Connected, Adaptive and Resilient:
A Multimodal Transportation Strategy for the Great Lakes and St. Lawrence Region

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COUNCIL OF THE GREAT LAKES REGION

CPCS

A Multimodal Transportation Strategy for the Great Lakes and St. Lawrence Region

Most Great Lakes states and provinces have developed long range transportation plans and modal plans to support their growth. What is lacking is an integrated multimodal transportation vision and strategy for the whole region, addressing both passenger and freight transportation priorities.

This Report – a first of its kind – seeks to address this gap and presents a Multimodal Transportation Strategy for the Great Lakes and St. Lawrence Region. It also includes specific recommendations for realizing this Strategy.

Acknowledgments

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Opinions

Unless otherwise indicated, the opinions herein are those of CPCS and the Council of the Great Lakes Region and do not necessarily reflect the views of the funders of this work.

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Executive Summary

The importance of the Great Lakes and St. Lawrence Region (Region) cannot be overstated: home to 107 million people, 51 million U.S. and Canadian jobs, generating $5.8 trillion in annual GDP, and $278 billion in bilateral U.S.-Canadian trade.[1]

The Region's multimodal transportation system – comprising an extensive network of highways, regional and urban roads, railroads and rail terminals, airports, marine ports and inland waterways, pipelines, and transit infrastructure and related services – helped shape the Region into the megaregion and continental hub it is today. These connections are central to the economic competitiveness and prosperity of the Region and the quality of life of its inhabitants. They will be just as critical to the Region's future.

But parts of the Region's transportation system have frayed. Aging infrastructure and capacity constraints stress the Region's transportation systems. Much of the Region's infrastructure suffers from deferred maintenance and is in need of repair. Intensifying current infrastructure problems is the legacy of silo-based planning. The Region also faces new and emerging technologies that will profoundly change how people and freight use transportation infrastructure and move through the Region. Infrastructure that is built today must support the Region's economic and social interactions for the next 20, 30 or even 50 years. With limited funds and urgent needs, achieving the best balance between repairing the Region's 20th-century infrastructure and laying the foundations for a high-performing transportation system in the 21st century is a critical and challenging task.

A vision for the Region's transportation system:

A connected transportation system that is adaptive and resilient to change and uncertainty, providing options and empowering users to choose, so the Region can continue to thrive and realize new opportunities.

Transportation strategies and plans of the past have largely been based on linear trends and projections. It is unlikely, given the many trends, issues, opportunities and unknowns facing the Region – as outlined in this Report – that the future will be similarly linear. This necessitates a different approach. The following sets out three broad strategies to help position the Region to move towards this vision:

1. Get more productivity from existing infrastructure

Paying for infrastructure has been a constant and worsening problem as cash-strapped governments at all levels face the absolute limits to deferred maintenance, and the prospect of increasing density and congestion on transportation systems. While key new-build infrastructure projects – such as the planned Gordie Howe International Bridge, or new rail transit lines in increasingly congested cities – are needed, there are smart ways for transportation infrastructure

[1] All dollar figures cited in this report represent U.S. dollars.

owners in the Great Lakes and St. Lawrence Region to get more productivity from existing infrastructure, and at a fraction of the cost of new capital projects.

Specific ways to do this include improving existing infrastructure management, better leveraging technologies that can increase infrastructure productivity, and infrastructure demand management policies and initiatives.

Making better use of existing capacity can deliver more value for fewer dollars, freeing up money for other infrastructure priorities. Initiatives that enhance productivity and utilization are also arguably easier to implement, given the approvals, permitting, funding and social license issues that often hold up major new-build capital projects.

Three recommendations for getting more productivity from existing infrastructure :

1. Region infrastructure owners can focus investment on asset preservation and modernization before expansion, and improve asset management practices.
2. Regional jurisdictions and stakeholders (private sector, universities, etc.) should collaborate in identifying productivity enhancing technologies and innovations and share related experiences and lessons on implementation.
3. Regional governments can explore demand management options before making investment in new physical capacity.

2. Enable more options

The multimodal transportation system in the Great Lakes and St. Lawrence Region faces many unknowns, including the potential of technology-driven game changers and disruptors, climate change, evolving trade policies and shifting economic conditions, all of which will influence how people and things move in the Region. At the same time, declining levels of individual auto ownership in many urban centers, and changing patterns of work and personal travel are also creating different transportation needs. New mobility options may also blur the line between public and personal transportation. Just how these and other forces will influence personal mobility and goods movement remains unclear, creating a host of risks for transportation infrastructure owners, policy makers and planners. Enabling more, and better transportation **options** for passenger and freight movement for both providers and users of the systems will help make the Region's transportation system more resilient and adaptable to an unknown future.

Three recommendations for enabling more options :

1. Senior leaders from state, provincial and municipal transportation agencies should work with industry and the federal levels of government to address known barriers to the competitiveness of underutilized regional transportation options, including but not limited to the maritime mode in the Great Lakes and St. Lawrence River.
2. Regional government and industry leaders should collaborate in identifying long-term strategic transportation/ utility corridors and industrial lands in the Great Lakes and St. Lawrence Region and develop a plan to preserve and protect these for future development.
3. Identify strategic multimodal hub locations in the Region, favoring hubs where multiple modes can converge and develop, and define a process to preserve and expand these in the longer term.

3. Embrace and incent technology and innovation

New and emerging technologies such as automated and driverless vehicles, evolving operating practices such as sharing economy models (e.g. ride sharing), as well as innovations in information management (such as real-time traffic information systems) can help get more capacity and productivity out of existing infrastructure, increase safety, and provide users with better options.

The old model of infrastructure (build as strong as possible to accommodate future increased use and minimize maintenance requirements) is no longer acceptable. Both vehicles and 21st-century infrastructure will be "smart", increasingly integrating physical and digital elements.

Ride-sharing and capacity sharing apps (e.g. Uber), real-time trip routing information (Google Maps), the introduction of emission reducing clean technology, wayside detection systems on railways for enhanced safety and reliability, and e-commerce delivery docks (e.g. Amazon) are among the innovations that are improving transportation in the Region and beyond. Public agencies in the Great Lakes and St. Lawrence Region should do more to encourage and leverage this kind of innovation by removing regulatory barriers to innovation, and incenting innovation, where appropriate. It should also look to private sector solutions – where these exist – before trying to develop bespoke solutions to problems the private sector has already solved.

Three recommendations for realizing the benefits of technology and innovation :

1. Pilot a bi-national, multi-jurisdictional "smart" corridor, with focus on compatible standards and testing for the gradual introduction of driverless vehicles in the Region.
2. State/provincial and municipal levels of government should look to develop smart regulations that don't unduly represent a barrier to the introduction of transportation technologies and innovations. This should be coordinated with federal levels of government.
3. Regional municipalities should develop a formal mechanism to share learnings about the introduction of smart city infrastructure, technologies and approaches.

Strategy implementation: a roadmap for the Council of the Great Lakes Region

The goal of this Multimodal Transportation Strategy is not to produce a product – another report or conference. Rather, it is to initiate an on-going process that will facilitate greater collaboration, a deeper understanding of regional transportation issues and priorities, and build constituencies that can jointly address the Region's transportation issues and opportunities.

The Council of the Great Lakes Region (CGLR) can take a leadership role in advancing this process, and help convene a forum for dialogue around the themes and recommendations outlined herein, toward the realization of the vision for the Region's multimodal transportation system.

1. Context and Rationale for a Multimodal Transportation Strategy for the Great Lakes and St. Lawrence Region

Starting with First Nations and the Coureurs de Bois that followed, the Great Lakes and St. Lawrence Region grew around the waterways that provided transportation connectivity. These maritime connections, as well as the port facilities, rail, road and air connections that followed, facilitated economic activity and trade. Manufacturing and other industries gravitated to the Region, generating jobs and attracting migration.

The Region has become an interconnected megaregion and continental hub comprising[2]:

107 million inhabitants, or roughly 30% of the total U.S. and Canadian population.

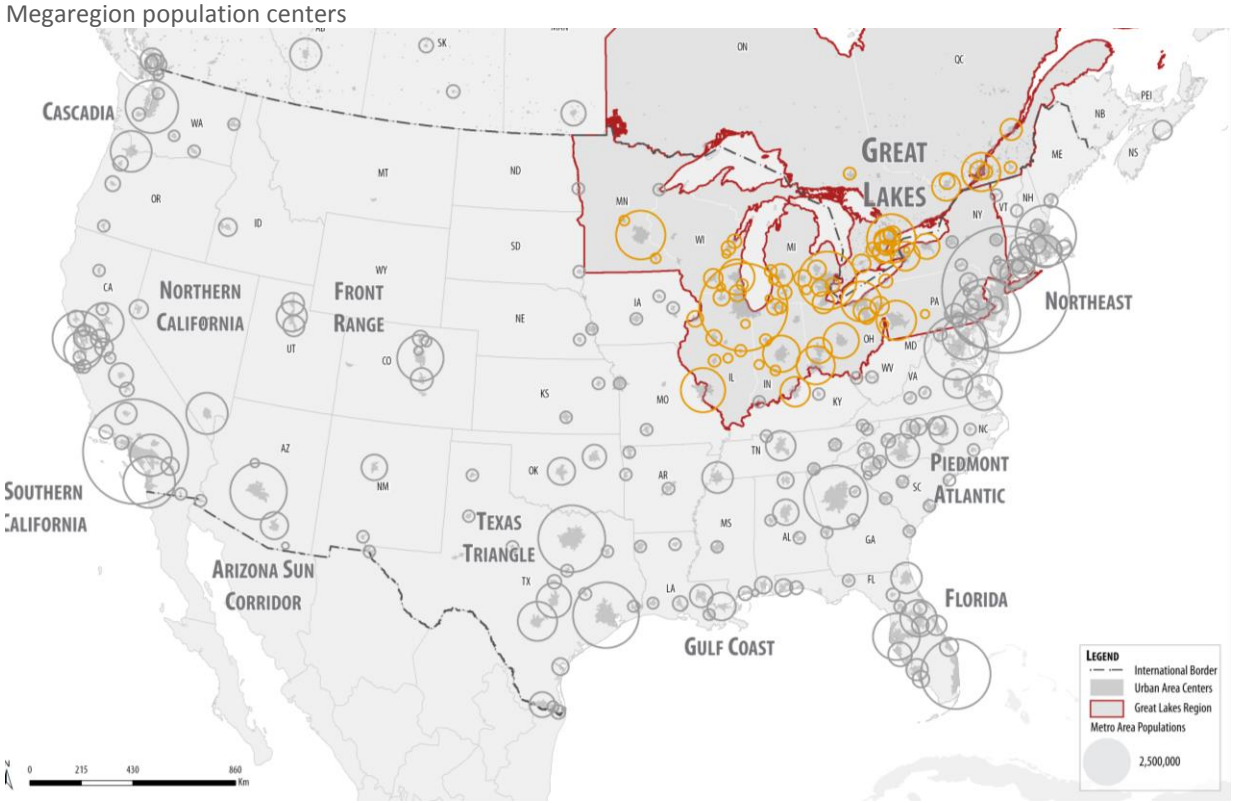
51 million jobs, across a wide range of sectors – many critically dependent on transportation.

15 U.S. and Canadian metro areas with population above 1 million residents.

$5.8 trillion in annual economic activity, representing 8% of global GDP. If the Region formed a country, it would have the 3rd largest GDP in the world, after the U.S. and China.

$1.3 trillion in global merchandise trade, across a range of sectors.

There is a high concentration of population in the Great Lakes and St. Lawrence Region
Megaregion population centers

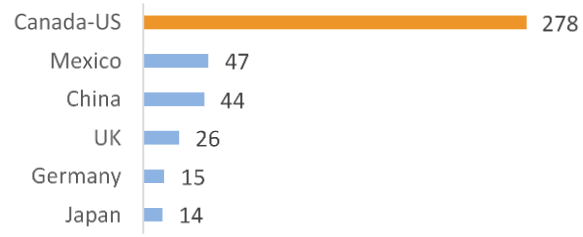


Source: U.S. Census Bureau, Statistics Canada (2011), CPCS analysis

[2] Sources: US Census Bureau, US BEA, US BLS, Statistics Canada

The Great Lakes and St. Lawrence Region is the critical point of economic connection between the U.S. and Canada. Goods also stream into this Region from all over North America and beyond. Trade between the Great Lakes states and provinces is also significant in its own right. U.S. and Canadian regions of the Great Lakes trade more with each other than with any other country in the world.

