REGIONAL LONG-RANGE GROWTH & TRANSPORTATION SCENARIOS

FINAL TECHNICAL REPORT

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SUBMITTED TO METRO VANCOUVER & TRANSLINK
AUTHORED BY WSP

AUTHORS

WSP

Blair Underhill	Transportation Planner
Kitty Chiu	Transportation Planner
Adrian Lightstone	Principal Consultant

REVIEWERS

TRANSLINK

Tony Vi	Senior Planner
Andrew Devlin	Manager, Policy Development

METRO VANCOUVER

Sean Tynan	Planner
James Stiver	Manager, Growth Management and Transportation

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1 INTRODUCTION

1.1 ABOUT THIS PROJECT

This project has been carried out through a collaborative effort between TransLink and Metro Vancouver. It expands on a longstanding partnership between the two organizations in planning for the future of the region. Metro Vancouver, working with its member jurisdictions, prepares regular population, housing, and employment projections to guide regional and local growth management planning across sectors, including transportation. TransLink, planning for mobility in the region, relies on these projections as inputs for its regional transportation modelling analysis and the basis for informing decisions around plans for the future, including policies, programs, and infrastructure projects.

Both TransLink and Metro Vancouver are undergoing respective long-range planning processes. TransLink is in the process of updating the Regional Transportation Strategy (RTS), a 30-year long range strategy that will outline a transportation and mobility vision for the region and identify priority transportation actions, investments and policies. At the same time, Metro Vancouver is undergoing a process of updating its long-range growth projections to inform broader questions around growth in the region. In recognition of the value in better integration across land use and transportation planning, the TransLink Board, Mayors' Council on Regional Transportation, and Metro Vancouver Regional District Board collectively endorsed the development of joint land-use transportation scenarios between TransLink and Metro Vancouver to provide a common starting point for long-range planning in the region.

The joint long-range growth and transportation scenarios are intended to contribute to several objectives, including:

- Inform a conversation on the long-term vision, goals, and values for the Metro Vancouver Region
- Provide guidance to both agencies on how external forces and trends might be considered for future planning
- Support both agencies in establishing assumptions for their models and projections for the future
- Serve as a tool for examining the resiliency of existing and proposed policies, programs, and infrastructure projects against uncertainties stemming from disruptive trends or other drivers of change

1.2 SCENARIO PLANNING FOR LONG RANGE PLANNING

Scenario planning is an approach to planning for the future that takes into account the varying ways in which the future could deviate from what is expected to occur based on the assumptions of today. Rather than planning towards a singular point forecast of the future, or a set of related futures with modest variations, scenario planning encourages the consideration of a range of plausible futures that are largely different from expectations and one another. This approach helps to broaden the scope of considerations used to inform strategies for the future.

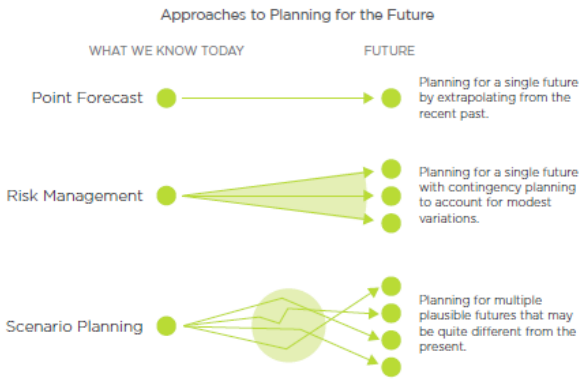

Figure 1: Approaches to forecasting and planning the future

A scenario-based approach is valuable as there is often much more uncertainty in the future than can be extrapolated from past trends. While typical planning processes assume that change will continue along historical trajectories into the future, scenario planning questions this assumption, and serves as a medium for exploring different paths that the future might take. In scenario planning, stories are crafted to represent a range of plausible alternative future states that could come about as a result of conditions that are beyond those involved in the planning process. Applied at a high-level, these stories allow for thoughtful dialogue on the potential opportunities and challenges that alternative futures might present, and serve as a mechanism for identifying and assessing strategies that would support a more resilient management of uncertain conditions in the future. In more targeted applications, these stories can help to evaluate and highlight trade-offs across specific strategy options.

In the context of long-range growth and transportation planning in Metro Vancouver, a wide range of external forces could have potential impacts on how the region develops. These external forces, sometimes referred to as disruptive trends, or disruptors, stem from all areas of the region's macro environment, including political, environmental, socio-cultural, technological, legal and economic factors. These forces could potentially impact the region in various ways, including the availability and ways in which land might be used, and the ways in which people travel. To account for every possible external force in existence would be resource intensive, and potentially create an overwhelming amount of information that may be less useful in informing strategy development. This report documents the process undertaken in this project to distill the range of external forces down to a manageable set of realistic inputs for developing the alternative future scenarios.

1.3 NAVIGATING THIS DOCUMENT

The remainder of this document outlines the process taken to develop the set of four scenarios outlined in the Regional Long-Range Growth and Transportation Scenarios Summary Report.

- **Section 2** outlines of the project approach.
- **Section 3** presents the research conducted on the broad set of external forces.
- **Section 4** summarizes the outcomes from the engagement components of the project.
- **Section 5** provides an overview of the four long-range growth and transportation scenarios.
- **Section 6** presents a discussion of potential next steps that could be taken beyond the scope of this project.
- **Appendix A** provides a more complete account of the stakeholders workshop on October 18, 2018.
- **Appendix B** provides a more complete account of subject matter expert feedback during February 2019.
- **Appendix C** provides a more complete account of the stakeholder workshop February 27, 2019.
- **Appendix D** is a glossary for frequently used terms in this document
- **Appendix E** is a list of anchor point assumptions.

2 PROJECT APPROACH

2.1 OVERVIEW OF PROJECT APPROACH

The long-range growth and transportation scenarios in this project were developed through an approach guided by methods outlined in the WSP Scenario Planning Toolbox. There are five major steps to the process, namely: external force analysis; scenario generation; validation with experts; development of implications for action; and resiliency analysis. The first three steps were carried out within this project, and are described in the following sub-sections. The forth step, implications for action, was adjusted in the workshop as a vetting of implications, opportunities, and challenges, as it was deemed premature to develop actions and policy responses at this stage in the planning process. The fifth step, resiliency analysis, is expected to take place through subsequent work on the respective update processes. **Section 6** provides a discussion on some of the next pieces of work expected to take place at that time.

2.2 EXTERNAL FORCE ANALYSIS

The scenario planning process began with the identification and analysis of a long list of external forces. Broadly defined, external forces are trends or conditions that are outside the immediate realm of control of those undertaking the planning process. Sometimes referred to as disruptive forces, disruptors or drivers of change, external forces can be generated from a wide range of macro environmental factors. A typical framework used to guide consideration for macro environmental factors is called the PESTLE (political, environmental, socio-cultural, technological, legal, and economic) framework. The framework is used to ensure that a diverse range of trends or external forces are included for consideration.

A long list of external forces were identified for the external forces analysis.[1] For each external force, extensive research was conducted to outline data points on current and projected conditions, the range of possible changes that could come about over the coming decades, as well as considerations for the types of impacts that could manifest. This research is summarized in **Section 3** of this report.

The purpose of the external forces analysis is to identify a manageable number external forces that can be used as anchor points, or starting concepts, for the scenarios. Different external forces may necessitate different planning responses depending on its expected impact, and the degree of variability or uncertainty in how it might play out in the future. External forces that are expected to be impactful, and have a clear, unwavering path forward, should be incorporated into core planning processes as there is little variability or uncertainty to explore through scenarios. On the other hand, external forces that have the potential to be impactful, but hold a wide range of variable outcomes that ought to be explored further, should be the focus of scenario analyses. Figure 2 outlines how the external forces are considered using an impact and variability analysis.

[1] Note: The number of external forces analyzed increased and decreased throughout the duration of the project. Originally a long list was developed (~40 external forces) with high level research undertaken on each. This number was decreased to 21 for presentation at the external forces workshop. During scenario development and refinement, several external forces were added for additional consideration. Several forces were combined and separated throughout the project, which may lead to some inconsistency in number of forces reported between the Summary Report and the technical report.

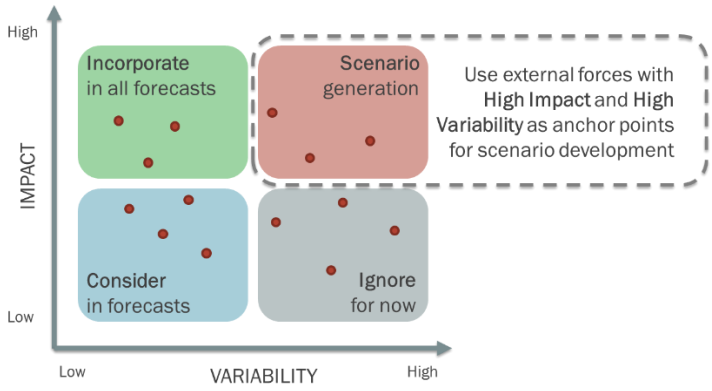

Figure 2: Impact and variability rating of external forces

In October 2018, a workshop with regional stakeholders was held to gather insights on the long list of external forces. Research on the external forces was presented to the stakeholders, and stakeholders were then asked to provide their perspectives on perceivable impacts, opportunities, and challenges related to the various external forces within their table groupings. Using a digital voting tool, Mentimeter, stakeholders were also asked to weigh in on the degree to which they think the external force could impact the region in the future, and the degree of variability (or uncertainty) associated with how that external force might manifest in the future. Outcomes from this engagement are outlined in **Section 4** of this report.

The results of the stakeholder engagement, combined with further research and internal working sessions between TransLink and Metro Vancouver culminated in the identification of 3 anchor points: Advanced Technology; Climate Change; and Economy & Trade. These became the starting points for scenario concepts developed through the scenario generation step of the project.

2.3 SCENARIO GENERATION

Expanding on each of the anchor points identified in the external forces analysis, additional research was conducted to establish a range of variability (representing the full extent of what is possible), and identify potential pathways for the future. Each pathway represents a possible direction that the future could take, given the variety of ways which the underlying external forces could manifest. Based on these pathways and the interactions between them, an initial set of 6 scenario concepts were developed.

Stories crafted around the 6 scenario concepts helped to articulate some of the opportunities and challenges that could arise. Each of the stories were crafted to be internally consistent, and built on realistic dynamics and interactions across underlying factors.

2.4 VALIDATION WITH EXPERTS

To ensure that the scenario concepts developed were grounded in sound logic, the scenario stories were shared with a multi-disciplinary group of experts for comment. This group included subject matter experts from industry and academia across the many disciplines covered by the external forces to address land use and climate change assumptions and implications.

Based on expert feedback, and by process of elimination, the 6 scenario concepts were subsequently refined to a set of 4 scenarios, removing those that yielded redundant implications to one another or the expected future, as well as those that were deemed outside the realm of plausibility.

Engagements with the subject matter expert panel are further discussed in **Section 4** of this report.

2.5 IMPLICATIONS, OPPORTUNITIES & CHALLENGES

In February 2019, the refined set of 4 scenarios were brought back to regional stakeholders through a follow-up workshop. At this workshop, stakeholders were asked to reflect on the scenarios presented to them to consider and the identified implications that each scenario would have for the region. Further to this, opportunities and challenges were identified for each scenario for comment from stakeholders, as well as providing stakeholders to add opportunities and challenges of their own. The workshop took on an open house format, and attendees were invited to move around the room across four stations dedicated to each of the scenarios. Stakeholder input from this workshop was documented on a set of posters, and used to further refine the scenarios and to inform discussions on potential strategies to consider for the region moving forward.

Outcomes from this engagement are outlines in **Section 4** of this report.

3 RESEARCH ON EXTERNAL FORCES

The number of external forces analyzed increased and decreased throughout the duration of the project. Originally a long list was developed (~40 external forces) with high level research undertaken on each. This number was decreased to 21 for presentation at the external forces workshop. During scenario development and refinement, several external forces were added for additional consideration. Several forces were combined and separated throughout the project, which may lead to some inconsistency in number of forces reported between the Summary Report and the technical report. This section summarizes 24 key external forces that were researched in more detail for developing and refining the scenarios.[2]

List of External Force Summaries:

[2] The Summary Report references that 25 external forces were researched. The discrepancy is because Federal Infrastructure Funding & Local Government's Growing Role were combined in this report and researched under one header.

3.1 3D PRINTING

Overview:

In 3D printing, a three-dimensional object is built from a CAD model, usually by adding material, layer by layer. There are many different materials that can be used to print, including plastic, carbon fiber, wood, and metal. Recently, concrete has become a material for 3D printing, which has allowed for a variety of commercial building applications to take place. 3D printing may impact employment, creating fewer jobs in construction, and more in design and architecture.

What is Happening Right Now:

- **Certain jobs are being lost, while others are being created.** The use of 3D printing and additive manufacturing is growing every year, and since 1989, sales of 3D-printed components have increased 25% annually.[3] While it still makes up only a small percentage of global manufacturing output, it is expected that this will continue to grow as manufacturers realize cost savings after the initial capital investment in machinery. As the use of 3D printing and additive manufacturing become more commonplace, it is anticipated that employment in manufacturing in production roles will decrease by 3.6% annually, while employment in architecture and engineering will increase by 3.3% per year, which will ultimately alter the make-up of the labour force.[4]
- **3D printing can shift global supply chains to localized distribution.** As 3D printing grows as a proportion of global manufacturing output, parts of global supply chains have the potential to be replaced by just-in-time manufacturing and delivery, replacing long trips with short trips.[5] While there is currently limited evidence to suggest the magnitude of this impact, shortened supply chains can significantly disrupt the economy. Manufacturers will be able to print parts in the location they will be used, decreasing or eliminating some transport times and costs altogether. This is currently being considered by Deutsche Bahn, and other transport providers.[6]
- **The cost of constructing some types of housing could decrease:** Advances in this construction field are anticipated to decrease construction costs and time, improving the potential to build more affordable housing.[7] A large-scale 3D concrete printer can build the outer shell of a home in a matter of days, at 10% the cost of traditional construction. This could be an effective way of building homes quickly after disasters, or for building low-income housing.[8] During construction, there is also the potential for up to 21% of potential energy savings in the construction sector due to drop in the amount of materials required and the energy required to move those materials.[9] Cost savings in construction may then be passed down to residents through reduced rent or purchase costs.

What this Means for the Future of Metro Vancouver:

- 3D printing has begun to display signs that it could impact employment by reducing jobs in manufacturing but increasing jobs in other fields that will use the technology for design purposes.
- 3D printing may decrease construction time and costs, providing more opportunities to build more affordable housing, increasing the housing stock in Metro Vancouver.
- 3D printing in combination with just-in-time manufacturing and delivery have the potential to impact massive global supply chains. Creating parts and items when required would change supply and delivery patterns, as well as asset management strategies.

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[3] The Economist Intelligence Unit (2018) Adding it up: The economic impact of additive manufacturing. Retrieved at: https://eiuperspectives.economist.com/sites/default/files/Addingitup_WebVersion.pdf
[4] ICTC (2017) Additive Manufacturing in Canada: The Impending Talent Paradigm. P 20. Retrieved at: https://www.ictc-ctic.ca/wp-content/uploads/2017/07/ICTC-Additive-Manufacturing-ENG-Final.pdf
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[6] The Economist Intelligence Unit (2018) Adding it up: The economic impact of additive manufacturing. Retrieved at: https://eiuperspectives.economist.com/sites/default/files/Addingitup_WebVersion.pdf
[7] BCG (2018) Will 3D Printing Remodel the Construction Industry? P 8. Retrieved at: http://image-src.bcg.com/Images/BCG-Will-3D-Printing-Remodel-the-Construction-Industry-Jan-2018_tcm9-181569.pdf
[8] Uguen-Csenge, E. (2019) New 3D printer can build home in days, says BC scientist. CBC News. Retrieved at: https://www.cbc.ca/news/canada/british-columbia/new-3d-concrete-printer-build-home-days-scientist-1.5111890
[9] The Economist Intelligence Unit (2018) Op. Cit.

- Some regional stakeholders outlined that despite improvements in 3D printing technology, municipal review and approval processes will still take time, and building codes are also slow to change.

3.2 ADVANCED BUILDING CONSTRUCTION TECHNOLOGY

Overview:

Emerging trends such as automation, advanced robotics, computer aided manufacturing (CAD), 3D printing (covered in 3D Printing), and new construction materials have the potential to change the way construction is conducted, and ultimately impact speed of construction and costs. Job loss may occur through automation, and lower construction costs could lead to more housing units being be built.

What is Happening Right Now:

- **Job loss in the construction industry is likely to accelerate.** It is anticipated that between 32-44% of construction jobs will be at high risk of automation[10] by the mid-2030s.[11] Through innovations in the design and construction of buildings such as 3D printing, automation has the capacity to significantly reduce personnel requirements. It is important that there are adequate quantities of other economic opportunities for these individuals as job loss occurs.
- **Modular and prefabricated construction has the potential to reduce construction timelines, while increasing the affordability and sustainability of homes and other buildings.** While land costs, permitting, and utilities all contribute to overall cost, innovations in modular and prefabricated construction suggests opportunities for improved quality, increased affordability, shorter timelines, and increased sustainability.[12] For example, prefabricated (prefab) housing provides similar cost savings to modular construction, offering a potential solution to lower-income residents.[13, 14] Some cities are also beginning to promote the development of passive house design, which results in ultra-low energy buildings, and heating- and cooling-related energy savings of up to 90% compared to existing housing stock.[15]
- **Updated public policy will improve building construction efficiency and cost effectiveness.** The BC Building Code was recently changed to allow for mass timber structures of up to 12 storeys. Mass timber technology allows for buildings to be manufactured off-site and assembled on-site for faster construction. Cross-laminated timber (CLT) has many advantages when compared to traditional materials. These include energy efficiency, cost effectiveness, fire protection and improved seismic performance.[16] For example, CLT mid-rise residential buildings are found to cost 15% less, with non-residential and commercial buildings costing 25-50% less.[17]

What this Means for the Future of Metro Vancouver:

- Improvements in passive home construction could radically improve energy efficiency of new builds, resulting in decreased pressure on the electrical grid, allowing capacity for other uses.
- New methods and materials for constructing homes and buildings will improve affordability and efficiency, leading to more units being built faster. Decreasing cost and improving affordability alongside efficient installation could lead to increases in housing stock in the region.
- Some regional stakeholders outlined that despite advances in building construction technology, building codes and approval processes are slow to change. There were also comments that transportation of large loads (e.g. pre-fab houses) could impact

[10] Note: High risk (or low risk) of automation is how many reports frame their arguments rather than stating high or low likelihood of automation and/or worker displacement.
[11] PwC (2018) Will robots really steal our jobs? An international analysis of the potential long term impact of automation. P 18. Retrieved at: https://www.pwc.com/hu/hu/kiadvanyok/assets/pdf/impact_of_automation_on_jobs.pdf
[12] BC Housing, Manufactured Housing Association of BC, & Real Estate Institute of BC (2014) Modular and Prefabricated Housing: Literature Scan of Ideas, Innovations, and Considerations to Improve Affordability, Efficiency, and Quality. P 75. Retrieved at: https://www.reibc.org/_Library/Research/ModularReport_Feb10.pdf
[13] City of Vancouver (2018) Temporary Modular Housing. Retrieved at: https://vancouver.ca/people-programs/temporary-modular-housing.aspx
[14] McMullin, A. (2019) Modular construction may prove to be a functional solution to the housing crisis. Vancouver Sun. Retrieved at: https://vancouversun.com/homes/westcoast-homes-and-design/modular-construction-may-prove-to-be-a-functional-solution-to-the-housing-crisis
[15] Lee, D. (2018) Residential Building Trends in Vancouver. Williams Engineering. Retrieved at: https://williamsengineering.com/mcm_blog-post/residential-building-trends-in-vancouver/
[16] WoodWorks (2012) Solid Advantages: Cross laminated timber (CLT) offers a new building system option for non-residential and multi-family construction. P 4. Retrieved at: http://www.woodworks.org/wp-content/uploads/CLT-Solid-Advantages.pdf
[17] WoodWorks (2012) Solid Advantages: Cross laminated timber (CLT) offers a new building system option for non-residential and multi-family construction. P 4. Retrieved at: http://www.woodworks.org/wp-content/uploads/CLT-Solid-Advantages.pdf

the transportation system if aggressively pursued. Conversely, fewer trips to and from construction sites may exist, with more work being done remotely.

