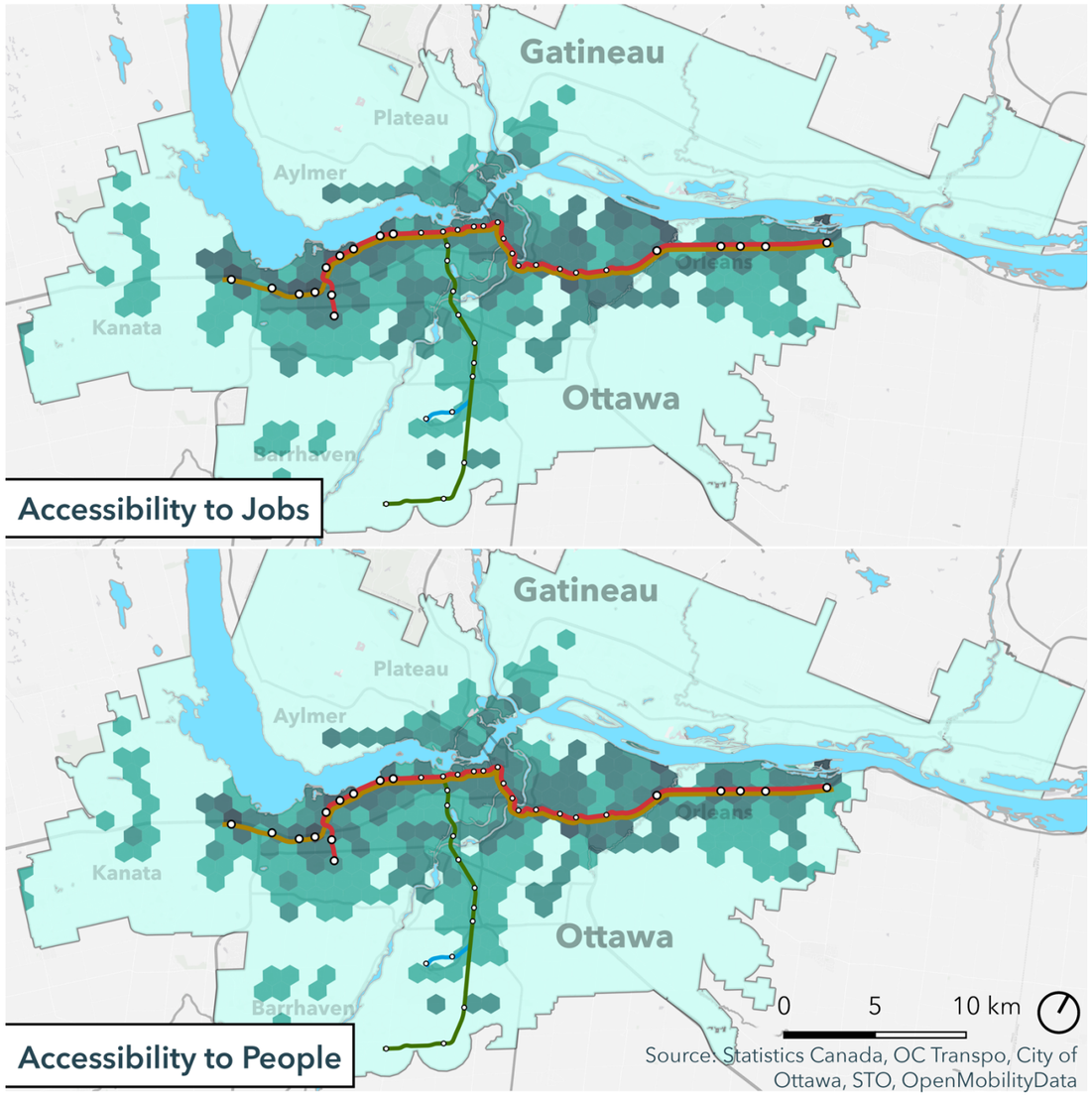

Figure 14

The large accessibility impacts of the Confederation Line extension will be felt the most in areas surrounding Queensview, Trim, Moodie, and Sherbourne Stations. This is intuitive as two stations are termini, and the other two are new additions to the rapid transit network. In some cases, these accessibility counts to jobs and people are double those of the June 2023 network.

The positive equity effects of the Confederation Line expansion are very pronounced. The largest accessibility gains are projected to impact more disadvantaged areas of the city. Areas including Bayshore, the ByWard Market, Lower Town, and Sandy Hill all stand to benefit with at least 20% increases in the average number of jobs and people accessible between 30 and 60 minutes. The line will provide benefits far into the east of Ottawa's urban boundary but benefits in west and south end communities such as Kanata, Stittsville, and Barrhaven will only slightly increase in areas that have rapid or express bus service.

Even though this project does not cross the river into Gatineau, its effects are felt in Quebec. Neighbourhoods as far west as District de Deschenes are projected to have over 12% increases in accessibility and areas surrounding the STO's Rapibus corridor are also projected to see gains.

Projected Equity Effects of O-Train Confederation Line 1 and 3

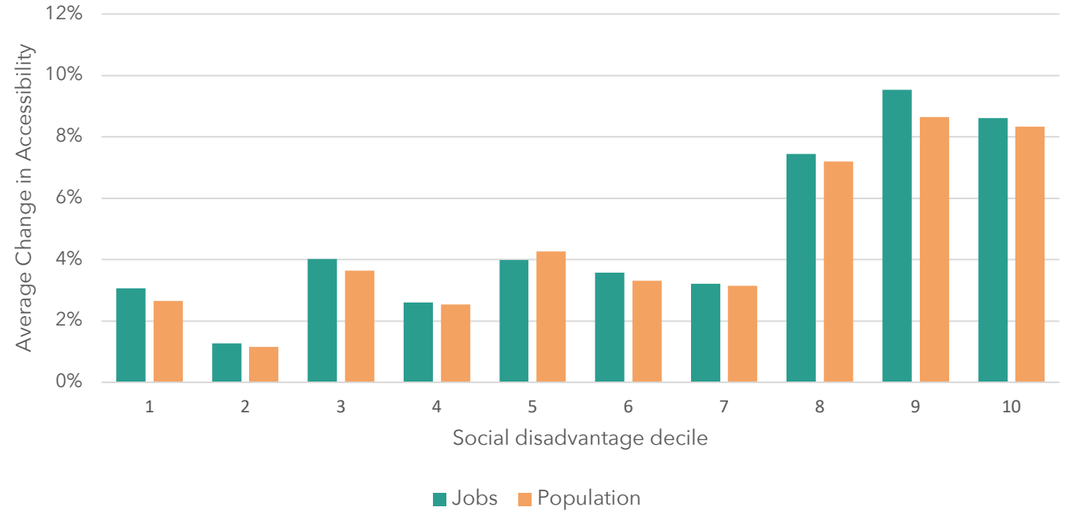

Figure 15

Projected Accessibility Changes from Line 2 Extension to Alexandre-Taché Boulevard relative to the Stage 2 network