Top destinations for merchandise exports from the Great Lakes Region, $US billions, 2015 data



"We don't just sell stuff to each other, we make it together"

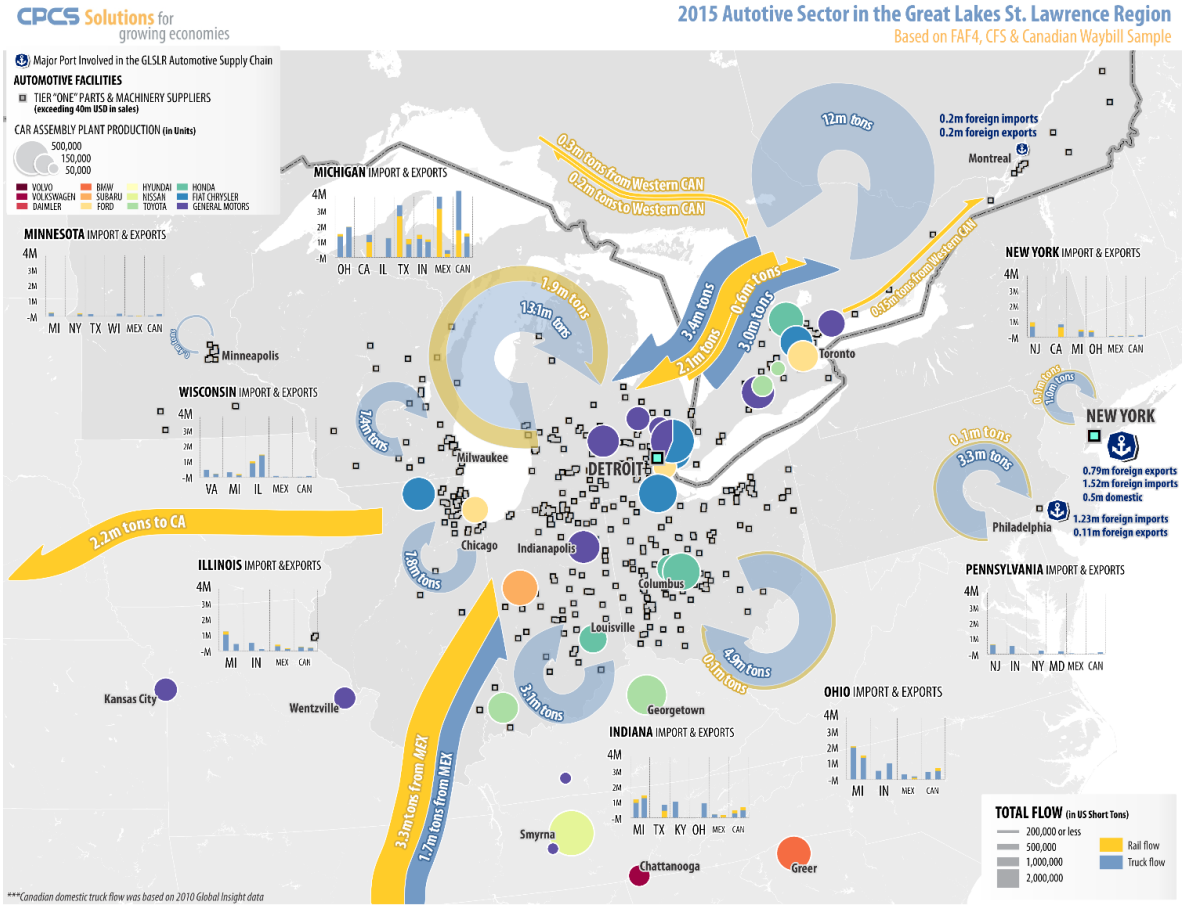
-Dr. Stephen Blank, NAFTA Scholar

Source: CPCS analysis, Statistics Canada, U.S. census Bureau

Great Lakes border crossings are among the busiest in the world. The largest share of goods crossing between the countries are not finished products, but parts and components moving along deeply integrated supply chains. The integration of automotive supply chains is a notable example, but there are many others. Not surprisingly, the most significant regional trans-border trading pair is between Ontario and Michigan, which accounts for $74 billion in annual trade.

The automotive sector in the Great Lakes and St. Lawrence Region is highly integrated

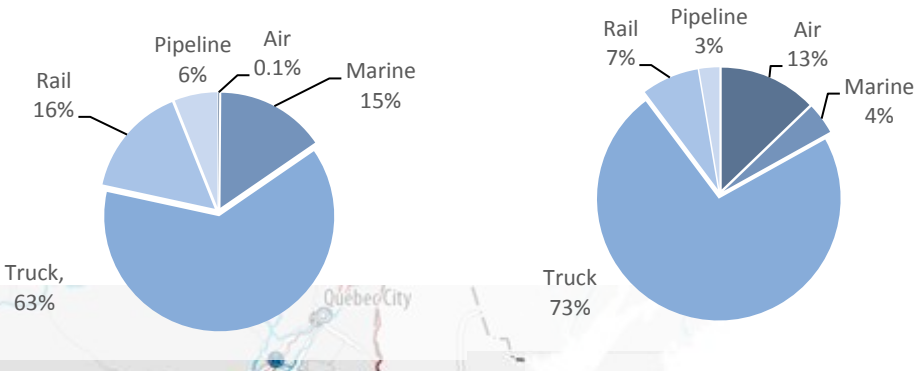
Automotive and automotive parts producers and transportation flows



The Region's significant interconnectedness and related economic activity is enabled by its multimodal transportation system, which serves both passengers and freight. By any measure, the Region's multimodal transportation system is extensive.

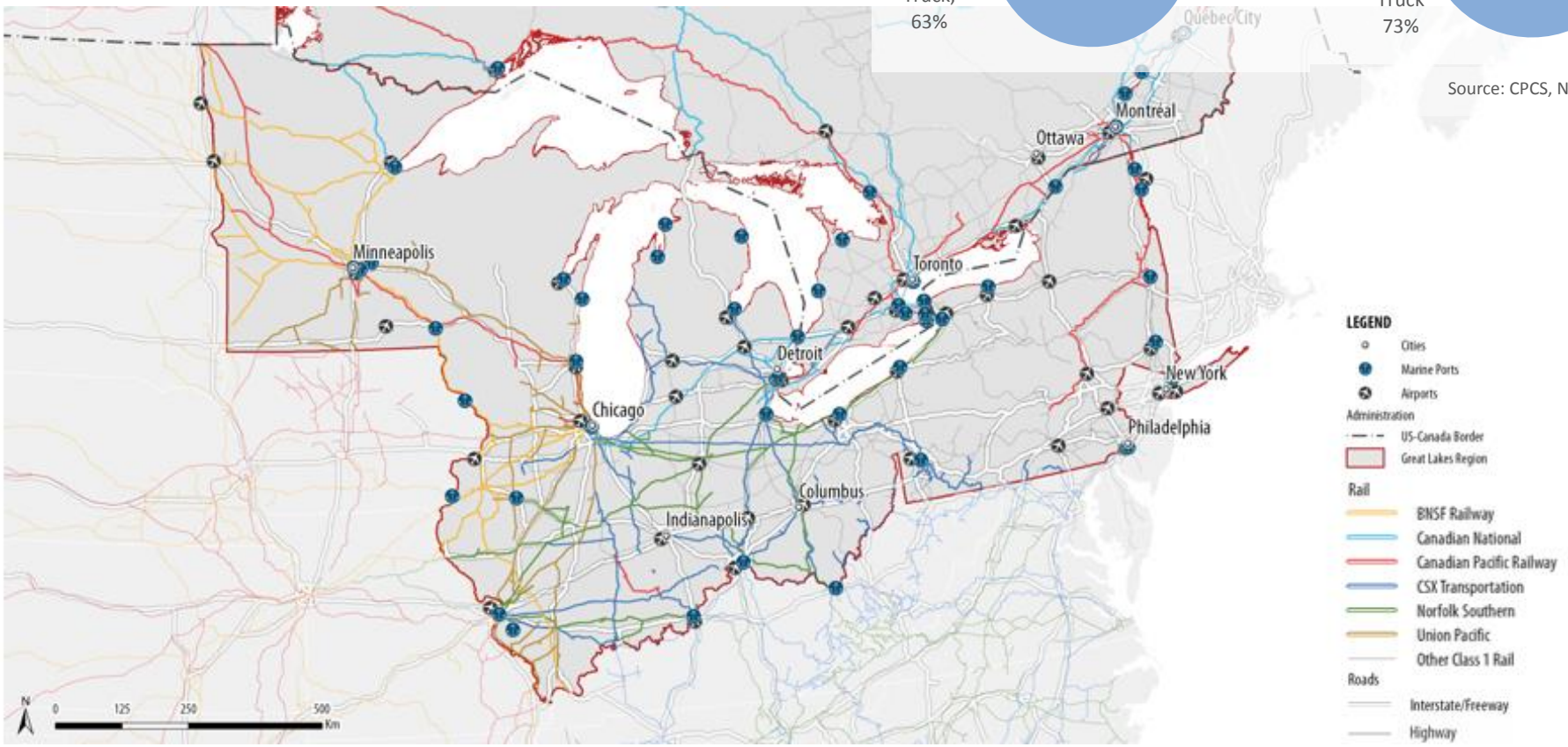
20,000 miles of highways
50,000 miles of rail lines and close to 70 intermodal terminals
15 large international marine ports and 50 regional marine ports
12 of the top 50 North American airports

Region Transportation Flows by Mode by Volume (Left) and Value (Right)



Source: CPCS, NCFRP Report 17

Multimodal infrastructure assets



Source: U.S. BLS, U.S. BEA, Statistics Canada, Freight Analysis Framework, TransBorder Data Sets, CPCS analysis

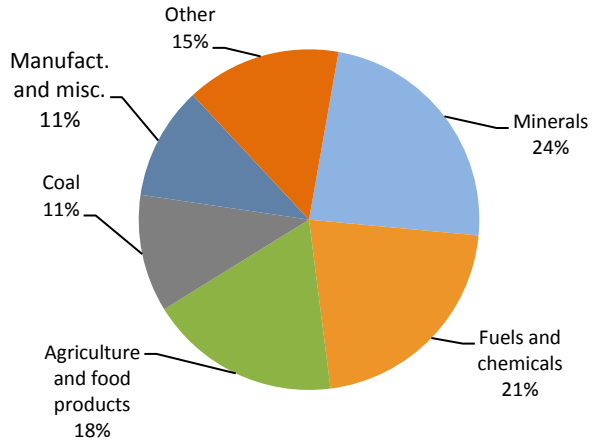
The economic importance of the Region's transportation system goes far beyond transportation jobs.

The transportation sector – as an industry – generates significant economic activity in the Great Lakes and St. Lawrence Region. Close to 2 million individuals are directly employed in transportation activity in the Region – driving trucks, buses, operating trains, planes and ships, and working in ports, warehouses and other logistics facilities. One study estimated that freight transportation generated 4 million direct, indirect and induced jobs in the Region, over $300 billion in annual GDP and $87 million in taxes. [3] The economic contribution of marine shipping alone is estimated to be more than 227,000 direct, indirect and induced jobs, and contributing more than $33.5 billion GDP and $4.6 billion in taxes annually.[4]

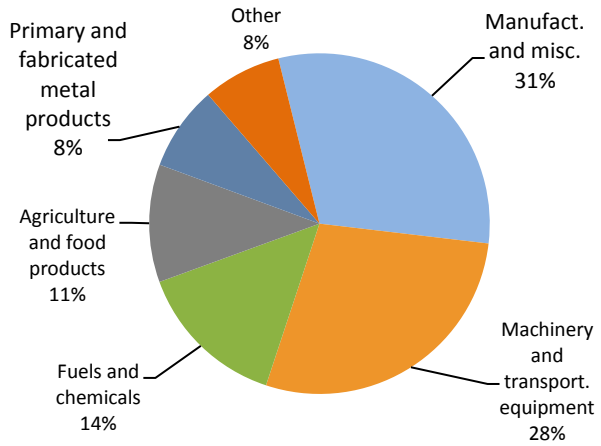
But to focus on these numbers – as significant as they are – misses the point. The true economic contribution of the transportation system is in enabling other economic activity. Without transportation infrastructure and services, there would be no trade, there would be no functional supply chains, there would be no goods-producing industries, and there would be no associated jobs. Simply put, an efficient and competitive multimodal transportation system is critical to all economic activity that relies on transportation and to the overall performance and competitiveness of the Great Lakes and St. Lawrence Region economy.

The following figures – showing top commodities moving in the Great Lakes and St. Lawrence Region by weight and by value – indicate that a broad base of industries are dependent on the Region's multimodal transportation system.

Top commodities by weight (all modes)



Top commodities by value (all modes)



Source: NCFRP Report 17: Multimodal Freight Transportation within the Great Lakes Saint-Lawrence Basin (2012)

[3] Adapted from Transportation Research Board, NCFRP Report 17, Multimodal Freight Transportation within the Great Lakes-Saint Lawrence Basin (2012)

[4] Martin Associates, The Economic Impacts of the Great Lakes-St. Lawrence Seaway System (2011)

Why Getting Transportation Right is So Important for the Region?

Transportation moves the Great Lakes and St. Lawrence Region economy. People and goods move through and across the Region. Many sectors, including those below could not operate without an effective transportation system.

