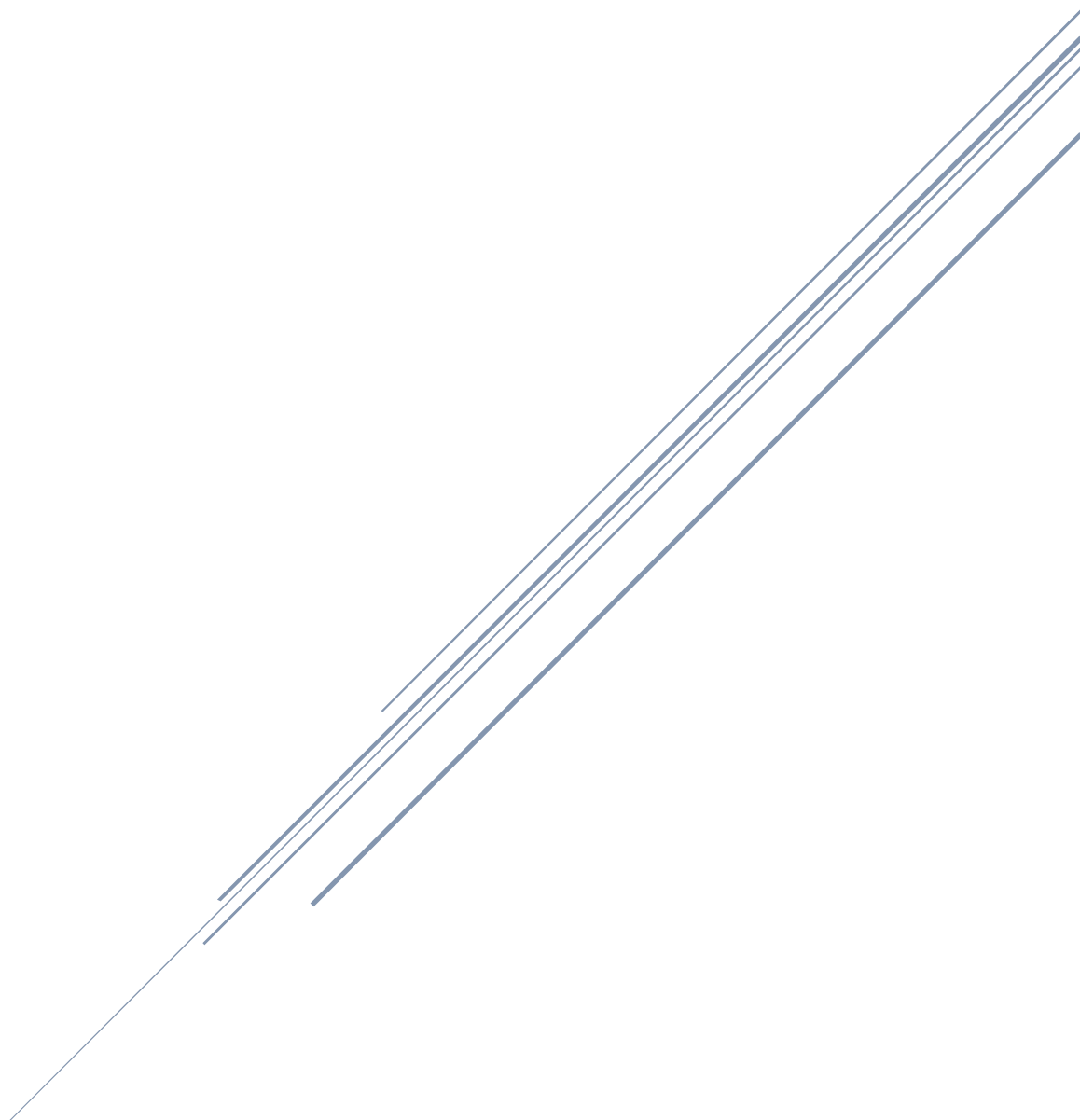


# A Vision of Niagara Region in 2041

## Discussion Paper



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# A Niagara Region Crystal Ball

## The External Influences and Trends

This discussion paper is intended to provoke discussion among Niagara's economic development stakeholders about future external influences and trends and how these will impact and shape Niagara region's economic evolution of over the coming two decades.

**Living in a World of Accelerating Change:** All around us, technological change is occurring at dramatically accelerating rates that have commonly become exponential rather than linear. Change does not just involve the application of technology but is driven as well by new business models and influenced by global mega-trends. The speed of the transformation has reached a point where, some say, it may defy the ability of humans to adapt quickly enough to keep up. Others wonder the extent to which governments have the capacity to take sufficiently timely policy and regulatory decisions.

The tempo of change is dramatically illustrated by how quickly technology that debuted a decade ago has transformed people's lives and disrupted and radically altered the business landscape. Just over ten years ago, in 2007:

- The Apple iPhone was unveiled;
- Google launched Android;
- Twitter was spun off as a separate platform;
- Facebook had just been opened to people outside of colleges and high schools;
- Airbnb was conceived; and
- IBM began building a cognitive computer called Watson.<sup>1</sup>

In June 2018, Apple, Alphabet, Microsoft, Amazon, and Facebook, ranked as the five most valuable companies by market capitalization – a very different line up than a decade previous.<sup>2</sup>

## Niagara Region's Neighbourhood – Benefiting from Being Part of Something Bigger

Niagara region's future must be considered in the context of the opportunities and influences that its surrounding geography presents and how Niagara can capitalize on its location. In economic development, collaboration is growing and the "home" fields are becoming larger.

**Niagara as Part of the Greater Golden Horseshoe Mega-Region:** Niagara region benefits from being part of a major North American economic mega-region, the Greater Golden Horseshoe (GGH). Anchored by the city of Toronto, this population concentration of 9.4 million people<sup>3</sup> extends into Niagara region. It ranks fifth among major US and Canadian metropolitan regions,<sup>4</sup> contains over one-

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<sup>1</sup> Thomas Friedman, "Thank You for Being Late: An Optimist's Guide to Thriving in the Age of Accelerations," November 2015.

<sup>2</sup> Corporate Information, Wright Investment Service (<https://www.corporateinformation.com/Top-100.aspx?topcase=b>), on June 20, 2018, largest companies by market cap.

<sup>3</sup> Canadian Census 2016.

<sup>4</sup> Based on a comparison with US "Combined Statistical Areas" in 2015 US Census. New York-Newark NY-NJ-CT-PA, Los Angeles-Long Beach CA, Chicago-Naperville IL-IN-WI, and Washington-Baltimore-Arlington DC-MD-VA-WV-PA are the four ahead, while San Jose-San Francisco-Oakland CA, Boston-Worcester-Providence MA-RI-NH-CT, Dallas-Fort Worth TX-OK and Philadelphia-Reading-Camden PA-NJ-DE-MD follow.

quarter of Canada's population, and attracts one in three new immigrants to Canada. As one of North America's fastest growing regions, the GGH population is forecast to reach 13.5 million by 2041.<sup>5</sup>

Such population growth presents Niagara with both challenges and opportunities. Niagara region's agricultural assets, coupled with its geographic proximity to the GGH's urban core, positions it ideally for Niagara producers to supply the GGH's daily food and beverage needs on a timely basis. For residents of the GGH, Niagara also offers an attractive change of pace, growing cultural and recreational options, and a quality of life, all readily accessible from the metropolitan core. Over time, facilitated by frequent two-way GO Transit rail and bus links, Niagara also can become an appealing location for enterprising lifestyle entrepreneurs who can choose their base of operations provided they have access to high-speed broadband networks. Over time, the area will be an increasingly attractive location for additional higher skill operational nodes for the financial and health care-related sectors, for example, to take advantage of talent graduating from post-secondary programs at Brock University and Niagara College. Among the faster-growing communities in the US and Canada in recent years have been university and college-centred cities on the perimeter of major metropolitan areas.