3.3 AGING POPULATION / CHANGING DEMOGRAPHICS

Overview:

Longer life expectancy and declining birth rates have resulted in an expanding proportion of the elderly population. This proportion is expected to grow in Metro Vancouver, along with BC and Canada. There is also increased multiculturalism and immigration in the region. This increased diversity will continue to require adjustments to goods and services to match the needs of the population.

What is Happening Right Now:

- **Our population is getting older and this will impact employment trends.** By 2031, almost one in four people in BC will be over the age of 65 (more than 1.3 million people).[18] Fifty years ago there were 6.6 workers for every retiree. Presently the ratio is 4 to 1 and in another twenty years it is forecasted to be 2.3 to 1.[19] The global retirement savings gap in 2015 is estimated ~$70 trillion. This gap is anticipated to grow to $400 trillion by 2050. An increase to average retirement age may change employment opportunities for younger generations, and impact population distribution, based on rental and low-cost housing availability.[20] There are a variety of factors contributing to keeping seniors in the labour market, including longer life expectancy, mortgage debt, rising wages, and opportunities in the local labour market.[21] The age distribution of the population is another question on whether human lifespan is increasing. There is still a limited dataset to work off to determine if maximum age is trending upwards with improvements to medicine and technology; the theory is reasonable but there is a lack of proof.[22]
- **Infrastructure needs of the future may be different than the past.** There is a shortage of long-term care facilities for seniors. In 2012-2013 in Ontario, over 34,000 individuals were on a wait list for their preferred long-term care facility.[23] 44% of Metro Vancouver residents are born outside of Canada (nation-wide is 22%) which could lead to different amenity preferences.[24] An example from Toronto of recent action taken for multi-cultural inclusion is Regent Park Aquatic Centre on Saturday evenings providing a safe space for Muslim women to swim. Another example is the first Canadian outdoor community tandoori oven in R. V. Burgess Park in Toronto to create a welcoming environment for everyone.[25] For additional impacts relating to changing demographics with regards to immigration, see external force summary regarding Federal Immigration Policy. About 44% of Metro Vancouver residents aged 65+ prefer very walkable neighbourhoods while 16% prefer very auto-oriented neighbourhoods.[26] Neighborhood design may need to be further considered with an aging population.
- **Older adults make fewer trips and are less likely to drive.** Compared with younger cohorts, older adults (65+) make fewer trips. With an aging population, average trip rates are likely to fall over the next 20-30 years, though future trends may not follow existing patterns.[27] Older adults (65+) are also less likely to drive. For 65-79 age bracket, auto driver mode share is 63% and 80+ years old is 50% compared to those 45-64 years old who have an auto driver mode share of 73%. However, older adults are more likely to be an auto passenger, resulting in limited sustainable mode share differences to young and

[18] Government of BC. Ministry of Health (2005) Healthy aging through healthy living: towards a comprehensive policy and planning framework for seniors in BC P 3. Retrieved at: http://www.health.gov.bc.ca/library/publications/year/2005/healthy_aging.pdf
[19] Vettese, F. (2018) When it comes to pensions, don't follow Ottawa's example. The Globe and Mail. Retrieved at: https://www.theglobeandmail.com/investing/personal-finance/retirement/article-when-it-comes-to-pensions-ottawa-and-the-public-service-are-setting/
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[21] Statistics Canada (2017) The impact of aging on labour market participating rates. Retrieved at: https://www150.statcan.gc.ca/n1/pub/75-006-x/2017001/article/14826-eng.htm
[22] Zimmer, C. (2018) How Long Can We Live? The Limit Hasn't Been Reached, Study Finds. The New York Times. Retrieved at: https://www.nytimes.com/2018/06/28/science/human-age-limit.html
[23] Gollom, M. (2017) 'We're so far behind':
[24] Todd, D. (2017) "Visible minority" now meaningless term in Metro Vancouver, Toronto. The Vancouver Sun. Retrieved at: https://vancouversun.com/opinion/columnists/douglas-todd-visible-minority-now-meaningless-term-in-metro-vancouver
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[26] Frank, L., Kershaw, S., Chapman, J., & Perrotta, K. (2014) Residential Preferences and Public Health in Metro Vancouver: Promoting Health and Well Being by Meeting the Demand for Walkable Urban Environments. UBC Health & Community Design Lab. P 34. Retrieved at: https://health-design.spph.ubc.ca/files/2014/09/Final-Report-Residential-Preferences-and-Public-Health-in-Metro-Vancouver-_09262014.pdf
[27] TransLink (2013) 2011 Metro Vancouver Regional Trip Diary Survey. P 19. Retrieved at: https://www.translink.ca/-/media/Documents/customer_info/translink_listens/customer_surveys/trip_diaries/2011-Metro-Vancouver-Regional-Trip-Diary--Analysis-Report.pdf

middle-aged adults.[28] With Canada's aging population, there is expected to be an increase in mobility-related disabilities and demand for accessible mobility services. An increase in accessible transit could reduce the estimated $800 million annual cost of collisions involving senior drivers with mobility disabilities.[29] A recent accessibility improvement in Metro Vancouver is TransLink's fully-automated touchless access to a gated transit system through RFID readers located above designated accessible fare gates.[30]

- **There is an increased share of under-utilized housing.** The downward trend in number of people per household combined with increased regional population growth is creating increasing pressure on available housing stock.[31] There are examples of initiatives that are trying to connect this disparity, such as in the updated Housing Strategy from the City of Victoria, which aims to explore intergenerational housing options to match seniors with extra bedrooms (under-utilized supply) with eligible lodgers.[32] Policy among municipalities in Metro Vancouver has also been aimed at encouraging the creation of secondary suites to increase housing availability.[33]

What this Means for the Future of Metro Vancouver:

- Aging demographics in Metro Vancouver may result in some changes to average trip rates as seniors take fewer trips than younger cohorts. There may be minor changes to mode share with the aging population – resulting in fewer drivers, but an increase as passengers in vehicles.
- An older population may change employment across all sectors. There is a global retirement savings gap that is resulting in longer durations in the workforce, along with longer life expectancy, increasing mortgage debt, and rising wages.
- Some regional stakeholders identified that there is a desire to age in place, but there is also evidence that seniors are becoming poorer, creating pressure on disposable income, accommodation, and transport preferences in an expensive region. As there is a transition towards more rental and less ownership, in combination with poorer older adults, more seniors may be faced with the potential of homelessness. There is also a lack of mid-rise housing and apartment options for older adults that may want to downsize from large residences. Lastly, the uncertainty around pension fund sustainability may further put pressure on this demographic.

[28] TransLink (2013) 2011 Metro Vancouver Regional Trip Diary Survey. P 20. Retrieved at: https://www.translink.ca/-/media/Documents/customer_info/translink_listens/customer_surveys/trip_diaries/2011-Metro-Vancouver-Regional-Trip-Diary--Analysis-Report.pdf
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3.4 AGRICULTURAL PRODUCTIVITY & FOOD SECURITY

Overview:

Consumption of resources is increasing as populations increase. This mixed with climate change could lead to food security issues. Population growth and urbanization also encroach on fertile lands currently dedicated to agriculture.

What is Happening Right Now:

- **Food security is a rising issue and may impact land use.** It is estimated that BC farmers produce 48% of all foods consumed in BC.[34] Remaining foods are primarily imported from the US, and also China and Mexico.[35] To produce a healthy diet for British Columbians in 2025, farmland will need to increase 49% over 2005 levels.[36]
- **Climate change may help and hinder agriculture in the region.** Recent frequency and intensity of extreme weather events (such as drought and high temperatures) have demonstrated vulnerability of agricultural production and food prices.[37] See Climate Change & Natural Hazards for more information.
- **Vertical farming has land use advantages over traditional (horizontal) farming.** From a land use perspective, it is suggested that vertical farms would supply nearly 10 times more growing area than traditional farms, with increasing food security, and/or opportunity to adjust land use zoning.[38] Vertical farming and lab farming are trends that may limit CO2 emissions and water consumption. One farm acre indoors can produce the same yield as 4-6 acres outdoors. By 2020 there will be 55 million smart devices in our homes, which may change how we buy our food.[39]
- **Urban farming facilities could decrease transport distances to local consumers.** The decrease in travel time could decrease costs to producers, while also decreasing vehicle-kilometres travelled (VKT).[40] Urban farming in the form of green roofs have the potential to absorb rainwater, prevent sewer system back-ups, and reduce building energy use by as much as 30%.[41]
- **New farming technologies and practices may lead to the creation of new jobs**. Positions could be created in high technology, food processing, process maintenance, infrastructure development, and research and development. Specific numbers are not provided, and this field of emerging technology is still in its infancy.[42]
- **Plant-based protein could impact our agricultural land use impact.** The Beyond Burger (plant-based burger produced by company Beyond Meat) generates 90% less GHG emissions, requires 46% less energy, has >99% less impact on water scarcity, and 93% less impact on land use when compared to a ¼ pound of U.S. produced beef.[43] Metro Vancouver produces a wide variety of livestock, but is trending downwards when it comes to cattle and pigs.[44]

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[34] BC Ministry of Agriculture and Lands (2006) BC's Food Self-Reliance: Can BC's Farmers Feed Our Growing Population? P 1. Retrieved at: https://foodsecurecanada.org/sites/foodsecurecanada.org/files/BCFoodSelfReliance_Report.pdf
[35] Ostry, A., Miewald, C., & Beveridge, R. (2011) Climate Change and Food Security in British Columbia. Pacific Institute for Climate Solutions. Retrieved at: https://pics.uvic.ca/sites/default/files/uploads/publications/Food%20Security_2011.pdf
[36] BC Ministry of Agriculture and Lands (2006) BC's Food Self-Reliance: Can BC's Farmers Feed Our Growing Population? P 2. Retrieved at: https://foodsecurecanada.org/sites/foodsecurecanada.org/files/BCFoodSelfReliance_Report.pdf
[37] Metro Vancouver (2018) Climate 2050 Discussion Paper. P 5. Retrieved at: http://www.metrovancouver.org/services/air-quality/AirQualityPublications/AQ_C2050-DiscussionPaper.pdf
[38] Al-Kodmany, K. (2018) The Vertical Farm: A Review of Developments and Implications for the Vertical City. MDPI. P 14. Retrieved at: https://www.mdpi.com/2075-5309/8/2/24
[39] Lempert, P. (2017) 10 Food Trends that will shape 2018. Forbes. Retrieved at: https://www.forbes.com/sites/phillempert/2017/12/13/10-food-trends-that-will-shape-2018/#2051d5b74104
[40] Al-Kodmany, K. (2018) The Vertical Farm: A Review of Developments and Implications for the Vertical City. MDPI. P 14. Retrieved at: https://www.mdpi.com/2075-5309/8/2/24
[41] Al-Kodmany, K. (2018) The Vertical Farm: A Review of Developments and Implications for the Vertical City. MDPI. P 20. Retrieved at: https://www.mdpi.com/2075-5309/8/2/24
[42] Benke, K., & Tomkins, B. (2016) Future food-production systems: vertical farming and controlled-environment agriculture. Sustainability: Science, Practice and Policy. P 15. Retrieved at: https://doi.org/10.1080/15487733.2017.1394054
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[44] Metro Vancouver (2014) Farming in Metro Vancouver: Policy Backgrounder. P 11. Retrieved at: http://www.metrovancouver.org/services/regional-planning/PlanningPublications/Farming_In_Metro_Vancouver_Oct_2014.pdf

What this Means for the Future of Metro Vancouver:

- Agricultural technology continues to evolve and it is difficult to predict what trends will continue from pilot efforts to wide-scale production.
- There are several benefits listed when it comes to vertical farming, green roof farming, and development of plant-based protein. Environmental benefits of decreased GHG emissions are widely cited for transport and non-transport related elements. There are also potential land-use and transport benefits. Namely, vertical facilities closer to denser populations could result in a decrease in goods movement VKT. Improved vertical farming efficiency may create pressure to revisit policy around what constitutes farm use on land in Metro Vancouver and usage of the Agricultural Land Reserve (ALR).
- It is suggested that new technologies and fields in agriculture would result in the creation of new jobs, though no numbers are provided. Seeing as many of these technological innovations are in their early stages, it may be pre-emptive to assume more than a marginal increase of jobs in this field.
- Some regional stakeholders commented that vertical farming could reduce transport distances between farm and table. There was also mention that diets may need to change as hay cannot grow in vertical farms, which will complicate animal feeding, and in turn potentially impact cost of meat to consumers. There were comments on the sustainability of the ALR in the face of sea level rise with regards to salinity issues impacting fields and crops. There was agreement that existing agricultural land in the region will not meet the food security demands of the growing regional population.

3.5 ARTIFICIAL INTELLIGENCE, AUTOMATION & AUTONOMOUS THINGS

Overview:

Artificial intelligence (AI), automation & autonomous things are being adopted into business work flows and becoming commercialized for consumers. AI refers to the ability of machines to operate intelligently, and exhibit human-like problem solving patterns. AI and automation are being incorporated into a variety of technologies and services, creating concern for job loss, privacy, cybersecurity, and decision making. A critical autonomous thing is connected and autonomous vehicles (CAVs) which are systems capable of intelligently navigating and responding to complex environments with little to no human input. CAVs are capable of communicating and interacting over wireless networks with other vehicles, infrastructure, people, and the cloud.

What is Happening Right Now:

- **AI and automation are expected to enhance certain jobs, while displacing others.** The First Industrial Revolution used steam and water for production. The Second relied on electric power for further mass production. The Third used electronics and information technology to automate production. It is now suggested that the Fourth Industrial Revolution is characterized by a fusion of physical, digital, and biological technologies to develop breakthroughs that have no historical precedent. The breadth and depth of this AI and automation revolution is likely to disrupt almost every industry in the world.[45] Amongst the most disruptive perhaps is the impact this revolution will have on employment. It is suggested that about half of all work activities have the potential to be automated in the coming decades. It is also likely that demand for work and workers could increase as economies grow due to productivity increases through AI. Among developed (G7) countries, it research has found that roughly 12% of existing jobs are at risk of being automated away, 75% will be enhanced by bringing automation to the workplace, and 13% net new jobs will be created as machines and robotics create new opportunities and job categories that do not exist today.[46] Impacts vary from sector to sector – notable employment impacts from automation, AI and CAVs are listed below:
    - **Agriculture, Forestry, Fishing, and Hunting:** There has been a long-term employment transition away from agriculture, forestry, fishing, and hunting as automation has become more sophisticated and machines are able to undertake more work in these fields, particularly notable with automated processes in agriculture. Thanks to automated farming processes in Japan, employment in this field dropped 500,000 workers in the last decade (2.2 million to 1.7 million farmers). Research predicted that half of jobs in Japan could be performed by robots by 2034, mostly in customer services, goods delivery, and agriculture.[47] The improved efficiency of agricultural processes in combination with the potential for vertical farming may reduce pressure on agricultural lands in Metro Vancouver; this will of course have to be considered against urban planning growth boundary rationale of agricultural lands in the region.
    - **Mining, Quarrying, and Oil and Gas Extraction:** This sector is already quite reliant on machinery to undertake work in combination with human oversight. Since automation has already left it's mark on automatable tasks in this field, it is anticipated that there will be a limited change in this field as the labour that exists is already quite specialized.[48] There is limited land in Metro Vancouver dedicated towards this field, and as such any changes to employment in this sector will have limited impact on land demand.
    - **Utilities:** There is a potential increase in jobs in electric power generation due to the increased demand for power. However, from a holistic perspective, there are fewer employed in the utilities sector than most others (<1%

[45] Schwab, K. (2016) The Fourth Industrial Revolution: what it means, how to respond. World Economic Forum. Retrieved at: https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond/
[46] Frank. M. Roehrig, P. & Pring, B. (2017) What to do when machines do everything: How to get ahead in a world of AI, algorithms, bots, and Big Data. John Wiley & Sons. p 35.
[47] McCurry, J (2016) Japanese firm to open world's first robot-run farm. The Guardian. Retrieved at: https://www.theguardian.com/environment/2016/feb/01/japanese-firm-to-open-worlds-first-robot-run-farm
[48] Oschinski, M. & Wyonch, R. (2017) Future Shock? The Impact of Automation on Canada's Labour Market. C.D. Howe Institute. p 13. Retrieved at: https://www.cdhowe.org/sites/default/files/attachments/research_papers/mixed/Update_Commentary%20472%20web.pdf

globally) and as such, the impact of automation in this field may be less impactful than others. Electric grids, substations, and transformers may require additional land, particularly in denser parts of the region.

- **Construction:** Over a longer term (30 years) it is anticipated that construction jobs will be automated to boost productivity. Over the short term, automation is expected to enhance quality and efficiency in this field. For further information on the impact of automation in construction, see 3D printing or Advanced Building Construction Technology.
- **Manufacturing:** Manufacturing is expected to see significant change to employment through automation in the near-term due to moderately high automatability of routine tasks. Research predicts that 35-50% of jobs in the manufacturing sector are at high risk of automation.[49] 3D printing in combination with decentralized manufacturing will allow for greater flexibility than centralized manufacturing that is often further from customers in Canada. This could add significant pressure to Metro Vancouver's existing industrial land base if companies demand space closer to their customers in metropolitan areas.[50]
- **Wholesale and Retail Trade:** This sector is expected to see significant change to employment through automation in the near-term due to moderately high automatability of routine tasks. Research predicts that 25-40% of jobs in the wholesale and retail trade sector are at high risk of automation.[51] Brick-and-mortar retail, particularly small businesses, are losing market share with the onslaught of online stores. Many believe that in-store experiences are still fundamental to consuming, particularly for consumables such as grocery shopping. Amazon has recently started piloting Amazon Go, a grocery store without checkout lines, using computer vision, sensor fusion, and deep learning, packaged together in what is branded as "Just Walk Out Technology".[52] [53] This will have implications for retail clerks going forward, but will also potentially decrease operational costs with less staff overhead.
- **Transportation and Warehousing:** It's anticipated that 75 to 375 million workers may need to switch occupational categories globally (in other words 3-14% of the global workforce).[54] Transportation is a field that is anticipated to be significantly impacted by automation with studies indicating that vehicle automation is expected to impact all driving-related jobs (e.g., taxi, freight, and bus drivers). It is suggested that over 50% of transportation and storage jobs are at high risk of automation by the mid-2030s.[55]
- **Information, Finance and Insurance:** CAVs will impact employment in sectors such as Information Technology and Finance and Insurance (NAICS 51 and 52). Marginal employment increases are expected as telecommunications will need to expand and there will be increased complexity of CAV-related financing and insurance at least over the short-term.[56] It is possible that if all safety-related promises are delivered regarding autonomous travel, vehicle insurance may become significantly less resource-intensive and fewer jobs will exist. It is not anticipated that changes in this field will have significant implications for land demand.
- **Real Estate, Rental and Leasing**: It is anticipated that real estate transactions and processes will be made more efficient through automation, decreasing human requirements during the process of transactions. Jobs at high risk of automation in this sector are in the range of 32-45% by the mid 2030s.[57] For more information on how AI and automation will play a part in this field, see E-commerce and Blockchain for more information. It is not anticipated that changes in this field will have significant implications for land demand.