Manufacturing

About 70% of all goods produced in the Great Lakes are manufacturing goods – led by transportation equipment

Construction

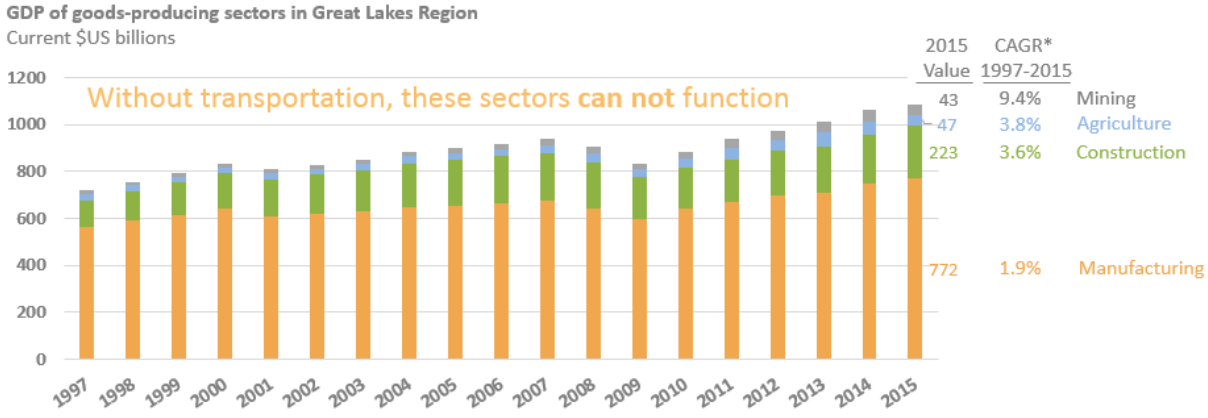
Construction represents about 20% of goods produced in the Region, however post-recession construction activity has not rebounded as quickly as the other industries profiled

Agriculture

Due to portions of the Great Lakes Region serving as the World's Bread Basket, agriculture represents a consistent, growing industry

Mining

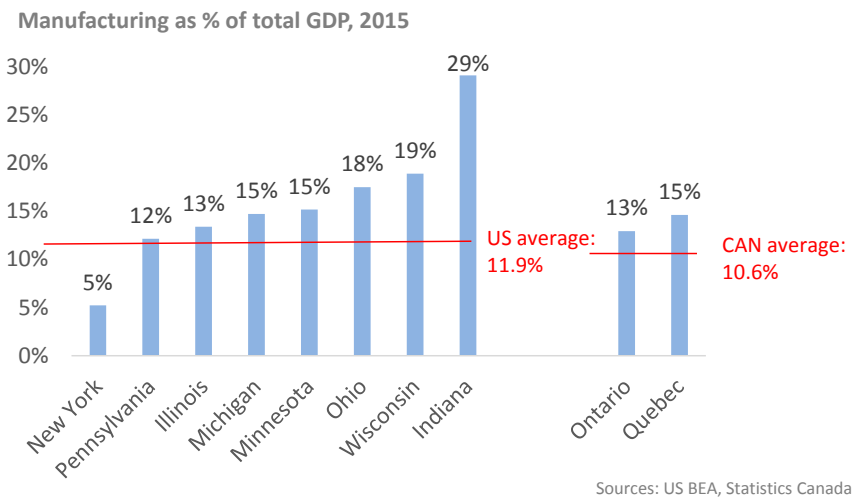
Of the industries profiled, mining represents the smallest share, but has grown by the largest percentage since 1997



Sources: Statistics Canada, U.S. BEA, CPCS analysis

* CAGR = Compound annual growth rate

The manufacturing sector is by far the largest goods-producing sector in the Region's economy. It contributes a disproportionately large share to regional GDP compared to the U.S. and Canadian average.



Sources: US BEA, Statistics Canada

Automotive manufacturing is the largest segment of the Region's manufacturing sector. The Great Lakes Region produces 53% of U.S. motor vehicles and 48% of U.S. primary metal manufacturing. Great Lakes provinces account for 81% of primary metal manufacturing and 98% of motor vehicle manufacturing in Canada.

Manufacturing in the Great Lakes and St. Lawrence Region is growing, contrary to public belief, particularly in advanced manufacturing – that is, manufacturing using innovation and technology to improve production processes.

The Region's manufacturing success rests heavily on efficient freight transportation. Transportation connectivity is critical in extended – often cross-border – production systems.

As important as transportation is to manufacturing, as well as other industrial sectors, an efficient transportation system is also critical to moving and connecting the Region's more than 100 million inhabitants. Chicago, Toronto, Montreal, Detroit, Columbus and many other Great Lakes and St. Lawrence Region cities face significant congestion challenges, crowded transit systems, and underperforming intercity connections. Chicago, for example, was recently singled out as having the single worst bottleneck in all of the U.S. and Canada.[5]

Efficient passenger transportation systems are known to help attract and retain talent and promote higher productivity.

[5] CPCS for the American Highway Users Alliance, *Unclogging America's Arteries 2015*. A similar study by CPCS, *Grinding to a Halt, Evaluating Canada's Worst Bottlenecks*, released by CAA (2016), identifies top Canadian bottlenecks.

2. Regional Transportation Trends, Issues, and Opportunities

Transportation is an enabler of economic activity and social connectedness. It shapes and influences how the economy is organized, where businesses locate and invest, and how we trade. It also influences where we choose to live, work and play. In short, the importance of transportation – and mobility more broadly – can't be overstated.

But as much as transportation shapes economies and societies, transportation infrastructure, services and systems can come under pressure. Growing and evolving demand for transportation, aging or inadequate infrastructure, outdated regulations, and social, political, and environmental factors are among these pressures.

The highly connected and integrated Great Lakes and St. Lawrence Region, which in many respects owes its present day form to transportation connections, is not immune to these pressures. Many such pressures are in fact particularly acute in the Region, creating barriers to mobility, and by extension, barriers to the Region's growth and prosperity.

Consultations with senior private and public sector executives and leaders in the Region supported by other research and analysis, revealed the top pressures facing the Region's transportation system as well as associated trends, issues and opportunities.

These can generally be categorized as:

- **Known knowns**: Transportation pressures and issues that are well understood, and which have relatively linear patterns; their impacts and implications can reasonably be foreseen.
- **Known unknowns**: Emerging factors understood to be significant, and that necessitate preparedness; their true implications for the Region's transportation system remain unclear.
- **Unknown unknowns**: The host of things that a regional multimodal transportation strategy for the Great Lakes Region needs to be ready for and resilient to; positioning will be key to adequately responding.

The most important trends, issues and opportunities falling under each of these categories are summarized in the following sections, along with their implications for the Region and for a forward-looking regional multimodal transportation strategy.

Known Knowns

Among the most significant "known knowns" creating challenges for the Region's transportation system are: increasing congestion and capacity constraints, particularly around major urban centers and transportation hubs; aging infrastructure; institutional and regulatory fragmentation resulting in barriers to transportation system efficiency; planning and investment; as well as new technologies. Each theme is outlined below.

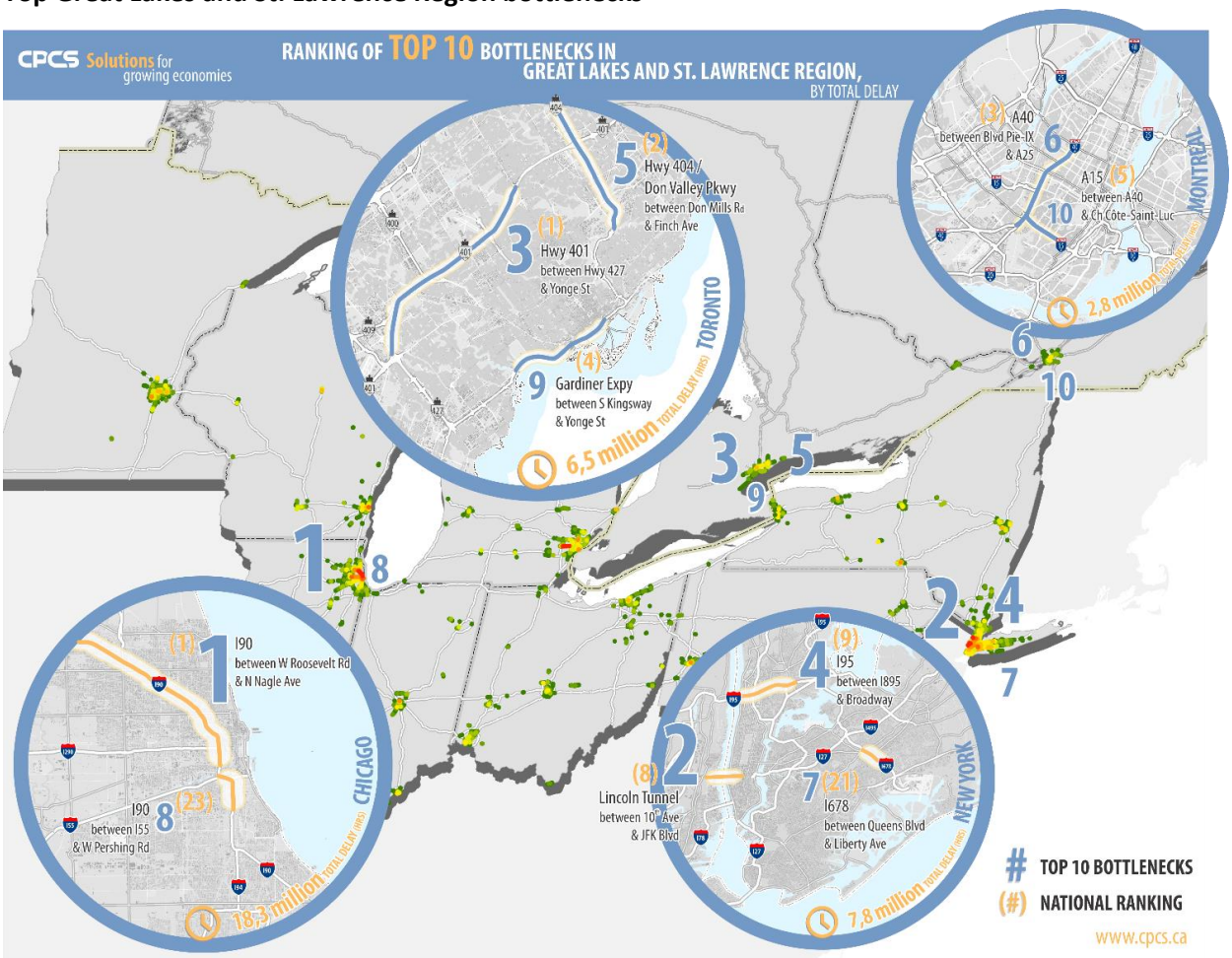
Many Parts of the Region's Transportation System are Capacity Constrained

Urban Congestion is Getting Worse

Those living in the Region's urban centers understand this challenge all too well: bumper to bumper traffic on major highways and urban arteries, overcrowded commuter trains, transit buses and metro systems, particularly during morning and afternoon peak periods.

Recent CPCS studies for the American Highway Users Alliance and the Canadian Automotive Association revealed that the Region is home to the top U.S. bottleneck (in Chicago) and 8 of the top 10 Canadian bottlenecks, including Canada's top bottleneck (in Toronto). The cost of roadway congestion – including lost time and productivity, stress, and increased fuel use – impact both passengers and trucks. Congestion also contributes to increased emissions.

Top Great Lakes and St. Lawrence Region bottlenecks



The problem of urban congestion in the Region is not going away and has been getting worse. Total passenger vehicle miles traveled on roads as well as transit ridership levels have been on the rise since 2011 (though still below pre-recession levels). Over 740 billion vehicle miles are traveled each day on roads in U.S. Great Lakes states alone.[6]

[6] CPCS analysis of FHWA Highway Statistics, 2015

At least three factors will contribute to increased pressure on urban transportation infrastructure in and around the Region's cities:

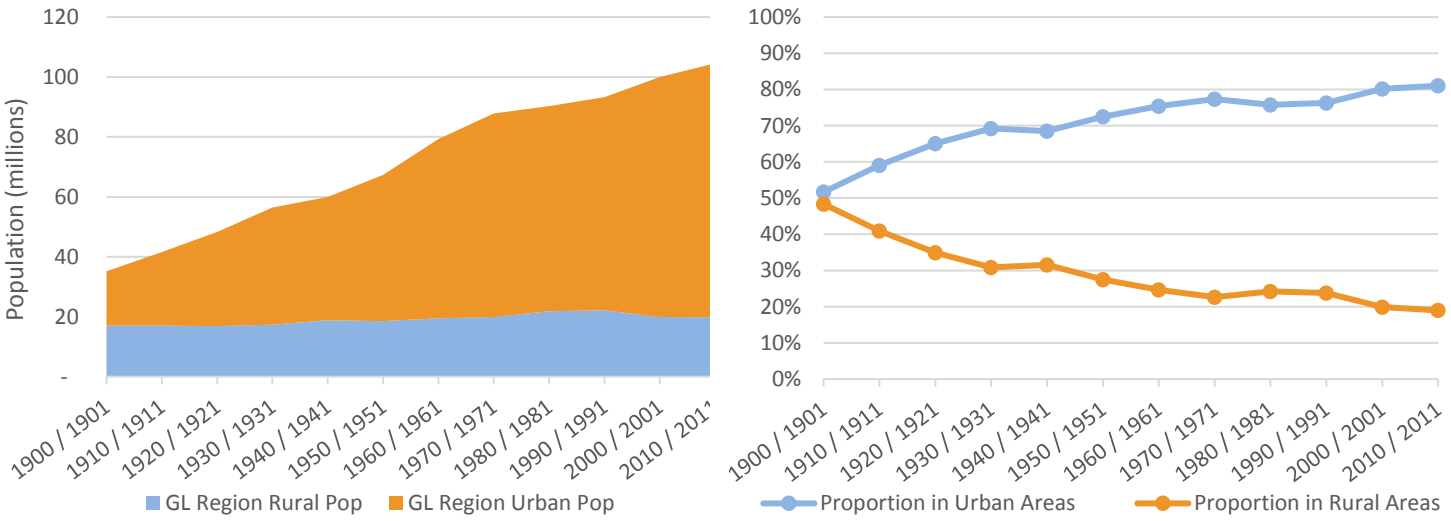
1) the growing population base in the Region – expected to increase from 107[7] million today to over 133 million by 2050[8],

2) the growing number of individuals who drive to work alone[9], and

3) the increasing concentration of the Region's population in suburban and urban centers.