**Niagara as a US-Canada Cross-Border Connector:** Niagara peninsula is a vital bridge for the Canada-US relationship and the connector between the Greater Golden Horseshoe and Buffalo, Rochester, Syracuse and Albany in New York State. One hundred billion dollars in Canada-USA trade flows across Niagara's four border crossings every year.<sup>6</sup> To facilitate international business, Niagara region was the first area in Ontario designated as a Foreign Trade Zone Point by the Federal government.

Though preferential NAFTA-style access to the US market remains an important consideration, Niagara region can position itself as a preferred North American site to enable firms to take fullest possible advantage of Canada's recent commitments to trade and economic pacts with the European Union and Pacific rim partners.

A Cross-Border Innovation and Prosperity Initiative, led by Brock University's Niagara Community Observatory and the University of Buffalo School of Architecture and Planning, continues to explore how assets on each side of the border could be meaningfully and strategically levered to strengthen innovation, prosperity and collective well-being. A binational Hamilton-Niagara-Buffalo health sciences corridor, facilitating access to two different health care systems and regulatory regimes, seeks to capitalize on Niagara's investment in state-of-the-art hospitals; the talent and research offered by Brock, Niagara College, and McMaster; and Buffalo's long-standing health sciences cluster and research and early-stage incubation facilities and funding resources.

In tourism, Niagara's unequalled international recognition is another common cross-border asset and opportunity, but one where a sense of competition may sometimes inhibit consideration of mutually-beneficial collaboration, including in the development and exploitation of new technologies applicable to the sector.

**Growing Regional Collaboration in Economic Development:** In economic development, there has been a marked increase in collaboration among likeminded but otherwise competing jurisdictions –

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<sup>5</sup> Ontario Ministry of Municipal Affairs (<http://www.mah.gov.on.ca/AssetFactory.aspx?did=10852>). Accessed on June 21, 2018.

<sup>6</sup> Niagara Trade Zone, "Your Launch Pad to Export Success," April 2018 ([https://niagaracanada.com/wp-content/uploads/sites/2/2018/05/NFTZ\\_Explanatory\\_Powerpoint\\_ENGLISH\\_FINAL\\_APRIL2018.pdf](https://niagaracanada.com/wp-content/uploads/sites/2/2018/05/NFTZ_Explanatory_Powerpoint_ENGLISH_FINAL_APRIL2018.pdf)). Accessed on June 15, 2018.

something that has been labelled as “co-opetition” or “competi-mating.” The geographic footprint for collaborative ventures has been steadily expanding – as seen in the recent awards of Canadian government funding for five Superclusters. Niagara College is a member of the advanced manufacturing supercluster, Next Generation Manufacturing Canada. Amazon’s recent public Request for Proposals (RFP) for a second headquarters location stimulated many regionally based responses, including Niagara region’s collaboration with Western New York state partners.

Within Niagara region, there has been a continuing focus on building Team Niagara involving the 13 Niagara economic development programs. Spurred by the opportunities presented by the 2015 PanAm Games, Niagara region and Hamilton established Invest Hamilton Niagara. Niagara Economic Development is also a member of several collaborative Ontario-wide investment attraction arrangements that benefit from Federal and Ontario financial support. The Ontario Manufacturing Communities Alliance (OMCA), and the Ontario Food Cluster (OFC) are examples. This Niagara Region Economic Development Master Plan initiative involves Niagara College and Brock University in recognition of their critical economic development role.

## Global Mega-Trends

Major global mega-trends are guide posts for those looking to the future. Lasting long-term impacts are inevitable. The main focus will often centre on how we manage the change. Frequently, these shifts require responses involving complex global systems. The status quo is not an option.

- 1. Rapid Technology Change – Disrupt or Be Disrupted:** What were linear rates of change have shifted to be exponential. All manner of businesses are being upended or radically changed by digital and technology-based disruptions. In the face of such change, governments have recognized that according a high policy priority to innovation is a national competitive imperative.

The convergence of digitally-based technologies has been a game changer that blurs traditional product sector boundaries, as technologies cut across and transform many products and services. Major thematic public policy initiatives – such as climate change – are also linked to commercial innovation across multiple sectors.

Just as multiple technologies converge to create ever more powerful and innovative impacts, an increasing number of novel business models will be built by companies that integrate various new platform technologies, often in highly customer-focused approaches that provide previously unavailable end-to-end experiences.<sup>7</sup>

Gartner, a US research and advisory firm, annually identifies a Hype Cycle of Emerging Technologies, those that show the most potential for delivering a competitive advantage over the next five to ten years. For 2017, the three dominant trends included “Artificial Intelligence (AI) Everywhere,” “Transparently Immersive Experiences,” and “Digital Platforms.” Prominent examples of AI enabled technologies are autonomous vehicles and machine learning. “Transparently Immersive Experiences” encompass augmented reality, virtual reality, 4-D printing,<sup>8</sup> connected homes and

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<sup>7</sup> McKinsey and Company, “Competing in a World of Sectors without Borders,” July 2017 (<https://www.mckinsey.com/business-functions/mckinsey-analytics/our-insights/competing-in-a-world-of-sectors-without-borders>). Accessed on June 19, 2018.

<sup>8</sup> 4-D Printing incorporates “shape memory” polymer fibers into composite materials so that a 3-D printer can be used to manufacture a 3-D object that, when later heated or cooled to a specific temperature, will transform into a different 3-D shape.

digital workspaces. According to Gartner, key platform enabling technologies are 5G, Blockchain, IoT Platforms, Quantum Computing, Neuromorphic Hardware, Digital Twin, Edge Computing, and Software-Defined Security.<sup>9</sup>

Digitization and Digital Technologies		
Artificial Intelligence (AI) Blockchain Manufacturing 4.0 Automotive Morphs to Mobility Precision Agriculture	The Internet of Things (IoT) Big Data Imaging Virtual & Augmented Reality Sensing Cybersecurity	3-D Printing Robotics High-Speed Broadband 5G Networks Quantum Computing
Advanced Technologies		
Gene Sequencing Nanotechnology	Biotechnology Neurotechnology	Geo-engineering Energy Storage

- 2. The Nature of Work:** Ontario has one of the world’s most educated populations. The Province leads all OECD jurisdictions in the proportion of the population that has achieved post-secondary completion. Niagara region exceeds the Ontario average for college completion, though it is below the provincial average in the numbers who have attained a university degree.

Technological change is however reverberating ominously in today’s workplace. Given the skills shifts associated with rapid technology advances, widespread concern has arisen over the potentially disruptive impact on the workforce, both in terms of threatened elimination of jobs and the rise of non-standard jobs (the gig economy).