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[49] PwC (2018) Will robots really steal our jobs? An international analysis of the potential long term impact of automation. P 18. Retrieved at: https://www.pwc.com/hu/hu/kiadvanyok/ assets/pdf/impact_of_automation_on_jobs.pdf
[50] Industry Today (2013) Opportunities for the Intensive Use of Industrial Land. P 10. Retrieved at: https://industrytoday.com/FlippingBook/17.10/files/assets/basic-html/index.html#31
[51] PwC (2018) Will robots really steal our jobs? An international analysis of the potential long term impact of automation. p 18. Retrieved at: https://www.pwc.com/hu/hu/kiadvanyok/ assets/pdf/impact_of_automation_on_jobs.pdf
[52] Amazon Go. https://www.amazon.com/b?ie=UTF8&node=16008589011
[53] Weinberger, M. (2018) I shopped at Amazon's cutting-edge convenience store without registers or lines, and now I'm convinced it's the future of retail — for better or for worse. Business Insider. Retrieved at: https://www.businessinsider.com/amazon-go-review-photos-how-it-works-2018-7
[54] McKinsey & Company (2017) Jobs Lost, Jobs Gained: Workforce Transitions in a Time of Automation. P 86. Retrieved at: phttps://www.mckinsey.com/~/media/mckinsey/featured%20insights/Future%20of%20Organizations/What%20the%20future%20of%20work%20will%20mean%20for%20jobs%20skills%20and%20wages/MGI-Jobs-Lost-Jobs-Gained-Report-December-6-2017.ashx
[55] PwC (2018) Op. Cit. p 18.
[56] Pettigrew, Fritschi and Norman (2018) The potential implications of autonomous vehicles in and around the workplace. p 3. Retrieved at: https://www.ncbi.nlm.nih.gov/pubmed/30200206p
[57] PwC (2018) Op. Cit. p 18.

- **Professional, Scientific, and Technical Services:** This sector may be automatable in the short-term but will continue to retain workers for non-routine tasks, limiting job displacement. This sector tends to have more workers with higher education levels which tend to be less automatable on average.[58] It is not anticipated that changes in this field will have significant implications for land demand.
- **Management of Companies and Enterprises:** There is likely to be lower risk of automation to this sector of employment due to high emphasis on social and literary skills and more complex tasks that are less automatable. Jobs at high risk of automation are in the range of 5-10% by the mid-2030s.[59] It is not anticipated that changes in this field will have significant implications for land demand.
- **Educational Services:** While administrative work supporting education services may be automated in part, there will continue to be an expanded emphasis and number of positions in educational institutions. AI and automation will provide enhancement to teaching. A limited percent of work in this sector is at high risk of automation.[60] It is not anticipated that changes in this field will have significant implications for land demand.
- **Health Care and Social Assistance:** The field of health care is anticipated to be among the least automatable. There are expected to be net job increases over the long term as automation enhances tasks and frees up people to further develop specialization in less routine areas.[61] It is not anticipated that changes in this field will have significant implications for land demand.
- **Arts, Entertainment, and Recreation**: It is anticipated that there will be a reduction in clerk/support/administrative related services for various roles across the entertainment industry. For arts and recreation, research suggests that limited displacement will occur due to non-routine manual tasks associated with the industry.[62] It is not anticipated that changes in this field will have significant implications for land demand.
- **Accommodation and Food Services**: Efficiencies are expected to occur in this sector through automation while still retaining human labour for many roles where experience is associated with service. It's expected that between 20-35% of jobs are at high risk of automation.[63] It is not anticipated that changes in this field will have significant implications for land demand.
- **Public Administration**: It is suggested that positions for senior public servants will continue to exist while supporting effort for government services may transition towards automatable jobs. Between 30-40% of these roles are at high risk of automation.[64] It is not anticipated that changes in this field will have significant implications for land demand.

- **CAVs may increase the willingness of households and employers to locate further from urban centres**. Similar to how the rise of the automobile led to the emergency of suburbs by reducing transport costs and improving efficiency relative to existing modes of travel, CAVs could further this trend towards a low-density future with the ability to engage in non-driving activities while being transported. While research is limited in this field, lower land prices and rents can be found further from downtown cores, thus this is a possibility dependent on travel costs and willingness to spend time in vehicles, regardless of productivity levels.[65] Since CAVs have the potential to reduce travel time costs, they may lead to an increase in vehicle travel, on the order of 15-20%. The increased travel could trigger more traffic congestion, though improved road space efficiencies and coordinated travel patterns could mitigate these impacts.[66] As CAV prevalence increases and the available levels of automation advance (Level 4 automated vehicles could account for up to 80% of cars on the road by 2040), there is

[58] PwC (2018) Op. Cit. pp 21-37.
[59] PwC (2018) Op. Cit. p 18.
[60] Oschinski, M. & Wyonch, R. (2017). Op. Cit.
[61] Oschinski, M. & Wyonch, R. (2017). Op. Cit.
[62] Oschinski, M. & Wyonch, R. (2017). Op. Cit.
[63] PwC (2018) Op. Cit.
[64] Oschinski, M. & Wyonch, R. (2017). Op. Cit.
[65] RAND Corporation (2016) Autonomous Vehicle Technology: A guide for policy makers. p 25-26. Retrieved at: https://www.rand.org/content/dam/rand/pubs/research_reports/RR400/RR443-2/RAND_RR443-2.pdf
[66] Fulton, L., Mason, J., & Meroux, D. (2017) Three Revolutions in Urban Transportation: How to achieve the full potential of vehicle electrification, automation, and shared mobility in urban transportation systems around the world by 2050. Retrieved at: https://steps.ucdavis.edu/wp-content/uploads/2017/05/STEPS_ITDP-3R-Report-5-10-2017-2.pdf

the potential that the increased accessibility provided by this mode will result in higher trip demand (up to 11%).[67] This increase in trip demand can come from longer distance trips if residents and employers begin to move out of downtown cores, and the ability of non-driver (e.g. un-licenced) individuals to take these trips.[68] Adoption of CAVs will also lead to changes in roadway design, allowing for increased throughput on narrower roads. With human drivers, we currently require wider lanes to travel safely at high speeds; this will not be the case for CAVs, which will only require marginally more space than the width of the widest vehicle on the road (trucks), and side-view mirrors will no longer be necessary, further limiting vehicle widths for safe operation.[69]

- **Job displacement from automation may impact population distribution.** All regions will be impacted in different ways as local labour markets are affected by automation. Under-funded government programs may not be able to withstand the disruptive impact of AI on local job markets, but it is also difficult to predict which regions will be most impacted. In the next few decades, it is suggested that approximately a quarter of US employment (36 million jobs) will have experienced high exposure to automation, and potential displacement of many existing positions.[70] While there are currently a variety of examples of narrow AI (where machines perform a single task), general AI (where machines perform a broad range of tasks) is anticipated to be more readily available around 2050, leaving little time for governments to prepare for impacts.[71] Without a robust local labour market, it is possible that population numbers would decrease, in search of more affordable places to live, or areas with more employment opportunity.[72] Retraining and reskilling has been suggested as an urgent priority for governments to create smoothness in workforce transitions.

What this Means for the Future of Metro Vancouver:

- AI and automation are anticipated to displace some jobs while also creating new positions. Industries anticipated to have the most employment displacement include transportation and warehousing, manufacturing, and construction. Industries anticipated to have the least employment displacement include educational services, and health care and social assistance. At this point it is worth continuing to watch trends in the technology, and align it with expected trends that are listed in the literature here along with updated reports. The largest anticipated impacts from a land demand perspective would be within the sector of manufacturing. With a transition to decentralized manufacturing, in combination with 3D printing, there is potential for significant demand of industrial lands for faster delivery of consumer goods and parts. Following manufacturing, there could also be a significant shift in demand for agricultural land, with technological improvements through vertical farming, reducing agricultural land needs, while still increasing productivity to match regional growth. With high automation, and low employment, these facilities and land demands may be best met outside the region, while instead prioritizing housing and other employment uses within the region.
- CAVs will have significant impact on transport, and employment. We can anticipate some of these impacts already, while many others will become known as CAVs begin to have significant adoption. It is currently unclear whether CAVs will have an impact on where people choose to live from a cost-convenience trade-off perspective. Transport costs include the value of a commuter's time, and if this time is now seen as an opportunity for productivity, it could alter how these trade-offs are considered by many. Another major consideration that will likely play into this decision is whether road pricing schemes are introduced in the next 30 years, and whether this shifts private transport to increasingly shared transport.
- Many driving-related jobs will be lost through CAV adoption and associated automation. This includes taxi, ride-sourcing, and bus drivers, while public transit agencies have indicated there may be a transition to on-board service attendants. There will continue to be maintenance that is undertaken by humans, and other opportunities will exist related to CAVs.

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[67] McKinsey & Company (2016) Automotive Revolution – perspective towards 2030. p 11. Retrieved at: https://www.mckinsey.com/~/media/mckinsey/industries/high%20tech/our%20insights/disruptive%20trends%20that%20will%20transform%20the%20auto%20industry/auto%202030%20report%20jan%202016.ashx

[68] Schoettle, B., & Sivak, M. (2015) Influence of Current Nondrivers on the Amount of Travel and Trip Patterns with Self-Driving Vehicles. Retrieved at: http://umich.edu/~umtriswt/PDF/UMTRI-2015-39.pdf

[69] Sohrweide, T. (2018) Driverless Vehicles Set to Change the Way We Design Our Roadways? SEH. Retrieved at: http://www.sehinc.com/news/future-what-do-driverless-cars-mean-road-design

[70] Muro M., Maxim, R., & Whiton, J. (2019) Automation and Artificial Intelligence: How machines are affective people and places. Brookings Institute. P 31. Retrieved at: https://www.brookings.edu/wp-content/uploads/2019/01/2019.01_BrookingsMetro_Automation-AI_Report_Muro-Maxim-Whiton-FINAL-version.pdf

[71] Vorhies, W. (2016) Artificial General Intelligence – The Holy Grail of AI. Data Science Central. Retrieved at: https://www.datasciencecentral.com/profiles/blogs/artificial-general-intelligence-the-holy-grail-of-ai

[72] Muro M., Maxim, R., & Whiton, J. (2019) Op. Cit. p 64.

- Population distribution may change if transport costs and land values remain similar to today. While current regional land use policy may limit this increase in average distance travelled, there may be a faster population increase in rural parts of the region as well as in adjacent regions (Squamish-Lillooet RD, Fraser Valley RD) that could increase average trip distances through inter-regional travel.
- For transportation, studies suggest that congestion will increase, despite efficiencies through platooning, faster travel speeds, connected mobility, and narrower travel lanes. A key determinant that remains difficult to predict is whether societies adopt a shared model for CAV use, or continue with primarily private ownership.
- Some regional stakeholders stressed that there will be road safety issues as there is a transition to CAVs. Older adults will have improved accessibility over the current system of relying on HandyDART services. There will be a need to think beyond CAVs to infrastructure such as smart parking garages. Stakeholders also identified conflicts for other road users such as pedestrians and cyclists.

3.6 BIOTECHNOLOGY & GENE THERAPY

Overview:

Biotechnology (or biotech) is the exploitation (or manipulation) of living organisms to develop or make products such as antibiotics and hormones. This overlaps with gene therapy, which is the practice of transplanting normal genes into cells to replace missing or defective ones primarily for the purpose of correcting genetic disorders. Biotech is mainly used in agriculture, food science, and medicine.

What is Happening Right Now:

- **Gene therapy is becoming less expensive, and could contribute longer, healthier lives.** Gene therapies saw a 135% increase in investment between 2017-2018,[73] and CRISPR has helped this decrease in costs, costing roughly 0.6% of conventional methods to edit a single gene. Although gene therapy presents the potential to address over 7,000 rare diseases that lack treatment today, it is anticipated that only a small fraction of the population will benefit, due to approval processes and the fact that current trials are primarily targeting rare diseases.[74] While this does not contribute directly to population or employment distribution, it does contribute to the macro trend of healthier longer lifespans, see Aging Population / Changing Demographics for more information on impacts.

- **Clean biofuel has the potential to decrease transport emissions.** The field of biofuel has generated controversy with regards to whether carbon impacts are significantly reduced compared to fossil fuels. Algae fuel is one that has potential to significantly reduce carbon emissions, and would allow any country to manufacture its own algae oil. Mass commercialization of this effort is not anticipated for several decades,[75] though two thirds of biotech companies in Canada identified themselves as either in the discovery or emerging phase of development in 2017.[76] As the current price per barrel is still substantially more expensive than petrol, it's difficult to determine whether biofuel would replace traditional fuel, and if it would occur at a high cost (due to policy interventions), which may result in fewer trips and decreased average distances.

- **Biofuel development may have land use implications.** Developing bio-energy through many means can be an inefficient use of land. 10% of the world's liquid transportation fuel in the year 2050 would require nearly ⅓ of all the energy in a year's worth of crops (corn, soy, wood) the world produces today. This consumption could result in mass harvesting of trees and other sources of biomass for electricity and heat generation. Current technology and processes also do not clearly indicate whether biofuel production is carbon neutral or negative – with some research suggesting that burning biomass emits more CO2 than fossil fuels for the same amount of generated energy.[77]

What this Means for the Future of Metro Vancouver:

- While biotech and gene therapy have the potential to impact human health and create a variety of products for societal consumption, it's unlikely that these trends will have a significant impact on land use demand, population and employment distribution, or sectoral employment in Metro Vancouver.

- There is potential that biofuel (generated through biotech) may have a breakthrough that will shift how we fuel our transport, though it is too early to determine whether prices will influence behaviour. It's also anticipated that this would come with policy intervention that could counter natural shifts in behaviour.

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[73] McKinsey & Company (2016) Aging with tech support – the promise of new technologies for longer and healthier lives. P 6. Retrieved at: https://www.mckinsey.com/~/media/McKinsey/Industries/Pharmaceuticals%20and%20Medical%20Products/Our%20Insights/Aging%20with%20tech%20support%20the%20promise%20of%20new%20technologies%20for%20longer%20and%20healthier%20lives/Aging%20with%20Tech%20Support.ashx

[74] McKinsey & Company (2016) Aging with tech support – the promise of new technologies for longer and healthier lives. P 37. Retrieved at: https://www.mckinsey.com/~/media/McKinsey/Industries/Pharmaceuticals%20and%20Medical%20Products/Our%20Insights/Aging%20with%20tech%20support%20the%20promise%20of%20new%20technologies%20for%20longer%20and%20healthier%20lives/Aging%20with%20Tech%20Support.ashx

[75] Gunther, M. (2012) Will algae every power our cars? The Guardian. Retrieved at: https://www.theguardian.com/environment/2012/oct/15/will-algae-ever-power-cars

[76] Deloitte & BIOTECanada (2018) Biotechnology Industry Data Survey 2018: Report on Key Findings. P 1. Retrieved at: http://www.biotech.ca/wp-content/uploads/2018/06/Biotechnology_Industry_Data_Survey_2018_-_Report_on_key_findings_AODA.pdf

[77] Steer, A., & Hanson, C. (2015) Biofuels are not a green alternative to fossil fuels. The Guardian. Retrieved at: https://www.theguardian.com/environment/2015/jan/29/biofuels-are-not-the-green-alternative-to-fossil-fuels-they-are-sold-as

- Biofuel production takes significant land, without clearly demonstrating benefits to CO2 emissions. Consideration in Metro Vancouver should be given to land use implications of this type of technology against climate and sustainability mandates that currently exist.
- This external force was not incorporated during stakeholder workshops and therefore did not receive feedback from subject matter experts or local representatives.

3.7 CHANGING ATTITUDES & PREFERENCES

Overview:

Changing attitudes for individuals changes the frequency and type of goods demanded and space preferences, while new trends in mobility and accessibility can change people's (un)willingness to travel certain distances and/or by certain modes.

What is Happening Right Now:

- **A shift in preferences from private ownership towards shared mobility could decrease VKT.** The percentage of teenagers and young adults (16-29) having active driver licences in Metro Vancouver has declined the most of any cohorts between 2004-2013. This decline coincided with BC's Graduated Licensing Program and introduction of the U-Pass program in 2003, along with expansion of the transit system and increase in gasoline prices.[78] Forecasts suggest that car-sharing users will increase from 4.8 million people in 2014 to 26 million in 2020 worldwide. Conversely, there is still a substantial amount of younger generations that plan to buy vehicles (80% in the US). While car-share and transit may meet the needs of many, it is difficult to determine at a regional scale whether there will be a substantive mode shift without policy intervention.[79]
- **Multi-generational household changes may impact housing demand and average household size.** Young adults (20-29) living in parental households is at 42% as of 2018, up 10 percentage points from the 1990s, and 15 percentage points from the 1980s.[80] More broadly, in 2017, 9% of the adult population (25-64) lived with one or more of their parents. This number is close to double 1995 numbers when 5% of the adult population shared a residence with at least one parent. If this trend continues to be displayed, there could be implications for type of housing demanded. A counter to this is that 70% of adults (25-64) who were living with a parent reported they were single, meaning there is no clear indication of whether household sizes would continue to increase through multiple generations living together with further expansion. The Census suggests that multigenerational households may be on the rise because of the high cost of living in some regions of the country.[81]
- **There is an increasing interest in living and working in urban areas.** Rural populations are on the decline, and fewer than 1 in 5 Canadians live in a rural area. Since Confederation, there has been a steady movement from rural to urban living. As of 2011, 19% of people in Canada lived in a rural area, which is largely correlated with a shift away from primary sector work. Urban regions, such as Metro Vancouver, have taken much of this growth. In particular, there is a small proportion of young adults (aged 15-29) living in rural Canada at 17%, below the national average of 20%, and younger generations are less willing to live outside of urban cores.[82] This has been attributed to pursuing postsecondary studies and employment in larger and more diverse labour markets. BC and Ontario have the lowest proportion of the population living in rural areas.[83]

What this Means for the Future of Metro Vancouver:

- There may be minor shifts in transport mode based on changing demographic attitudes. Current trends in Metro Vancouver indicate a slight shift away from private vehicles towards car-share and public transit.
- Population distribution may be impacted slightly by increases in adults living with one or more parents. There could be an increase in seeking out areas that are more affordable for more space, generally further from urban centres. Similarly, housing preferences may impact land use demand, for more bedrooms per unit. However, with high rates of single adults living with one or more parents, it is unclear whether this trend would continue to broaden with non-single adults and offspring.
- Some regional stakeholders identified that younger generations are more open to shared spaces and less interested in homes with a private yard, potentially influencing land use and housing stock preferences. Stakeholders challenged the trend of

[78] Metro Vancouver. (2014) 10-year trend in active drive licensing rates in Metro Vancouver. Retrieved at: http://www.metrovancouver.org/services/regional-planning/PlanningPublications/140507_Transportation_Drivers_License_Trends.pdf
[79] Daigle, T. (2016) Owning vs. sharing: how car habits are changing. CBC News. Retrieved at: https://www.cbc.ca/news/technology/car-sharing-services-growing-1.3394451
[80] Statistics Canada (2018) Living arrangements of young adults aged 20 to 29. Retrieved at: https://www12.statcan.gc.ca/census-recensement/2011/as-sa/98-312-x/98-312-x2011003_3-eng.cfm
[81] Statistics Canada. (2019) Family Matters: Adults living with their parents. Retrieved at: https://www150.statcan.gc.ca/n1/daily-quotidien/190215/dq190215a-eng.htm
[82] Fry, R., Igielnik, R., & Patten, E. (2018) How Millenials today compare with their grandparents 50 years ago. Pew Research Center. Retrieved at: https://www.pewresearch.org/fact-tank/2018/03/16/how-millennials-compare-with-their-grandparents/
[83] Statistics Canada (2015) Canada goes urban. Retrieved at: https://www150.statcan.gc.ca/n1/pub/11-630-x/11-630-x2015004-eng.htm

lower licensing rate and were unclear if it would continue in the region as younger generations start having children. Comments were made that Metro Vancouver is an active region, and this will have land use impacts and demand for more recreational facilities, as well as green space, alongside continued growth of the region.