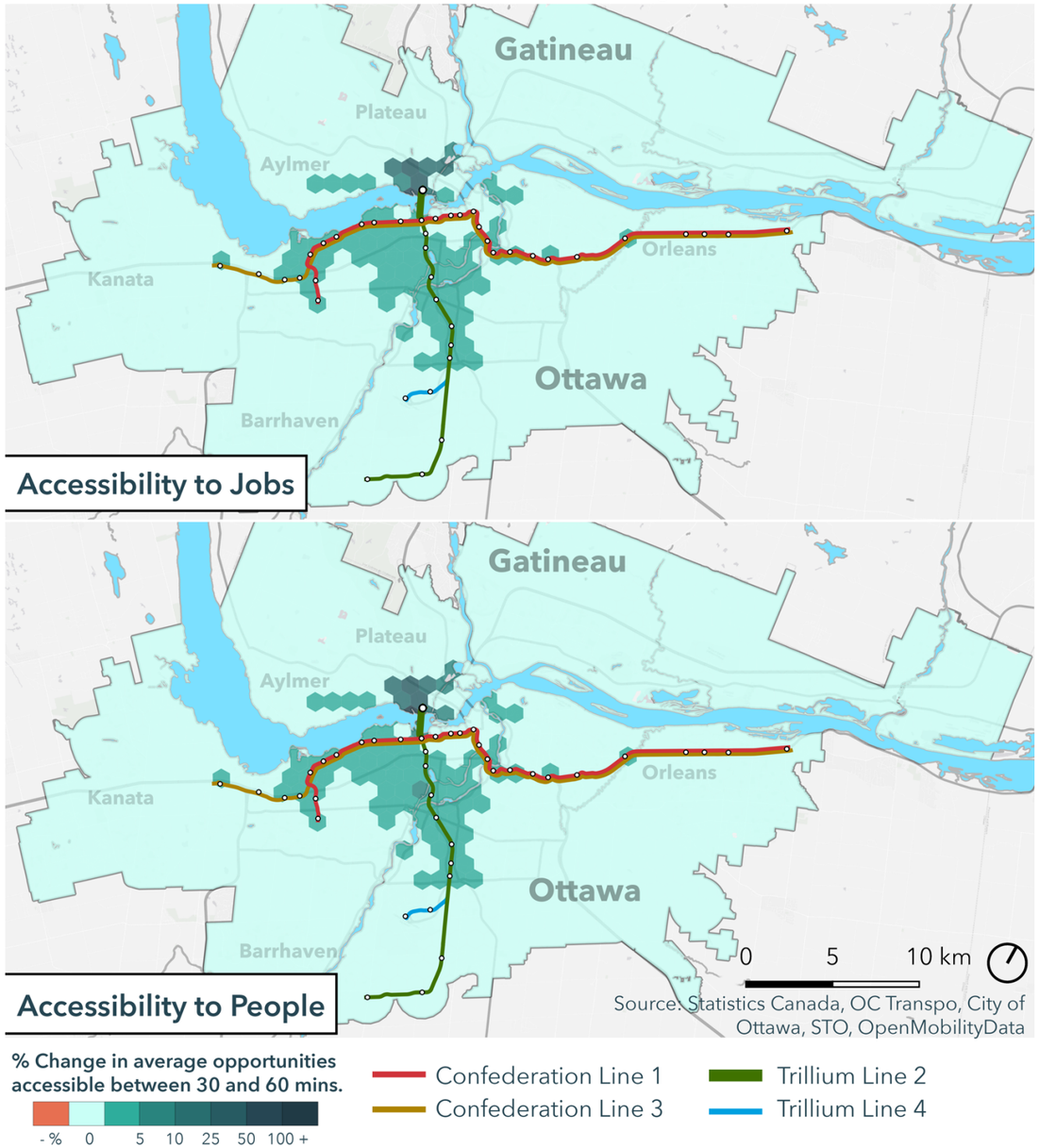

Figure 16

Extending the Trillium Line 2 across the William Commanda Bridge to Alexandre-Taché Blvd., as proposed in Ottawa's 2013 Transportation Master Plan would provide accessibility gains comparable to the entire Line 2 and 4 expansion project. The effects of extending the bridge are very concentrated around the new terminus station. Extending this line would positively impact more socially disadvantaged areas of the city.

The largest accessibility gains from this extension are, predictably, located immediately around the proposed Alexandre-Taché Station in Gatineau. For example, Université du Québec en Outaouais would see a 31% increase in the average number of jobs accessible and a 36% increase in the average number of people accessible between 30 and 60 minutes from this extension. On the Ontario side of the river, the largest gains are found immediately surrounding Bayview Station and near Carleton University. The increases in Ontario are much smaller than those found on the Quebec side and are in the single digits. Small network effects of this extensions stretch as far west as Moodie Station, and as far east as Montreal Station.

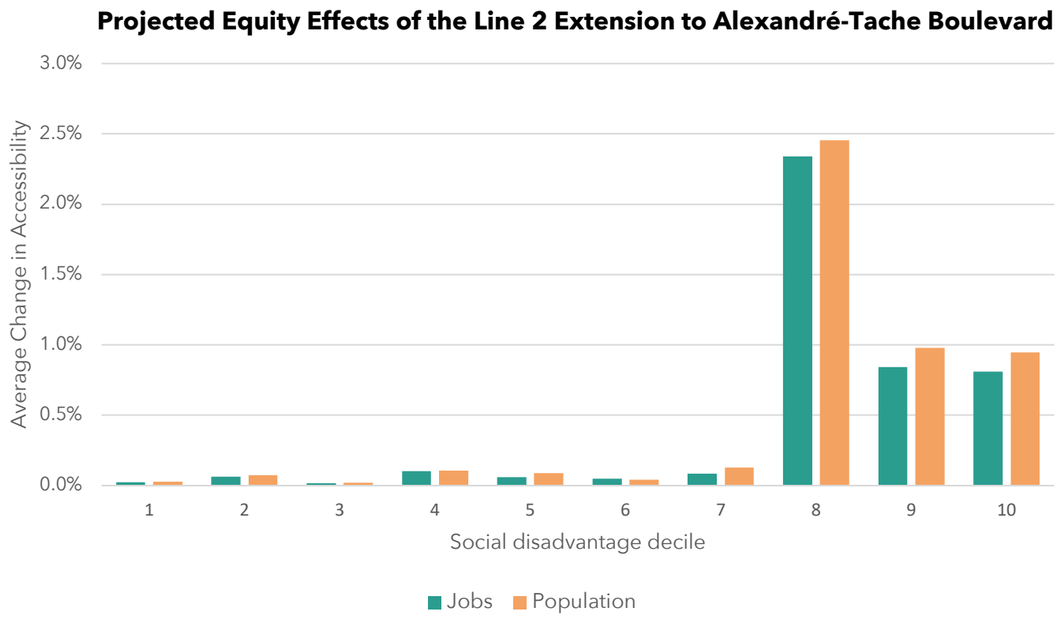

Figure 17

Projected Accessibility Changes from Line 2 Extension to Lorrain Boulevard relative to the Stage 2 network