Recent OECD studies on the potential impact of automation, which were released in March 2018, refined earlier predictions of the jobs that could be susceptible to automation. The adjusted estimates indicate that 14 percent of jobs in OECD countries are “highly automatable.” This is defined as having more than a 70 percent probability of automation. In addition, another 32 percent could face “significant change in how they are carried out.” The definition for “significant change” is having a risk of automation between 50 and 70 percent. For Canada, the estimates are close to these OECD averages. About 14 percent of jobs in Canada are “highly automatable,” while some 28 percent face a risk of “significant change,” that is a significant share of tasks, but not all, could be automated, thereby changing the skill requirements for these jobs.<sup>10</sup>

Retail is an example of an area of business facing major dislocation because the business model is shifting. The rapid growth in e-commerce is cutting into sales at traditional brick-and-mortar retail outlets, leading to downsizings, closures, and the repurposing shopping malls. The revamped new retail centre models adopt a mixed-use approach, incorporating residential, offices, shared work spaces, additional entertainment offerings, and other varied uses. Customer service call centres are another category under threat. Speech recognition technologies and automated intelligent enquiry

<sup>9</sup> Gartner, “Top Trends in the Gartner Hype Cycle for Emerging Technologies, 2017,” August 15, 2017 (<https://www.gartner.com/smarterwithgartner/top-trends-in-the-gartner-hype-cycle-for-emerging-technologies-2017/>). Accessed on April 21, 2018.

<sup>10</sup> Nedelkoska, Ljubica, and Glenda Quintini, Organization for Economic Cooperation and Development. “Automation, Skills Use and Training,” Working Papers #202, March 2018 (<https://www.oecd-ilibrary.org/docserver/2e2f4eea-en.pdf?expires=1531768312&id=id&accname=guest&checksum=5B9F4B3DEF03EF637E9811D651A78C8C>). Accessed on July 16, 2018.

response systems have advanced to the point where it is difficult to distinguish between human and automated responses.

Whatever the mathematics of these types of analyses may be, there is definitely a more pervasive sense of economic and job insecurity in the wake of the financial crisis and in the face of future market prospects. Since the 2008-2009 downturn, fewer Canadians self-identify as middle class (and more as lower class). A sense of middle class decline poses a threat to economic, societal and political stability.<sup>11</sup> The rapidity of workforce change and the associated risks to employment have invited wider international discussion of guaranteed annual income support programs.

**What Education and Training are Required for the Jobs of the Future?** As the nature of future jobs can be increasingly difficult to foresee, a number of studies stress the need to focus on skills which will facilitate the progression of workers into new occupations. These skills involve higher cognitive functions, such as creativity, critical thinking, people management, communication and teamwork. In addition, digital literacy and digital problem solving skills will be in demand across all occupations and industries.<sup>12</sup> The responses to these shifts obviously need to engage and benefit from the insights of the players at all levels in the education system.

With the rapid pace of change, lifelong learning becomes an imperative. Available data indicates, however, that spending on workplace training in Ontario declined 37 percent in constant dollars from 1993 to 2015.<sup>13</sup> The adequacy of government funding levels that support retraining in Ontario appears in need of re-examination, as do the alignment of programs with the new realities.

**Growing Income Disparities:** A current preoccupation in advanced economies centres on the fact that middle class workforce compensation has stagnated and does not appear to be keeping pace with overall growth of the economies (and the wealth being accumulated by the world's richest people). This is among the prominent areas of dissatisfaction that has been propelling political change. A measure of this disparity is the link over time between per capita GDP and median income. In Ontario, a growing divergence between per capita GDP and median adjusted income started in the early 1990s and has generally widened since.<sup>14</sup> With lower levels of unemployment in developed economies, some upward pressure on wages appears to be emerging recently. It is uncertain whether this is a trend that will sustain itself.

- 3. Global Demographic Shifts:** The global population is forecast to rise to a 8.6 billion in 2030 and 9.8 billion in 2050, with Africa leading the way.<sup>15</sup>

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<sup>11</sup> Organization for Economic Cooperation and Development, "The Squeezed Middle Class in OECD and Emerging Countries: Myth and Reality," Issues Paper, December 1, 2016 (<https://www.oecd.org/inclusive-growth/about/centre-for-opportunity-and-equality/Issues-note-Middle-Class-squeeze.pdf>). Accessed on May 2, 2018.

<sup>12</sup> Institute for Competitiveness & Prosperity, "The Labour Market Shift: Training a Highly Skilled and Resilient Workforce in Ontario," Working Paper 29, September 2017 (<https://www.competeprosper.ca/work/working-papers/labour-market-shift-training-highly-skilled-and-resilient-workforce-ontario>). Accessed on May 14, 2018.

<sup>13</sup> Institute for Competitiveness & Prosperity, "The Labour Market Shift: Training a Highly Skilled and Resilient Workforce in Ontario," Working Paper 29, September 2017 (<https://www.competeprosper.ca/work/working-papers/labour-market-shift-training-highly-skilled-and-resilient-workforce-ontario>). Accessed on May 14, 2018.

<sup>14</sup> Ontario Ministry of Finance, "Ontario's Long-Term Report on the Economy," 2017 (<https://www.fin.gov.on.ca/en/economy/ltr/>). Accessed on May 8, 2018.

<sup>15</sup> United Nations, "World Population Prospects – Volume II: Demographic Profiles – 2017 Revision," ([https://esa.un.org/unpd/wpp/Publications/Files/WPP2017\\_Volume-II-Demographic-Profiles.pdf](https://esa.un.org/unpd/wpp/Publications/Files/WPP2017_Volume-II-Demographic-Profiles.pdf)). Accessed on June 16, 2018.

The aging of society affects multiple areas and has wide spread impact. According to the United Nations, population aging is poised to become one of the most significant social transformations of the 21<sup>st</sup> century, with implications for financial and labour markets and the demand for goods and services. In Canada in 2017, 23 percent of the population was sixty years and over. By 2050, the proportion will rise to 32.4 percent. This will be less than Europe (34.2 percent) but higher than the US (27.9 percent).<sup>16</sup> Though living longer and drawing a greater share of social services, more seniors will look to be engaged and want to contribute to society. Niagara region has an older population profile than Canada and Ontario,<sup>17</sup> a situation that has invited Brock and Niagara College to focus on aging.

In the developing and emerging economies, a global success story has been the marked – though still incomplete – progress on reducing global poverty. Nearly 1.1 billion people moved out of extreme poverty (less than \$US 1.90 per day) between 1990 and 2013, even as the world’s population grew by 1.9 billion. The 767 million still in poverty in 2013 represent an even bigger challenge.

One of the most economically relevant trends has been the growth of the global middle class, especially in Asia. Standing at 3.2 billion people in 2016, the middle class is expected to become a majority of the global population for the first time ever around 2020. Slower growth will occur in developed countries (one-half to one percent annually). Higher rates of 6 percent or more will be the norm for emerging countries. As a result, eight out of nine people in the million members of middle class who will be added globally between 2016 and 2022 will be Asian. Households entering the middle class will seek to purchase consumer durables, as well as services including tourism, entertainment, health, education and transport.<sup>18</sup> The economic potential is dramatically illustrated by the growth in travel from Asian and Latin American countries to Ontario in 2017. Arrivals from China were up 7 percent over 2016, from South Korea by 25 percent, India 32 percent, Mexico 64 percent, and Brazil 24 percent.