3.8 CLIMATE CHANGE & NATURAL HAZARDS

Overview:

Metro Vancouver is one of the most at-risk regions in Canada. It is a high-hazard area with respect to earthquakes, riverine and coastal flooding. While the probability of a disaster in Metro Vancouver is known, it is highly uncertain when an extreme event might occur. In addition to the current risks, climate change is impacting our planet globally as well as in the Metro Vancouver region. Climate change will increase the probability and potential severity of flooding from sea level rise or river-based floods, severe storms, and heat waves.

What is Happening Right Now:

- **Flooding impacts will have land use and transport implications.** Sea levels are expected to rise, which will require planning to mitigate impacts to coastal and inland regions, though the magnitude of this rise carries significant uncertainty. The province of BC suggests planning for 1 metre of sea level rise by the year 2100 and 2 metres by the year 2200,[84] as modelling has shown a 5% increase in total precipitation for the region by the 2050s with large increases in rainfall in the fall and winter seasons.[85] On the other hand, summer rainfall is expected to decline by nearly 20% with increased likelihood of extended drought periods.[86] While these projections carry some uncertainty to how their impacts will be realized, a major source of this uncertainty is the potential collapse of the West Antarctic ice sheet (WAIS). If the WAIS were to disintegrate in the coming decades, it is possible sea-level rise could be 3.3 metres beyond representative concentration pathway (RCP) 8.5. While this is important to consider beyond 2050, the choice of RCP is minimally different up to 2050 between RCPs 2.6, 4.5, and 8.5.[87]
- **Reduction in overall land base due to sea level rise in the region could have significant impacts on land use and transportation infrastructure decisions.** River and ocean-based flooding are expected to become more frequent and more severe in Metro Vancouver in the coming decades. Fraser Basin Council and KWL developed and assessed four flood scenarios for Metro Vancouver (two coastal scenarios and two Fraser River spring freshet scenarios, each for present day and year 2100) on 1 in 500 year floods. Losses under coastal and Fraser River flood scenarios are estimated to range from $19.3 billion (coastal present-day scenario) to $32.7 billion (Fraser River 2100 scenario) including significant losses to agriculture, infrastructure and residential, commercial, industrial, and public/institutional buildings.[88]
- **Electricity demand increases with heat waves.** The number of days above 25ºC in Metro Vancouver would roughly double, from 18 now to more than 30 per year in 2050.[89] Average national growth for energy demand is forecast at approximately 1.1% each year to 2035.[90] BC Hydro reports out that peak daily and hourly demand is associated with the hottest and coldest weather of the year.[91] With increased heatwaves anticipated in Metro Vancouver, demand is likely to exceed existing forecasts that have not accounted for increased heatwaves. Rail systems in the region may be warped through intense heat. Train speeds can be reduced to mitigate impacts, which would affect service frequency and quality for commuter rail and goods movement by rail, particularly if ridership increases at a level not forecast.[92]

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[84] The Arlington Group Planning + Architecture Inc., EBA, De Jardine Consulting, & Sustainability Solutions Group. Sea Level Rise Adaptation Primer: A toolkit to build adaptive capacity on Canada's south coasts. British Columbia Ministry of Environment. P 9. Retrieved at: https://www2.gov.bc.ca/assets/gov/environment/climate-change/adaptation/resources/slr-primer.pdf

[85] Metro Vancouver (2018) Climate 2050 Discussion Paper. P 5. Retrieved at: http://www.metrovancouver.org/services/air-quality/AirQualityPublications/AQ_C2050-DiscussionPaper.pdf

[86] Metro Vancouver (2018) Climate 2050 Discussion Paper. P 5. Retrieved at: http://www.metrovancouver.org/services/air-quality/AirQualityPublications/AQ_C2050-DiscussionPaper.pdf

[87] Bakker, M. R., Wong, T. E., Ruckert, K. L. & Keller, K. (2017) Sea-level projections representing the deeply uncertain contribution of the West Antarctic ice sheet. Scientific Reports. Retrieved at: https://www.nature.com/articles/s41598-017-04134-5

[88] Fraser Basin Council (2016) Lower Mainland Flood Management Strategy: Phase 1 Summary Report. PP 4-19. Retrieved at: https://www.fraserbasin.bc.ca/Phase_1_Results.html

[89] Carman, T. (2017) Climate change in BC: Here's how 2050 could look. CBC News. Retrieved at: https://www.cbc.ca/news/canada/british-columbia/climate-change-in-b-c-here-s-how-2050-could-look-1.4146580

[90] National Energy Board (2013) Canada's Energy Future 2013: Energy Supply and Demand Projections to 2035. P 25. Retrieved at: https://www.neb-one.gc.ca/nrg/ntgrtd/ftr/2013/2013nrgftr-eng.pdf

[91] BC Hydro (2019) BC Hydro sets record for highest February power load. Retrieved at: https://www.bchydro.com/news/press_centre/news_releases/2019/february-power-load.html

[92] Spurr, B. (2016) GO train service wilts in summer heat. Toronto Star. Retrieved at: https://www.thestar.com/news/gta/transportation/2016/07/24/go-train-service-wilts-in-summer-heat.html

- **Warmer winters and less frost may improve road safety and increase opportunities for active transportation year-round.** While active transportation participation is not solely determined by the weather, it does have an impact, with 53% of respondents in the 2016 Mobi Member Survey stating they do not like riding in the rain and bad weather, which was the highest preventative reason from riding more often.[93] Conversely, with an increase of rain in the fall and winter, it is possible that this will offset any potential active-transport shifts from a weather perspective.
- **It's unclear what impact increased heat waves, decreased water supply, and decreased air quality may have on agricultural productivity.** The anticipated rising temperature of the region will change the type of crops that can be grown and also decrease energy requirements for greenhouses. Watershed snowpack is expected to decrease by over 50% by 2050 compared to present day, potentially impacting the region's water supply, thus impacting the water available for crop production.[94] With the increases in temperature, there will also be new pests and diseases that impact crops. More extreme precipitation and heat waves, along with limited water supply could also stress crops. At this point, it is difficult to determine whether there will be net benefits or losses.[95] See Agricultural Productivity & Food Security for more information.
- **Global population distribution and employment across most sectors is anticipated to change with climate change.** Roles particularly in the primary sector are anticipated to change as climate change impacts become more severe. The increased intensity and frequency of environment-related hazards that are exacerbated by climate change will make working in various conditions less safe or desirable. For example, anticipated flood levels are expected to exceed the durability of the region's dams, built primarily in the 1970s and 80s.[96] This will decrease average working-life years in some fields, while further requiring technological innovations for dangerous work. 34% of jobs in G20 countries rely on ecosystem services and effective and sustainable management of the environment.[97] In Metro Vancouver, the limited amount of primary sector work means that employment in the region will be less impacted than other parts of the province, country, and world. From a population perspective, sudden-onset climate-related hazards contributed to 24 million displaced people in 2016, far more than other geophysical hazards such as earthquakes, and more than those fleeing from conflict.[98] Many cities around the world are in low-lying areas or adjacent to major water bodies. With urbanization occurring and more rural-to-urban movement, population vulnerability is also increasing. By 2050, it is anticipated that the mobility of up to 200 million people will be impacted by climate change while other research suggests 25-30 million global climate migrants annually.[99]
- **A major earthquake disaster could significantly impact population and job growth.** In New Zealand, the Christchurch-Canterbury earthquakes of 2010/2011 have seen the city's population decrease by 2.4% compared to June 2011; prior to this period, the city's population was growing by 1% per year. Total employment in the region decreased by 8% (26,800), with accommodation, food services and retail sectors being hit the hardest. Notably, the construction industry increased by 18% (4,500 people) during and after this period. International and domestic tourism declined by 32% and 23% respectively since the earthquakes. An estimated total net cost to the Crown for clean up and reconstruction from the earthquakes is $13.5 billion. [100] While the Canterbury region is not Metro Vancouver, much can be learned from these impacts in a developed part of the world.

What this Means for the Future of Metro Vancouver:

- Metro Vancouver is one of the highest-risk regions in Canada from a multi-hazard perspective with potential for earthquakes, coastal and riverine flooding, and heatwaves and drought. Many of these risks will increase as a result of climate change.

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[93] Dr. Meghan Winters' Cycling Research Team (2017) Understanding a New Bikeshare Program in Vancouver: 2016 Mobi Member Survey Results. SFU. P 17. Retrieved at: http://cyclingincities-spph.sites.olt.ubc.ca/files/2019/01/Mobi-Member-Survey_2016Results_20170411_SentToPartners.pdf
[94] Metro Vancouver (2018) Climate 2050 Discussion Paper. P 5. Retrieved at: http://www.metrovancouver.org/services/air-quality/AirQualityPublications/AQ_C2050-DiscussionPaper.pdf
[95] Whiting, D., & Lai, C. (2008) Climate Variable Mapping and Agriculture: Metro Vancouver. Retrieved at: http://www.metrovancouver.org/services/regional-planning/PlanningPublications/Climate_Variable_Mapping_report_final.pdf
[96] Metro Vancouver (2018) Climate 2050 Discussion Paper. P 6. Retrieved at: http://www.metrovancouver.org/services/air-quality/AirQualityPublications/AQ_C2050-DiscussionPaper.pdf
[97] International Labour Organization (2018) The employment impact of climate change adaptation: Input document for the G20 Climate Sustainability Working Group. Retrieved at: http://www.g20.utoronto.ca/2018/ilo_-_the_employment_impact_of_climate_change_adaptation.pdf
[98] Stapleton, S. O., Nadin, R., Watson, C., & Kellett, J. (2017). Climate change, migration and displacement: The need for a risk-informed and coherent approach. Overseas Development Institute. Retrieved at: https://www.odi.org/sites/odi.org.uk/files/resource-documents/11874.pdf
[99] Ibid.
[100] New Zealand Parliament (2011) Economic effects of the Canterbury earthquakes. Retrieved at: https://www.parliament.nz/en/pb/research-papers/document/00PlibCIP051/economic-effects-of-the-canterbury-earthquakes

- Flooding from rivers or rising sea-levels could lead to changes in the desirability of land within the flood plain. By 2050, sea level rise will be relatively minor (~0.5m) with uncertainty on how much increase there will be thereafter. Infrastructure built today will last well beyond 2050; regional planning today must account for uncertainties associated with long-term flood risk and sea level rise. A decreased regional land base should be considered for population and employment distribution going forward.
- A major earthquake in the Metro Vancouver region could have significant impact on population and employment, among damages to buildings, transport, water mains and many other services we rely on for everyday life. Low-lying parts of the region are also susceptible to liquefaction, which will absorb roadways and building foundations like quicksand.
- The region is going to become warmer, with increased heat waves during the summer. These heatwaves could create slow downs for public transportation, by way of rail warping for SkyTrain and West Coast Express. In turn, this lack of reliability could result in a change of mode choice and/or trip demand.
- From a global perspective, employment particularly in the primary sector will be heavily impacted by climate change. In Metro Vancouver, due to limited participation in the primary sector, impacts will be less felt. Jobs associated with agricultural and industrial lands in the flood plain are at highest risk of being impacted.
- Active transportation in the region may increase with warmer weather. It's possible that this will be offset by more precipitation in winter and fall months as rain is seen as one of the largest deterrents for cycling in the region.
- Some regional stakeholders commented on impacts related to natural hazards and climate change:
    - The cost of dyke construction has largely been downloaded to cities, where property tax is not sufficient to finance infrastructure upgrades. (See Federal Infrastructure Funding and Local Government's Growing Role for more information). Further to this, there needs to be a coordinated response to dyke infrastructure if passed to a municipal level, as lack of response from one municipality may impact adjacent municipalities.
    - Areas vulnerable to flooding from sea level rise are well known in the region, and evacuation route planning and simulation will be required as this becomes an increasing eventuality. King tides are happening more frequently which is an early warning of how sea level rise will impact parts of the region.
    - Metro Vancouver may see an increase in provincial refugees from wildfires impacting other parts of the province.
    - As the region becomes warmer, there will be an increased energy draw from air conditioning units. Passive housing may be a way to counteract the energy draw for newer buildings. See Advanced Building Construction Technology for more details.
    - Seismic retrofits were identified as something that cost significantly less money before earthquakes than redevelopment post-earthquake. Buildings 4-6 stories tall are most impacted by earthquakes.

3.9 E-COMMERCE & BLOCKCHAIN

Overview

E-Commerce accounts for any transaction conducted over the internet for the purchase of goods or services. Growth in E-Commerce has been driven by expanded access to mobile technology and the internet. A blockchain is a digital, secure, decentralized record of transactions (i.e. a ledger) whether it is for money, goods, property, work, or votes. It makes it simple to see if anyone has changed any parts of the chain which helps against illegal transactions. Blockchains allows users to verify their identities and protect ownership of their assets without the need of an intermediary.

What is Happening Right Now:

- **A lack of available industrial land is resulting in missed economic growth and increasing land pressures.** Regional industrial development is growing as a result of the demands of retailers and e-commerce, leading to a shift away from traditional industrial uses. This is in part due to evolving consumption patterns and changes in consumer behavior away from traditional brick-and-mortar retail towards more online-shopping, while still wanting the benefit of immediate shipping – as of 2016, 80% of Canadians reported having shopped online that year,[101] and retail e-commerce sales in Canada are anticipated to reach $94 billion in 2021, accounting for 13.7% of total retail sales.[102] As a result, there are shrinking retail footprints and expansion of distribution centres. A lack of large plots of available industrial land for these distribution purposes is resulting in major users (e.g. Costco, Amazon) looking to other regions such as Calgary. The changing nature of consumption creates additional land pressures on the region, with limited supply available.[103] This adjustment from traditional industrial uses is continuing to erode industrial land availability, with 2.7% available down from a previous record low of 3.8% in the region.[104]

- **Blockchain has the potential to change the real estate market through increased transparency and decreased transaction costs.** There is a greater demand for transparency and property-related information to be available in a digital form. Blockchain platforms such as bitcoin and the crypto market exceeds $100 billion currently. The value of blockchain is projected to exceed $176 billion by 2025, and $3.1 trillion by 2030.[105] Tying separate systems together is where blockchain could help, decreasing potential for fraud in all types of real estate transactions. With blockchain efficiencies, there is also a potential to limit intermediaries and decrease costs associated. At this point, there are no clear indicators that suggest how fast this technology would be adopted and whether time and money savings will come to fruition in real estate markets and whether this transparency would lead to a potential increase in housing stock through improved efficiency.[106]

- **Blockchain is anticipated to streamline the global movement of freight**. Trade complexity often comes with conflicts in prioritization, inaccurate data on invoices and different tracking systems. Reducing these barriers could lead to 5% increase in global GDP and an increase of global trade by 15%. As a coastal port region, Metro Vancouver stands to receive some of these suggested benefits, with efficiencies in the transport network as well.[107]

What this Means for the Future of Metro Vancouver:

[101] Canada Post. (2017) Looking to attract the Canadian millennial shopper? Get to know them first. Retrieved at: https://www.canadapost.ca/web/en/blogs/business/details.page?article=2017/03/20/canadian_millennials&cattype=business&cat=shipping
[102] Briggs, P. (2018) E-Commerce in Canada 2018: eMarketer's latest forecast with a focus on grocery. P 2. Retrieved at: https://emdev1euseditorialassets.blob.core.windows.net/1ec27ae58cabc93603621d3d74c6e912/67
[103] Avison Young (2015) Metro Vancouver Industrial Overview. P 8. https://www.avisonyoung.ca/documents/20342/570840/Vancouver_IndustrialOverview_Spring2015.pdf/aab55cd6-9f8e-4225-a2c9-0142184ba5d8?t=-1998266084
[104] Laanela, M. (2017) Metro Vancouver running out of industrial land. CBC News. Retrieved at: https://www.cbc.ca/news/canada/british-columbia/metro-vancouver-running-out-of-industrial-land-1.4117401
[105] World Economic Forum. (2018) Building Block(chain)s for a Better Planet. P 11. Retrieved at: http://www3.weforum.org/docs/WEF_Building-Blockchains.pdf
[106] Deloitte. (2017) Blockchain in commercial real estate: The future is here! P 3. Retrieved at: https://www2.deloitte.com/us/en/pages/financial-services/articles/blockchain-in-commercial-real-estate.html
[107] DHL Trend Research. (2018) Blockchain in logistics: Perspectives on the upcoming impact of blockchain technology and use cases for the logistics industry. P 13. Retrieved at: https://www.logistics.dhl/content/dam/dhl/global/core/documents/pdf/glo-core-blockchain-trend-report.pdf

- E-Commerce can be expected to continue to impact land demand, with traditional retail shifting to smaller footprints, and more of a demand on industrial land for fulfillment, shipping, and distribution centres. This will in turn create lower land availability for traditional industrial land uses, in a region that already is limited in this regard.
- Supply chain efficiency could be expected to increase through blockchain technology, though at this point it is too early to determine if this will create significant adjustments to trip rates.
- Blockchain has the potential to improve efficiency of all types of real estate transactions. While this may not change land demand, it could remove intermediaries, increasing affordability, and potentially demand.
- This external force was not incorporated during stakeholder workshops and therefore did not receive feedback from subject matter experts or local representatives.

3.10 ELECTRIC MOBILITY

Overview

Electric vehicles (EVs) operate by electric propulsion rather than an internal combustion engine. This includes a number of different forms such as hybrid electric vehicles (HEV), Plug-in Hybrid Electric Vehicles (PHEV), and Battery Electric Vehicles (BEV).

What is Happening Right Now:

- **BEVs continue to have range limitations, potentially constraining growth of trip distance and trip rate.** EV adoption in Canada grew in 2017 with close to 50,000 plug-in vehicles in the country, and a 68% growth in sales that year,[108] and could make up between 12-20% of the vehicle fleet in BC by 2030. Further to this, the province of BC passed the Zero-Emission Vehicles Act that sets a target of all vehicles sold in BC to be zero emissions by 2040.[109] While electric vehicle batteries and range continue to improve each year, there are still current findings that suggest extreme weather, and use of heating and air conditioning can drastically decrease battery life. This would in turn impact range the vehicle could travel, and potentially decrease average trip distance. That said, with currently limited market penetration, it is unlikely those who travel longer distances may opt for an electric vehicle in the coming decades unless significant improvements to range are seen.[110]
- **Not all housing is equipped for EV charging.** Findings suggest 38% of early mainstream EV buyers will struggle with access to home-based charging. Metro Vancouver consumer preference research suggests that 2 in 5 buyers will struggle with home-based charging which would be a barrier to uptake and could affect tens of thousands of households in coming years.[111] To help mitigate this impact and increase access, BC Hydro along with partners have installed over 300 Level 2 charging stations for public use in urban areas and 30 DC fast chargers to enable EV travel along major transportation corridors across BC.[112]
- **Electric trucks and buses may decrease environmental impact of goods and people movement.** In 2017, Thor Trucks (now Xos Trucks) developed a class 8 tractor capable of pulling 80,000 lbs and a range of up to 300 miles, with regenerative braking and charge times as low as 90 minutes. While perhaps not practical for long-haul trucking (yet), this type of truck provides a 100% emission free option that is less expensive to maintain and fuel than conventional options.[113, 114] With regards to the movement of people, TransLink is currently developing a low carbon fleet strategy, demonstrating zero-emission battery electric buses, and procuring renewable fuels.[115]

What this Means for the Future of Metro Vancouver:

- Aside from major emission benefits, electric mobility may have transport implications. Limited range may impact electric vehicle uptake. Conversely, high capital cost (purchasing the EV) and low operating costs (extremely inexpensive fueling) could result in an increase in trips, particularly over short distances around the region.
- Due to lack of home-based charging options, it's possible there could be a slight change in population distribution with preference towards having home charging infrastructure. There is no current literature to suggest that electric vehicles are enough to sway a portion of the population to adjust their housing situation.