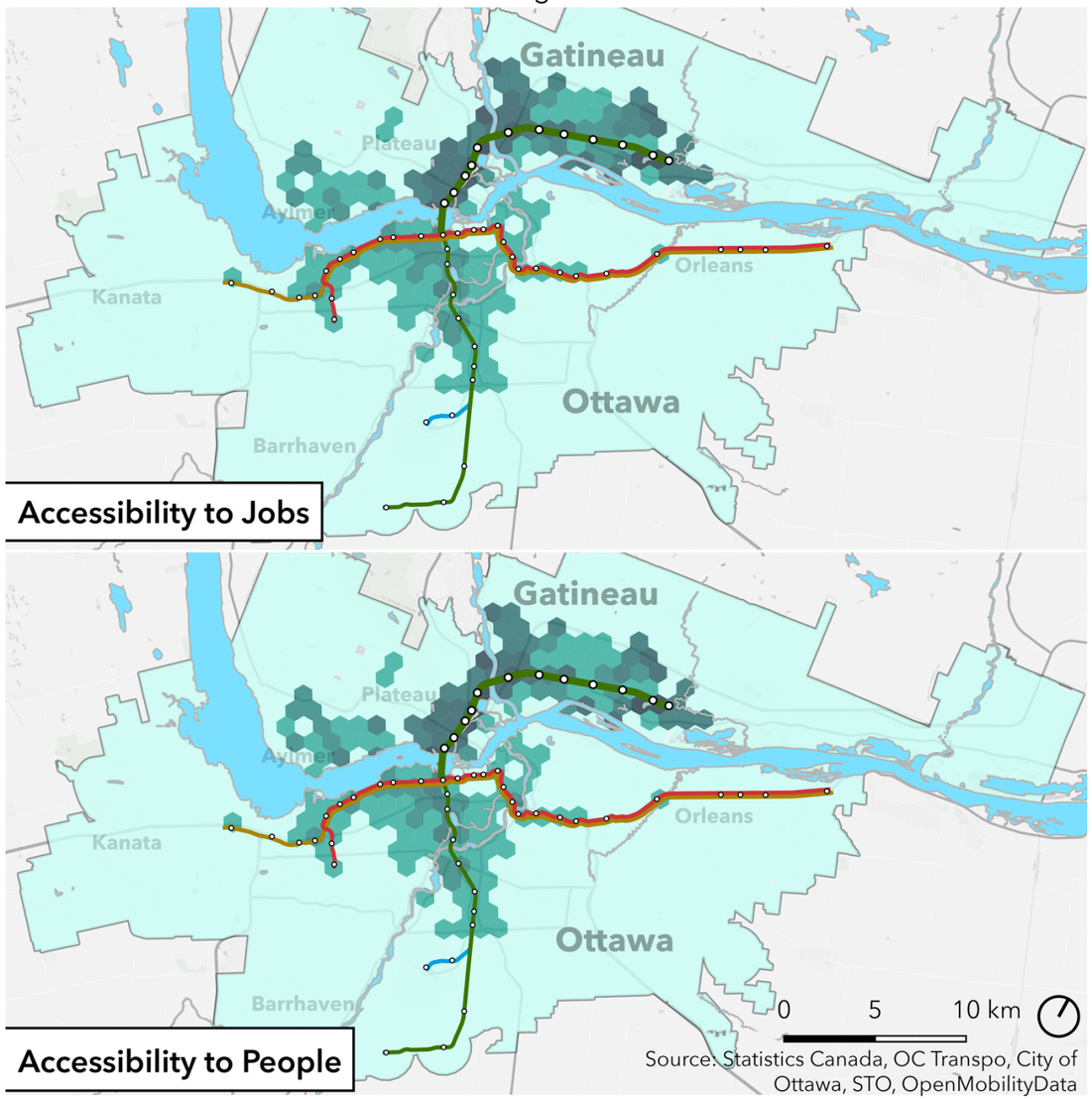

Figure 18

Building on the concept of the Line 2 extension to Alexandre-Taché Boulevard is fully extending Line 2 the length of the Rapibus corridor and terminating at Lorrain Station. The Rapibus Corridor parallels a single rail track that is sparsely used. As figure 18 shows, this extension into Gatineau would generate widespread accessibility increases. This extension would have clear equity benefits, as evidenced by figure 19.

The largest accessibility gains from this extension would be found on the Quebec side of the river in areas surrounding Lac Beauchamp. The largest increases in Ontario would be felt surrounding Bayview Station, Carleton University, and Dow's Lake Station, with double digit increases in the average number of jobs and people accessible within a 30-to-60-minute time interval. The creation of this line would not improve the accessibility to jobs or people from downtown Ottawa and Centretown. This is because the proposed line is west of downtown and would be an indirect route for many Gatineau bound trips. The existing Rapibus corridor directly serves downtown Ottawa, so this line would not offer any tangible service improvement for this area. While accessibility increases are the highest surrounding the corridor, network effects of the line mean that gains are distributed throughout the region. In some cases, accessibility increases in Aylmer are not much smaller than those of the Gatineau Tramway, which directly serves Aylmer. Accessibility increases are observed as far west as Moodie Station and as far east as Montreal Station.