Of concern in terms of global instability is the continuing progression of the world-wide refugee crisis and the humanitarian and political challenges that accompany it. In 2017 for the fifth straight year, there were record number of displaced people – 68.5 million in total – in places such as the Democratic Republic of the Congo, South Sudan, the mid-east and north Africa, and Myanmar.

Without immigration, Ontario’s talent pool will no longer grow. The entry of Canadian-born talent into the workforce is now plateauing, adding to the importance of immigration to grow employable talent. The diversity that results is viewed as a competitive advantage.

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<sup>16</sup> United Nations, “World Population Aging,” 2015

([http://www.un.org/en/development/desa/population/publications/pdf/ageing/WPA2015\\_Report.pdf](http://www.un.org/en/development/desa/population/publications/pdf/ageing/WPA2015_Report.pdf)). Accessed on June 20, 2018.

<sup>17</sup> In 2016, Niagara region’s median age was 45.7 years versus 41.3 years in Ontario and 41.2 years in Canada. In Niagara region, 21.4% of the population was 65 years and over compared to 16.7% in Ontario and 16.9% in Canada.

<sup>18</sup> Kharas, Homi, Brookings Institute, “The Unprecedented Expansion of the Global Middle Class: An Update,” Global Economy & Development Working Paper 100, February 2017 ([https://www.brookings.edu/wp-content/uploads/2017/02/global\\_20170228\\_global-middle-class.pdf](https://www.brookings.edu/wp-content/uploads/2017/02/global_20170228_global-middle-class.pdf)). Accessed on June 19, 2018.



**Ontario Population Growth:** The Ontario government's projection for provincial population growth foresees slowing from current average annual increases of 1.3 percent to 0.8 percent by 2040. A notable shift will occur in age distribution, with the cohort from 15 to 64 years dropping from nearly 68 percent to just under 60 percent, while the proportion of those 65 years and over swells from 16 to 25 percent (Exhibit 1).

In a continuation of the longer-term trend to urbanization, the rates of population growth will be greatest in cities, with the Greater Toronto Area (GTA) having the highest in Ontario (42 percent), followed by the remainder of the Golden Horseshoe just beyond the GTA (24 percent).

<b>Exhibit 1</b> <b>Demographic Projections for Ontario to 2040</b> <b>Ontario Ministry of Finance</b>		
<b>DEMOGRAPHICS</b>	<b>2016</b>	<b>2040</b>
Ontario's Population	13,983,000	17,802,000
Average Annual Population Growth	1.3%	0.8%
Age Distribution (Share)		
0-14 Years	15.9%	15.0%
15-64 Years	67.8%	59.8%
65+ Years	16.4%	25.2%
Ancillary Observations: <ul style="list-style-type: none"> <li>• More people now turn 65 than young people turn 15. Therefore, future growth of people in the working age group (15-65 years) will come exclusively from net migration to Ontario (domestic and international).</li> <li>• In 2016, 110,011 international immigrants came to Ontario, of which 41.0% were economic immigrants, the lowest proportion among provinces and territories (Immigration, Refugees and Citizenship Canada).</li> </ul>		
Source: Ontario's Long-Term Report on the Economy, 2017, Ontario Ministry of Finance		

4. **Globalization:** A wave of nativism, nationalism and protectionism presents important challenges to aspects of globalization. Nonetheless, even if national borders regain greater importance as a result of more inward-looking economic and immigration policies, the hyper-connectivity that facilitates international exchanges has been embedded by digital technologies, while global supply chains have become ubiquitous. The service and intellectual property quotient in international commerce (rather than just goods) is also becoming more dominant and is less susceptible to border measures, except for the movement of the people who possess or deliver the knowledge and the skills. Within Canada, the provinces are closer to eliminating long-standing internal trade barriers. As a wine, cider, beer and spirits producer, Niagara will benefit if collaborative national arrangements can be forged.
5. **Climate Change and Energy:** Though controversial and influenced by political outcomes, the direction of government and corporate climate change and environmental policies is moving inevitably – even if unevenly – toward greater sustainability, alternative energy sources, CO<sub>2</sub> and pollution reduction, zero emission outcomes, water quality initiatives, and energy efficient buildings. The competitiveness of alternative energy sources will be greatly heightened when lower-cost high-capacity energy storage technology becomes available.

Environmental risks have gained prominence in recent years, and are identified in the World Economic Forum's 2018 "Global Risks Report"<sup>19</sup> as an area of special concern for the future. Extreme weather events, natural disasters and the failure of climate-change mitigation and adaption rank as the top three global environmental risks in terms of impact. The likelihood of biodiversity

<sup>19</sup> World Economic Forum, "The Global Risks Report 2018 – 13<sup>th</sup> Edition," January 17, 2018 (<https://www.weforum.org/reports/the-global-risks-report-2018>). Accessed on June 4, 2018.

loss and ecosystem collapse and man-made environmental disasters also ranked highly, in the World Economic Forum's estimation.

Fresh water remains a limited and therefore especially valued resource. As climate change leads to higher temperatures in water challenged areas and as demand grows, Niagara is fortunate to be in a temperate climatic zone in the Great Lakes region. Assured access to fresh water represents a vital competitive advantage.

Niagara's iconic Falls, abundant protected natural terrain, and conservation areas predispose many to hope that Niagara is a guardian of its natural heritage. An assumed reputation for sustainability can be part of the calculus in the choice of Niagara as a location to visit or live. Longstanding Ontario government planning policies that govern development, such as the Greenbelt, the Escarpment and conservation areas, have set a framework that supports retention of lands for agriculture and agriculture-related and recreational uses and favours environmentally sensitive development.

Climate change will impact Niagara's agriculture. Warmer temperatures will expand the range of varieties – for example, of grapes – that can be cultivated in Niagara, though in other parts of the world – such as California's wine regions – hotter weather may be damaging. As is pointed out however, by experts such as Dr. Tony Shaw, a Fellow at Brock's Cool Climate Oenology and Viticulture Institute, climate change also brings greater risks of volatility in the weather, involving greater extremes, including more serious frosts in the winter that can adversely affect vines.

If it chooses, Niagara region is afforded the opportunity to demonstrate, through concerted action, world-class leadership that can ensure and enhance a balanced reputation and commitment to sustainability in ways which will deliver longer-term benefit and return from its natural assets, while protecting them.

Advanced technologies can play a role. Areas for attention are Great Lakes water quality and transportation including for pleasure cruising; how to limit environmental impact in what is a heavily travelled Canada-US land transportation corridor; developing environmentally-sensitive active and shared transportation models for people; and greenhouse management efficiencies to sustain long-term competitiveness. Clean technology innovation presents abundant business opportunities for which there are supportive funding programs. Brock and Niagara College are active research partners in developing answers.