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[108] Lambert, F. (2018) Report shows electric vehicle sales grew 68% in Canada last year. Electrek. Retrieved at: https://electrek.co/2018/02/09/report-electric-vehicle-sales-canada/
[109] Baker, R. (2019) BC passes law to increase sales of zero emission vehicles. CBC News. Retrieved at: https://www.cbc.ca/news/canada/british-columbia/zero-emission-vehicles-2040-b-c-1.5155274
[110] AAA (2019) AAA Electric Vehicle Range Testing. P 3. Retrieved at: https://www.aaa.com/AAA/common/AAR/files/AAA-Electric-Vehicle-Range-Testing-Report.pdf
[111] Metro Vancouver (2018) Key insights about electric vehicle consumer preference in Metro Vancouver. Retrieved at: http://www.metrovancouver.org/services/air-quality/AirQualityPublications/2017CanadianZeroEmissionsVehicleSurveyinMetroVancouver-2018Jan15-5.6aAttachment.pdf
[112] BC Hydro. (2018) ecoEnergy Innovation Initiative – The BC Electric Vehicle Smart Infrastructure Project. P 5. Retrieved at: https://www.bchydro.com/content/dam/BCHydro/customer-portal/documents/power-smart/electric-vehicles/ev-project-reports.pdf
[113] Peters, A. (2018) These electric semis hope to clean up the trucking industry. Fast Company. Retrieved at: https://www.fastcompany.com/40552884/2018-world-changing-ideas-awards-winners-developing-world-energy-thor-trucks
[114] Xos Trucks. Retrieved at: https://xostrucks.com/et-one/
[115] TransLink. (2018) I Love Transit 2018: TransLink keeps sustainability in focus. Retrieved at: https://buzzer.translink.ca/2018/10/i-love-transit-2018-translink-keeps-sustainability-in-focus/

- It is not anticipated that a transition towards electric mobility will have significant impacts to employment distribution, employment by sector, or land use demand.
- Regional stakeholders identified the following impacts:
    - Greenhouse gas emissions will be reduced, if the trend towards electric mobility continues, which will have a positive impact on air quality.
    - EVs will not solve congestion, they will only reduce greenhouse gases. The current inexpensive pricing of electricity in BC could incentivize more driving.
    - The current fuel tax will not be robust if there is significant uptake of EVs. This will impact revenues for TransLink and impede transport infrastructure spending unless replaced through another mechanism.
    - It remains to be seen how popular electric active modes will be in the region (e-bikes, e-scooters).
    - Closing of gas-stations may create more opportunities for infill in the region, but these are also often contaminated sites.
    - There will be higher electrical demand on the grid, particularly overnight when most charging would likely occur, when use has previously been lower. BC Hydro may require expansion of infrastructure across the region to account for this 24-hour electricity demand.

3.11 FEDERAL IMMIGRATION POLICY

Overview

Immigration has been an essential component in making Canada grow to what it is today. People born outside of Canada currently represent approximately one in five people in Canada. Immigration makes an important economic and social contribution to the country for immediate and long-term outcomes. With an aging population and low natural replacement rates, immigration is the reason why the national population continues to grow.

What is Happening Right Now:

- **Immigrant-owned companies contribute to more employment than non-immigrant owned companies.** Firms owned by immigrants accounted for a disproportionate share of job creation. These firms accounted for 25% of jobs created, while only representing 17% of the firms studied. Among firms studied, very few firms actually accounted for much of the job creation and job loss. Most companies create or lose few jobs. Working from these findings, an increase to immigration in coming years could lead to an increase in total employment.[116] This is not specific to a single employment sector. Canada currently has one of the highest per capita admission rates of immigrants at approximately 200,000 immigrants and refugees per year over the last decade.[117] This number is expected to climb to over 300,000 per year over the next several years.[118] As the immigrant population grows and Canada continues to experience an aging population and low fertility rate, based on the studies, it is expected that more jobs will be created should a proportion of these newcomers start their own businesses or take over existing ones.
- **Recent immigrants in Metro Vancouver are most likely to work in retail trade, health care and social assistance, or professional, scientific and technical services.** Recent immigrants were also more likely to work in accommodation and food services than Canadian born workers whereas Canadian born labour force was noticeably more likely to work in educational services.[119] Half of these recent immigrants (2011-2016) are living in Toronto (29%), Montreal (15%) and Vancouver (12%), and only 9% of recent immigrants live in non-census metropolitan areas.[120]

Table 1: Distribution of top ten occupations by % labour force, population aged 15 years and over.[121]

	Metro Vancouver		
	Canadian Born	Total Immigrants	Recent Immigrants
44-45 Retail trade	11.1%	11.0%	12.2%
62 Health care and social assistance	9.6%	10.9%	7.7%
54 Professional; scientific and technical services	9.8%	9.9%	10.8%
72 Accommodation and food services	7.6%	9.0%	13.0%
31-33 Manufacturing	5.1%	7.7%	7.2%
23 Construction	7.8%	6.5%	7.7%
48-49 Transportation and warehousing	5.2%	6.0%	3.9%
61 Educational services	8.5%	5.8%	4.7%
52 Finance and insurance	4.6%	5.1%	3.7%
56 Administrative and support; waste management and remediation services	4.1%	5.0%	5.8%

[116] Picot, G. & Rollin, A. M. (2019) Immigrant entrepreneurs as job creators: The case of Canadian rivate incorporated companies. Statistics Canada. P 19. Retrieved at: https://www150.statcan.gc.ca/n1/en/pub/11f0019m/11f0019m2019011-eng.pdf?st=OW4ddwIw
[117] Smick, E. (2006) Canada's Immigration Policy. Council on Foreign Relations Retrieved at: https://www.cfr.org/backgrounder/canadas-immigration-policy
[118] Government of Canada (2018) Notice – Supplementary Information 2019-2021 Immigration Levels Plan. Retrieved at: https://www.canada.ca/en/immigration-refugees-citizenship/news/notices/supplementary-immigration-levels-2019.html
[119] Immigration, Refugees, and Citizenship Canada (2018) Immigrant Demographics: Vancouver, BC 2018. Retrieved at: https://newtobc.ca/wp-content/uploads/2013/07/Vancouver-Immigrant-Demographic-Profile-2018.pdf
[120] Statistics Canada (2017) Geographic distribution of immigrants and recent immigrants and their proportion within the population of census metropolitan areas, Canada, 2016. Retrieved at: https://www150.statcan.gc.ca/n1/daily-quotidien/171025/t001b-eng.htm
[121] Immigration, Refugees, and Citizenship Canada (2018).

- **Recent immigrants use public transit more than Canadian-born persons.** A Statistics Canada study in 2004 compared transit usage of recent immigrants to Canadian-born persons. In every CMA, transit usage was significantly higher (often double) that of Canadian-born persons. Immigrants who immigrated more than 20 years ago were more in line with average population transit use.[122] With 44% of Metro Vancouver residents being born outside of Canada, and immigration expected to increase, overall amenity preferences (not just public transit use) may change.[123]

Table 2: Percent of persons who use public transportation to commute to work, by immigration status, selected CMAs, 2001[124]

	Canadian-born	Immigrated within past 10 years	Immigrated 11 to 20 years earlier	Immigrated more than 20 years ago	Total
Montréal	20.9	48.6	35.5	24.5	23.6
Toronto	20.7	36.3	26.8	19.9	24.0
Ottawa-Hull	18.5	33.8	26.5	18.9	19.9
Calgary	13.6	25.8	17.0	13.5	14.8
Winnipeg	14.1	24.5	16.4	12.7	14.5
Vancouver	11.4	21.1	14.7	11.0	13.1
Edmonton	9.4	19.6	11.8	7.8	9.9
Victoria	10.8	18.3	13.9	8.9	11.0
Hamilton	8.5	16.7	10.8	6.5	8.8
London	6.8	15.1	8.0	4.0	6.9
Windsor	3.3	9.8	5.3	1.8	3.6
Kitchener	4.5	9.0	6.1	2.5	4.6

What this Means for the Future of Metro Vancouver:

- A continued upward trend in federal immigration rates may result in higher transit ridership than expected.
- Associated employment with immigrant-owned companies result in a slight uptick in overall employment. There is limited research to suggest that employment distribution within the region will be overly impacted by federal immigration policy.
- Most immigration occurs within census metropolitan areas, with Metro Vancouver having the third highest intake in Canada after Toronto and Montreal.
- As continued upward trends in federal immigration rates occur, sectoral employment may shift based on statistics that counter Canadian-born labour force participation rates.
- This external force was not incorporated during stakeholder workshops and therefore did not receive feedback from subject matter experts or local representatives.

[122] Heisz, A. & Schellenberg, G. (2004) Public Transit Use Among Immigrants. Statistics Canada. P 3. Retrieved at: https://www150.statcan.gc.ca/n1/en/pub/11f0019m/11f0019m2004224-eng.pdf?st=T8Lqr3CU
[123] Todd, D. (2017) "Visible minority" now meaningless term in Metro Vancouver, Toronto. The Vancouver Sun. Retrieved at: https://vancouversun.com/opinion/columnists/douglas-todd-visible-minority-now-meaningless-term-in-metro-vancouver
[124] Heisz, A. & Schellenberg, G. (2004).

3.12 FEDERAL INFRASTRUCTURE FUNDING & LOCAL GOVERNMENT'S GROWING ROLE

Overview

There has been an increased responsibility on regional and local municipalities with regards to funding and operating infrastructure that previously has received increased support from higher orders of government. With consistent pressure to keep property taxes low, local authorities are in a continuous struggle to meet demands of their constituency while also keeping a balanced ledger.

What is Happening Right Now:

- **Regional population and employment distribution may be impacted without substantial dike upgrades.** Fraser Basin Council analysis suggests that only 4% of dikes in the region are built to a sufficient standard to withstand their design flood scenario. With transfer of infrastructure funding directed more at municipalities and less to the province and federal government, it's difficult to determine how upgrades will be funded.[125] Flood infrastructure in BC was largely federally and provincially funded through the Fraser River Flood Program until 1994. Updated dike standards will be costly for municipalities to upgrade and are not seeing the same federal and provincial matching that has previously existed.[126] Additionally, federal regulations (such as wastewater treatment regulations in 2012) have billions of dollars in implications for local government infrastructure with unclear cost-sharing from higher level governments. Metro Vancouver estimates costs at $1.5-$1.7 billion.[127, 128]

- **Senior government contributions to public transit allow for sustainable growth in operations and services.** Senior levels of government currently funds approximately 5% of transit operations in Metro Vancouver and generally up to 48% of transit infrastructure investments. [129] If there are trends towards less senior government funding, transit infrastructure would struggle to acquire necessary investment, and some transit projects may see cancellations due to lack of funding and shifting priorities, reallocating funds to other projects.[130] As a result, service coverage, reliability, and frequency would all fall, likely resulting in decreased ridership and increased auto mode share. Service deficits also risk increasing as operating funding is more difficult to obtain than capital funding. This has already resulted in service deficits in many Canadian transit agencies.[131] Canadian municipalities are requesting the federal government establish permanent annual funding for public transit of $3.4 billion starting in 2028 to make long-term plans and reduce project delays.[132]

What this Means for the Future of Metro Vancouver:

- Land availability in parts of Metro Vancouver are contingent on upgrading infrastructure. If there is a lack of federal support for investing in this infrastructure, the region, along with its municipalities may need to re-evaluate how it plans to use its lands.

- Transport infrastructure requires backing from higher levels of government. These investments will continue to undulate with new governments and changing priorities.

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[125] Fraser Basin Council (2016) Lower Mainland Flood Management Strategy: Phase 1 Summary Report. PP 25-29. Retrieved at: https://www.fraserbasin.bc.ca/Phase_1_Results.html
[126] Hoekstra, R. (2011) Costly new dike standards to pinch BC cities' budgets, including Richmond. Richmond News. Retrieved at: https://www.richmond-news.com/news/costly-new-dike-standards-to-pinch-b-c-cities-budgets-including-richmond-1.495378
[127] Ibid.
[128] Paris, M. (2011) Who will pay for cleaning up Canada's raw sewage? CBC News. Retrieved at: https://www.cbc.ca/news/canada/who-will-pay-for-cleaning-up-canada-s-raw-sewage-1.1091522
[129] TransLink. (2018) Phase Two of the 10-Year Vision: 2018-2027 Investment Plan. Retrieved at: https://www.translink.ca/-/media/Documents/plans_and_projects/10_year_plan/10-year_vision_phase_2_investment_plan.pdf
[130] CBC News (2018) Only project paused by Ford government spending halt is Hamilton's LRT: Metrolinx. Retrieved at: https://www.cbc.ca/news/canada/hamilton/hamilton-lrt-metrolinx-eisenberger-1.4805442
[131] Wilt, J. (2017) Here's why Canadian cities struggle to pay for public transit. The Narwhal. Retrieved at: https://thenarwhal.ca/here-s-why-canadian-cities-struggle-pay-public-transit/
[132] Curry, B. (2018) Cities seek permanent transit transfer ahead of 2019 budget. The Globe and Mail. Retrieved at: https://www.theglobeandmail.com/politics/article-cities-seek-permanent-transit-transfer-ahead-of-2019-budget/

- Some regional stakeholders indicated that while municipalities are being burdened with more responsibility, they can also respond faster than higher levels of government. The high demand of services in municipalities is going to be difficult to service with a relatively low tax base. Creative solutions could include considering amalgamation of municipalities in the region, which may solve some problems while creating others. A current issue that is already being seen in the hand down of responsibility is that immigration is largely a federal responsibility, but the provision of services and accommodating new residents often falls to municipalities.

3.13 GIG ECONOMY & PRECARIOUS EMPLOYMENT

Overview

The emergence of a more casual, temporary, and/or flexible employment style with a general shift from permanent, full-time work to temporary, contract, and freelance work. This work is often underpinned by digitisation. The gig economy is based on workers taking on various individual gigs, as opposed to full-time work, and its precariousness is marked by a lack of job security and social benefits like extended health insurance and pension plans. The work is often low paid and cyclical, requiring individuals to continuously look for new assignments to maintain a steady flow of income.

What is Happening Right Now:

- Workers who find themselves in the gig economy are often low-paid and work fewer hours, resulting in less purchasing power for housing and transport. These individuals often also lack extended health insurance, training, and retirement benefits, adding further uncertainty to their lives, with many noting having experienced regular stress as a result.[133] Several current and emerging start-up business models rely on the gig economy as a key part of their labour force that delivers the primary service. As Canada's service-based economy continues to grow, more individuals may find themselves primarily in the gig economy.
- The Canadian workforce is interested in more flexibility with regards to hours and location of work. BC has one of the largest proportions of self-employed workers in Canada at 18%,[134] and many individuals have stated they would prefer some type of self-employment or increased flexibility for working location and hours, rather than traditional salaried positions at fixed offices.[135, 136] Combined with the point above, this may lead to fewer working hours, lower compensation, and a downwards trend in wealth/earning. This may impact demand for certain housing stock if regional employment is less able to afford existing supply.
- The combination of gig work and the use of co-working spaces could impact regional travel patterns. While the percentage of people working from home has declined nearly 1 percentage point between 1996 and 2016, the percentage of people with no fixed workplace increased nearly 4 percentage points to 11.5% over the same period.[137] This indicates that telecommuting is not particularly prevalent for standard workers, though co-working spaces and working from a location other than an office is increasing as the gig economy expands. Individuals in the gig economy are likely to make more multi-dimensional trips[138] than their traditional counterparts as they move from gig to gig throughout the day.[139] If enough people are making these types of trips, peak period travel may become less specific and employment nodes may change. There may also be less public transit use if individuals are needing to connect gigs across the region that aren't time-competitive if undertaken on transit. Similarly, transit use may also decrease if there is an increase in workers that are telecommuting from home or nearby co-working locations.

What this Means for the Future of Metro Vancouver:

- Data and definitions surrounding non-standard work still lack clarity and consensus, making it difficult to assess the full impacts of precarity in the labour market. Furthermore, much of the data on employee preference is based on surveys of select individuals, resulting in aggregate data that may not accurately identify the total impact on the labour market and other sectors of the economy.

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[133] Vancity (2018) Independent's Day: Why gig work is taking hold in BC Retrieved at: https://www.vancity.com/SharedContent/documents/pdfs/News/Vancity-Report-Gig-Economy-2018.pdf
[134] Vancity (2018).
[135] Wang, S. (2015) 70% of employees would quit their jobs for a remote-working one. Retrieved at: https://www.canadianbusiness.com/innovation/70-of-employees-would-quit-their-jobs-for-a-remote-working-one/
[136] CPA Canada (2018) Does telecommuting help or hinder an enterprise? Retrieved at: https://www.cpacanada.ca/en/news/canada/2018-05-16-does-telecommuting-help-or-hinder-an-enterprise
[137] Statistics Canada (2017) Journey to work: Key results from the 2016 Census. Retrieved at: https://www150.statcan.gc.ca/n1/daily-quotidien/171129/dq171129c-eng.htm
[138] Note: Multi-dimensional trips is the process of taking multiple trips using one or multiple modes to connect destinations, before returning to a home destination. Also referred to as trip-linking.
[139] Metrolinx (2016). Further Connecting the Greater Toronto and Hamilton Region: Discussion Paper for the Next Regional Transportation Plan. Retrieved at: http://www.metrolinx.com/en/docs/pdf/board_agenda/20160628/20160628_BoardMtg_RTP_Draft_Paper_EN.PDF

- The housing market may also be impacted as increased casual employment may not provide workers with enough capital to put down payments on homes, requiring more to rent. Impacts to transportation could be prominent, as there are indications that VKT may increase as people travel to more locations, and that there is a risk of traditional peak hours blending together to create an all-day peak. This however may be offset by an increased number of people working from home.
- Some regional stakeholders commented that we are more likely to see increases in casual employment in the future, and that the aging population is likely to contribute to this trend. Casual employment will also likely cause a shift away from a traditional 9-5 working pattern to a 24/7 on-demand economy. They also noted that as this trend continues, corporations will see higher profits through shifts to hoteling styles of work at offices or use of co-working spaces to decrease overhead, and employees will likely have fewer benefits and protections, exacerbating the wealth gap as a result.

3.14 GLOBAL OUTSOURCING & RE-SHORING

Overview

A common global trend is the outsourcing of certain business processes to other countries where tasks can be completed at a lower cost. Much of the outsourcing has been related to manufacturing and call centre jobs. The next wave of outsourcing includes knowledge sector jobs such as information technology. This is being counteracted by re-shoring, the bringing back of previously outsourced jobs back to a nation, for certain industry processes, either for efficiency or for increases in national employment.