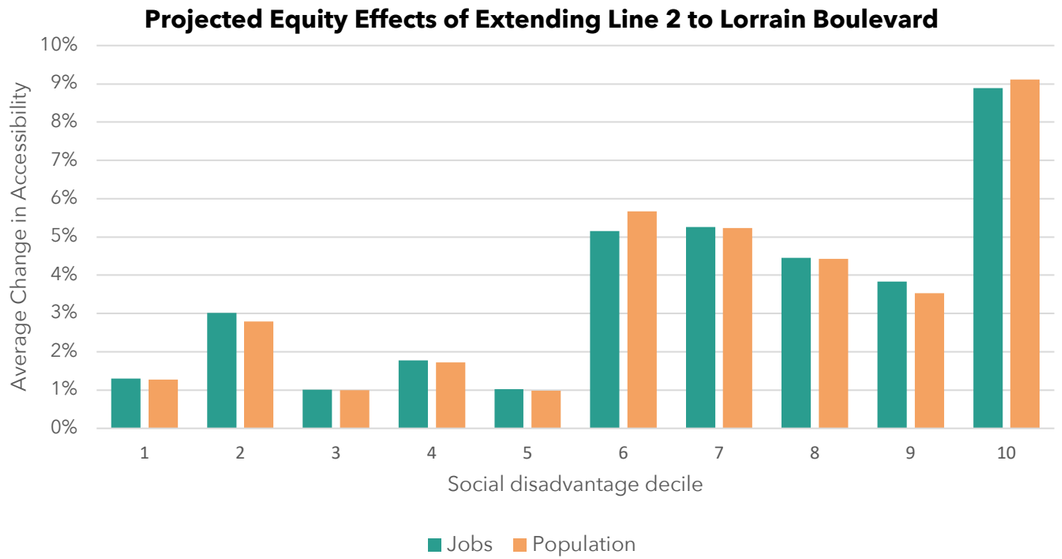

Figure 19

Projected Accessibility Changes from the Gatineau Tramway

relative to the post-Stage 2 network

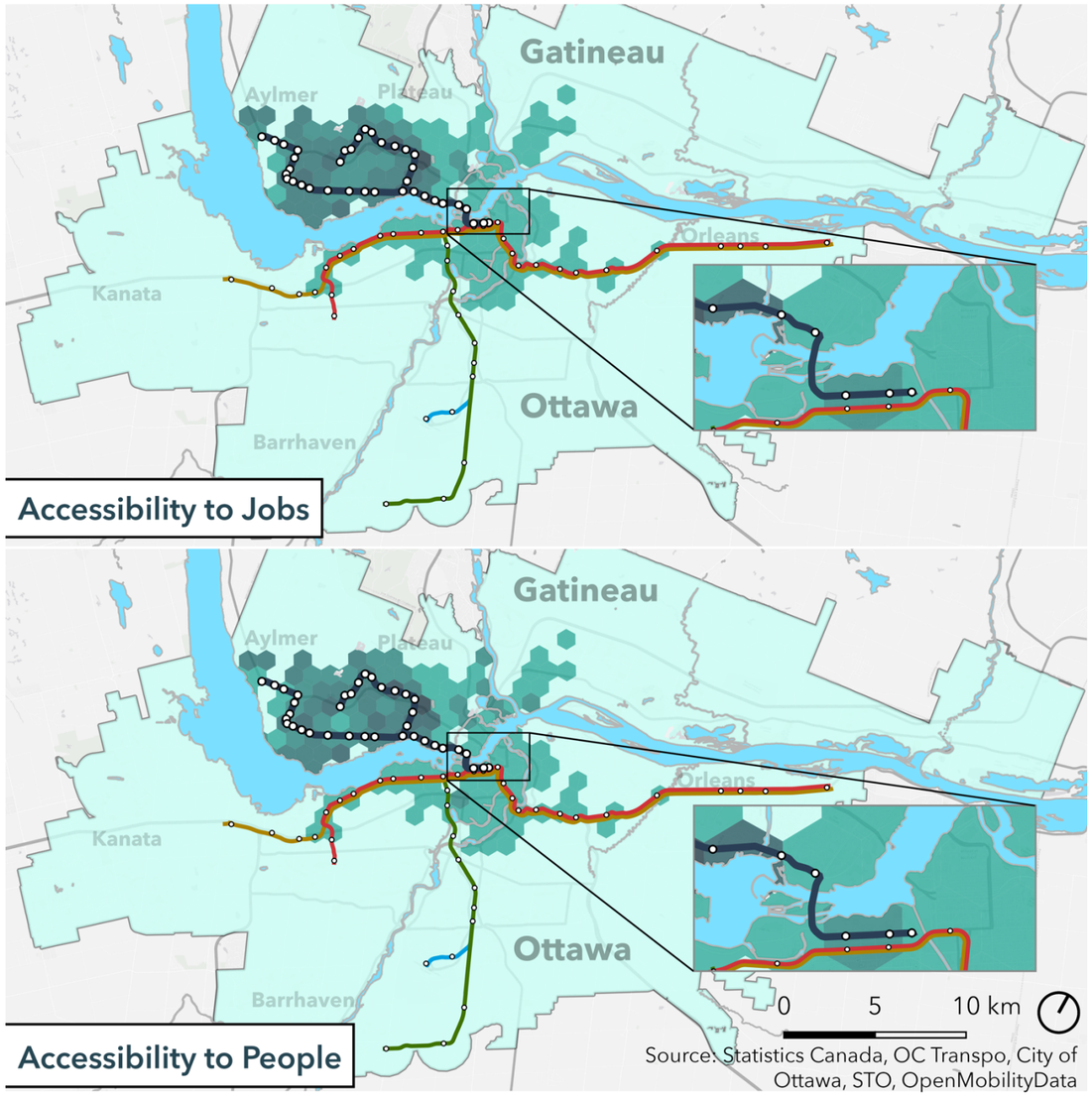

Figure 20

The Gatineau Tramway's accessibility gains are widespread, but compared to other projects, relatively small. The accessibility increases are generally the highest along the Plateau branch. Accessibility at the intersection of Boulevard du Plateau and Boulevard des Grives is projected to increase 88% for jobs and 76% for people. In Ontario, the accessibility gains are highest in the Parliamentary Precinct and downtown with 6% increases to jobs and 8% increases to people. The network effects of the line are projected to result in small accessibility gains as far west as Queensview Station, and as far east as Montreal Station.

The accessibility increases in Gatineau, and very small gains in Ontario suggest that this project makes sense almost entirely for the City of Gatineau. In the context of planning for an integrated capital city, the Gatineau Tramway project, as currently envisioned, falls short of other possibilities that would provide much higher and more efficient accessibility gains.

The route's effect on equity is mixed. The eighth decile of the social disadvantage index will have by far the largest accessibility increases. This is driven by several areas along the middle of the Tramway route that are projected to see large increases in accessibility.

Projected Equity Effects of the Gatineau Tramway

Figure 21

Projected Accessibility Changes from Gatineau Tramway extension into Downtown Loop (R1) relative to the Gatineau Tramway network

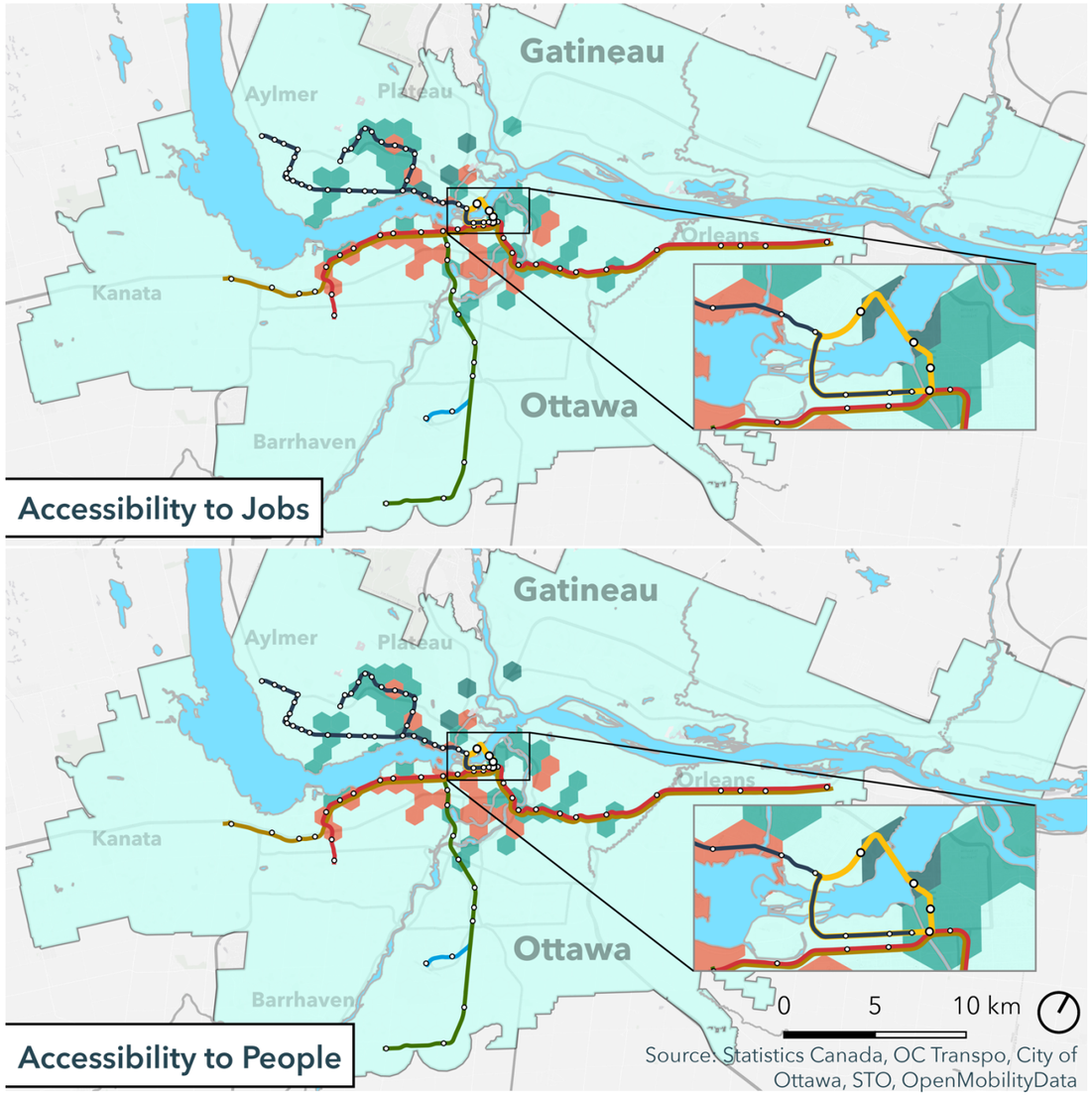

Figure 22

If the Gatineau Tramway were to be expanded into a downtown loop between Ottawa and Gatineau, the accessibility increases would be very small. This route pattern follows this configuration: trains from Aylmer enter Ottawa via the Portage Bridge and return to Aylmer via the Alexandra Bridge, trains from the Plateau enter Ottawa via the Alexandra Bridge and return to the Plateau via the Portage Bridge.

Because of this configuration of the downtown loop, parts of the region are actually projected to have negative accessibility growth due to the route splitting and providing a less direct route to downtown Ottawa from the Plateau. Areas of Ottawa also receive less frequent and more indirect access to downtown Hull. Predictably, the areas that benefit the most are those along the loop route. This includes destinations such as Major's Hill Park, the US Embassy, and the National Art Gallery.