This has led to the revitalization and gentrification of some formerly run-down industrial neighborhoods, such as in Cleveland and Toronto, creating new economic opportunities; it is also creating new mobility challenges.

Increase in regional population (left) and the share of the population living in urban centers (right)
Region population trends



Source: U.S. Census (year ending in 0) / Statistics Canada (years ending in 1)

Note: Definition of "urban", as used by the U.S. Census and Statistics Canada has changed since 1900, though does not impact the message above

Urban congestion on one part of the transportation system can have multimodal impacts. For example, congestion on Highway 401 in Toronto (top Canadian bottleneck) constrains the reliability of passenger trips to Toronto Pearson International Airport to catch a flight. Plans for the Toronto Pearson Regional Transit Centre, led by the Greater Toronto Airports Authority, seek to improve transit options, ease congestion around the airport, and improve regional mobility.

The aging demographic in the Great Lakes and St. Lawrence Region will also put new kinds of demands on urban transportation systems. In particular, growing elderly populations will need means of independent mobility, when driving personal cars is no longer possible.

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[7] 2016 population data for U.S. Great Lakes States and Canadian Great Lakes Provinces is based off the U.S. Census Bureau and Statistics Canada.

[8] Great Lakes Province Population Projections: Statistics Canada provides population forecasts for Quebec and Ontario from 2017-2038. Population growth is assumed to be equal to overall Canadian growth rates from 2039 to 2050. Great Lakes State Population Projections: Population growth in Great Lakes States is assumed to be equal to overall U.S. population growth due to a lack of state population projections.

[9] U.S. Department of Transportation, Beyond Traffic 2045

Rail Infrastructure is Capacity Constrained

The Region's rail network is also congested – around major rail hubs, in urban areas, and Chicago in particular. The Chicago Region is North America's largest and most important rail hub and home to ten separate railroads – including commuter and intercity passenger and freight railroads – operating on shared infrastructure. When things don't work properly in Chicago, the impact can back up to other parts of the rail network – leading to delays and increased costs.

> *"A lone train stopped in Chicago can force other trains to stop or slow as far away as Los Angeles or Baltimore. It's a ripple effect – everything in my system backs up."*
>
> - *Scott Haas, Vice President for UPS*
> *(Source: Amtrak Blue Ribbon Panel Report)*

Public and private sector rail system owners, operators and others embarked on the decade-plus long Chicago Region Environmental and Transportation Efficiency (CREATE) Program to collaboratively plan and improve the system in the City of Chicago for all users by investing in rail line capacity, rail-rail and rail-highway grade separations and other operational improvements. However, funding challenges notwithstanding, in recent years rail stakeholders have recognized that fixing the Chicago bottleneck will not fully solve the problem; there are other shared rail infrastructure needs outside and leading into the City that also need attention, spurring development of the Chicago Gateway and Indiana Gateway projects.[10]

> *"One of the reasons for our Chicago Gateway project was to bring public and private parties together, regardless of state borders. The rail congestion issues, like the networks themselves, exist across state lines and need to be considered on a regional and national basis."*
>
> - *Amtrak*

There is also a lack of intermodal rail and inland port capacity around Great Lakes and St. Lawrence Region transportation hubs, including the Greater Toronto Hamilton Area and Chicago. Fueled by the growth of urban boundaries, these communities require expanding freight rail and inland container port capacity. Without this critical infrastructure, these communities will not live up to their economic growth potential. Moreover, more goods will have to be transported by truck, which will add to congestion – further constraining economic growth. There are significant challenges in making this type of infrastructure investment, including lack of adequate appropriately zoned corridors and industrial land, encroachment on available corridors and industrial land, cumbersome regulatory review and permitting processes, and public resistance to transportation–related development. This local public opposition can have the unintended consequence of curbing the overall Region's and Nation's growth and competitiveness on a global stage and adds to the existing road congestion throughout the Region.

[10] Report of the Amtrak Chicago Gateway Blue Ribbon Panel, Amtrak, (2015)

The Challenge of Shared Rail Corridors

In many parts of the Region, commuter and intercity passenger rail services run on rail infrastructure owned and operated by freight railroads, further adding capacity pressures to the rail system.

VIA Rail, for example, which has seen both the absolute number of passengers as well as total passenger-miles increase in Ontario and Quebec (notably on the busy Toronto-Ottawa-Montreal Corridor (TOM))[11], largely runs on the busy CN main line between Toronto and Montreal. The challenges associated with running on track predominantly owned by freight railroads include reduced on-time-performance and challenges in adding service frequencies. These are the primary reasons VIA Rail has been advocating for the development of a dedicated higher frequency rail (HFR) corridor between Toronto, Ottawa and Montreal.

Also of note, the U.S. Federal Railroad Administration (FRA) is embarking on a passenger rail planning study for the Midwest Region. Initial discussions with the Midwest Interstate Passenger Rail Commission indicated that this study will identify passenger rail pressures and issues for the Region.

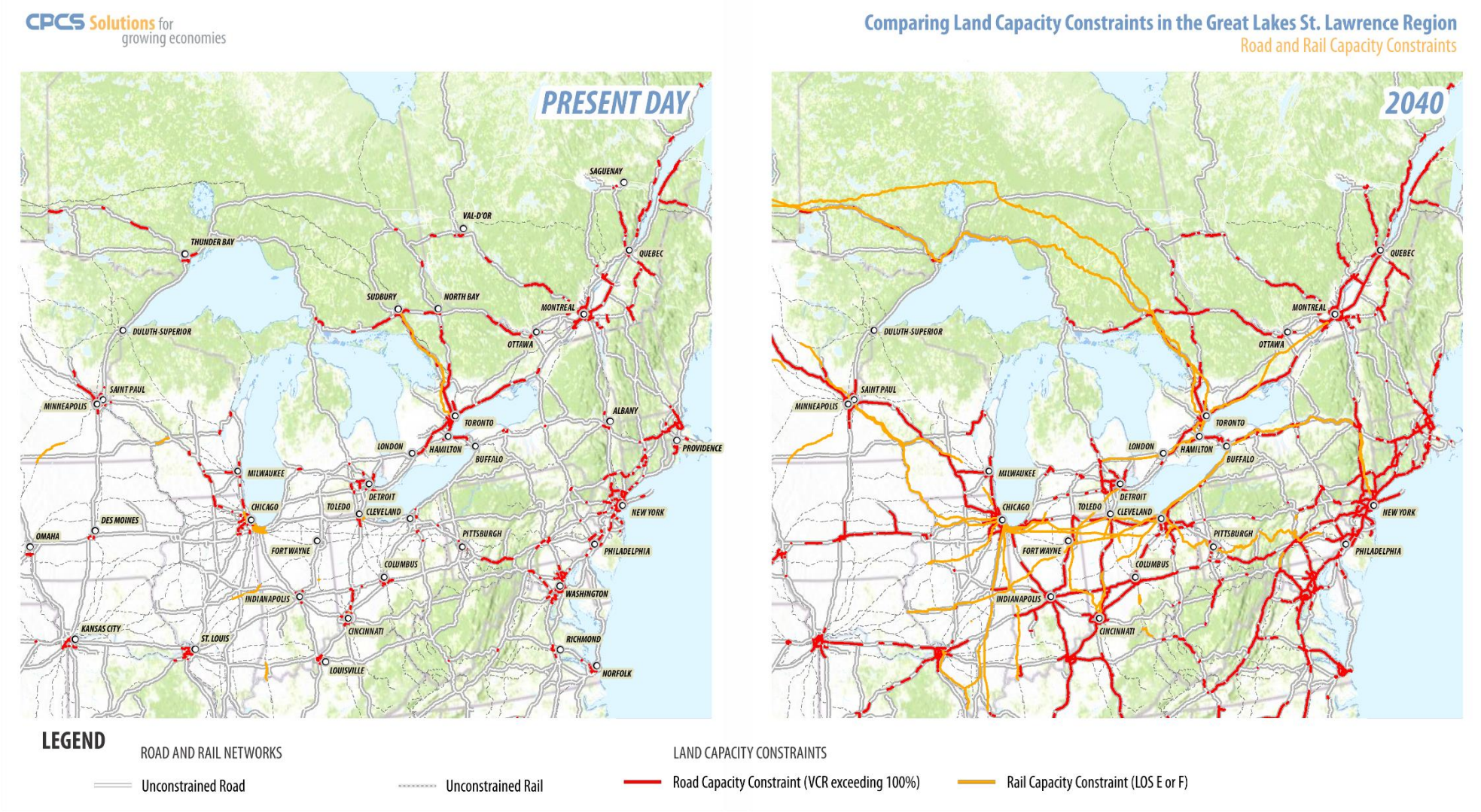
Commuter rail service has similarly added pressure to rail networks in and around major centers in the Great Lakes and St. Lawrence Region. Although commuter rail ridership in the Region has been relatively flat in recent years (except for GO in Toronto, which has seen significant growth), freight service on many lines used by commuter operations has been increasing in response to market demands. Capacity pressures and operational conflicts can be particularly acute during peak morning and afternoon commuter periods, into and out of downtown cores where many rail operations often converge. Collaboration between commuter rail operators and freight railroads, and the purchase of trackage from freight railroads (e.g. GO in Toronto, AMT in Montreal) have contributed to improved commuter rail service.

Surface Transportation Capacity Constraints Likely to Worsen

A previous study by CPCS for the U.S. Transportation Research Board on the Great Lakes multimodal freight transportation system[12] compared present day road and rail capacity constraints to a projected 2040 context, assuming steady state traffic forecasts and no additional capacity investments. This theoretical comparison makes the point that pressures on capacity are expected to increase over the next twenty-plus years. These constraints are likely to be most acute around major urban transportation hubs where there is intense competition for land use. Freight railroads will make investments to ensure appropriate capacity. Protecting corridors for future capacity expansion needs, and moving forward with the Gordie Howe International Bridge between Detroit, Michigan and Windsor, Ontario, are two priorities identified by Regional stakeholders to help address surface capacity constraints in the Region.

[11] By contrast, Amtrak ridership and passenger-miles in Great Lakes states has been on the decline.
[12] NCFRP Report 17, Great Lakes-St. Lawrence Basin Multimodal Freight Transportation System (2012)

Road and rail capacity constraints in the Great Lakes and St. Lawrence Region likely to worsen
Demand and capacity over the Region's transportation system (present, 2040)



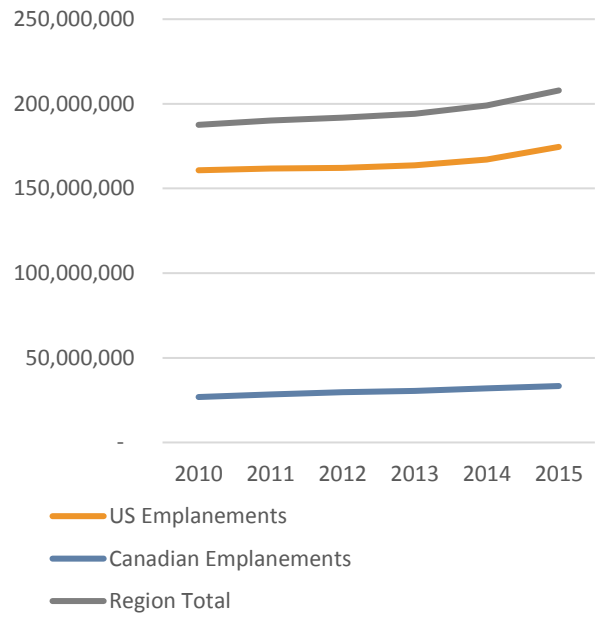
Source: CPCS, adapted from NCFRP, Report 17: Multimodal Freight Transportation System with the Great Lakes St. Lawrence Basin

Other Transportation Capacity Challenges

Transportation infrastructure capacity pressures in the Region are not limited to road and rail. Increasing air passenger travel through Great Lakes and St. Lawrence Region, as well as increasing air cargo volumes, are leading to congested airports – particularly at major air hubs including Chicago O'Hare International Airport and Toronto Pearson International Airport.

Beyond crowded airports – particularly at and around U.S. Great Lakes Region air hubs – one of the implications has been declining on-time performance and reliability of air service in many of the Region's airports, including some of the largest. Detroit and Minneapolis airports, for example, have seen their on-time performance decrease between 2011 and 2015, by 20% and 10%, respectively.