What is Happening Right Now:

- The re-shoring of businesses is likely to result in highly automated facilities and processes, with little human labour required. Outsourcing is becoming less about cost cutting and increasingly about enhancing competitive advantage, efficiency, accuracy, and agility.[140] As a result, the global market size for outsourced services peaked in 2014,[141] as disruptive outsourcing begins to replace traditional outsourcing of services.[142] Approximately 84% of survey respondents for Deloitte's 2018 Global Outsourcing Survey indicated they have initiated discussions, conducted pilots, or fully implemented disruptive solutions to their businesses.[143] Disruptive technologies are being used as tools to re-shore Canadian manufacturing processes as wages in Asian countries rise, resulting in the creation of highly automated factories that improve production speed and flexibility, and help protect from low quality manufacturing.[144] It also drastically reduces the labour force required.[145] While many machines are able to do the work of multiple humans, and automated warehouses may take up less space on the ground, industrial land vacancy rates in Metro Vancouver are low and rezoning to increase land for future warehouses may be required.[146] However, automated facilities may help reduce industrial sprawl as they have the possibility of being built up, similar to the idea of vertical farming.[147] See Agricultural Productivity & Food Security for more information.
- Goods movement patterns are likely to be impacted as a result of either outsourcing or re-shoring changing supply chains in Metro Vancouver. Re-shored manufacturing along with just-in-time delivery is likely to change distributional infrastructure, potentially freeing up significant lane resources for new industry and competing uses.[148] Updating of truck routes and other freight-related policies may be required to account for potential re-shoring activities. That said, manufacturing processes in the region are relatively limited, so it is difficult to determine how much re-shoring of this type of sector may realistically occur.[149]

What this Means for the Future of Metro Vancouver:

- If the trend towards less outsourcing and increased re-shoring continues, the need for industrial and commercial land is likely to increase, while creating new jobs primarily in the service sector. It is possible that re-shoring of tasks may return to the region, but not necessarily employment to go along with the tasks. See 3D printing or Advanced Building Construction Technology for more information. With additional manufacturing, there may be an increase in goods movement around the

[140] Plotkin, D. (2018). Disruptive Technologies Shake Up Outsourcing. The Wall Street Journal. Retrieved at: https://deloitte.wsj.com/cio/2018/12/04/disruptive-technologies-shake-up-outsourcing/
[141] Statistia (2019). Global market size of outsourced services from 2000 to 2018. Retrieved at: https://www.statista.com/statistics/189788/global-outsourcing-market-size/
[142] Disruptive outsourcing is an outsourcing process that uses emerging (disruptive) technologies like the cloud and robotic process automation to complete tasks, effectively reducing the amount of traditional outsourcing, and increasing re-shoring as these processes can be initiated locally.
[143] Plotkin, D. (2018). Disruptive Technologies Shake Up Outsourcing. The Wall Street Journal. Retrieved at: https://deloitte.wsj.com/cio/2018/12/04/disruptive-technologies-shake-up-outsourcing/
[144] Poloz, S. (2019). Poloz talks trade: Canada's services a bright spot. Bank of Canada. Retrieved at: https://www.bankofcanada.ca/2019/04/poloz-talks-trade-canadas-services-bright-spot/
[145] Groom, B. (2018) Reshoring: bringing manufacturing home. Raconteur Media Ltd. Retrieved at: https://www.raconteur.net/manufacturing/reshoring-manufacturing-home
[146] Penner, D. (2019). BC's industrial land squeeze spreads well beyond the Lower Mainland. Vancouver Sun. Retrieved at: https://vancouversun.com/business/commercial-real-estate/b-c-s-industrial-land-squeeze-spreads-well-beyond-the-lower-mainland
[147] Vincent, J. (2018). Welcome to the automated warehouse of the future. The Verge. Retrieved at: https://www.theverge.com/2018/5/8/17331250/automated-warehouses-jobs-ocado-andover-amazon
[148] Hutton, T. & Barnes, T. (2018) Metro Vancouver Industrial Lands Report 2018 – Industrial Lands and the Innovation Economy. P 7. Retrieved at: http://www.metrovancouver.org/services/regional-planning/PlanningPublications/IndustrialLandsandtheInnovationEconomy-Jun2018.pdf
[149] Statistics Canada (2018) Employment by industry, annual average, in thousands – Metro Vancouver. Retrieved at: http://www.metrovancouver.org/services/regional-planning/PlanningPublications/EmploymentbyIndustry.pdf

region if re-shoring increases substantially, connecting different manufacturing processes and parts within and outside the region.

- Some regional stakeholders outlined the following:
    - The trend of outsourcing is currently happening and has shifted from manufacturing to the knowledge sector, though there are some jobs which cannot be outsourced, where there is a significant social interaction component, such as the service industry.
    - While not directly outsourcing or re-shoring, some large multinational corporations are opening satellite offices in Vancouver, indicating a distributed business trend for some companies.
    - Automation will effectively remove the cost of labour, making the cost of transportation along the supply chain more important, and changing the competitive advantage of outsourcing.
    - The negative impacts of job loss resulting from outsourcing can be mitigated with retraining programs.
    - Government should strive towards keeping a diverse regional economy so that a dip in one sector does not disproportionately affect the entire regional economy.

3.15 GREEN ENERGY TRANSITION

Overview

A combination of forces motivating a transition of energy sources towards renewables and low emission sources, reshaping energy systems. These include pricing policies from government, changes to the costs of production and supply, technology improvements, and change in demand from the market.

What is Happening Right Now:

- **The global energy transition away from fossil fuels and non-renewable resources is underway.** Germany is part of this energy transition. Since beginning their *Energiewende* as policy in 2010 (but socially as early as 1980), jobs in renewables have outpaced jobs in coal in Germany.[150] Natural gas, oil, and uranium sources may all be depleted by the end of the 21st Century if they continue to be extracted at the current rate,[151] and the global demand for oil is expected to peak between 2020 and 2040, supported by the economics of alternative sources and public policy.[152] Further, trillions of dollars of investments are being divested from carbon-intensive companies. Countries, major cities, and pension funds are selling shares from coal, oil and gas companies and investing in clean energy.[153] As the demand for fossil fuels decreases due to social and policy initiatives, jobs in those sectors will be lost. Renewables provide the opportunity to replace these jobs, and may even provide more energy sector jobs than ever before, helping to keep pace with population growth.

- **The energy transition may be impacted by growing demands for electricity as ZEVs increase in popularity and become required for new vehicles in BC.** Government fleets in BC are piloting the use of ZEVs, with the goal of a full transition.[154] Paired with the increase in consumer purchases of ZEVs (and the Premier stating that all new cars sold in the province from 2040 onwards must be ZEVs),[155] as well as programs like Clean Energy Vehicles for BC, and increases in population, demand for electricity is expected to increase nearly 40% by 2047. See Electric Mobility for further information. Grid electricity in BC (and Metro Vancouver) is primarily generated by hydroelectric dams, and the Province has plans to decarbonize the energy system, which can help alleviate the impact of growing electricity demand.[156] However, BC Hydro expects that the current supply (without Site C improvements) will result in an energy deficit of 2% in 10 years, an equivalent amount of power needs of 100,000 homes.[157]

- **Energy sprawl may have a land use impact while transitioning to renewables.** On the path towards a renewable BC, energy sprawl must be carefully monitored.[158] As fossil fuel plants are shut down, less gas stations are required, and more projects to increase renewable sources are undertaken, land uses will inevitably need to adapt. Some fossil fuel energy plants and gas stations may be able to be converted for renewable use, though alternative sources may also require new developments. Four wastewater treatment plants in Metro Vancouver use sewage to generate energy on site in the form of heat and electricity. This energy is then used to operate the wastewater plants.[159] These could be used as a model to convert other energy plants, helping to mitigate energy sprawl. Land uses for farms and along rivers for example may require updating to include access for wind farms and/or dams. Updating zoning and using low- or zero-impact renewable solutions

[150] Energy Transition (n.d.). Infographics. Retrieved at: http://wiki.energytransition.org/infographics/
[151] Schöngerger, P., and Reiche, D. (2016) Germany's Energy Transition (eds., Hager, C., and Stefes, C.H.). Palgrave MacMillan. Retrieved at: https://books.google.ca/books?hl=en&lr=&id=qBkIDQAAQBAJ&oi=fnd&pg=PR5&dq=energy+transition&ots=6KrfbpzjtA&sig=nbe7XHnCKc7CMRiQogd1vzDO3FU#v=onepage&q&f=false
[152] Van de Graaf, T., and Verbruggen, A. (2015). The oil endgame: Strategies of oil exporters in a carbon-constrained world. Environmental Science & Policy. Retrieved at: https://journals-scholarsportal-info.ezproxy.library.yorku.ca/pdf/14629011/v54icomplete/456_toesooeiacw.xml
[153] McKibben, B. (2018) At last, divestment is hitting the fossil fuel industry where it hurts. The Guardian. Retrieved at: https://www.theguardian.com/commentisfree/2018/dec/16/divestment-fossil-fuel-industry-trillions-dollars-investments-carbon
[154] Capital Region District (2017). Feasibility Study: Zero Emissions Fleet Initiative Pilot Project. Retrieved at: https://www.crd.bc.ca/docs/default-source/climate-action-pdf/zefi-feasibilitystudy.pdf?sfvrsn=5a11e0ca_2
[155] CBC News (2018). Every new car sold in 2040 will be zero-emission, BC government says. Retrieved at: https://www.cbc.ca/news/canada/british-columbia/every-new-car-sold-in-2040-will-be-zero-emission-b-c-government-says-1.4913679
[156] Metro Vancouver (2018). Energy. Retrieved at: http://www.metrovancouver.org/services/air-quality/AirQualityPublications/C2050-IssueAreaSummary-Energy.pdf#search=generating%20energy%20from%20waste
[157] BC Hydro (2017). Long-term energy outlook a story of energy, capacity needs. Retrieved at: https://www.bchydro.com/news/conservation/2017/long-term-energy-capacity-needs.html
[158] The Nature Conservancy (n.d.). Energy Sprawl: the development of land and water area required for energy production. Retrieved at: https://www.nature.org/en-us/what-we-do/our-insights/perspectives/energy-sprawl-solutions/
[159] Metro Vancouver (n.d.). Turning Wastewater into Energy. Retrieved at: http://www.metrovancouver.org/services/liquid-waste/innovation-wasterwater-reuse/wastewater-energy/Pages/default.aspx

(e.g., adding solar panels to rooftops) will be crucial to ensuring minimal impacts on natural lands and water and limiting energy sprawl.

What this Means for the Future of Metro Vancouver:

- The energy transition is likely to impact employment availability and distribution, land uses, transportation, and the population more broadly in a financial sense. In a transition towards 100% renewable energy, there may be gaps in supply and capacity if production of fossil fuel energy is eliminated faster than the renewable supply is created. However, once renewable sources are implemented, they can maintain their production locations indefinitely which can help to limit energy sprawl that is an attribute of fossil fuel exploration and extraction.
- Some regional stakeholders indicated that a more distributed network of energy production is needed, though this transition is likely to have fewer impacts in BC than elsewhere due to the share of hydroelectric power that exists. They also noted that while the transition is market-driven, there are policies including carbon taxes and other initiatives that can be used to help drive the shift.

3.16 INTERNET OF THINGS & DIGITAL CONNECTIVITY

Overview

Interconnectivity between computing systems, physical objects, and places will allow for data to be sent and received over a complex digital network. Connectivity has broad applications, including smart home devices, traffic management, transit fare collection, and marketing. This connectivity will likely improve transport efficiency and will improve accessibility and reliability of all vehicle modes. Internet of Things (IoT) is also anticipated to have land use efficiency applications, including examples such as smart-farming, leveraging digital communication to improve the quantity and quality of products.

What is Happening Right Now:

- Shared mobility services are likely to become more reliable and more integrated, increasing their use and decreasing the use of single occupant vehicles. Connected Mobility as a Service (MaaS) could result in improved reliability on shared transport services, decreased requirement of owned vehicles, and decreased trip demand.[160] Additional examples provided in the external force pertaining to Shared-Use Mobility.
- IoT technology will improve managing transport congestion and efficiency. IoT transport applications already exist, with variable parking rates in LA for example.[161] Uptake of smart parking could result in decreased congestion and decreased costs.[162] An often-cited figure is that at any time, ~30% of vehicles in major cities are looking for parking, adding significant increases in total travel time.[163]
- IoT can lead to sustainable land use while also causing potential job loss. The general IoT pace of uptake is significant. It is forecasted that 20.4 billion connected things will be in use worldwide by 2020 and total spending on endpoints and services will be approximately $2.9 trillion.[164] Agricultural sensors and other devices are improving productivity and reducing energy use and waste.[165] Recent research suggests that many farm worker occupations are highly automatable, while accounting for relatively few jobs compared to other major occupation groups. It remains to be seen whether job displacement coincides with additional opportunities as operations mature, or if it results in outright job loss.[166] See Agricultural Productivity & Food Security for more detail.
- IoT monitoring could improve public health. IoT devices are in development that may serve a variety of purposes relating to personal health. These devices could reduce hospitalization, catch early warnings of system failure, and otherwise act as a signal to determine when help is needed. While this may account for minor transport and land use implications, it may result in optimization of existing health facilities in the region, reducing need for expansion, as well as continued healthy living of an Aging Population.[167]
- IoT could increase access to a broader, remote labour force underpinned by digitization. The IoT pace of uptake is significant. It is forecasted that 20.4 billion connected things will be in use worldwide by 2020 and total spending on endpoints and services will be approximately $2.9 trillion.[168] With all of these connected things, it is easier than ever to

[160] Sochor, J., Stromberg, H. & Karlsson, I.C.M. (2015) Implementing Mobility as a Service: Challenges in Integrating User, Commercial, and Societal Perspectives. Transportation Research Record. P 3. Retrieved at: https://journals.sagepub.com/doi/pdf/10.3141/2536-01
[161] LA Express Park Website – Retrieved at: http://www.laexpresspark.org/about-la-expresspark/
[162] Geng, Y. & Cassandras, C.G. (2013) New "Smart Parking" System Based on Resource Allocation and Reservations. IEEE Transactions on Intelligent Transportation Systems. P 1138.
[163] Dowling, C., Fiez, T., Ratliff, L., & Zhang, B. (2017) How much urban traffic is searching for parking? Simulating Curbside Parking as a Network of Finite Capacity Queues. Retrieved at: https://www.researchgate.net/publication/313879093_How_Much_Urban_Traffic_is_Searching_for_Parking
[164] Gartner (2017) Gartner Says 8.4 Billion Connected "Things" Will Be in Use in 2017, Up 31 Percent From 2016. Retrieved at: https://www.gartner.com/en/newsroom/press-releases/2017-02-07-gartner-says-8-billion-connected-things-will-be-in-use-in-2017-up-31-percent-from-2016
[165] PwC (2017) Innovation for the Earth: Harnessing technological breakthroughs for people and the planet. P 18. Retrieved at: https://www.pwc.com/ee/et/publications/pub/innovation-for-the-earth.pdf
[166] Vermeulen, B., Kesselhut, J., Pyka, A., & Saviotti, P. P. (2018) The Impact of Automation on Employment: Just the Usual Structural Change? Sustainability 2018, 10, 1661, P 12. Retrieved at: https://www.mdpi.com/2071-1050/10/5/1661/pdf
[167] Manyika, J. (2015). The Internet of Things: Mapping the value beyond the hype. McKinsey Global Institute. P 41. Retrieved at: https://www.mckinsey.com/~/media/McKinsey/Business%20Functions/McKinsey%20Digital/Our%20Insights/The%20Internet%20of%20Things%20The%20value%20of%20digitizing%20the%20physical%20world/The-Internet-of-things-Mapping-the-value-beyond-the-hype.ashx
[168] Gartner (2017) Gartner Says 8.4 Billion Connected "Things" Will Be in Use in 2017, Up 31 Percent From 2016. Retrieved at: https://www.gartner.com/en/newsroom/press-releases/2017-02-07-gartner-says-8-billion-connected-things-will-be-in-use-in-2017-up-31-percent-from-2016

contact people and perform work duties from any location with an internet connection. There are, however, setbacks associated with digitizing the labour force, namely cybersecurity threats. Predictions indicate that global spending on cybersecurity products and services will exceed $1 trillion USD from 2017 to 2021. Corporations have included increased budget spending for cybersecurity in wake of increasing digital connectivity as well as improvements in Quantum Computing capabilities.[169]

What this Means for the Future of Metro Vancouver:

- IoT and digital connectivity will be a necessary component for connected and autonomous vehicles. IoT as it pertains to intelligent transport systems will enable those using roads to adjust their schedules and plan using routes that are less congested. For transit users, we already see improvements of real-time bus locations to allow for improved reliability and knowledge of a system.
- Digital connectivity will disrupt aspects of land use planning, with particular examples in the agriculture sector. We see new applications harnessing digital connectivity but are still years away from mass commercialisation. There are also likely implications in the field of public health.
- Some regional stakeholders indicated that digital connectivity would impact employment and the available labour pool, with increased ease in hiring from around the world. Digital connectivity will also lead to transport efficiencies, such as connecting the municipal traffic systems in the region, and tracking vehicle speeds and locations to identify pinch points in the network will also lead to transport efficiencies, such as connecting the municipal traffic systems in the region, and tracking vehicle speeds and locations to identify pinch points in the network.

[169] Morgan, S. (2018) 2018 Cybersecurity Market Report. Cyber Security Ventures. Retrieved at: https://cybersecurityventures.com/cybersecurity-market-report/

3.17 NANOMATERIALS

Overview

Nanomaterials (generally defined as materials between 1-100 nanometres in size (1nm = 10^{-9}m)) often have unique optical, electronic, or mechanical properties that can be commercialized for technological applications in fields such as manufacturing, energy, construction, and healthcare. The field is still very much in its infancy, and many applications for nanomaterials have not yet been realized. From a land use and transport perspective – the trend of nanomaterials appears to be relatively limited in the near future to create substantial disruption.

What is Happening Right Now:

- **Nanomaterials could improve vehicle safety and fuel efficiency.** The global nanotechnology market is expected to exceed $125 billion by 2024. Nanomaterials captured the highest share of the global nanotechnology market, and automotive application captured nearly 5% of the nanomaterials market.[170] Nanotechnology is applied to a variety of car body parts decreasing vehicle weights by up to 10%, resulting in improved fuel economy. However, reducing weight can decrease stability if the vehicles is involved in a crash, decreasing safety. Additional automotive applications include nanomaterials in engine cylinders, decreasing abrasion and friction and, in turn, fuel consumption. Fuel efficiency is also improved through nanomaterial application in tires, along with prolonged durability. Application of nanomaterials to mirrors to improve repellency increases safety. There is currently a limited basis for determining the improved safety and environmental prospects of these improvements in the case of wide-spread adoption.[171, 172]

- **Nanomaterials promise improved building materials and decreased pollution.** There are a variety of nanomaterial applications in construction that may have land use implications on residential and commercial real estate development. These include production of inexpensive corrosion-free steel, improved strength and durability of cement composites (with significant pollution reduction), and production of thermal insulation materials that have ten times improved performance over current commercial options.[173]

- **There will likely be positive and negative environmental effects from nanotechnology.** The global market for nanomaterials in energy applications is anticipated to grow from $5.7 billion in 2018 to $10 billion by 2023 which applies to both renewable and non-renewable energy production (e.g. petroleum refining, wind energy, solar energy) and energy storage (e.g. batteries and fuel cells).[174] Advances in nanotechnology have added improvements to air and water quality monitoring, as well as provided materials that may be able to reduce pollution substantially across a variety of emissions. Conversely, negative impacts are not yet well known, but may include toxicological effects for some chemical compositions depending on size and shape of nanoparticles. Nanomaterial and nanotechnology data is being collected and analyzed in a variety of ways, making it difficult to determine the completeness and quality of data, and thus is difficult to determine the value, pace, and application being delivered through research.[175] Ultimately, more research in this field is required to make a determination on externalities associated with a relatively new field of research and technology.[176]

What this Means for the Future of Metro Vancouver:

- Application of nanomaterials exists today in many consumer goods and construction and manufacturing processes. There are many benefits cited for the application with some negative impacts also being reported. There is insufficient research in the

[170] Research and Markets (2018) Global Nanotechnology Market (by component and applications), funding & investment, patent analysis and 27 companies profile & recent developments – forecast to 2024. Retrieved at: https://www.researchandmarkets.com/research/fn3j4f/global?w=12
[171] Maurya, S.W. (2018) Recent Advances of Nanotechnology in Transportation. AZO Nano. Retrieved at: https://www.azonano.com/article.aspx?ArticleID=4826
[172] Mathew, J., Joy, J., & George, S. C. (2018). Potential applications of nanotechnology in transportation: A review. Journal of King Saud University-Science.
[173] Pacheco-Torgal, F., & Jalali, S. (2011). Nanotechnology: advantages and drawbacks in the field of construction and building materials. Construction and building materials, 25(2), P 583. Retrieved at: https://repositorium.sdum.uminho.pt/bitstream/1822/10831/1/Nanotechnology.pdf
[174] BCC Research (2019) Nanotechnology in energy applications. Report highlights. Retrieved at: https://www.bccresearch.com/market-research/nanotechnology/nanotechnology-in-energy-applications.html
[175] Robinson, R. L. M., Lynch, I., Peijnenburg, W., Rumble, J., Klaessig, F., Marquardt, C., ... & Karcher, S. (2016). How should the completeness and quality of curated nanomaterial data be evaluated?. Nanoscale, 8(19), 9919-9943. Retrieved at: https://pubs.rsc.org/en/content/articlelanding/2016/nr/c5nr08944a#!divAbstract
[176] Rickerby, D. G., & Morrison, M. (2007). Nanotechnology and the environment: A European perspective. Science and Technology of Advanced Materials, 8(1-2), P 19. Retrieved at: https://www.tandfonline.com/doi/pdf/10.1016/j.stam.2006.10.002

field to make a determination on whether nanomaterials will have a major impact to population, employment, land use and transport over the next several decades.