## Economic Trends

Global economic growth has been on a lower trajectory since the Great Recession in 2008-2009, explained in part by weak productivity growth and an aging population. Though more modest and variable, growth has nonetheless been sustained for the decade since the downturn. Along with a somewhat stronger recent growth outlook in 2018 and 2019, the S&P stock index continues its second longest bull run. Concerns are emerging, however, as to how long the run of GDP growth will continue. Many economists believe that rising US government deficits, the significant stimulus of the 2018 US tax cuts, and an already low US unemployment rate invite the return of inflation. This is among the factors

that heighten the risk of a major economic correction by the early 2020s.<sup>20</sup> The US and global outlook is also threatened and complicated by protectionist and nationalist tendencies and economic policy uncertainties. The US Administration's "America First" policies have affected cross-border flows of goods, while influencing some companies to invest in the US.

The Niagara economy grew at 2.1 percent in 2015 and 1.7 percent in 2016, levels just below Ontario averages.<sup>21</sup> For 2018, the Conference Board of Canada forecast for the Niagara CMA is 1.4 percent, the lower end of the range of 1.4 to 2.4 percent for Southern Ontario cities.<sup>22</sup> Positive recent signs have emerged. In February 2018, the Niagara CMA registered its lowest unemployment rate in 18 years (5.2 percent), while investment in commercial and industrial building construction in 2017 reached decade high levels.

Looking ahead over the coming two decades, the Ontario Ministry of Finance forecasts that average annual economic growth rates to 2040 will be just over 2 percent, or a half percentage lower than the average from 1982 to 2015 (Exhibit 2). Labour force growth and labour participation rates will also be lower, as the population ages. For people 65 and over, an increase in the number remaining in the workforce is already discernible, a trend that is likely to grow further.

<b>Exhibit 2</b> <b>Economic and Labour Force Projections for Ontario to 2040</b> <b>Ontario Ministry of Finance</b>		
<b>Metric</b>	<b>Actual (Annual Average) 1982-2015</b>	<b>Projection (Annual Average) 2016-2040</b>
Real Gross Domestic Product (GDP)	2.6%	2.1%
Exports	3.4%	2.2%
Imports	4.0%	2.1%
Housing Starts	66,000	71,300
Primary Household Income	5.0%	3.9%
Labour Market		
Participation Rate	67.3%	63.2%
Labour Force Growth	1.4%	0.8%
Employment Growth	1.4%	0.9%
Unemployment Rate	7.7%	5.8%
Labour Productivity	1.2%	2.2%
Source: Ontario's Long-Term Report on the Economy, 2017, Ontario Ministry of Finance		

**Global Foreign Direct Investment:** International greenfield foreign direct investment (FDI)<sup>23</sup> flows – though significant in absolute terms – have yet to recover to peaks prior to the 2008-2009 recession.

<sup>20</sup> Dodge, David, Richard Dion, Serge Dupont, John Weekes, and Michael Horgan, Bennett Jones, "Economic Outlook." Spring 2018 (<https://www.bennettjones.com/Spring2018EconomicOutlook>). Accessed on June 12, 2018.

<sup>21</sup> Conference Board of Canada.

<sup>22</sup> Conference Board of Canada, Media Release, "Economic Slowdown on the Horizon for Southern Ontario Cities," March 13, 2018 (<https://www.newswire.ca/news-releases/economic-slowdown-on-the-horizon-for-southern-ontario-cities-676649683.html>). Accessed on May 8, 2018.

<sup>23</sup> "Greenfield" investment projects involve investment at entirely new locations or involve an expansion of an existing investment. Greenfield investment does not include mergers and acquisitions (M&A).

Since the global downturn, annual levels of FDI flows have been uneven and well below the annual levels registered prior to the global downturn.<sup>24</sup>

The United States has traditionally been the largest source of foreign direct investment (FDI). China's outward FDI has increased significantly in recent years. In 2017 however, China adopted more cautious policies on investment abroad and slipped to third place in FDI outflows behind Japan, but ahead of the United Kingdom, Hong Kong, Germany and Canada.<sup>25</sup> In the first FDI wave, the Chinese concentrated on foreign acquisitions, especially those that secure needed basic agricultural commodities and resources. Prior to the 2018 US-China trade confrontation, Chinese investment in North American manufacturing and in the technology sector emerged as a growing segment, with an increasing number of greenfield investments.

Looking ahead, major influences in 2018 will be repatriation of profits held abroad by US-based multinationals and US tax reform which will encourage investment and expansion in the US. The nearer-term FDI outlook is clouded by international policy uncertainty and protectionist tendencies that will adversely affect FDI location decisions.

**Foreign Direct Investment in Canada:** Since the Great Recession in 2008-2009, the stock of foreign direct investment (FDI) in Canada showed steady growth from 2011 to 2015. Increases in 2016 and 2017 were modest however, with the flow of direct investment in 2017 at \$33.8 billion being the lowest since 2010, well behind the record of \$126.1 billion in 2007.<sup>26</sup>

The total stock of FDI in Canada at the end of 2017 was \$824.0 billion. By country, the US stock of FDI in Canada has declined by a few percentage points over recent years but still hovers around 50 percent of the total. European FDI has been up marginally, with its stock representing just over one-third of the total. The larger, growing European sources over the last decade are The Netherlands, Switzerland and Germany. Asia represents about 10 percent.

In the Canadian manufacturing sector, the stock of FDI in 2017 was slightly less than 2008 in absolute terms, falling as a proportion of all FDI in Canada from nearly one-third to just over one-fifth. Food manufacturing fared well, however, nearly doubling since 2008, with the greatest gains being registered prior to 2015. Significant sectors that showed growth over the 2008 to 2017 span were mining and oil and gas extraction which grew strongly to 2014 but has declined since; finance and insurance; wholesale and retail trade and transportation and warehousing; and the management of companies and enterprises.<sup>27</sup>

Ontario attracted 114 foreign greenfield projects in 2017, down 18 percent over 2016, but still ranked fourth among provinces and states after California, New York and Texas. These projects involved investment of \$6.9 billion.<sup>28</sup>

Though reliable statistics are not available, strategic expansions in Ontario by existing foreign investors appear to have been the most notable and reliable source of increased FDI in southern Ontario in recent

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<sup>24</sup> United Nations Conference on Trade and Development (UNCTAD), "World Investment Report 2018," June 7, 2018.

<sup>25</sup> United Nations Conference on Trade and Development (UNCTAD), "World Investment Report 2018," June 7, 2018.

<sup>26</sup> Statistics Canada, The Daily, March 1, 2018 and April 25, 2018.

<sup>27</sup> Statistics Canada, International Investment Position, Foreign Direct Investment in Canada by NAICS, Table 36-10-0009-01.

<sup>28</sup> fDi Intelligence, "The fDi Report 2018: Global Greenfield Investment Trends," 2018.

years, especially in manufacturing. Foreign investors who are already established in Ontario know their own milieus well and possess relationships, including with post-secondary institutions. This allows them to move quickly and confidently to scale-up existing operations, including being well positioned to hire highly qualified people and to take advantage of tax rates, incentives and arrangements that support innovation. This underlines the importance of business retention and expansion activities in economic development.

Niagara region has many foreign-affiliated investors, including General Motors, Rich Products, Convergys, Airbus Helicopters, THK, Rexroth Bosch Group, and Jungbunzlauer. Recently, Niagara has attracted important new domestic and foreign investment – the GE Brilliant Factory and Northern Gold being examples.