Great Lakes St. Lawrence Region passenger enplanements going up
Top airport enplanements (2011-2015) (left) and on-time performance (right)



Airport	2015 Enplanements	% Change in Enplaned Passengers	% Change in Annual Delay Times
Chicago O'Hare	36,305,668	14%	-8%
NYC JFK	27,782,369	17%	6%
Toronto Pearson	19,775,712	23%	N/A
Minneapolis	17,634,273	11%	10%
Detroit	16,255,520	3%	20%
Philadelphia	15,101,349	1%	-26%
NYC LaGuardia	14,319,924	19%	18%
Chicago Midway	10,830,850	19%	1%
Montreal	7,367,059	12%	N/A
All others	44,354,749	-35%	N/A
Regional Total	207,896,605	9%	N/A

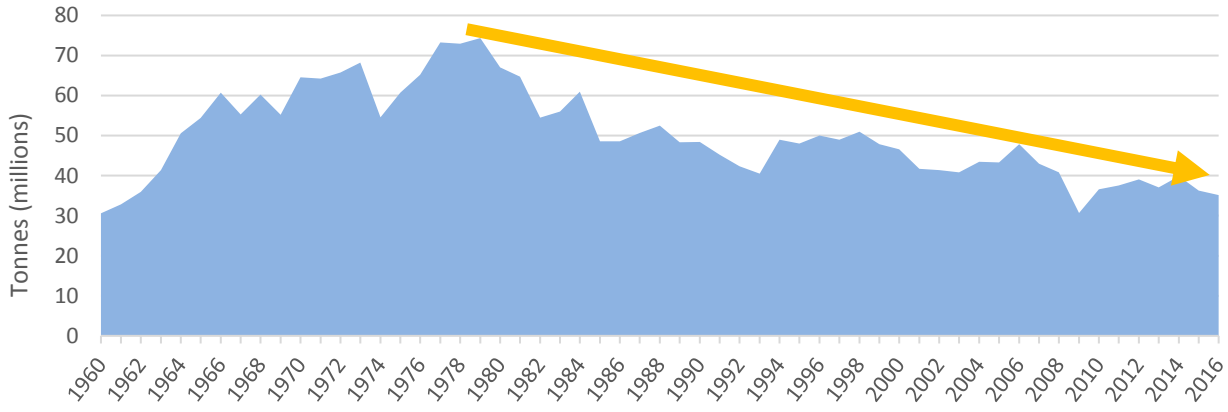
Source: CPCS analysis of FAA Passenger Boarding and All-Cargo Data, Statistics Canada, Air Carrier Traffic at Canadian Airports (51-203-X), BTS Airline On-Time Statistics and Delay Causes

Intermodal connection issues to and from airports were also highlighted as a challenge. As one stakeholder noted, airports are not destinations. More must be done to provide passengers with improved and more seamless connections to/from airports and their ultimate destinations. The efficient flow of people and goods is vital to ensure the sustainable and unhindered growth of any region. For example, road congestion in the Greater Toronto Area and Southern Ontario at large threatens to dampen the significant economic benefits that Toronto Pearson International Airport's growth brings to the region. The airport is well on its way to reaching mega hub status, a term reserved for an elite group of airports that are highly connected to a large proportion of the world's GDP and benefit from a high degree of international connecting passengers. The Toronto Pearson Regional Transit Centre is in part a means of ensuring that both the region and the airport continue uninterrupted along a strong growth trajectory well into the future.

The Maritime Transportation System in the Region has Significant Available Capacity

In contrast to capacity constrained road, rail and air transportation, the maritime mode in the Great Lakes and St. Lawrence Region – which largely handles bulk traffic such as iron ore, grain, coal and limestone – is underutilized. The long-term trend has been one of decreasing traffic volumes in many parts of the system as traffic through the St. Lawrence Seaway – the key connection between the Great Lakes and the Atlantic Ocean – demonstrates. By most accounts the Seaway, as well as many Great Lakes ports, including the Ports of Cleveland and Thunder Bay, are operating well below their available throughput capacity. Seasonal issues notwithstanding (the Seaway is closed approximately three months per year), they are open and ready for business.

Seaway traffic levels are about half what they were in the mid-1970s
Total traffic through the St. Lawrence Seaway (millions of metric tonnes)



Source: CPCS analysis of historic traffic data from: St. Lawrence Seaway Management Corporation

Available capacity on the Great Lakes maritime transportation system could be better utilized for freight transportation and could, to some extent, help alleviate surface transportation capacity constraints in the Region, where there is an appropriate business case.

But, the decision to use the maritime mode is driven by the owners of the freight (shippers), who make mode choice and routing decisions based on logistics cost, transit time and reliability considerations. To shift freight to the maritime mode in the Region necessitates a clear and commercial value proposition with respect to competing modes. In particular, this means reducing the cost of maritime transportation, and addressing other structural barriers.

Currently, there are many interests, regulations and inefficiencies that impose costs on the maritime system, hindering its cost competitiveness. The high cost of pilotage, high (unionized) port terminal handling costs, and cabotage regulations that restrict competition, are among the factors that drive up the cost of maritime transportation. The many organizational interests in the Great Lakes maritime system challenge attempts at collaboratively working to reduce costs for the shippers that are the ultimate users.

> *"We've been talking about these [cost] issues forever, but nothing seems to change".*
>
> *-Maritime sector stakeholder*

There is significant frustration with the slow pace or progress in addressing the drivers of high maritime transportation costs.

If the maritime transportation system is to become a more competitive transportation option and contribute to transportation system resilience in the Region, maritime transportation costs must come down.

Opportunities to address other structural barriers to the competitiveness of the maritime mode, such as the seasonal closure of the Seaway from late December to mid-March, may also warrant new approaches.

Infrastructure in the Region is Aging and in Need of Rehabilitation

Years of Underinvestment are Increasing the Cost of Infrastructure Use and Creating Risks

The American Society of Civil Engineers (ASCE) periodically develops a report card on U.S. infrastructure that includes all transportation modes. In its latest report, infrastructure scored a "D+", with associated rehabilitation investment needs of $2 Trillion over the next decade at the national level. A similar Canadian study also underscored the poor and declining state of roads and bridges.[13] Another survey of infrastructure quality – globally – has seen U.S. and Canadian infrastructure quality decrease relative to international jurisdictions.[14]

Though not specific to the Great Lakes and St. Lawrence Region, an ASCE infrastructure report estimates that the average American family will lose $1,060 each year in personal disposable income due to deficient and unreliable transportation by the year 2020.[15]

Freight sectors are similarly impacted with higher operating costs (which ultimately gets passed on to customers).

> *"We're using almost 100 percent more tires to produce the same mileage of transportation…Why is that? Because the road infrastructure has so many potholes in it, it's tearing up tires faster than before."*
>
> *- FedEx Chairman and CEO Fred Smith*
> *(Source: U.S. House Transportation and Infrastructure Committee)*

Infrastructure failure presents an even greater cost. The collapse of the I-35 Bridge in Minneapolis during rush hour in 2007, killing 13 people and injuring close to 150, is a sad example of the cost and risk of underinvestment.

The risk of failure of the Poe Lock at Sault St. Marie (Soo Lock), or failure of other locks and dams on the inland waterway system – more than half of which are over 50 years old – could also cripple those industries that are reliant on low-cost water transportation. A U.S. Department of Homeland Security report found that a 6-month failure-related shutdown of the Poe Lock would plunge the U.S. into recession, close factories and mines, halt auto and

[13] Canadian Infrastructure Report Card (2016)
[14] World Economic Forum, cited in The Infrastructure that Matters Most, The Canadian Chamber of Commerce
[15] Report Card for America's Infrastructure, ASCE (2013)

appliance production in the U.S. for most of a year, and result in the loss of some 11 million jobs across the nation.[16] The impacts on Canada, though not studied, could also be disastrous.

The cost to rehabilitate aging infrastructure in the Great Lakes and St. Lawrence Region will be significant – likely valued in the tens or even hundreds of billions of dollars. But the cost of continued underinvestment will surely be greater.

Institutional and Regulatory Fragmentation

The Great Lakes and St. Lawrence Region is a highly integrated market. But it is also plagued by institutional and regulatory fragmentation. Beyond the bi-national nature of the Region, and the eight U.S. states and two Canadian provinces that border the Great Lakes and the St. Lawrence River, there are thousands of municipalities and other agencies with a hand in influencing the Region's transportation system. The institutional and regulatory fragmentation has resulted in many barriers to the efficient movement of people and freight through the Region. Specific examples include:

Modal Connectivity and Systems Integration Challenges

Historically, the transportation system has been viewed as a collection of individual modal networks – each serving its own purpose and with silo-ed priorities. That legacy approach, based on institutional constructs and missions, has not provided a seamless experience for users of the system, and is today outdated. The integration of modes of transportation has been noted by many as problematic in parts of the Region.

For transit users, mobility has been constrained or frustrated due to the piecemeal approach to system development. The poor integration of ticketing and fare systems across certain commuter and transit operations, as well as poor physical connections from one mode to another, are typical examples.

Freight transportation is similarly subject to modal connectivity issues in parts of the Region. These connectivity issues can be physical (e.g. poor or lacking rail access to a marine facility, or poor road connectors to rail facilities) or regulatory (e.g. lack of harmonizing regulations between states and nations).

"Chicago congestion is a big issue, backup at rail yards (are a problem), intermodal connectors are in poor condition…Secondary roads are often in poor condition and turning geometry, particularly in older neighborhoods often leads to extensive backups where left hand or cross-traffic moves are required to enter terminals or container yards. The poor secondary road conditions contribute to equipment damage, tire failure and missed cut-offs for train service".

(Source: NCFRP Report 17)

[16] The Perils of Efficiency Impacts of an Unexpected Closure of the Poe Lock, U.S. Department of Homeland Security (2015)

Inefficiencies and Inconsistencies at the Border

Nearly all consultations noted that better coordination on border crossings and infrastructure is needed. In many cases border processes and the application of rules differ by port of entry, adding confusion and inefficiencies to border crossings. One stakeholder representing the Region's manufacturers noted that coordinating not only on infrastructure projects, but also on operations – such as number of booths available at crossings – is essential. In the air sector, pre-clearance facilities and processes, as are in place at airports in Toronto, Montreal and Ottawa, have greatly improved the flow of people, goods and investments.

A Call to Improve Border Crossing Infrastructure and Processes

"To move people, natural resources, and goods more efficiently across the 49th parallel, Canada can improve the physical infrastructure and border-crossing process. In the manufacture of cars, for example, delays at the U.S. border can add hundreds of dollars to a vehicle's cost because components often cross the border several times before completion. To reduce congestion at key crossings, we could pursue investments in joint border-monitoring stations or in terminals at remote locations."

Source: Canadian Advisory Council on Economic Growth, Positioning Canada as a Global Trading Hub

Regulatory Inconsistency Adding Cost and Challenges to Movement of Freight

Transportation sector regulatory structures in the Region are largely mode-specific – contributing to modal integration challenges. This historic structure does not reflect the modern reality of multimodal freight hubs. Modal regulations also often differ across jurisdictions. Most notably, road transportation regulations are largely set and governed at the state and provincial level. This has in many cases led to inconsistent regulations across the Region. A typical example is truck size and weight regulations, which can vary greatly from one state or province to another. A recent CPCS study for the U.S. Transportation Research Board on Oversize and Overweight (OSOW) Freight Transportation revealed that the level of border "friction" caused by inconsistent regulations and permitting requirements across U.S. Great Lakes states is more problematic than in most other parts of the U.S.[17]

Through the U.S.-Canada Regulatory Cooperation Council (RCC) the two nations continue to work together on regulations to enhance economic competitiveness while maintaining high standards when it comes to health, safety, and the environment.[18] The 2016 RCC Work Plans reflect review of regulatory activities in the areas of connected vehicles, motor vehicle standards, rail safety, transport of dangerous goods, aviation, marine safety & security, locomotive emissions, alternative fuel use in transportation, among many others.

[17] NCHRP Report 480, Oversize/Overweight Freight Transportation (2016)
[18] US-Canada Regulatory Cooperation Council, U.S. Department of Commerce, International Trade Administration

During stakeholder consultations it was noted several times that regulatory harmonization efforts are positive. However, many noted that more needs to be done. A parallel dialogue to the work of the RCC at the state and provincial levels would help drive further alignment. One stakeholder emphasized that it is critical that the regulations reflect a "common sense" and harmonized approach.

While a thoughtful process is required to develop regulations, industry has remarked that in many ways government moves too slowly and businesses are left waiting.

Regulatory Coordination Through Beyond the Border Initiative

Stakeholders remarked that many good steps are being taken by the joint US-Canada "Beyond the Border" Initiative which details a shared vision and actions towards economic competiveness and security. Positive steps taken as part of this initiative:

- Harmonized the requirements for U.S. Customs-Trade Partnership Against Terrorism (C-TPAT) and Canada's Partners in Protection (PIP) and developed a joint enrollment web portal to make the application into both programs faster and easier; members now receive Free And Secure Trade (FAST) benefits to make cross-border trade even faster.
- Published three Border Infrastructure Investment Plans that detail major infrastructure upgrades at land border crossings and identify certain crossings as priorities for future investment.

While the Beyond the Border work notes that it may feed into future U.S. border infrastructure prioritization discussions (e.g. how projects are conceptualized and prioritized for infrastructure investment), this has not yet occurred.

Limited Coordination in Planning Across Jurisdictional Lines

As one stakeholder commented, today each stakeholder "does its own thing". Federal, state/province and municipal governments each plan, design, fund and build projects and establish regulations with limited coordination with other levels or neighboring jurisdictions. There is likewise a lack of coordination with respect to project permitting. Coordination is getting better, but often happens after key decisions have been made and priorities established, resulting in a slow, and often ineffective way forward.

In some areas, collaboration is occurring, but that too can slow the process of decision-making, in particular where consensus-based decisions are desired. In the Region, there is a threat of invasive species (Asian carp) entering the Great Lakes which could potentially destroy the Great Lakes ecosystem. This crisis has been on the Region's radar for over a decade. Determining a solution and taking action cannot wait another decade. One stakeholder noted that the U.S.

Army Corps of Engineers (the lead U.S. agency on this matter) is well-meaning, but their process is too rigid and long to be effective in solving the problem.