Equity Effects of Extending the Gatineau Tramway into a Downtown Loop (R1)

Figure 23

Projected Accessibility Changes from Gatineau Tramway extension into Downtown Loop (R2) relative to the Gatineau Tramway network

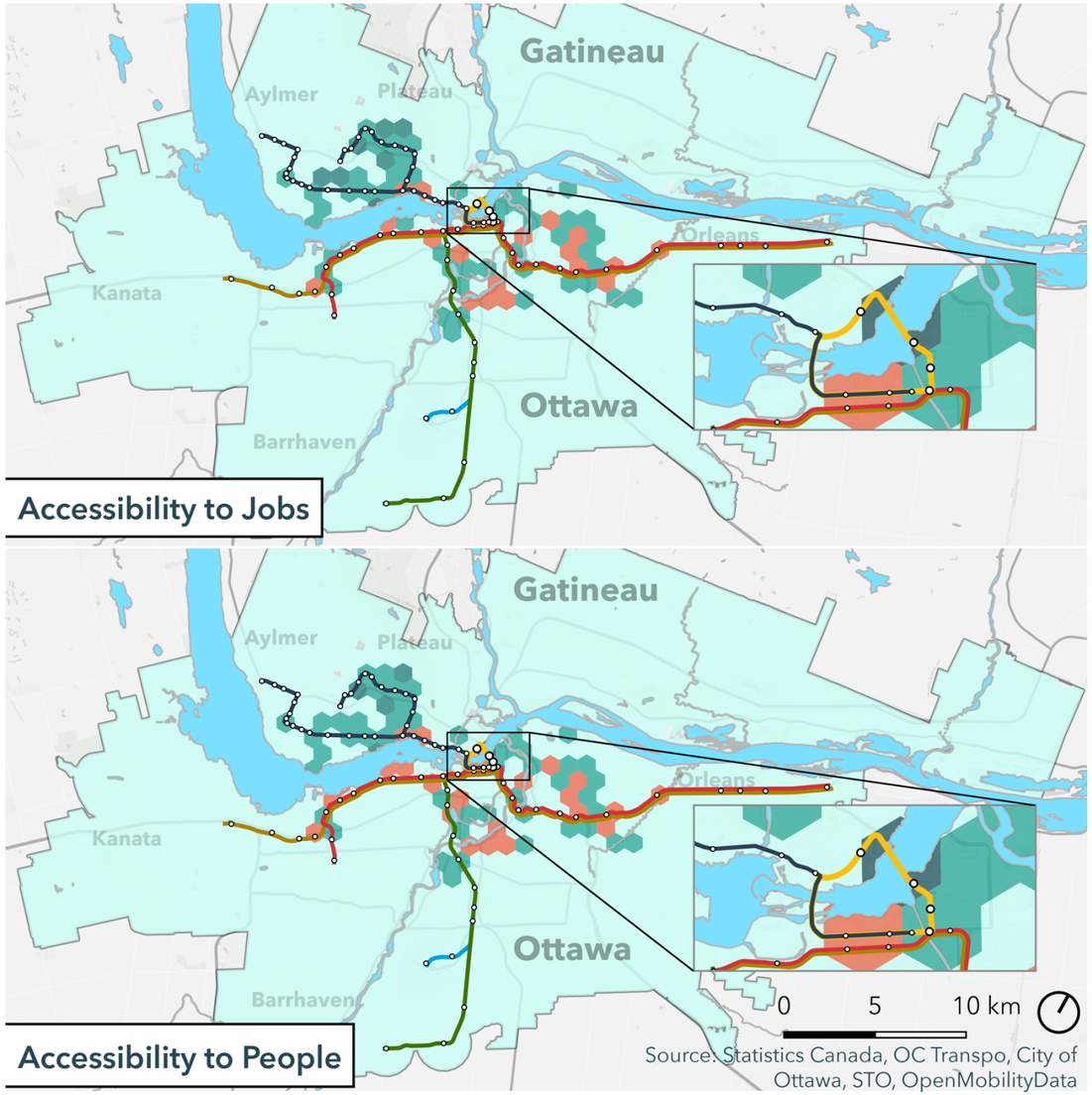

Figure 24

The reverse configuration of the downtown loop also fails to significantly increase accessibility growth. This configuration has trains from Aylmer crossing at Alexandra Bridge and returning via Portage Bridge, and trains from the Plateau crossing at Portage and returning via Alexandra. The accessibility gains from this configuration are slightly higher than the R1 configuration. This is because it provides a faster connection from Ottawa to jobs along the Aylmer branch.

Since the accessibility gains are small and concentrated, the equity changes are mixed. Figure 22 shows how some disadvantaged areas have the largest gains, while some less disadvantaged areas are also projected to have positive impacts.

Equity Effects of Extending the Gatineau Tramway into a Downtown Loop (R2)

Figure 25

Projected Accessibility Changes from QED Tramway Extension

relative to the Gatineau Tramway network

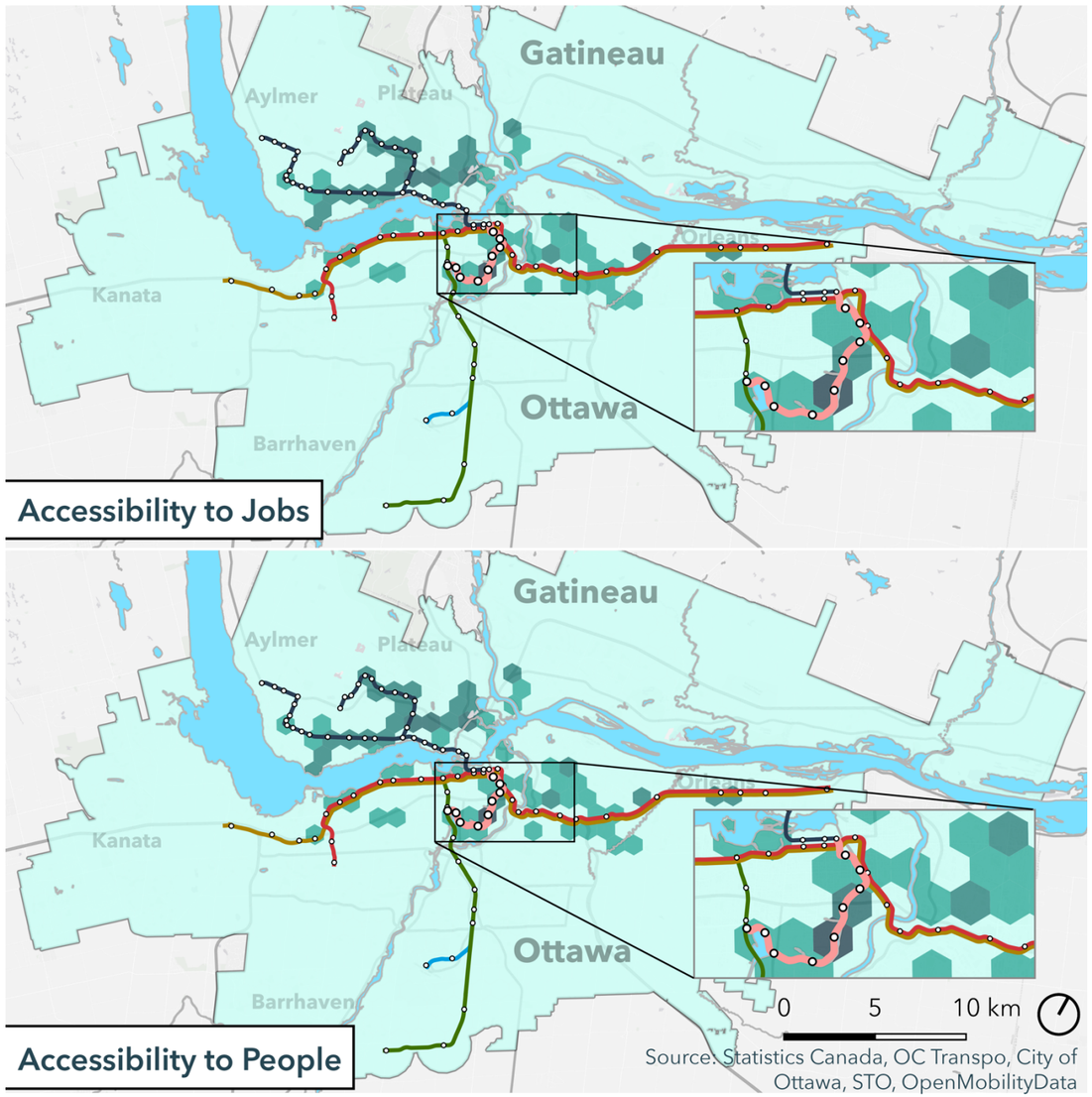

Figure 26

The Queen Elizabeth Driveway (QED), which is owned by the NCC, is a logical route option for extending the Gatineau Tramway into Ottawa. The QED follows the western bank of the Rideau Canal, and connects with existing O-Train stations, vibrant urban communities, and important institutions. The QED is currently used as a scenic parkway into the city, while occasionally opening for active transportation at certain times during the summer months [91]. This extension would provide rapid connections to Ottawa City Hall, uOttawa Station on Line 1, the Golden Triangle, The Glebe, Lansdowne Park, Old Ottawa South, Commissioner's Park, and the new Civic Hospital which is adjacent to Dow's Lake Station on O-Train Line 2.