## Challenges to Realizing Ontario's and Niagara's Longer-Term Potential

**What CEOs and Futurists Say About Ontario's Potential:** In 2017, Ontario's Institute for Competitiveness and Prosperity interviewed selected CEOs of companies headquartered or operating in Ontario and conferred with "futurists," who advise such companies on strategy relative to disruptive technologies and new business opportunities.<sup>29</sup> The objective was to identify where Ontario can "win" over the next 10 to 20 years and what businesses, government and post-secondary educational institutions need to do to realize Ontario's future potential.

The key points that emerged from the sessions with the CEOs and futurists were:

1. Talent is Ontario's greatest strength;
2. Ontario "stands tall" on research, though it lacks the capacity to commercialize this research;
3. The biggest thing holding Ontario back is a cautious attitude to risk; and
4. Attracting global talent, visitors and international capital is hard and, above all, requires a compelling "Why Canada?" value proposition.

The Institute's report issued a challenge:

"... Ontario must change. The elements of competitiveness that gave the province its advantages in the past can no longer sustain or ensure the future. Instead, concerted efforts must be made toward innovating, investing in technologies, and making big, bold moves across clusters."

**"Big Ideas:"** Leaders offered five "Big Ideas" for Ontario to reach its potential based on its existing strengths, primarily around talent and innovation. These proposals crystalize points often made about where Ontario (and Canada) must do better.

1. Embrace disruption and see technologies and consumer trends as once-in-a-lifetime opportunities to grab new markets and secure new customers through the world;

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<sup>29</sup> Institute for Competitiveness & Prosperity, "The Future Is Not Destiny: CEO Perspectives on Realizing Ontario's Potential," Working Paper 30, September 2017 (<https://www.competeprosper.ca/work/working-papers/the-future-is-not-destiny-ceo-perspectives-on-realizing-ontarios-potential>). Accessed on June 5, 2018.

2. Market Canada and Ontario to the world by defining our competitive differentiators and then by creating a simple and compelling narrative around them to be broadcast to the world – to investors, visitors, and domestic and international talent;
3. Adopt lifelong education and work-integrated learning to keep Ontarians on the cutting edge of 21<sup>st</sup> century skills in the digital age;
4. Take risks and be leaders, rather than followers, in order to capture the full value of technology and innovation; and
5. Woo the world’s best talent to Canada, especially high-achieving students, experienced STEM talent, and executives with track records, especially in scaling-up companies.

Like the Institute’s recent assessment, expert commentaries and reports have identified the critical areas where Canada and Ontario have been underperforming other competitor countries – for which the US is often the benchmark – and need to do better. The lists commonly include:

1. Productivity, where Canada has fallen further behind the US with Canadian business under-investing in machinery, equipment, information technology and systems, and intellectual property;
2. Competitiveness, principally involving higher electricity costs, personal taxes, and, in light of the recent US tax cuts, corporate tax levels;
3. Infrastructure maintenance and investment, notably the transportation infrastructure needed to mitigate costly congestion, especially in the Greater Golden Horseshoe;
4. Innovation, a telling indicator being Canada’s declining R&D intensity;<sup>30</sup> and
5. Lower than desirable levels of post-graduate study and retention, and private sector investment in skills training.

## Sectors of Opportunity

**National Priorities:** Based on the proposals of the Federal government’s Advisory Council on Economic Growth, the Canadian government has established private-sector led Economic Strategy tables to recommend a focused and comprehensive approach to “clear the path” to make Canada a global leader in six high-potential sectors:

- |                          |                       |                           |
|--------------------------|-----------------------|---------------------------|
| • Agri Food              | • Health/Bio-Sciences | • Digital Industries      |
| • Advanced Manufacturing | • Clean Technology    | • Resources of the Future |

The Advisory Council chose the agri-food sector to illustrate the type of ambitious, targeted coordinated approach that should be envisaged in order to move Canada up in the rankings, for example compared to The Netherlands and Brazil.<sup>31</sup>

<sup>30</sup> Council of Canadian Academies, Expert Panel on the State of Science and Technology and Industrial Research and Development in Canada, “Competing in a Global Innovation Economy: The Current State of R&D in Canada,” 2018

<sup>31</sup> Advisory Council on Economic Growth, “Unleashing the Growth Potential of Key Sectors,” February 6, 2017 (<https://www.budget.gc.ca/aceg-ccce/pdf/key-sectors-secteurs-cles-eng.pdf>). Also see information on the Economic Strategy Tables at <https://www.ic.gc.ca/eic/site/098.nsf/eng/home>. Accessed on June 14, 2018.

**Niagara Priorities:** At the regional level, Niagara's region-wide strengths and opportunities, according to Niagara Economic Development, lie in:

- Agri-Business
- Manufacturing
- Transportation and Logistics
- Tourism

These were chosen taking into account the priorities of the 12 Team Niagara municipal partners.<sup>32</sup>

**The Outlook for Agri-Business in Niagara:** Ontario's Greenbelt policies, together with those applicable to the Niagara Escarpment and conservation areas, ensure preservation of Niagara's highly productive agricultural lands, including specialized and intensive land-use for higher value crops such as grapes, tree fruits, berries, and greenhouses. Niagara is an agricultural powerhouse. The gross farm receipts from Niagara region's 1,827 farms totaled \$838 million in 2015 representing 43 percent of all farm receipts in the entire Golden Horseshoe. With the legalization of recreational use, cannabis production is becoming a fast growing part of the mix and a highly significant economic development opportunity, not just for cannabis flower production but for value added products such as oils and edibles which are claiming growing market shares in legalized recreational markets. Still uncertain is the extent of its impact on the greenhouse and other segments and whether (as some forecast) over production in a few years is a potentially disruptive risk.

Agricultural producers in Niagara face major competitive challenges including increased minimum wages, availability of talent, a degree of uncertainty or demanding processes regarding seasonal immigrant workers, and competition from increasingly efficient lower wage jurisdictions able to capitalize on logistics advances. The major steps forward in controlled greenhouse environments and precision agriculture, involving the application of a host of technologies, provides a suite of potential responses. Autonomous vehicles are already planting, spraying and harvesting crops. Greenhouses can be managed remotely. Integrated systems incorporate satellite data, GPS, weather data and forecasts, drone and aerial imaging, and variable application of nutrients. Greenhouses benefit from LED lighting, climate controlled environments, and computer controlled irrigation and nutrient systems. Cannabis growers are setting an even more ambitious technological pace, adopting state-of-the-art systems, including high security. Canada has a first mover advantage to supply cannabis to newly opened export markets for medical use. An emerging leading edge concept is intensive vertical indoor farming within and on the edges of major urban concentrations, providing at least daily delivery of fresh and flavourful leafy greens and herbs produced in operations that employ robots, sensors, and controlled environments. Niagara, though part of the trend, is only beginning to exploit this growth opportunity in spite of its experience with advanced greenhouse technologies and favourable access for the production to the GTA market.