The slow progress on the development of the Gordie Howe International Bridge is another case in point. The project first received approval close to a decade ago, but has been mired in legal and funding challenges. A former governor of Michigan consulted for this study noted that there has been widespread ignorance of the need for a second bridge and of the benefits to be gained from more efficient regional integration.

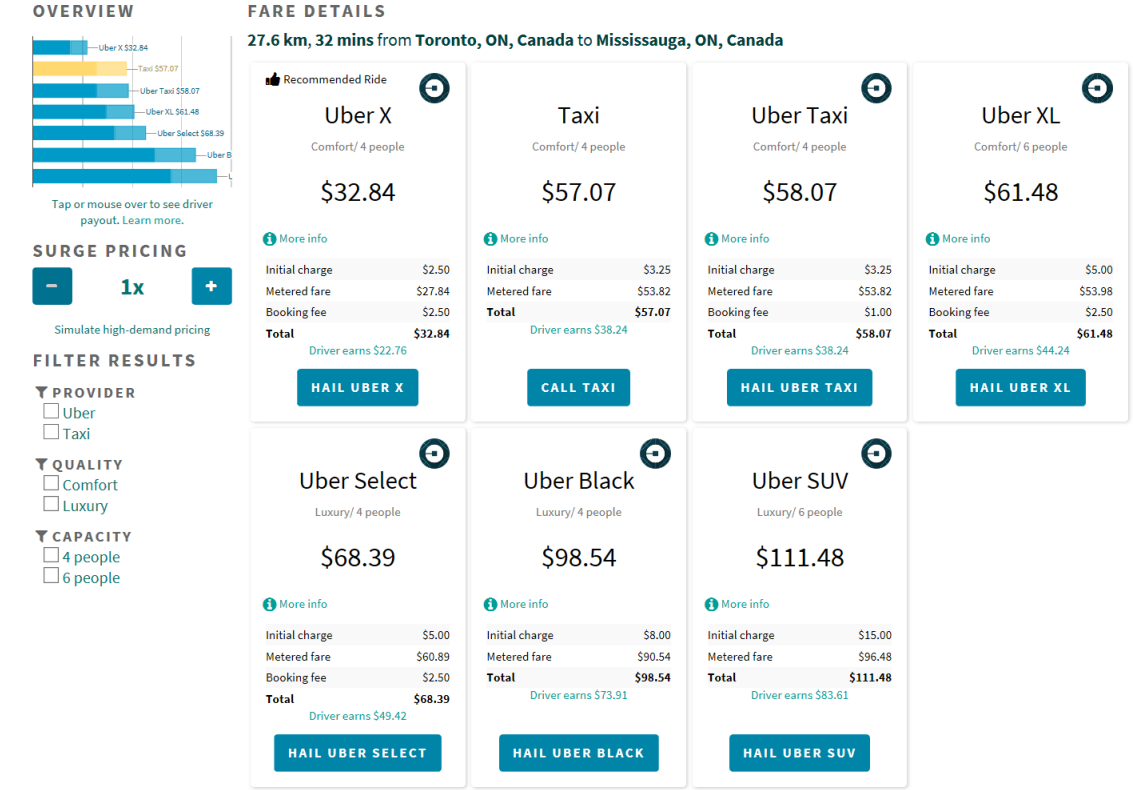
When they met in February 2017, Prime Minister Justin Trudeau and President Donald Trump noted that they "look forward to the expeditious completion of the Gordie Howe International Bridge."

Technology has Reshaped Transportation

Technology has been a game changer in how we move and make transportation decisions. Specific examples include:

- **Real time trip routing, travel time and incident reporting apps.** Gone are the days of paper maps and hoping for a congestion free commute. Apps, such as Google Maps and Waze provide real-time information to drivers on routing, journey times, traffic conditions, and alternative routes among other relevant information. Though particularly beneficial for drivers, these technologies help spread demand over existing roadway capacity, increasing road system productivity. Departments of Transportation, in some cases, are leveraging these technologies as a better and cheaper alternative to instrumenting their roadways.
- **Ridesharing and carpooling.** Ridesharing has become an option for urban and rural areas alike in the Region via services like Uber and Lyft. Options such as UberPOOL, UberBLACK and other variations of the service allow the passenger to request specific vehicle features and pricing parameters based on their preferences. These "sharing economy" models provide more options and related information for passengers. Want to get from Toronto, ON to Mississauga, ON? Pick an option:

Technology enables better visibility on more transportation options
Ride Guru App



Source: Ride Guru

- **Better information about transit.** We now know when the next bus is coming thanks to better transit information platforms. Transit agencies, collecting volumes of data, have been recognizing the value of making this data public. The Chicago Transit Authority, for example, shares its real-time feeds, along with extensive ridership information by station and GIS files on the City of Chicago Open Data Portal, helping others leverage this data to make better decisions about transportation, planning, and real estate development, among other uses.[19]

The implications of these and similar technologies for the Region's transportation system are many. As recently noted by the Canadian Advisory Council on Economic Growth, improved data on transportation services can help passengers make better, more informed decisions about how to get from A to B. Freight interests can make better supply chain decisions. And public agencies – at all levels – can make better, evidence-

A small increase in ridesharing, enabled by new technologies, can help save $9 billion in Toronto alone.

(Source: Unappointed Council on Transportation Infrastructure Investment)

[19] Open Data: Challenges and Opportunities for Transit Agencies A Synthesis of Transit Practice, TRB (2015)

based transportation planning, operations and investment decisions faster, more cheaply, and with greater reliability.

These and other technologies also help make better use of existing transportation infrastructure capacity, increasing infrastructure productivity and reducing the need for costly investments in new capacity.

Technology has also revolutionized many freight sectors. The impacts of e-commerce are well known. A growing number of people in the Great Lakes and St. Lawrence Region now prefer to order products online from e-commerce retailers rather than drive to traditional brick and mortar stores. This is not new, and will likely continue at an increasing pace.

Behind the scenes, some of the largest companies that provide consumer goods, like Amazon, Walmart and others, have found creative ways to use technology more effectively to manage/control their operations in response to consumer demands. They've done this both in terms of streamlining their supply chains, and also to move away from the model of dropping off packages at individual doorstops which has a high cost in terms of physical assets and labor requirements.

Amazon: From E-Commerce Retailer to Logistics Company

Amazon is using supply chain insights gained through years of data collection and analysis on customer trends and preferences to move away from its dependence on traditional carriers, such as UPS and FedEx, to deliver its products – and to bring its entire supply chain in-house. In recent weeks, Amazon has announced that it will establish a dedicated air cargo hub in the Region (greater Cincinnati, OH) and lease up to 40 cargo planes to comprise a dedicated fleet of airplanes to complement its dedicated fleet of 4,000 semi-trailers to meet consumers' e-commerce demands.

With more packages being delivered every day, Amazon is placing itself in control of its entire supply chain, including last-mile delivery. For example, in cities across North America, Amazon has introduced "delivery lockers" that provide safe and convenient self-service package drop-off/pick-up locations. These locations not only are aimed at reducing package theft, but also have the potential to minimize the number of doorstops/truck trips drivers must make.

Electric Vehicles and Alternative Transportation Fuels

Just a decade ago, fully electric cars were measured in the hundreds.[20] Today, there are likely millions (there were 1.25 million in 2015). The electrification of cars, buses and freight delivery vehicles is also underway in the Great Lakes and St. Lawrence Region.

Some have predicted that all new road vehicles – buses, cars, vans, trucks and others – will be entirely electric by 2030. Both the Dutch government and the Norwegian government are

[20] Global Electric Vehicle (EV) Outlook 2016 - Beyond one million electric cars, International Energy Agency (2016)

considering a ban on gas-powered car sales (allowing only electric vehicle sales) beginning by 2025. And, Germany is becoming the first major country to set an official deadline for a ban on gas-powered cars; the mandate will require all new cars registered in the country to be emissions-free by 2030.[21]

Though the Great Lakes and St. Lawrence Region is behind Europe in the deployment of electric cars, the number of electric cars on regional roads and highways is increasing. Some regional governments are also advancing plans to electrify transportation in the Region. The Province of Quebec is among the jurisdictions that is implementing an aggressive plan to expand the electric car network. It has committed to investing over $400 million over five years to install over 800 charging stations and offers a range of incentives to encourage electrification of vehicles. The Province has projected that there will be over 100,000 electric cars on Quebec roads within the next five years. In its broad vision document, Transportation 2030, the Canadian federal government, has similarly indicated an intent to invest in electric car charging.

Other lower emitting transportation fuels are also gaining use and acceptance in the Region. Some truck companies have been converting part of their fleets to liquefied natural gas (LNG). A notable example is Robert Transport along Highway 401 between Montreal and Toronto. Transit buses have also been integrating vehicles than run on lower emitting fuels. One of the key challenges with broader adoption of alternative transportation fuels including LNG and compressed natural gas (CNG) is the lack of adequate fueling (i.e. supply side) infrastructure along the existing transportation network.

Known Unknowns

Among the most significant "known unknowns" that are likely to shape the Great Lakes and St. Lawrence Region's transportation system are future applications of emerging technologies, including, in particular, automated vehicles, climate change, and changing trade patterns and policies.

Continuing Impact of Innovation and Technology on Mobility

In many respects, we have already seen the benefits of new technologies in shaping how people and things move through the Region, and how transportation decisions are informed (known knowns). Yet, much remains unknown about the implications of other emerging technologies. Specific examples include: smart technology, autonomous vehicles, and other disruptive technologies.

Smart Technology

The proliferation of smart technology such as smartphones, wearable devices, as well as the rise of the "Internet of Things"- sensors and actuators embedded in physical objects that are linked through wired and wireless networks – will continue, providing increasing information connectivity. Around 99.4% of objects that will one day be part of the "Internet of Things" are,

[21] *All new cars mandated to be electric in Germany by 2030*, eletrek.co, June 14, 2016

today, unconnected, and 50 billion things are expected to be connected to the Internet by 2020, including 20 percent of all vehicles.[22] The implications of smart technology on transportation in the Great Lakes and St. Lawrence Region in the future remains in many respects unknown. For instance, will our need for mobility be decreased by "virtual" connectedness?

Autonomous Vehicles

Autonomous vehicles are here and will unquestionably become integrated components of transportation systems for both freight and passenger users in the not too distant future. Nearly a dozen companies are currently testing driverless cars, such as Google (Waymo), Tesla, General Motors (Cruise), Ford and others.

Much has already been written on the potential safety benefits of driverless vehicles. For many, this would also allow an option to "drive" alone when otherwise impossible – a promotional video shows how a blind person helped test drive Waymo.[23] Driverless vehicles will also provide better mobility options for those that can't or shouldn't drive – for example, the Region's growing elderly population, or tired, distracted or intoxicated drivers.

Driverless vehicles will also likely revolutionize ridesharing, and perhaps even transit. In cities around the U.S., Uber is testing driverless cars for ridesharing. Uber has recently announced a partnership with Daimler to develop self-driving cars with the mission of reducing traffic accidents, freeing up vast lots currently used to park the world's billion-plus cars, and cutting congestion.[24]

For freight, (semi-)autonomous trucking is being spearheaded by a handful of companies including Volvo, Daimler, Peloton and others, and fully autonomous trucking is on the near-term horizon. This concept, as applied to freight, uses wireless vehicle-to-vehicle technology to enable the driver of a lead truck to control the speed (and braking) of the truck behind. It is expected that truck "platooning" will provide trucking industry benefits in terms of fuel savings (reduced wind resistance).

Governments are responding to the emergence of automated and driverless vehicles, albeit much more slowly than advancements in the technologies themselves. The U.S. National Highway Traffic Safety Administration (NHTSA) has published a proposed rule requiring all new vehicles to have vehicle-to-vehicle (V2V) communication capabilities (to be in effect in 2019). This would enable manufacturers to phase the technology into their fleets over a few years, with all new vehicles being required to talk to each other by 2023.[25]

The Province of Ontario has recently (January 2016) launched a pilot project to test the use of automated vehicles on Ontario's roads.

(Ontario Ministry of Transportation)

[22] Intelligent Connectivity for Seamless Urban Mobility, Arup with Qualcomm (2015)
[23] Waymo, waymo.com
[24] *Uber and Daimler Join Forces on Self-Driving Cars*, Uber, January 31, 2017
[25] Federal Register, Docket number NHTSA-2016-0126

Challenges in terms of regulatory and liability environments as well as broader questions of how infrastructure will need to respond are key outstanding issues which will influence the pace of introduction of automated and driverless vehicles in the Great Lakes and St. Lawrence Region.

Other Disruptive Technologies with Potentially Significant Implications for Transportation

Amazon and UPS are testing delivery drones for light package delivery in select markets. Vespa is testing "robot servants" to follow the "master" with up to 40 pounds of "stuff."[26] Starship Technologies is likewise developing small self-driving robotic package delivery vehicles. These and other means of delivering products are emerging and regularly piloted.

Additive manufacturing (or 3D printing) has also emerged as an alternative to the physical flow of certain products. 3D printing is best used for custom, small batch products, and is increasingly common in specialized applications or as an alternative to maintaining inventories of specialized product components. Today, the aerospace and medical industries are successfully using the technology to produce custom devices (such as knee implants, hearing aids and heart valves) on demand for Just-in-Time delivery, significantly reducing inventory costs. Entrepreneurs are also innovating on MakerBot machines by developing their own prototypes. Companies like UPS are further enabling this by providing these machines at many of their locations.[27] UPS has also co-invested in larger scale 3D printing farms, which at the very least suggests that the logistics industry is aware of the potentially disruptive nature of 3D printing for specialized parts logistics. One stakeholder remarked that they are already seeing supply chains shorten through the introduction of 3D printed products. In some sectors, 3D printing is replacing Just-in-Time with "Real Time" inventory.