The benefits are heavily concentrated along the route. Relative to the original Gatineau Tramway project, this extension would provide very strong benefits to the southeast of The Glebe, which includes parts of Lansdowne Park.

In Gatineau, single digit growth in the average number of jobs and population accessible within 30 to 60 minutes is projected along both branches of the Gatineau Tramway.

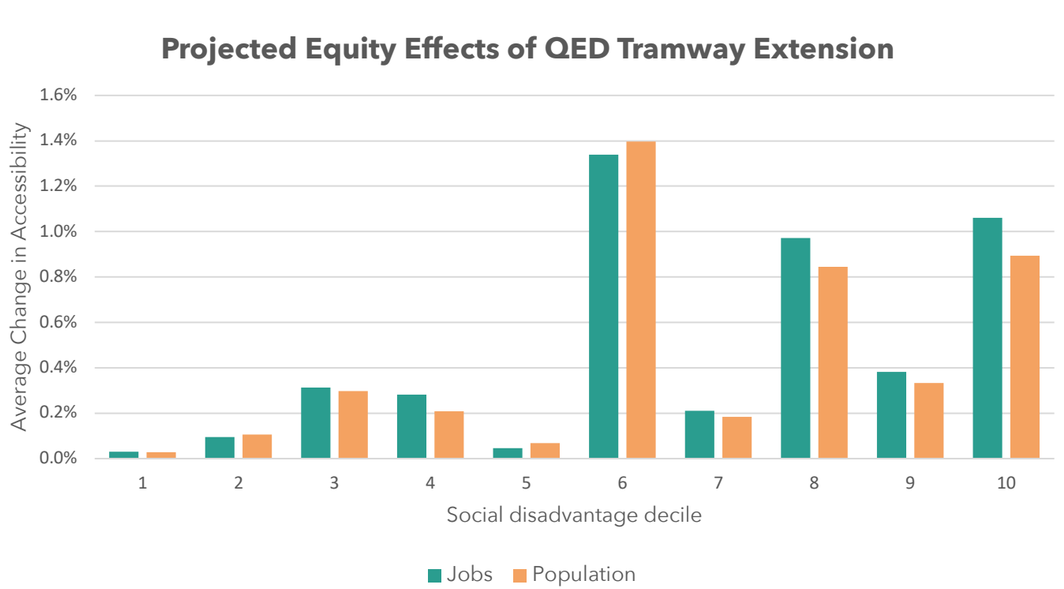

Figure 27

Projected Accessibility Changes from the Montreal Station Tramway Extension relative to the Gatineau Tramway network

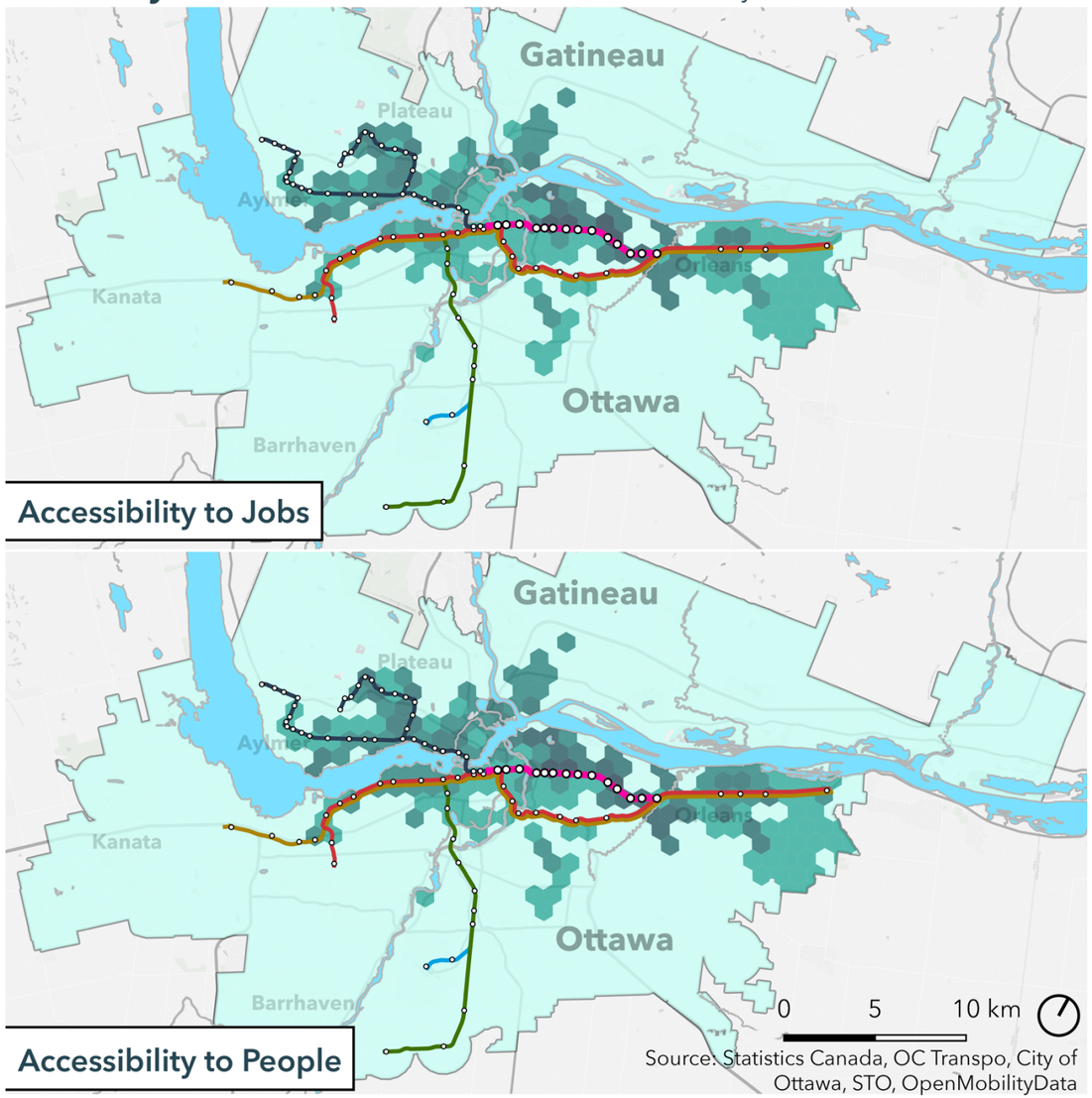

Figure 28

Another option for an extension of the Gatineau Tramway could be along Rideau St. and Montreal Road before terminating at Montreal Station on Line 1 and 3.

The largest benefits from this line are projected to be found along the alignment east of the intersection of Montreal Road and St. Laurent Blvd. Growth is strong throughout Vanier and parts of Rockcliffe Park. Accessibility growth stretches as far as the eastern border of the urban boundary. In the west end, areas surrounding as far west as Queensview Station are projected to have increases in accessibility. On the Gatineau side, accessibility is projected to increase at a relatively high rate along the Plateau branch of the Gatineau Tramway.

The equity effects of this extension are very positive. This extension of the Tramway would significantly increase accessibility for the neighbourhoods of Vanier and downtown Gatineau.