- This external force was not incorporated during stakeholder workshops and therefore did not receive feedback from subject matter experts or local representatives.

3.18 QUANTUM COMPUTING

Overview

Quantum computing will allow for solving of intractable problems (problems with lots of possible answers) which are very difficult for conventional computers to solve because it requires looking at all configurations of a solution so as the size of the problem grows, so does the amount of time required to test all configurations. Quantum computers are able to establish a state where all possible configurations exist at the same time, also known as superposition. The application for quantum computing is the ability to analyze complex data to develop solutions that may be out of reach for traditional computing.

What is Happening Right Now:

- **Quantum sensors will have long term implications for other external forces.** Currently work at the nano-scale is slow and difficult to undertake. See the Nanomaterials summary for more. It's also anticipated that quantum computing will change how we interact with Artificial Intelligence and improve natural language processing, effectively allowing us to better communicate with AI.[177]
- **Quantum computing will pose threats to security systems across all sectors.** Quantum computing will have the ability to pose a significant threat to cybersecurity, which could create issues for online banking transactions, all our communications, driverless cars, and elections. Quantum cybersecurity is striving to counter this threat by advancing quantum key distribution, and quantum-safe algorithms. With respect to transport, it's anticipated that traffic control and route optimization will improve efficient scheduling with the potential of also reducing congestion.[178]
- **Quantum computing will displace workers.** D-Wave Systems and 1Qbit are two major quantum computing companies operating in Canada (1Qbit head offices are in downtown Vancouver). It is anticipated that quantum computing will completely disrupt a wide variety of employment sectors, with a main one being financial trading. Improvements in quantum computing are measured, in part, by the number of qubits used within a quantum processor. The first 2-qubit quantum computer was developed in the 2009 by researchers at Yale University.[179] More recently 72-qubit quantum processors were tested in 2017, which is approaching the range where a quantum computer can solve problems that are beyond the power of conventional devices.[180] As they continue to improve, quantum algorithms will far surpass any human actor's decision with significantly more complete information on what is right and wrong, all within an instant, completely changing how the system currently works.[181]

What this Means for the Future of Metro Vancouver:

- Quantum computing may create significant employment redundancy in fields that rely on analysis of models that could be automated via stronger computing power. Trading and investment work for example, may be heavily impacted.
- Traffic efficiency may improve through real-time quantum computer algorithms; however, this will not solve supply and demand issues that cause congestion.
- Quantum computing will require significant updates to all security systems, and if these are not undertaken, there could be consequences to any system that is digitally connected.
- This external force was not incorporated during stakeholder workshops and therefore did not receive feedback from subject matter experts or local representatives.

[177] Winer, Y. (2018) Seven Ways Quantum Computing Can Change the World. Medium. Retrieved at: https://medium.com/thrive-global/seven-ways-quantum-computing-can-change-the-world-ff5bfbe43e0f
[178] Marr, B. (2017) 6 Practical Examples of How Quantum Computing Will Change our World. Forbes. Retrieved at: https://www.forbes.com/sites/bernardmarr/2017/07/10/6-practical-examples-of-how-quantum-computing-will-change-our-world/#55b676a080c1
[179] Yale University Office of Public Affairs (2009) Scientists Create First Electronic Quantum Processor.
[180] PhysicsWorld (2018) Google aims for quantum supremacy. Retrieved at: https://physicsworld.com/a/google-aims-for-quantum-supremacy/
[181] ibid.

3.19 REAL ESTATE MARKET DYNAMICS

Overview

Affordability in Metro Vancouver is currently a major issue. Housing and transportation costs relative to income lead to a lack of affordability in the region. This has implications on residents, businesses and regional economy.

What is Happening Right Now:

- **High costs for housing and transport may make it challenging to attract and retain a thriving workforce.** Attracting new citizens to a region is key to growing the region's economy and population. Lower income renter households in the region earning less than $50,000 can spend up to 67% of their pre-tax income on housing and transportation costs.[182] Other major regions in Canada, including Calgary and Ottawa, have lower housing costs and higher median incomes than Metro Vancouver.[183] Salary disparity in relation to other regions is another issue. In the 25-34 age group, workers with a degree in Metro Vancouver make $36K compared to $52K in Calgary, $51K in Ottawa, and $41K in Toronto.[184] This lack of competitiveness could lead to the region being less attractive.
- **People and employers may seek more affordable option further from urban centres.** Both population and employment distribution are partly driven by land costs. Metro Vancouver has a rental vacancy rate of ~1% (ranging from lowest being 0.2% in Southeast Vancouver to highest of 3.3% in Metrotown) which is tied to the increasing costs of buying into the housing market as well as the stress of finding a place to live in the region.[185] With high real estate costs, there is the potential that people and employers will seek more affordable options further from urban centres (land values typically increase with proximity to urban centres)[186]. With this decentralization, there would be longer commutes, and increases to vehicle congestion and greenhouse gasses as workers move further from employment centres in search of affordable housing.[187, 188]
- **Housing will continue to be at odds with other land uses such as agriculture and industrial lands.** Previously, real-estate expansion (see Urbanization) has consumed farmland and ecologically sensitive lands in areas surrounding established urban areas. Metro Vancouver has an existing greenbelt in the form of the Agricultural Land Reserve (ALR). Increasing pressure for more housing supply could result in political dispute of this growth boundary, as it has in the Greater Toronto Area.[189]
- **Income disparities between immigrants and non-immigrants may impact location and type of housing demand in the region:** Income disparities have increased between immigrants and non-immigrants which affects the ability to afford housing in competitive markets such as the Metro Vancouver region. These pressures, combined with the increase in immigration nationally, may impact where immigrants choose to live and the type of housing that is demanded.[190]

What this Means for the Future of Metro Vancouver:

- Continued growth is projected for the Metro Vancouver region, and as such, increased residential development will be required. Without income alignment alongside housing and transport costs, affordability in the region will remain a struggle, potentially resulting in a less attractive region.

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[182] Metro Vancouver (2015) The Metro Vancouver Housing and Transportation Cost Burden Study: A new way of looking at affordability. Retrieved at: http://www.metrovancouver.org/services/regional-planning/PlanningPublications/HousingAndTransportCostBurdenReport2015.pdf
[183] Metro Vancouver (2015) The Metro Vancouver Housing and Transportation Cost Burden Study: A new way of looking at affordability. Retrieved at: http://www.metrovancouver.org/services/regional-planning/PlanningPublications/HousingAndTransportCostBurdenReport2015.pdf
[184] Barnes, T., & Hutton, T. (2016) Dynamics of Economic Change in Metro Vancouver: Networked Economies and Globalizing Urban Regions. Prepared for Metro Vancouver. P 15-16. Retrieved at: http://www.mvprosperity.org/Documents/DynamicsofEconomicChangeinMetroVancouver.pdf
[185] CMHC (October 2018) Vancouver Rental Market Statistics Summary by Zone. Retrieved at: https://www03.cmhc-schl.gc.ca/hmip-pimh/en/TableMapChart/Table?TableId=2.1.31.3&GeographyId=2410&GeographyTypeId=3&DisplayAs=Table&GeograghyName=Vancouver
[186] RAND Corporation (2016) Op. Cit. p 25.
[187] Burda, C., & Singer, G. (2015) Location Matters: Factoring location costs into homebuying decisions. Pembina Institute. Retrieved at: https://www.pembina.org/reports/location-matters.pdf
[188] Bay Area Council Economic Institute (2016) Solving the Housing Affordability Crisis: How Policies Change the Number of San Francisco Households Burdened by Housing Costs. Retrieved at: http://www.bayareaeconomy.org/files/pdf/BACEI_Housing_10_2016.pdf
[189] Gray, J. (2017) Is the greenbelt squeezing Toronto's housing market? The Globe And Mail. Retrieved at: https://www.theglobeandmail.com/news/toronto/is-the-greenbelt-squeezing-torontos-housingmarket/article32369107/
[190] Thomas, R. (2013) Viewing immigrants' neighbourhood and housing choices through the lens of community resilience. Surveys and Perspectives Integrating Environment and Society. P 2-3. Retrieved at: https://journals.openedition.org/sapiens/1516

- There may be a higher demand for housing outside existing urban areas, where land is less expensive. This may not align with current growth plan and zoning, creating an imbalance in available housing within the budget of the population. With more suburban demand, we can expect an increase in average trip distance for auto commuters. Regional stakeholders also made this comment about transportation impacts.
- The Metro Vancouver region is constrained by natural and political boundaries, as well as the ALR. These constraints mean many land uses will have to compete for land which forces decision makers to determine best use of lands as outlined zoning bylaws.
- Increasingly competitive housing markets may create a shift in immigrant rental and ownership patterns in the region. These may be overcome if there is a reduction in disparity between immigrant and non-immigrant incomes.
- Some regional stakeholders commented that there is a lack of economic diversity in the region which means that the housing sector carries more weight as an economic driver. Stakeholders also thought that the housing market would not continue to rise for 50 years due to limited supply opportunities.

3.20 SHARED-USE MOBILITY

Overview

There are many mobility options anchored on the concept of shared services and access to vehicles. These can be sourced through a digital platform and include car-sharing, ride-sharing, (e)bike-sharing, (e)scooter-sharing, and ride-hailing from taxis and transport network companies (TNCs), along with of course, traditional public transit.

What is Happening Right Now:

- **Ride-hailing through TNCs appears to be increasing congestion in urban centres.** Recent reports in major cities have suggested that TNCs have added significantly to congestion, up to 60% in San Francisco between 2010 and 2016, for example.[191] Similar findings were provided in New York City.[192] There is also concern of adding VMT that may not have existed otherwise, with studies finding up to 1/3 of trips would have been undertaken by walking, biking, or using transit if travelling by TNC wasn't an option.[193] With ride-hailing operations not permitted in BC at this time, Metro Vancouver is the largest region in North America without these services. The BC government has developed ride-hailing recommendations and regulations for future operations, beginning as early at September 2019.[194] [195]Although this point deals with ride-hailing, and not car-sharing, it impacts perceptions of shared-use while the terms tend to be intertwined in the public view.
- **Car-share households tend to drive less, and the availability of car-share networks can impact vehicle ownership.** The global car-sharing market is expected to see 35% year-on-year growth and a projected revenue collection of more than $16.5 billion by 2024.[196] In early 2018, City of Vancouver was regarded as the car-sharing capital of North America, with more than 3,000 car-share vehicles in the city, more than any other city on the continent.[197] Over 2/3 of car-share households in Metro Vancouver that shed one or more vehicles reduced their VKT after joining. Car-share companies are expanding into municipalities in areas that are being redeveloped and intensified, indicating a tight tie to land use and residential growth in the region to accommodate shared services with sustainable business models.[198] Many municipalities within Metro Vancouver have begun adjusting parking requirements for new developments to allow for fewer required parking spots in apartments if there are sufficient car-share spaces allocated.[199]
- **There is a trend towards buying rides instead of buying vehicles.** As more shared options become available in urban areas, there is less need to own a vehicle for transport. New technology is starting to bring these shared transport options together in a package referred to as Mobility as a Service (MaaS). Early pilot projects in Europe suggest that there is appetite for commercialization of subscription services that give users access to transit, car-share, car rental, bike-share, taxi, and other mobility services.[200] While this may primarily attract those in urban areas, there may be suburban and rural applications that spur out of MaaS as well.[201] Overall, ride-sharing still has a limited market share, accounting for only 1% of total VMT

[191] Erhardt, G. D., Roy, S., Cooper, D., Sana, B., Chen, M., & Castiglione, J. (2019). Do transportation network companies decrease or increase congestion? Science advances, 5(5). Retrieved at: https://advances.sciencemag.org/content/5/5/eaau2670
[192] Schaller Consulting (2018) The New Automobility: Lyft, Uber, and the Future of American Cities. Retrieved at: http://www.schallerconsult.com/rideservices/automobility.pdf
[193] Henao, A., & Marshall, W. E. (2018). The impact of ride-hailing on vehicle miles traveled. Transportation, 1-22. Retrieved at: https://link.springer.com/content/pdf/10.1007%2Fs11116-018-9923-2.pdf
[194] Legislative Assembly of British Columbia (2018) Select Standing Committee on Crown Corporations: Transportation Network Companies in British Columbia. Retrieved at: https://www.leg.bc.ca/content/CommitteeDocuments/41st-parliament/2nd-session/CrownCorporations/Report/SSC-CC_41-2_Report-2018-02-15_Web.pdf
[195] The Globe and Mail (2019) BC opens doors for ride-hailing applications on Sept. 3. Retrieved at: https://www.theglobeandmail.com/canada/article-bc-opens-doors-for-ride-hailing-applications-on-sept-8/
[196] Markets Insider (2017) Carsharing Market to witness a massive 34%+ growth over 2016-2024. Retrieved at: https://markets.businessinsider.com/news/stocks/carsharing-market-to-witness-a-massive-34-growth-over-2016-2024-1002207831
[197] Britten, L. (2018) Vancouver is 'car-sharing capital of North America,' report says. CBC News. Retrieved at: https://www.cbc.ca/news/canada/british-columbia/vancouver-car-share-car2go-evo-1.4504926
[198] Metro Vancouver (2014) The Metro Vancouver Car Share Study – Technical Report. P 65. Retrieved at: http://www.metrovancouver.org/services/regional-planning/PlanningPublications/MetroVancouverCarShareStudyTechnicalReport.pdf
[199] Metro Vancouver (2016) The Metro Vancouver Apartment Parking Study – Summary Booklet. P 10. Retrieved at: http://www.metrovancouver.org/services/regional-planning/PlanningPublications/AptParkingStudySummaryBooklet.pdf
[200] IMove (2017) Developing Mobility as a Service in IMOVE Living Labs. P 29. Retrieved at: https://www.viktoria.se/sites/default/files/pub/viktoria.se/upload/publications/imove_wp1_d1.1_and_d1.2_final.pdf
[201] Aapaoja, A., Eckhardt, J., Nykänen, L., & Sochor, J. (2017, October). MaaS service combinations for different geographical areas. In 24th world congress on intelligent transportation systems (Vol. 29). PP 6-10. Retrieved at: https://www.researchgate.net/publication/319127507_MaaS_service_combinations_for_different_geographical_areas

in the United States in 2016. This is in part due to lack of coverage in suburban and rural areas.[202] However, there is also concern of adding VMT that may not have existed otherwise, with studies finding up to ⅓ of trips would have been undertaken by walking, biking, or using transit if travelling by TNC wasn't an option.[203]

- **Shared micro-mobility can help with first- and last-mile trips.** Shared micro-mobility (bike-share, scooter-share, etc) has a place but companies are finding it difficult to break even, resulting in many going out of business and laying off employees. Many bike-share and scooter-share companies have appeared in cities across the world in recent years. Metro Vancouver has seen an expansion of public bike-sharing with new pilot programs in more municipalities in 2017 and 2018.[204] It still remains to be seen whether companies can operate for profit in these businesses that tend to have very low margins. Despite the value to active transport that is provided in cities, there are many companies that have gone out of business, which asks the question of whether current models are sustainable or if shared active modes need subsidies to thrive.[205]

What this Means for the Future of Metro Vancouver:

- Shared mobility provides many people with additional transport options, particularly in urban areas. Fewer services are available in suburban and rural areas, where the majority of VKT is derived. If car-share services are able to develop sustainable business models to operate in more rural areas for first- and last-mile trips near rapid transit, this would create more of an impact on average trip distance in the region.
- No significant shift to population or employment distribution is anticipated as car-sharing and bike-sharing are currently not seen to generate enough pull as key reason for where people want to live or work. This may shift if policy is developed to price private vehicles in the region.
- Land use implications of shared mobility are also limited. Parking requirements for developments are seen to be a major opportunity for increasing car-share parking spots, reducing need private parking spots. If there is a significant change to regional car-share beyond urban areas, we could also see a change to how much curb-side and private parking space is needed.
- Some regional stakeholders highlighted the following impacts:
    - Shared mobility may be more common with energy rates changing.
    - E-bikes could bridge the gap between bikes and cars for longer distance trips, however demand for bike lanes would increase if this were the case.
    - Shared mobility will improve access for people with mobility challenges.
    - Shared mobility is likely to increase congestion., through cannibalization of trips from transit, walking, and cycling.
    - There may need to be considerations for all demographics, such as access to car seats for children or accessibility needs for those with mobility challenges in some car-share vehicles.

[202] McKinsey & Company (2017) Cracks in the ridesharing market – and how to fill them. Retrieved at: https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/cracks-in-the-ridesharing-market-and-how-to-fill-them
[203] Henao, A., & Marshall, W. E. (2018). The impact of ride-hailing on vehicle miles traveled. Transportation, 1-22. Retrieved at: https://link.springer.com/content/pdf/10.1007%2Fs11116-018-9923-2.pdf
[204] City of Richmond. (2018) Public Bike Share – Proposed Pilot Project: Report to Committee. Retrieved at: https://www.richmond.ca/__shared/assets/14_BikeSharePilot_CNCL03261849800.pdf
[205] Li, P. & Horwitz, J. (2018) The rise and fall of bike-sharing company Ofo is a lesson for China's tech investors. The Globe and Mail. Retrieved at: https://beta.theglobeandmail.com/business/international-business/asia-pacific-business/article-the-rise-and-fall-of-bike-sharing-company-ofo-is-a-lesson-for-chinas/

3.21 SHARING / PLATFORM ECONOMIES

Overview

The sharing economy broadly encompasses a range of interactions that emphasize the sharing of assets instead of personal ownership; sharing is either from peer-to-peer, business-to-peer or business-to-business, and often facilitated by a digital platform. The sharing economy works to reduce the pricing power of traditional industry giants and typically to avoid regulations or taxes.