It remains unclear if and how these technologies will move the needle on how goods are delivered, or otherwise obtained in the Region, but new approaches are bound to emerge and become more widely adopted if these can demonstrably reduce supply chain costs and costs to end users.

Climate Change

The Earth's average temperature has risen by 1.5°F over the last hundred years, and is projected to rise another 0.5 to 8.6°F over the next century. These small changes in average temperature translate to big changes in weather – more floods, droughts, and more frequent and severe storms and other weather events.[28]

These changes in the environment are likely to become more noticeable in the coming years. The Great Lakes and St. Lawrence Region will almost certainly be impacted, as will its transportation system, though exactly how and to what extent, remains unclear.

Impacts could range from increasingly fluctuating water levels on the Great Lakes (as is already occurring) or changes to the Seaway navigation season, to higher agricultural outputs in the

[26] *This robot will carry your stuff and follow you around*, MIT Technology Review, Feb. 2, 2017
[27] *UPS To Launch On-Demand 3D Printing Manufacturing Network*, UPS.com, May 18, 2016
[28] U.S. Environmental Protection Agency

Region – an important freight sector that depends on both the climate and Lake and Seaway infrastructure to compete in the global marketplace. Transportation networks and supply chains could be reconfigured if, for example, low-lying coastal port zones such as in the Gulf of Mexico become negatively impacted by increasing water levels and storms. Warming waters may spur the growth of toxic algae, as has been occurring in Lake Erie, or leave shores, breakwaters and other marine infrastructure more vulnerable to increased erosion.

In any case, the unknowns associated with climate change will increase risk to infrastructure and necessitate increasing considerations of resiliency in transportation plans, investments and operations so that transportation can adapt to whatever climate change might throw at the Great Lakes and St. Lawrence Region.

GHG emissions from transportation have increased by about 17 percent since 1990, largely due to increased demand for travel and historic inefficiencies of the vehicle fleet.

(U.S. Environmental Protection Agency)

Since transportation in the Region generates approximately one-quarter of all greenhouse gas emissions (GHG) which are understood by many to be a leading cause of climate change,[29] governments in the Region are reacting by promoting lower emitting means of transportation. Quebec's noted vehicle electrification plans, as well as the Province of Ontario's plans to electrify the GO commuter rail service are likely related responses, as are federal plans to "green" transportation, as outlined in Transport Canada's Transportation 2030 vision. On the U.S. side of the border, Michigan, Ohio, and Illinois are among the top states in terms of green-tech patenting, focused on new technologies in battery power, hybrid systems, and fuel cells.[30]

Through a combination of regulations, new technologies and commercial considerations, other transportation services providers, including truck, air, rail and marine carriers in the Region, are also reducing their emissions.

Changing Patterns of Trade

The Great Lakes and St. Lawrence Region has long been an integrated trading region, perhaps most notably exemplified by the Region's highly integrated automotive industry.

But at least three factors are likely to result in changes to regional trading patterns, with resulting implications for transportation:

Evolving Trade Policies

Virtually every stakeholder consulted in the development of this Report – and on both sides of the U.S.-Canada border – raised concerns about evolving trade policies and their implications for the future of trade between the U.S. and Canada in the Great Lakes Region. The anticipated "tweaking" of the North American Free Trade Agreement (NAFTA) and pressure on automotive manufacturers to produce cars for the U.S. market in the U.S. are among the items that could

[29] U.S. Environmental Protection Agency
[30] Larry Gigerich, "What's Driving Today's Location Decisions in the Auto Industry?"

have broad ramifications for trade in the Region. Some have similarly noted concerns about the potential "thickening" of the border.

A recent report by the Canadian Advisory Council on Economic Growth has recommended improving and nurturing deeper trading relationships and private and public sector networks in North America to counter or otherwise mitigate the economic risks associated with evolving regional and global protectionist policies.[31]

Changing Pacific Trade

A significant share of Great Lakes and St. Lawrence Region manufacturing has shifted production to Asia, enabled in particular by the low cost of container transportation, and driven primarily by the low cost of labor in Asia, and in China in particular. This is not new and has been going on for decades. The freight transportation system in the U.S. and Canada has responded by strengthening West-East linkages between coastal ports (particularly on the West Coast) and inland markets, including in the Great Lakes and St. Lawrence Region.

But there are at least three factors that are likely to influence the pattern of trade with Asia. First, steadily increasing wage rates in Eastern China are pushing production westward to lower cost jurisdictions such as Vietnam and Bangladesh. This is resulting in a greater share of Asian trade with North American routing through the Suez Canal to North America's East Coast, rather than over the Pacific to North American West Coast ports. As an inland market, the Great Lakes and St. Lawrence Region has not been particularly challenged in adapting to this shift. Second, with the increasing prominence of automation in manufacturing, the advantage of low-cost labor is for many sectors not what it has been in the past, resulting in a diminished need to shift manufacturing to lower cost jurisdictions such as in Asia. Third, the U.S., under President Trump, has signaled a shift away from trade with Asia, as exemplified recently by its withdrawal from Trans Pacific Partnership negotiations. This could lead to a decrease in U.S. trade flows to the Region from the coasts.

Canada should seek new, preferential trade arrangements with large and fast-growing nations, especially in Asia, and more specifically with China, Japan and India.

Source: Canadian Advisory Council on Economic Growth, Positioning Canada as a Global Trading Hub

In part to respond to evolving U.S. trade policies, Canada may seek to expand and nurture deeper trade links with Asia. This is among the recommendations of the Canadian Advisory Council on Economic Growth. This could lead to increasing east-west trade patterns for the Canadian Great Lakes and St. Lawrence Region.

Impact of Nearshoring and Automation

Some have suggested that "nearshoring," that is, shifting production from Asia to locations closer to home markets will result in a resurgence of manufacturing jobs in the Great Lakes and St. Lawrence Region.

[31] Advisory Council for Economic Growth, Positioning Canada as a Global Trading Hub (February 2017)

Though production may in some cases be shifting back from Asia to North America, this is unlikely to mean that jobs lost to Asian manufacturers will return in their same numbers to the Region. Two factors in particular are worth noting. First, many of the jobs initially lost are coming back in the form of automated manufacturing processes, requiring a fraction of the jobs used to make the same products. This trend will no doubt continue, but the true long-term implication to the Great Lakes and St. Lawrence Region remains somewhat unclear. Second, an important share of production has been "nearshored" to Mexico, rather than back to the Great Lakes and St. Lawrence Region. This is certainly the case in the automotive industry. How this will play out in the context of a renegotiation of NAFTA remains to be seen, though it is likely that this will result in more jobs on the U.S. side of the border in the Great Lakes and St. Lawrence Region over the next few years.

Unknown Unknowns

If history is any indicator, the Region should prepare itself for significant game changers and disruptors. What these may be is anyone's guess. The best forecasters are notorious for getting projections severely wrong. Crystal balling and scenario planning have merit in helping the Region plan for unknown unknowns. But decisions still need to be made.

Below, we define a set of questions for consideration. These are general and not comprehensive, but frame some of the reflections that inform this Strategy.

Questions for an Unknown Future

How will people and freight move in the Region?

- Will ridesharing and automated vehicles mark the end of personal car ownership and what does this mean for public transit use and investment?
- Will "mobility" mean more than the physical transportation of people and things?

How will the Region trade?

- How and with whom will the Region trade, and what will the Region's most important transportation gateways, corridors, and hubs look like?
- Will the Region's borders continue to have practical significance?

How will transportation infrastructure and services in the Region interact with the natural and built-up landscape?

- Will climate change necessitate the relocation of transportation assets and built up areas?
- How will passengers, freight and neighborhoods interact?

How will transportation and mobility in the Region be governed?

- How will we pay for mobility, transportation infrastructure and services?
- How will regional cooperation work across institutions, agencies and stakeholders?

The key is not so much in searching for answers to these questions as much as to consider how to make the Region's transportation system resilient and adaptable to an unknown future.

Key Considerations for a Multimodal Transportation Strategy

Transportation strategies and plans of past have largely been based on linear trends and projections. It is unlikely, given the many noted trends, issues, opportunities and unknowns, that the future will be similarly linear. This necessitates a different approach. The regional Multimodal Transportation Strategy should enable transportation system resilience and adaptability, and provide users with more and better mobility options and connections. To this end, the Strategy should leverage technology, innovation and new data sources. There will be a greater need for collaboration – across jurisdictions, across modes, and across public and private sectors – to move faster, more nimbly and to leverage each's strengths. Lastly, the Strategy should be bold and able to inspire a common vision for the Region's transportation system. But it will also need to be practical, not rely solely on public funding, and provide a clear basis for progress.

In short, the Multimodal Transportation Strategy for the Great Lakes and St. Lawrence Region will need to differ from transportation strategies of the past.

3. A Multimodal Transportation Strategy for the Great Lakes and St. Lawrence Region

The following sets out three broad strategies to help position the Region to move towards and realize the vision for the Region's multimodal transportation system, given the context described in the previous sections.

1. Get more productivity from existing infrastructure

Paying for infrastructure has been a constant and worsening problem as cash-strapped governments at all levels face the absolute limits to deferred maintenance, and the prospect of increasing density and congestion on transportation systems. While key new-build infrastructure projects – such as the planned Gordie Howe International Bridge, or new rail transit lines in increasingly congested cities – are needed, there are smart ways for transportation infrastructure owners in the Region to get more productivity from existing infrastructure, and at a fraction of the cost of new capital projects.

Making better use of existing capacity can deliver more value for fewer dollars, freeing up money for other infrastructure priorities. As an example, a number of airports throughout Southern Ontario are currently working together to assess how existing assets can be better utilized to support the growing needs of that sub-region. Initiatives that enhance productivity and utilization are also arguably easier to implement, given the approvals, permitting, funding and social license issues that often hold up major new-build capital projects.

Regional infrastructure owners can get more productivity from existing infrastructure in at least three ways:

- **Improving infrastructure management**: The Region's potholes and other decaying infrastructure must be repaired. Deferring maintenance improves today's budgets but threatens much larger costs down the road. Regularized asset life-cycle requirements, including maintenance and renewal, can extend the useful life of existing transportation infrastructure and enhance its performance, productivity and safety. Developing a longer-term infrastructure management strategy may in many cases generate greater benefits than the search for higher profile "shovel-ready" projects that can dominate last-minute public agency infrastructure agendas. Some have branded "shovel-ready" a dangerous term when it comes to infrastructure projects,[32] too often tied to getting money out the door quickly, rather than strategically. Private infrastructure owners, such as railroads and owners of vertical infrastructure, provide a good model for infrastructure management and funding – one which prioritizes maintenance of existing assets. A regional, multi-modal planning and investment group could also help guide better performance/future investment. It can also help coordinate asset management improvement efforts and information sharing across the Region.

[32] Public Policy Forum, Building the Future: Strategic Infrastructure for Long Term Growth, October 2016

- **Leveraging technology**: Intelligent Transport Systems (ITS) and other technology enhanced transportation operations, including traffic signals that adapt flexibly to different traffic patterns, variable speed limits that change according to traffic flows, and communication technologies that assist travelers (in all modes) are all examples of current technologies that can enhance the productivity of existing transportation assets. The role out of Primary Inspection Kiosks (PIKs) at Canadian airports, which allow travelers to fill out a Canadian Border Services Agency eDeclaration on their mobile phones, as well as other options such as self-bag drops, are contributing significantly to improving the efficiency of passenger flows. While many of these technologies require investment, others – such as real-time information on traffic conditions as made available by Google, for example – require no public investment at all. More can be done to look at best practices in the Great Lakes and St. Lawrence Region and beyond to explore and to leverage technology to enhance the performance of transportation in the Region.

- **Demand management:** Transportation planners tend to focus on the "supply" of transportation infrastructure and services. Demand management approaches can be as effective but are underutilized in the Great Lakes and St. Lawrence Region. Many transportation system capacity constraints and bottlenecks are limited to specific "peak" periods. Actions that spread demand for infrastructure to minimize peak congestion (e.g. using pricing tools to incent off-peak travel on transit systems or ride sharing on highways), or include operational changes that could improve capacity of existing facilities (e.g. incenting off-peak truck delivery), can deliver significant transportation system performance improvements, at much less the cost of building new capacity. Spreading demand across modes is another opportunity, where some modes are underutilized. Demand management approaches, including the use of pricing tools such as cordon charges, High Occupancy Toll (HOT) lanes, and parking levies, can be politically contentious, but there are many examples of the successful application of these tools around the world. Infrastructure owners in the Great Lakes and St. Lawrence Region should engage in an informed debate about these and other demand management tools, as an alternative or complement to, steel and concrete-based capacity expansion measures.

Three recommendations for getting more productivity from existing infrastructure :

1. Regional infrastructure owners can focus investment on asset preservation and modernization before expansion, and improve asset management practices.
2. Regional jurisdictions and stakeholders (private sector, universities, etc.) should collaborate in identifying productivity enhancing technologies and innovations and share related experiences and lessons on implementation.
3. Regional governments can explore demand management options before making investment in new physical capacity.