Equity Effects of the Montreal Station Tramway Extension

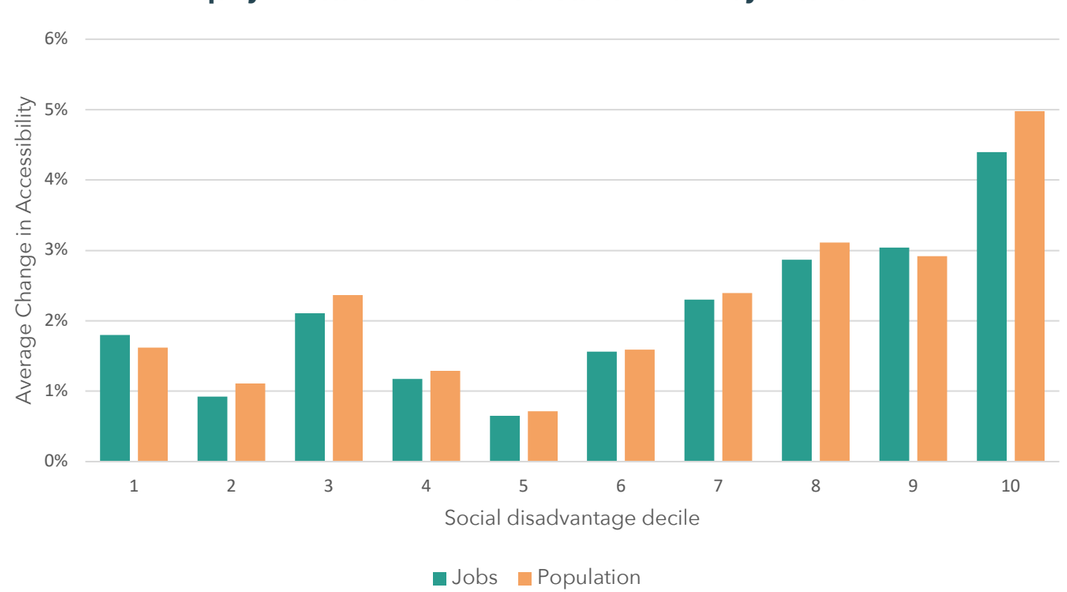

Figure 29

Projected Accessibility Changes from the Bank St. Tramway Extension relative to the Gatineau Tramway network

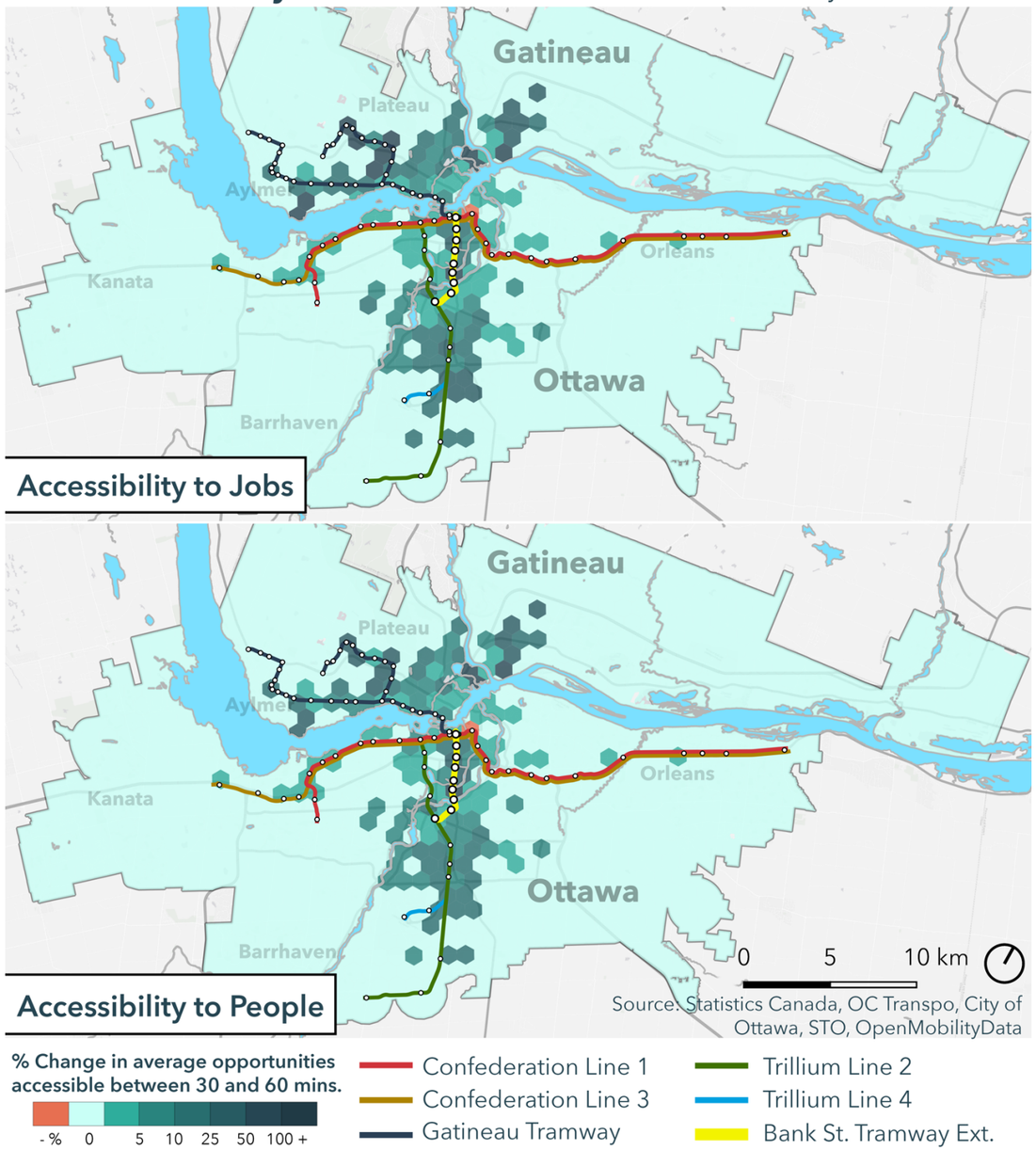

Figure 30

The final option analyzed for an extension of the Gatineau Tramway is down Bank St. This alignment required the removal of the Elgin St. Station as trains would turn south down Bank St before connecting with Billing's Bridge on the Transitway BRT and Mooney's Bay Station on Line 2.

The benefits of this extension would be felt the strongest in Old Ottawa South, with a projected 79% increase in the average number of jobs accessible and an 82% increase in the average number of people accessible within 30 to 60 minutes. Strong accessibility increases would be felt across Gatineau. By connecting the Bank St. extension to both the Transitway BRT and O-Train Line 2, accessibility benefits are projected to be felt as far south as Leitrim.

An interesting element of figure 30 is that the Bank St. extension impacts areas outside of the core more than those inside the urban core. High growth is projected for Ottawa's south end, as well as Gatineau's suburbs.