Adding value to Niagara agriculture produce through more direct-to-market retail channels locally and processing operations in Niagara afford additional opportunities to get higher returns for Niagara producers. Wine and craft beverage start-ups face complex and overlapping regulatory regimes. A pilot project in Peterborough developed an expedited and integrated all-levels-of-government approach to

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<sup>32</sup> A Summary Chart on Municipal Economic Development has been prepared by GIAG based on a review of municipal websites including landing pages directly related to economic development, standalone economic development pages and Economic Development Strategies, Municipal Strategic Plans and Annual Reports. The review examines structure, areas of focus, sectors covered and any issues identified. At the time of preparation, stakeholder interviews had not been conducted with the municipalities. Planned interviews with appropriate stakeholders will provide more accurate and detailed information for updating this report as part of regional context.



overcoming the complexities of overlapping regulation. This could be replicated in Niagara to make Niagara a favoured location to launch of new craft beverage ventures.<sup>33</sup>

Niagara region's two post-secondary educational institutions and the Vineland Research and Innovation Centre (VRIC), plus neighbouring institutions such as the University of Guelph, afford immense competitive advantage through their research, prototyping, trial and training programs, which have a Niagara-specific relevance.

**The Future of Manufacturing in Niagara:** Though Niagara's manufacturing sector represents a much smaller portion of the total workforce than in the past, Niagara has deep and resilient manufacturing traditions on which to build, as Industry 4.0 – the fourth industrial revolution – transforms manufacturing globally. Niagara region, moreover, attracted one of the world's leading proponents and developers of Industry 4.0 systems, General Electric, which created a new state-of-the-art Welland plant adopting its Brilliant Factory systems, now to be operated under the ownership of Advent International. Airbus Helicopters Canada provides an important aerospace and advanced composites presence.

Looking to the needs of Niagara's agri-businesses, manufacturing opportunities are available to service the requirements of producers and processors – including cannabis growers – for highly advanced technology and supportive software systems. The Netherlands stands as an example of technological leadership in agri-tech. By purposely creating and adopting the latest advances, the country ranks as the world's secondary largest global exporter of food after the United States, despite its small land area. The Niagara manufacturing sector can capitalize on support from Niagara College, the Vineland Research and Innovation Centre, and Brock University. Niagara locations are well positioned to be innovative North American production and software systems development bases for Canada and the US, taking advantage of European – especially Dutch partnerships – that can take advantage of personal heritage and of Canada's Comprehensive Economic and Trade Agreement (CETA) with the European Union.

The automotive sector – still an identifiable component of Niagara region's manufacturing base – is in transition globally towards becoming the mobility sector in which business models, powertrains and autonomous vehicles are redefining whose technology, integration, and revenue streams win. This invites an evaluation of future vulnerabilities and exploration of what it will take for Niagara to retain the presence of firms such as GM and THK and sustain a meaningful stake over the longer term.

**Tourism and Niagara:** Niagara owns one of the world's most recognizable and enduring tourism brands with a legacy that dates well before many of today's best branded destinations were conceived. Challenges to realizing its still greater potential lie in growing and enriching the experience and creating the desire on the part of visitors to return; making Niagara the recreational, wine and culinary, and arts, festival and culture get away; and generating revenue-enhancing overnight stays. The Falls remains an anchor but the region's offerings have immense potential to further broaden visitor options and the experience. Tourism has been transformed by the shared economy, smart phones, social media, and mapping and GPS. Technology promises important further advances, especially augmented and virtual reality, multiple language speech recognition technologies, and intelligent processing of voice enquiries. These systems could be a focus for aggressive development in Niagara region, possibly through cross-border partnerships, as a demonstration of the region's tourism leadership.

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<sup>33</sup> Association of Municipalities Ontario, "Reducing Business Burdens: Great Ideas from Five Innovative Ontario Municipalities," May 31, 2017 (<https://www.amo.on.ca/AMO-PDFs/Reports/2017/ReducingBusinessBurdensGreatIdeasfromFiveInnovativ.aspx>). Accessed on June 13, 2018.



Niagara region has had success in attracting major international, national and provincial sports events, though structures to support sports tourism bids are needed. The region also has the potential to expand business meeting and incentive travel attraction.

**Niagara's Transportation and Logistics Sector:** Niagara sees opportunities in supporting the movement of goods and people by leveraging its central Canada-US border location that places it within a one-day trip of half of the Canada-US population. As well, Niagara is intersected by the Great Lakes Seaway system and two class one railways, and has access to seven nearby airports. Niagara region's designation as a Foreign Trade Zone Point seeks to mitigate processes that impose barriers and costs. The Niagara corridor is of strategic national commercial importance, meriting Federal government involvement and investment. As Niagara looks ahead, it needs to determine how – whether through increased physical capacity or technology adoption – it can ensure that congestion and border processes will not impede the corridor's smooth functioning and growth. Transportation and logistics will continue to experience fundamental business model and technology transformations – driven by the use of autonomous trucks, on demand buses, driverless shuttles, and Uber and Lyft type ride hailing services.

Exhibit 3 Prominent Emerging Technology Platforms and Their Potential Impact		
	Outlook	Considerations for Niagara Region
<b>Industry 4.0</b>	Industry 4.0, also referred to as the fourth industrial revolution, is the name attached interconnected automation and digitization that brings together multiple advanced technologies to transform manufacturing. It encompasses cyber-physical systems, such as the Internet of Things, Big Data, robotics, 3-D software and printing, and cognitive computing (AI).	<ul style="list-style-type: none"> <li>• Niagara region can call upon its strong manufacturing tradition and today's innovative programs at Niagara College and Brock as it taps into the new Industry 4.0 paradigm</li> <li>• GE's new Welland facility is adopting the company's advanced Brilliant Factory Industry 4.0 platform systems</li> <li>• Other global Industry 4.0 leaders include Bosch and Siemens</li> </ul>
<b>Artificial Intelligence (AI)</b>	AI – based on neural networks and machine learning, ideas dating to the 1940s – has emerged in the last five years to be one of the technology industry's brightest hopes. Applications currently rely on supervised learning where computers are told what to do in millions of cases. An area of focus is also on using AI to augment human capabilities. Artificial General Intelligence (AGI) systems that are near human intelligence are judged likely to take longer, maybe decades. <sup>34</sup> Canada is a recognized leader with Montreal, Toronto and Edmonton having emerged as the Canadian hubs.	<ul style="list-style-type: none"> <li>• AI is a major and rapidly moving area of advances that will have wide-spread impact, including creation of autonomous systems</li> <li>• Multilingual speech recognition technologies and enquiry response systems can enhance tourism offerings, but may replace some call centre operations, of which there are some significant ones in Niagara region. AI is critical to Mobility applications and will grow rapidly in health care diagnosis. AI can also take the massive amounts of tourism-related data that can be captured to determine patterns and preferences and to predict future opportunities.<sup>35</sup></li> </ul>

<sup>34</sup> Bloomberg Businessweek, "Apple and Its Rivals Bet Their Futures on These Men's Dreams," May 17, 2018 (<https://www.bloomberg.com/news/features/2018-05-17/apple-and-its-rivals-bet-their-futures-on-these-men-s-dreams>). Quoting Yann LeCun, University of Toronto. Accessed on June 4, 2018.

<sup>35</sup> Ie, "Technology: Disruptive Innovation in the Tourism Industry," October 17, 2017 (<https://www.ie.edu/corporate-relations/insights/technology-disruptive-innovation-in-the-tourism-industry/>). Accessed on June 18, 2018.