2. Enable more options

The multimodal transportation system in the Great Lakes and St. Lawrence Region faces many unknowns, including the potential of technology-driven game changers and disruptors, climate change, evolving trade policies and shifting economic conditions, all of which will influence how people and things move in the Region. At the same time, declining levels of individual auto ownership in many urban centers, and changing patterns of work and personal travel are also creating different transportation needs. New mobility options may also blur the line between public and personal transportation. Just how these and other forces will influence personal mobility and goods movement remains unclear, creating a host of risks for transportation infrastructure owners, policy makers and planners. Enabling more, and better transportation **options** for passenger and freight movement for both providers and users of the systems will help make the Region's transportation resilient and adaptable to an unknown future by allowing markets to select the best transportation options for their needs.

Policy makers and planners can do at least three things to enable more transportation options:

- **Remove barriers to the competitiveness of transportation options**. More can be done to increase the productivity and competitiveness of existing transportation options by addressing costs and inefficiencies that impede their competitiveness. Examples of barriers include inconsistent truck size and weight regulations across jurisdictional lines or inconsistent border operations in the Region. With the rise of new transportation services (such as ride-sharing), new regulatory environments must be shaped that increase options and widen competition and not shift advantages to one mode. In the maritime transportation system, the high cost of pilotage, high (unionized) port terminal handling costs, inconsistent environmental regulations (e.g. ballast water, air emissions) and cabotage regulations restrict competition, are among the factors that drive up the cost of transportation. Some of these issues fall under federal jurisdiction and state, provincial and municipal actors should jointly engage with federal agencies where appropriate – as has started to happen with the work of the Council of Great Lakes Governors and Premier's Maritime Task Force, for example. Furthermore, state, provincial and municipal government heads of government, legislators and business leaders in the Region should also work jointly to identify those barriers they can themselves tackle as a Region.

- **Identify, preserve and protect existing corridors and industrial land and prepare strategic "utilities" corridors for future development.** Regional state and provincial governments should lead a concerted, coordinated effort, together with transportation and other stakeholders, to define the Region's long-term strategic gateways, corridors and transportation hubs. The Council of the Great Lakes Region could help bring these interests together to do this. These strategic corridors and industrial lands could also be better coordinated with other potential needs – electricity transmission, oil and gas pipelines, road and rail needs, among others – to facilitate future development. These corridors and lands should then be designated, appropriately zoned, and protected from encroachment and other conflicting development. The same concepts should apply for existing corridors and transportation and industrial hubs. As municipalities plan for new development, they have the opportunity and the responsibility to support compatible land use. In 2013, the Federation of Canadian Municipalities and the Railway Association of Canada developed proximity guidelines

to ensure adequate setbacks from railways. The implementation and application of these types of guidelines is a good example for utilities, developers, and municipalities to follow. Such initiatives are ambitious, and require the participation of many jurisdictions and stakeholders - but this can facilitate the process of improving future and existing transportation and utility links within the Region, helping secure the Region's economic development potential and protecting corridors vital to the Region's economy. This approach would simplify future transportation system expansion, and reduce the cost, timelines and challenges of single purpose corridor development.

- **Improve regional transportation connections and hubs**. More can be done in the Region to integrate the transportation system – providing more and multimodal transportation options to users. In some cases, this means increasing physical connections, such as the development of intermodal logistics hubs for freight such as CN's proposed Milton Logistics Hub in Ontario or CSX's proposed Crete Intermodal Terminal in Illinois, or mobility hubs for passengers, as is being proposed by the Greater Toronto Airports Authority, with its plans for a Toronto Pearson Regional Transit Centre. In other cases, this means better integrating fare, ticketing, information and communications systems in order to facilitate passenger mobility and service level visibility from one mode, service provider or jurisdiction, to another. Better integration also means improving means for funding projects across jurisdictional boundaries.

Three recommendations for enabling more transportation options :

1. Senior leaders from state, provincial and municipal transportation agencies should work with industry and the federal levels of government to address known barriers to the competitiveness of underutilized regional transportation options, including but not limited to the maritime mode in the Great Lakes and St. Lawrence River.
2. Regional government and industry leaders should collaborate in identifying long-term strategic transportation/ utility corridors and industrial lands in the Great Lakes and St. Lawrence Region and develop a plan to preserve and protect these for future development.
3. Identify strategic multimodal hub locations in the Region, favoring hubs where multiple modes can converge and develop, and define a process to preserve and expand these in the longer term.

3. Embrace and incent technology and innovation

New and emerging technologies such as automated and driverless vehicles, evolving operating practices such as sharing economy models (e.g. ride sharing), as well as innovations in information management (such as real-time traffic information systems) can help get more capacity and productivity out of existing infrastructure, increase safety, and provide users with better options.

The old model of infrastructure (build as strong as possible to accommodate future increased use and minimize maintenance requirements) is no longer acceptable. Both vehicles and 21st-century infrastructure will be "smart", increasingly integrating physical and digital elements. The new world of "Manufacturing 4.0" and "Internet of Things" will have enormous impact on infrastructure. Technology and innovation present a tremendous opportunity for the Region's transportation system and economy. Regional stakeholders can do four things enable and realize the full potential of technology and innovation for the Region's multimodal transportation system:

- **Make the most of private sector innovation**. Ride-sharing and capacity sharing apps (e.g. Uber), real-time trip routing information (Google Maps), the introduction of emissions-reducing clean technology, wayside detection systems on railways for enhance safety and reliability, and e-commerce delivery docks (e.g. Amazon) are among the private sector innovations that are improving transportation in the Region and beyond. These and other private sector innovations are the result of significant research, investment, trial and error. Many fail; yet, the cost of these investments, and the cost of failure, is borne in large part by the private sector. Public agencies in the Great Lakes and St. Lawrence Region should do more to encourage and leverage this kind of innovation by removing regulatory barriers to innovation, and incenting innovation, where appropriate. They should also look to private sector solutions – where these exist – before trying to develop bespoke solutions to problems the private sector has already solved. Transit fare ticketing system integration technologies are an example, as exemplified by the problematic and costly roll out of the customized Presto fare card in Ontario.

- **Support and learn from smart cities**. Computer vision, cloud storage and augmented reality are among the technology areas that are helping make cities "smarter". These and other technologies also create new streams of data that can be harnessed to improve transportation operations, make better decisions faster, and improve visibility of transportation infrastructure and services. Central to smart city technology infrastructure is connecting technology across sensors and devices, systems and processes (which have, in the past, been silos). Smart initial investment in these technologies can save billions of dollars through efficiency, safety and environmental improvements. Columbus, OH, a winner of the U.S. Smart City challenge, is a good example of cities pioneering many new technologies and approaches. A similar Smart Cities Challenge in Canada, announced in the recent federal budget, provides further opportunities to advance smart cities planning and investment.

- **Pave the *digital* way for automated vehicles**. Automated and driverless vehicle technology is advancing rapidly. The question is now not *if* driverless vehicles are coming but rather *when* and *how*. "Smart" vehicles have the potential to significantly increase the capacity and safety of the Region's road network by increasing the utilization of space on roads (vehicles operating in closer proximity, without stop and go traffic partners) and reducing the risk of human error causing accidents. Autonomous trucks will shift more easily to 24/7 operations, increasing the efficiency of truck transportation and mitigating the truck driver shortage issue that plagued the truck industry in the Region and beyond in the U.S. and Canada. But the roll out of driverless vehicles will necessitate smart infrastructure – able to assess changing situations and communicate in real-time with users. New infrastructure will not be passive – roads, bridges, rails, wires will all be in constant communication with users and with other modes. As home to the heart of North America's automotive sector, the Great Lakes and St. Lawrence Region should be a leader in enabling the roll-out driverless vehicles and the 21st-century infrastructures on which these vehicles will travel.

- **Harmonize IT regulations and standards.** In an increasingly interconnected 21st-century infrastructure world, infrastructure must be built to compatible standards to support seamless movement and continuous communication with transportation service providers and users. There are historic parallels with the adoption by railroads of the same track width in the 1860s

or standard red-green road traffic signals in the 1920s. Twenty-first-century infrastructure owners and users must likewise work to develop consistent, or at least interoperable, standards and related regulations. Consistent standards for "geo-fences", signage, road markings, and vehicle certifications, as well as network and data standards are among the many issues that will require coordination across jurisdictions. So will regulations for driverless trucks or truck platoons that have significant potential to lower freight transportation costs. Transport industry manufacturers must also ensure that vehicles use interoperable communication systems. In an on-coming era when infrastructure cycle time will be shorter – because of need to upgrade software elements – prior collaboration among governments, agencies and builders on planning is required.

Three recommendations for realizing the benefits of technology and innovation :

1. Pilot a bi-national, multi-jurisdictional "smart" corridor, with focus on compatible standards and testing for the gradual introduction of driverless vehicles in the Region.
2. State/provincial and municipal levels of government should look to develop smart regulations that don't unduly represent a barrier to the introduction of transportation technologies and innovations. This should be coordinated with federal levels of government.
3. Regional municipalities should develop a formal mechanism to share learnings about the introduction of smart city infrastructure, technologies and approaches.

Strategy implementation: a roadmap for the Council of the Great Lakes Region

The goal of this Multimodal Transportation Strategy is not to produce a product, be it another report or conference. Rather, it is to initiate an on-going process that will facilitate greater collaboration, a deeper understanding of regional transportation issues and priorities, and build constituencies that can jointly address the Region's transportation issues and opportunities.

The Council of the Great Lakes Region (CGLR) should take a leadership role in advancing this process, and help convene a forum for dialogue around the themes and recommendations outlined herein, toward the realization of the vision for the Region's multimodal transportation system.

To do this, the CGLR should take the following specific actions:

- **Initiate a smart corridor pilot initiative:** The Great Lakes and St. Lawrence Region has an opportunity to lead the next big, bold and visionary transportation strategy – perhaps as precedential as the development of the U.S. interstate highways system. Specifically, regional stakeholders can pioneer the creation of bi-national, multi-jurisdictional standards for a digital interstate/provincial highway system. This will take significant coordination across jurisdictions. Such a grand vision should start with a practical first set of steps, as did the interstate highways system with an initial corridor (what is now Interstate 44). Starting with a single, bi-national regional corridor (for example, Quebec City to Detroit along Autoroute 20 and Highway 401, and onward through Chicago on U.S. Interstate 94 and beyond) could be a practical way to start. CGLR should help initiate this pilot by coordinating a process with jurisdictions along this pilot corridor and automotive manufacturers in the Region to engage in a discussion about establishing common "smart infrastructure" standards and vehicle regulations for driverless vehicles along this corridor. Recently announced plans for a Ford Motor Co.-led, government-backed research and development center for driverless technologies in Ottawa, along with other research work and institutions focused on driverless vehicles (e.g. American Centre for Mobility in suburban Willow Run, Michigan) may provide a unique opportunity to leverage and coordinate with ongoing regional research initiatives to build traction for this pilot program.
- **Create an active, on-going Regional transportation infrastructure planning and investment forum:** Such a forum could build on and/or be an extension to CGLR's Great Lakes Infrastructure Exchange and focus on building and maintaining momentum with respect to the strategies and recommendations outlined in this report. Among other things, CGLR should use this forum to convene discussions that could help overcome fragmentation among transportation modes and government agencies, between public and private sectors, and among large numbers of civil society organizations. It can help raise and maintain visibility on specific barriers to the competitiveness of transportation options in the Region – such as pilotage and port labor costs and conditions, which impede the competitiveness of the maritime mode in the Great Lakes. It can likewise raise the profile of the maritime mode at the state and provincial level. It can also help promote measures to institutionalize planning across silos – instead of occasional or emergency structures that collapse when an immediate

need is over. This same forum should, working with Regional consistencies, seek to advance many of the specific recommendations contained in this Report, including but not limited to opportunities to get more productivity from existing infrastructure, identifying key trade corridors that necessitate protection for future development, and advancing specific infrastructure projects that could have a Regional impact – such as border infrastructure.

- **Seek to build intellectual infrastructure as foundation for change:** More can be done to increase academic and research capacity related to multimodal transportation systems in the Region. Beyond the Cross Border Institute and the University of Windsor, the McMaster Institute for Transportation and Logistics, the Department of Supply Chain Management at Michigan State University and a small number of other institutions focused on specific areas of transportation, there are few institutes or programs that look broadly at long-term economic, strategic and policy considerations relating to multimodal transportation systems in the Region. CGLR should help encourage relevant stakeholders to build this capacity. It should also encourage more in-depth and continuing collaboration among universities, research centers and corporate research departments – across the range of research areas (from maritime transportation, to driverless vehicle technology, to urban transit financing, etc.). Building such academic and research capacity can not only better position universities in the Region to better inform Regional decision makers on transportation needs, opportunities and solutions for the 21st century, but can also build and help sustain regional leadership and related constituencies for change.

Moving forward:

This Report presents a vision for the Region's multimodal transportation system, and a path towards this vision. Moving forward with this Multimodal Transportation Strategy for the Great Lakes and St. Lawrence Region will take time, dialogue, and coordination among public and private stakeholders. Equally important will be a sense of shared responsibility for achieving this vision.

To this end, this Report provides a starting point for Regional discussions and collaboration that can build the foundation for an increasingly connected transportation system that is adaptive and resilient to change and uncertainty, and that positions the Region for social and economic prosperity for decades to come.