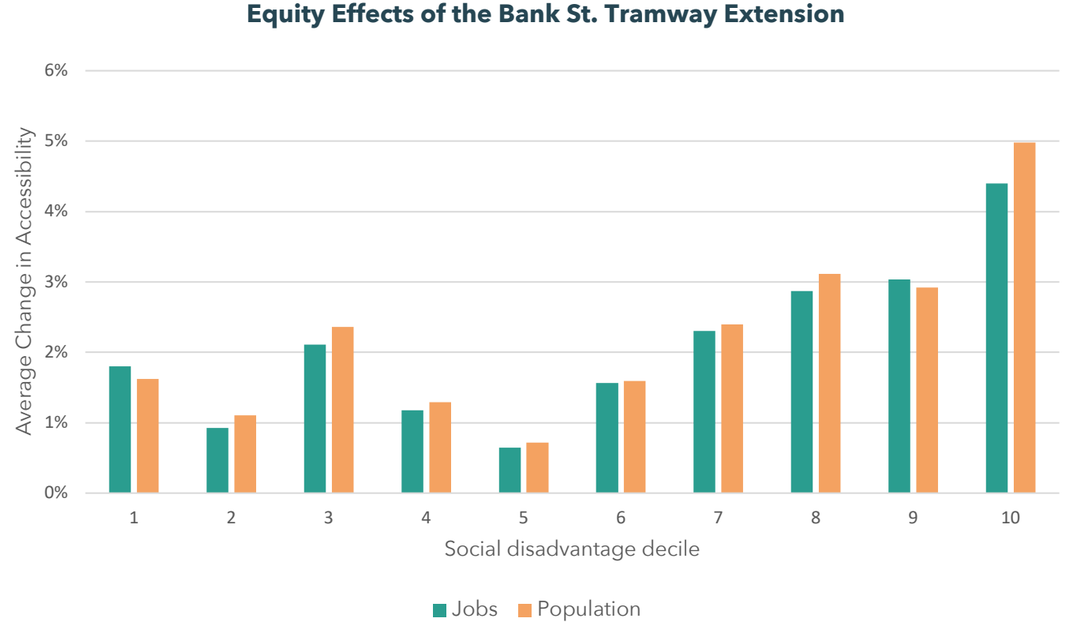

Figure 31

Discussion

This analysis provides a sketch of various rail alignments connecting Ottawa, ON and Gatineau, QC. It relies on assumptions about vehicle speeds and headways, land use data that is already dated, and does not consider bus route realignments in response to new rail lines. Despite this, the analysis helps understand the interaction between land use and transportation and provides several key findings to guide interprovincial transit planning in the National Capital Region.

The first key finding is that the Gatineau Tramway is not the most efficient method of connecting Ottawa and Gatineau by rail. On a per kilometre basis, the accessibility increases from this project are significantly smaller than extending the O-Train Trillium Line 2 across the William Commanda Bridge to either Alexandre-Tache Blvd or Lorrain Blvd. The difference is even more concerning for the Tramway project considering that the Line 2 simulations all used 12-minute headways, which are much less frequent than those used to estimate the Gatineau Tramway (5 minutes on branches, 2.5 minutes in the main corridor).

Extending Line 2, even just 1.8 km to Alexandre-Taché Boulevard, would have accessibility effects comparable to the entire $1.6 billion, 16 km Trillium Line expansion project. While this would entail a significant refurbishment, or even rebuilding of the William Commanda Bridge, its effects on accessibility would be strong. A more ambitious proposal that extends Line 2 along the entire Gatineau Rapibus corridor would have stronger accessibility gains and positive equity effects. Doing so would increase cumulative accessibility growth almost 3.5 times higher than that of the Gatineau Tramway. This corridor should not be written off as a connection between the two cities. The City of Ottawa's belief that this connection would overcrowd Bayview Station is difficult to take at face value given that the Confederation Line is operating at 43% pre-COVID ridership [92] and Bayview Station was only just rebuilt in 2019. An agency looking to expand ridership would view this connection as an opportunity, rather than a threat. The fragmented nature of transit planning in Ottawa-Gatineau means that the costs and benefits of such a connection are disconnected, resulting in poor service for riders. With the NCC pursuing its Building LeBreton process, which could include a new NHL arena for the Ottawa Senators hockey club, significant new residential and commercial spaces, and new attractions and amenities, the opportunity to dramatically promote interprovincial accessibility along an existing right of way and influence land use patterns could be considered a strategic goal.

The relative accessibility gains of the Gatineau Tramway are discouraging for a project that is projected to cost over $3 billion [37]. Its equity effects are also not encouraging, as it mostly serves areas that are less socially disadvantaged. For the project to be effective in its current planned configuration, densification along the route should be prioritized. Fortunately, this is beginning to occur with developments adding mixed-use, higher densities to the Plateau branch of the Tramway [93]

Significantly larger benefits of the Gatineau Tramway could be realized if the Tramway were to extend beyond its expected Elgin St. terminus. Through-running trains into Ottawa would create a true interprovincial rail connection that this analysis projects to have widespread benefits for residents on both sides of the Ottawa River. To realize the highest benefits, both in absolute and per kilometre terms, extending the tramway down Bank St. to Billing's Bridge and Mooney's Bay Station should be studied further. Other corridors, such as Rideau-Montreal, should also be considered. These extensions would have per kilometre accessibility changes comparable to the Confederation Line 1 and 3 extensions. These alignments would also serve residents most dependent on public transit, producing positive equity effects.

The absolute and per kilometre accessibility also increase, but at a smaller rate for an alignment that connects to Dow's Lake Station along the Queen Elizabeth Driveway. While this growth is not as high as other prospective corridors, this route could be strategically beneficial as a connection between Gatineau, uOttawa Station on Line 1, urban neighbourhoods surrounding the Rideau Canal, Lansdowne Park, the new Civic Hospital, and Dow's Lake Station on Line 2. This line would create redundancy for the Confederation Line, alleviate concerns about crowding at Bayview Station, and its construction would likely be less disruptive to residents and local businesses than other corridors such as Bank St. or the Rideau-Montreal corridor. Extending the line further into Ottawa is also supported by Gatineau residents, with 58% of public consultation respondents indicating that they would like to be able to get beyond the Lyon O-Train Station in Ottawa using the Tramway, and with many indicating that uOttawa was their destination [94].

On the other hand, the downtown loop concept does little to increase accessibility between the two cities. Its benefit would largely come from the increase in access to nationally significant places. While beneficial for tourism, the downtown loop does little to improve, and in some cases diminishes, accessibility from other parts of the city. From a land use and transportation planning perspective, the loop would represent a significant missed opportunity to better connect the two cities. The fact that the loop was endorsed, contradicting previous studies and seemingly without further technical analysis, raises the prospect that political and business interests play a significant role in transportation planning in the region.

Considering that the Gatineau Tramway's benefits are projected to be the largest if it were to extend further into Ottawa, the Wellington St. at-grade alignment should be chosen over the Sparks St. tunnel. While avoiding the costs of tunneling under Sparks St., this alignment would provide the largest flexibility for future extension east or south.

In the short term, the findings also reinforce the need to incentivize and promote mixed-use, dense, transit-oriented communities around future O-Train Stations, especially in sparsely populated areas such as Limebank, Bowesville, and Moodie Stations that are projected to have very high accessibility growth after the Stage 2 project is completed. For existing communities that are not projected to have strong accessibility growth from the Stage 2 project, such as Stittsville and Barrhaven, these findings reinforce the need to promote network benefits by providing quality bus service to O-Train termini.

Conclusion

This analysis explores how under construction, planned, and proposed rail alignments would affect accessibility to jobs and people in the National Capital Region. Using simulated GTFS data and open-source routing software, time-based cumulative accessibility was projected for several future transit options. The findings suggest that the Gatineau Tramway is not the most efficient method of connecting Ottawa and Gatineau by rail. Extending O-Train Line 2 across the William Commanda Bridge would generate stronger relative accessibility increases. If the Gatineau Tramway were to go ahead, opportunities to extend it into Ottawa should be explored. This should not be done by creating a loop between the downtowns, and instead should be oriented to serve areas of the city where more people live and work. The findings are exciting for the future of the region and imply a need for further conversations and analysis on how to better connect the two cities. To realize the possible benefits, better collaboration between stakeholders is needed. The experience of other jurisdictions indicates that various models, ranging from inter-jurisdictional compacts to contracting of operations, can produce positive regional results.

While these findings are exciting, this analysis faces limitations as it relies on static land use data. The land use and transportation cycle is a long-term process, and the use of 2016 jobs data and 2021 population and demographic data omits that individuals and firms will respond to transportation investments. GTFS simulations are also reliant on assumptions, some of which may be subject to change given limited planning documents for some lines. Furthermore, GTFS data from new lines does not involve any anticipated bus route changes. The effect of this discrepancy on accessibility projections should be explored in future research.

To conclude, accessibility is the main goal of a transportation network and Ottawa-Gatineau should recognize this in its public transit investments. This report analyzes which under construction, planned, and proposed rail projects would have the greatest benefits and uses an equity lens to assess how the benefits are distributed across the population. The results imply the need for more critical thinking about where and why the region is investing in rail transit once again.

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