Exhibit 3 (Continued)		
Prominent Emerging Technology Platforms and Their Potential Impact		
	Outlook	Considerations for Niagara Region
<b>Internet of Things (IoT)</b>	The Internet of Things is a typically wireless network of physical devices, including machines, vehicles and appliances, embedded with electronics, sensors, actuators and connectivity which enables them to connect and exchange data, creating greater digital integration. IoT is widely applicable, including in the home, manufacturing, agriculture, health care, transportation, and within municipalities. The number of IoT devices (8.4 billion) surpassed the global population in 2017 and is forecast to reach 20.4 billion in 2020. <sup>36</sup>	<ul style="list-style-type: none"> <li>• Bell, Huawei and BeWhere are undertaking a pilot IoT project in Niagara, using Bell's advanced cellular network, with Henry of Pelham that uses sensors to remotely monitor temperature and water levels and prevent vine disease.</li> <li>• IoT is at the centre of smart city initiatives, connecting and engaging with tourists, and Industry 4.0.</li> </ul>
<b>Broadband Optical Fibre</b>	High-speed broadband is an essential part of basic infrastructure, like water, sewage, electricity, and phone connections. The Canadian Radio-television and Telecommunications Commission (CRTC) declared broadband internet a basic telecommunications service in December 2016. Generally, Niagara has good access, in part because major cross-border high-speed optical fibre is routed through the Niagara peninsula. Demand for greater capacity and speed continues to grow. Nielsen's Law of Internet Bandwidth, for example, states that a high-speed user's connection speed grows by 50% a year. This rate of growth is only slightly less than the 60% a year postulated by Moore's Law which addresses computing speed. <sup>37</sup>	<ul style="list-style-type: none"> <li>• To apply the latest technology and utilize advanced software systems, high-speed broadband is essential to businesses and agricultural enterprises</li> <li>• Providing tourists with wireless access to online information and social media tools, requires broadband and WiFi access</li> </ul>
<b>5G Networks</b>	The Ontario, Quebec and Canadian governments announced a \$400 million partnership (ENCQOR – Evolution of Networked Services through a Corridor in Quebec and Ontario for Research and Innovation) in March 2018 with five private sector partners to create a Montreal to Waterloo corridor of 5G test beds which will become operational by early 2019. 5G networks will be critical to autonomous vehicles and IoT applications.	<ul style="list-style-type: none"> <li>• 5G network access will become a basic requirement for autonomous vehicles and for many IoT networks, all important to Niagara</li> </ul>

<sup>36</sup> Gartner, "Gartner says 8.4 billion connected things will be in use in 2017," 7 February 2017 ([www.gartner.com/newsroom/id/3598917](http://www.gartner.com/newsroom/id/3598917)). Accessed on June 4, 2018.

<sup>37</sup> Nielsen Norman Group, "Nielsen's Law of Internet Bandwidth," (<https://www.nngroup.com/articles/law-of-bandwidth/>). Accessed on May 10, 2018.

Exhibit 3 (Continued)		
Prominent Emerging Technology Platforms and Their Potential Impact		
	Outlook	Considerations for Niagara Region
<b>Cyber Security</b>	Today's increasingly digitized and digitalized systems bring inevitable risks of hacking and data and identity theft. Cyber breaches recorded by businesses have almost doubled in five years, from 68 per business in 2012 to 130 per business in 2017. <sup>38</sup>	<ul style="list-style-type: none"> <li>A high level of security is vitally important for the cannabis sector, the integrity of systems in business and the public sector, and for personal data protection.</li> </ul>
<b>Precision Agriculture</b>	Driven by the cost and constraints on the availability of labour, precision agriculture researchers and companies have developed systems incorporating drones and autonomous vehicles using satellites and GPS to plant and fertilize; robotic harvesters with vision sensors and software to scan plants; picking platforms; controlled environments with LED lighting and computer controlled irrigation and nutrient systems; water jet lettuce harvesting methods; and robotic apple picking machines. <sup>39</sup>	<ul style="list-style-type: none"> <li>The competitiveness of Niagara region agriculture is dependent on aggressive development and adoption of advanced technologies and software systems, supported by research, development, testing, prototyping and talent development at Niagara's post-secondary institutions and VRIC. Of note is the NSERC Chair in Precision Agriculture and Environmental Technologies at Niagara College. Innovation may be spurred by creating locations where ag-tech clusters can grow.</li> </ul>
<b>Mobility, including Autonomous Vehicles</b>	By 2030, internal combustion engines (ICE) will still represent a significant portion of the market in North America, but battery electric vehicles (BEV) will near cost competitiveness with major reductions in battery cost. Level 4 robotaxis, shuttles and commercial vehicles will be adopted worldwide, along with deployment of Level 4 vehicles for personal use. There will be full availability of vehicle to vehicle (V2V) infrastructure with continuing expansion of vehicle to infrastructure capability. 26.2% of global distances travelled will be shared, with vehicle sharing models largely adopted in urban areas. Adhesives will be the primary joining material. Manufacturing will see possible integration of all industrial machinery, collaborative robots, inventory and logistics systems talking to each other, not only in a plant but across the company and suppliers, with high utilization of renewable energy. <sup>40</sup>	<ul style="list-style-type: none"> <li>Trends in the mobility sector will be critical to the longer-term future of GM's St. Catharines Propulsion plant which produces V6 and V8 engines and transmissions, and to companies in its supply chain.</li> <li>Technology holds out the promise of increasing the vehicle capacity on highways, potentially offering options other than just constructing more high capacity highways.</li> </ul>

<sup>38</sup> Accenture, "Cost of Cyber Crime Study," 2017 (<https://www.accenture.com/ca-en/insight-cost-of-cybercrime-2017>). Accessed on June 4, 2018.

<sup>39</sup> CNBC, Jeff Daniels, "Agriculture Robotics May Ease Farm Labour Crunch," March 8, 2018 (<https://www.cnbc.com/2018/03/08/wave-of-agriculture-robotics-holds-potential-to-ease-farm-labor-crunch.html>). Accessed on June 4, 2018.

<sup>40</sup> Center for Automotive Research, Ann Arbor, Michigan, "Technology Roadmap Analysis – Current Year to Beyond 2030," February 28, 2017 (Prepared for Innovation, Science and Economic Development Canada)

Exhibit 3 (Continued)		
Prominent Emerging Technology Platforms and Their Potential Impact		
	Outlook	Considerations for Niagara Region
<b>Augmented and Virtual Reality</b>	Virtual reality is a computer-generated recreation of real life environments and situations that immerse the user by making them feel like they are part of the environment. Augmented reality layers computer-generated enhancements atop an existing realty recreation. Augmented reality will find early applications in health care and energy.	<ul style="list-style-type: none"> <li>• Brock's Cool Climate Oenology &amp; Viticulture Institute (CCOVI) is establishing a first-of-its-kind Mediated Reality Wine Lab for researchers to study how factors within an environment affect customers' consumer choices regarding wines.</li> <li>• Augmented reality will be a valuable tool specific skills and situational training.</li> <li>• Augmented and Virtual Reality can enhance tourists' experiences though storytelling and by providing views and access to locations and situations not otherwise readily available</li> </ul>
<b>Blockchain</b>	Blockchain is an open, distributed ledger that can record transaction between two parties in a verifiable and permanent way. By design, a blockchain is resistant to modifications of the data.	<ul style="list-style-type: none"> <li>• Blockchain is being widely applied to transportation and supply chains and associated contracts and financial transactions, an apparent natural fit for Niagara</li> </ul>