What is Happening Right Now:

- **Peer-to-peer and business-to-peer sharing may increase the affordability of items like vehicles, which may have impacts on public transit and active mode share**. It is estimated that $23 billion in venture capital funding was poured into the shared economy market between 2010 and 2017,[206] and by 2025 sharing revenues are predicted to reach $335 billion.[207] Shared-Use Mobility through platforms like Modo, Turo, Car2Go, and Evo, as well as ride-hailing platforms like Uber and Lyft increase the availability of private cars for use for trips which may have been foregone or taken using a more sustainable mode.[208] On the other hand, bike- and scooter-sharing platforms can help to combat this and increase the use of sustainable modes, and has already seen a positive impact in Vancouver.[209, 210]

- **Business-to-business sharing of resources can positively impact land use**. Shared parking facilities for example can serve a variety of businesses and individuals, ensuring that the lots are used sustainably and throughout an entire day. Zoning regulations can be used to locate businesses that see parking peaks at different times during the day on shared land to maximize use of a parking facility.[211]

- **Shared home and room rentals are impacting the rental stock in areas.** Through sharing apps such as AirBnB and VRBO, users can rent out a room or their entire living space for an additional income, in a region with low rental vacancy. With units placed on the temporary rental market, the already low affordable rental stock may continue to deplete and rental costs are then likely to continue rising. Decentralized accommodations are also likely to impact hotels and motels, particularly if costs are lower.[212]

- **Co-working spaces may put pressure on traditional office parks and employment centres.** Workers are becoming more interested in having access to amenities, social areas, and break spaces and catering to these needs is a way to attract and retain talent. Co-working spaces are aiming to meet this desire through acquiring land in heavily sought after urban areas. This in turn may create pressure for some employers to move from traditional suburban office parks in order to attract or retain a talented workforce.[213]

- **A wholly shared economy has the potential to decrease the consumption of resources and waste of a society, while creating jobs, increasing incomes, and addressing environmental issues**. Sharing models can exist for goods and services across a broad spectrum of applications. Tool libraries, bike repair shops, and board game cafes are all examples of operations under a shared economy system.[214] With roughly 68% of adults in developed and emerging markets are willing to

[206] Wallenstein, J. and Shelat, U. (2017). Hopping Aboard the Sharing Economy. Boston Consulting Group. Retrieved at: https://www.bcg.com/en-ca/publications/2017/strategy-accelerating-growth-consumer-products-hopping-aboard-sharing-economy.aspx
[207] Credit Suisse (2015). Global Equity Themes. Retrieved at: https://research-doc.credit-suisse.com/docView?document_id=x657090&serialid=%2BoJISdkXI8WqPDLKlKH51yO3NdPKCzCWPXEKeyF0dQo%3D
[208] Hemmingway, A. (2018). What's missing from the Uber debate? Market power, congestion, pollution, and even deaths. Canadian Centre for Policy Alternatives. Retrieved at: https://www.policynote.ca/whats-missing-from-the-uber-debate/
[209] Shaheen, A., and Martin, E.W. (2018). Unraveling the Modal Impacts of Bikesharing. Access Magazine. Retrieved at: http://www.accessmagazine.org/wp-content/uploads/sites/7/2015/12/access47.shaheen.pdf
[210] Ginsberg, N. (2018). Achieving a Major Bike Mode Shift in Vancouver. Bicycles Create Change. Retrieved at: http://www.bicyclescreatechange.com/achieving-a-major-bike-mode-shift-in-vancouver-dale-bracewell/
[211] Victoria Transport Policy Institute (2015). Shared Parking. Retrieved at: https://www.vtpi.org/tdm/tdm89.htm
[212] Sawatzky, K. (2016) Short-term consequences: Investigating the extent, nature and rental housing implications of Airbnb Listings in Vancouver. Simon Fraser University. Retrieved at: http://summit.sfu.ca/item/16841
[213] Association of Bay Area Governments & Metropolitan Transportation Commission. (2019) The Future of Jobs: Perspective paper. Retrieved at: https://mtc.ca.gov/whats-happening/news/new-horizon-perspective-paper-future-jobs
[214] The Sharing Project (2012). A report on sharing in Vancouver. Retrieved at: https://ccednet-rcdec.ca/sites/ccednet-rcdec.ca/files/the_sharing_project_report.pdf

share their assets,[215] there is potential for this economic model to develop in the medium term. The Sharing City, Seoul project in South Korea is an example of how this can work in practice through policy mechanisms.[216]

What this Means for the Future of Metro Vancouver:

- While most industries risk being impacted by the sharing economy in some way, it is unclear if it will touch all industries, and to what intensity the traditional organization will be disrupted.
- Some regional stakeholders noted that the younger generation owns less and shares more, including work space. However, co-working spaces are expensive to rent in downtown Vancouver, and there is a lack of options elsewhere in the region. Stakeholders also highlighted that the transportation sector will be impacted the most by the sharing economy. Mobility and access gaps can be reduced or eliminated through updating municipal curbside and sidewalk policies and through electric bikes for example. Impacts by short term rentals are less clear, and there is uncertainty around how people will group together for improving availability of the housing rental market.

[215] Ibid.
[216] Johnson, C. (2013). Is Seoul the next Great Sharing City? United Nations University. Retrieved at: https://ourworld.unu.edu/en/is-seoul-the-next-great-sharing-city

3.22 SHIFTING GLOBAL ECONOMY & TRADE

Overview

Development in emerging economies is changing global dynamics. Some cities in other parts of the world are becoming more competitive, changing the existing trading patterns among major global powers. Changing national politics can influence imports and exports of global trade through free trade agreements in some cases, and protectionist policies in others.

What is Happening Right Now:

- **Protectionist global trade policies could have an impact on agencies, businesses, and residents in Metro Vancouver.** Local goods movement patterns may change if there is a decrease in global trade and materials need to be sourced from new suppliers that may be more local, adding value to just-in-time delivery and manufacturing. Additionally, prices for goods may rise due to tariffs and decreased access, reducing affordability for consumers.[217] International tariffs by one country have countermeasures applied by other countries as retaliation. Take for example the steel and aluminium tariffs imposed by the United States, for which Canada announced intention to impose similar trade-restrictive countermeasures. The outcome would be neither a net loss or gain, but increased costs to import and export would result in more expensive goods. In this example, Canada and the US reached an agreement to eliminate all tariffs on both from for steel and aluminum between the two countries.[218]

- **Job loss can occur as an outcome of global trade disputes.** The Bank of Montreal estimates 150,000 jobs may be lost as a result of a China-U.S. trade war.[219] These jobs represent a reduction of Canada's GDP by 0.8 percentage points. Populist movements of some of Canada's major trading partners are demanding new trade barriers and re-evaluations of standing free trade agreements, which could lessen trade and reduce economic growth.[220] Further protectionist measures from other key trading partners of Canada may have similar results on the economy.

- **Innovation corridors and economic partnerships can limit negative impacts to the economy.** Washington State and BC formed the Cascadia Innovation Corridor in 2016, which seeks to strengthen ties between the regions in order to maximize local competitive advantage and access to foreign markets. These partnerships may also lead to further re-shoring (See Global Outsourcing and Re-shoring) and increased transport links between cities along this corridor.[221]

- **A global shift towards more renewable energy sources is likely to impact the BC economy.** The province will likely realize a reduction in some of its leading exports including coal and liquid petroleum as global economies scale back their use and import of fossil fuels and related products in this Energy Transition.[222] That said, Canada and BC's exports in nearly all industries are expected to grow in the short term,[223] and vessel calls and tonnage to the Port of Vancouver specifically is expected to grow in the coming years.[224]

What this Means for the Future of Metro Vancouver:

- Canadian exports represent roughly 30% of annual GDP, meaning that if trade is reduced, the economy is likely to shrink and individuals across a range of economic sectors will be impacted – and not just those in sectors facing tariffs or other restrictions. Local goods movement patterns may change if there is a decrease in global trade and materials need to be

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[217] Business Development Bank of Canada (2018). Protectionism on the rise. Retrieved at: https://www.bdc.ca/en/articles-tools/entrepreneur-toolkit/publications/monthly-economic-letter/pages/1807.aspx
[218] Global Affairs Canada (2019). Joint Statement by Canada and the United States on Section 232 Duties on Steel and Aluminum. Retrieved at: https://www.canada.ca/en/global-affairs/news/2019/05/joint-statement-by-the-united-states-and-canada-on-section-232-duties-on-steel-and-aluminum.html
[219] Guatieri, S. (2019). Tariff Tally Toll. Bank of Montreal. Retrieved at: https://economics.bmocapitalmarkets.com/economics/amcharts/7629H6-18SHHM-YJPHY9-XR398B-200.pdf
[220] Lane, T. (2017). How Canada's International Trade is Changing with the Times. Bank of Canada. Retrieved at: https://www.bankofcanada.ca/2017/09/how-canada-international-trade-changing-with-times/
[221] Wilson, K. (2019). Premier John Horgan will travel to Seattle to strengthen the Cascadia Innovation Corridor. Georgia Straight. Retrieved at: https://www.straight.com/tech/1197126/premier-john-horgan-will-travel-seattle-strengthen-cascadia-innovation-corridor
[222] Government of British Columbia (2018). Country Trade Profiles. Retrieved at: https://www2.gov.bc.ca/gov/content/data/statistics/business-industry-trade/trade/trade-data/country-trade-profile
[223] Export Development Canada (2019). Global Export Forecast, Spring 2019. Retrieved at: https://www.edc.ca/en/guide/global-export-forecast.html
[224] Port of Vancouver (n.d.). How is the port authority managing increased traffic through the port? Retrieved at: https://www.portvancouver.com/about-us/topics-of-interest/vessel-numbers-now-and-into-the-future/

sourced from new suppliers who may be more local. Additionally, prices for goods may rise due to tariffs and decreased access, thus reducing affordability for consumers, and decreasing consumption overall.

- Some regional stakeholders commented that a lack of warehousing space in the region will force goods that are produced locally to be transported out of the region for production and then back to the region for consumption. Further to this, if base resource prices increase, the overall costs of the supply chain increase and budgets may become uncertain. Protecting and growing the supply of industrial land is therefore required in order to ensure regional competitiveness.

3.23 URBANIZATION

Overview

Urbanization represents the global shift in populations from rural to urban areas. At a regional scale, this has and continues to manifest in the form of a growing emphasis on existing urban areas. Globally, this is resulting in the growth of cities in countries and an increase in population and employment.

What is Happening Right Now:

- **Urban intensification is taking place increasingly in the suburbs in addition to urban core areas.** The 2016 Census showed that population growth in Canada is accelerating in suburban areas at the fringes of urban cores faster than within the cores themselves.[225] These areas of high growth typically contain auto-dependent residents, and BC and Ontario have the lowest provincial proportion of population living in rural areas across Canada at 14% – the national average is 19%.[226] Further to this, 79% of growth in the Vancouver Census Metropolitan Area between 2006-2016 was in auto-dependent suburban and exurban areas.[227] As these areas continue to grow in population, there may be impacts to sustainable growth such as increased urban sprawl and increased VKT and private auto use. Auto-oriented neighbourhoods are often hard to serve effectively with transit due to longer blocks and lower density.
- **Increasingly dense neighbourhoods will require increased infrastructure maintenance.**[228] In 2018, there were 548 cities in the world with at least 1 million inhabitants, and by 2030, it is anticipated that 706 cities will have at least 1 million residents.[229] While the City of Vancouver has a population density of ~5,400 inhabitants/km^2, the region hovers closer to 850 inhabitants/km^2. Many cities elsewhere exceed population densities of 20,000 inhabitants/km^2, which shows a much lower density in Canada and Metro Vancouver when compared to the global scale.[230, 231] Across Canada, much of the infrastructure is in a state of poor repair and requires rehabilitation or reconstruction to maintain operations. As urban intensification continues, this infrastructure will necessitate upgrades that may be at odds with shifting political agendas.[232] It is estimated that Canada requires between $150 million and $1 trillion in infrastructure investment to achieve optimal efficiency.[233]
- **Urban intensification and sprawl are contributing to the loss of agricultural lands.**[234] In 2018, 55% of the world's population lived in urban areas (82% in North America), a proportion that is expected to increase to 68% by 2050.[235] This trend impacts the ability of the local food supply to meet demand, resulting in increased imports of crops which may have historically been produced and sold locally. However, if this trend is reflected globally, the global food supply may be at risk of not being able to meet urban demand, and prices may increase putting low-income individuals at risk of not being able to afford food.[236] Furthermore, as agricultural land depletes, individuals employed on farms will need to seek new employment which may lead them to urban areas. The Agricultural Land Reserve currently limits sprawl in the Metro Vancouver region,

[225] Gordon, D. (2018). Still Suburban? Growth in Canadian Suburbs, 2006-2016. Council for Canadian Urbanism. Retrieved at: http://www.canadiansuburbs.ca/files/Still_Suburban_Monograph_2016.pdf
[226] Statistics Canada (2011). Canada goes urban. Retrieved at: https://www150.statcan.gc.ca/n1/pub/11-630-x/11-630-x2015004-eng.htm
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[228] City of Surrey (2018). 10-Year Servicing Plan. Retrieved at: https://www.surrey.ca/files/10YearServicingPlan.pdf
[229] United Nations Department of Economic and Social Affairs (2018). The World's Cities in 2018. Retrieved at: https://www.un.org/en/events/citiesday/assets/pdf/the_worlds_cities_in_2018_data_booklet.pdf
[230] Stats Canada (2019) Population and dwelling counts, for Canada, provinces and territories, census metropolitan areas and census agglomerations, 2016 and 2011 censuses – 100% data. Retrieved at: https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/hlt-fst/pd-pl/Table.cfm?Lang=Eng&T=201&S=3&O=D
[231] Wikipedia (2019) List of cities by population density. Retrieved at: https://en.wikipedia.org/wiki/List_of_cities_by_population_density
[232] Mitham, P. (2017). George Massey Tunnel replacement will be missing link if NDP cancels the project. Business in Vancouver. Retrieved at: https://biv.com/article/2017/08/george-massey-tunnel-replacement-will-be-missing-l
[233] Israelson, D. (2017). Time and money lost to Canada's infrastructure gap a 'tremendous loss'. The Globe and Mail. Retrieved at: https://www.theglobeandmail.com/report-on-business/time-and-money-lost-to-canadas-infrastructure-gap-a-tremendous-loss/article37302054/
[234] Mason, M. (n.d.). Has Urbanization Caused a Loss to Agricultural Land? Retrieved at: http://www.moyak.com/papers/urbanization-agriculture.html
[235] United Nations Department of Economic and Social Affairs (2018). 2018 Revision of World Urbanization Prospects. Retrieved at: https://www.un.org/development/desa/publications/2018-revision-of-world-urbanization-prospects.html
[236] Satterthwaite, D., McGranahan, G., and Tacoli, C. (2010). Urbanization and its implications for food and farming. Philosophical transactions of the Royal Society of London. Retrieved at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2935117/

but legislation has been adjusted in recent years that indicates existing land uses are not immune to change, and agricultural use in some areas could be relaxed for other purposes.[237]

What this Means for the Future of Metro Vancouver:

- Massive increases in development density within the urban containment boundary may result in a loss of environmental lands and green spaces, an increase in more non-permeable surfaces, and impacts to air quality. Furthermore, massive investments in infrastructure rehabilitation and reconstruction are needed to accommodate the anticipated population growth.
- Some regional stakeholders indicated a number of difficulties related to food production, education quality and availability, public infrastructure servicing, and park space as more and more individuals move into urban areas. Furthermore, they noted that rural businesses will be negatively impacted as people leave these areas.

[237] West Coast Environmental Law (2014) Why amendments to Bill 24 don't protect agricultural land. Retrieved at: https://www.wcel.org/blog/why-amendments-bill-24-dont-protect-agricultural-land

3.24 VIRTUAL REALITY / AUGMENTED REALITY

Overview

Virtual reality (VR) and augmented reality (AR) are exactly what they claim to be: VR is the creation of a virtual world, and AR enhances perspectives of reality through our senses (primarily visual but has applications with smell, sound, and touch). Many applications for AR and VR have been acknowledged but the technology currently has limited commercialized examples.

What is Happening Right Now:

- **VR and AR can improve safety on roads and in the workplace.** The market for AR and VR is growing, with a worldwide market of $6.1 billion in 2016 and a projected market of $95 billion by 2020.[238] The majority of AR and VR investments are in automotive, retail and consumer, healthcare, and technology, media and telecommunications.[239] VR has been used extensively to train users across a variety of applications including surgery, aircraft inspection, power production, and in the mining industry and has been more effective compared to conventional screen-based training. These applications could lead to improvements in driving safety as well as for applications in work environments that have a hazardous nature, such as construction.[240] AR systems built directly into vehicle windshields can also improve safety with enhanced traffic sign recognition, particularly for poor visibility situations.[241] Limited examples of commercialization do not provide sufficient evidence to determine if these AR and VR applications will be commonplace in the near future.

- **VR prototyping may replace physical prototyping, saving time and money, particularly for infrastructure development.** While the extent of applications remains to be seen, there are already some examples of VR prototyping being undertaken, in lieu of physical prototypes, in order to save time and money. This type of prototyping could decrease costs of infrastructure and real estate development among other assets in the region.[242]

- **Increased use of VR may negatively impact well-being as well as privacy.** People are spending an increasing amount of time in front of screens, decreasing leisure time spent on other activities. There is a lack of regulation around personal data which may push users away from VR technologies. Enhanced security may need to come before significant user adoption.[243] Hyperpersonalization through advertising is a particular issue with current lack of AR data security.[244]

- **There are opportunities for AR and VR applications in employment, medical services, and education, which may contribute to less physical space requirements and changes in travel patterns.** Facebook purchased startup Oculus VR for $2 billion in 2014, for its VR headset technology. Beyond gaming applications, it is also envisioned that this would lead to applications such as telecommuting, studying in a classroom with teachers, or consulting with a doctor "face-to-face".[245] Facebook has since acquired an additional 10 AR/VR companies – indicating the growth of this field.[246] However, while AR and VR technology will certainly enable more flexibility for making a workplace seem more 'real', there are still unclear trends on whether the workplace will substantially shift away from the conventional. 20% of remote workers state that loneliness is one of the largest issues with a lack of direct interaction with coworkers. It's unclear whether a fully materialized VR system would counteract loneliness or not.[247]

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[238] McKinsey & Company (2017) Augmented and virtual reality: The promise and peril of immersive technologies. Retrieved at: https://www.mckinsey.com/industries/media-and-entertainment/our-insights/augmented-and-virtual-reality-the-promise-and-peril-of-immersive-technologies

[239] PwC. (2017) The Essential Eight technologies – Board byte: augmented and virtual reality. P 2-4. Retrieved at: https://www.pwc.com/us/en/governance-insights-center/publications/assets/essential-emerging-technologies-augmented-and-virtual-reality.pdf

[240] Xie, H., Tudoreanu, E., & Shi, W. (2006). Development of a virtual reality safety-training system for construction workers. P 1. Retrieved at: http://itc.scix.net/data/works/att/ff9b.content.00092.pdf

[241] Abdi, L., Meddeb, A., & Abdallah, F. B. (2015, May). Augmented reality based traffic sign recognition for improved driving safety. PP 94-102. Retrieved at: https://www.researchgate.net/publication/299778634_Augmented_Reality_Based_Traffic_Sign_Recognition_for_Improved_Driving_Safety

[242] McKinsey & Company (2017).

[243] McKinsey & Company (2017).

[244] Deloitte (2019) How to begin regulating a digital reality world: Businesses and governments should guide augmented reality development. Retrieved at: https://www2.deloitte.com/insights/us/en/industry/public-sector/regulating-digital-reality-augmented-spaces.html

[245] Dredge, S. (2014) Facebook closes its $2bn Oculus Rift acquisition. What Next? The Guardian. Retrieved at: https://www.theguardian.com/technology/2014/jul/22/facebook-oculus-rift-acquisition-virtual-reality

[246] Molla, R. (2017) These are the companies investing most aggressively in AR and VR. Vox Media. Retrieved at: https://www.vox.com/2017/4/28/15376268/facebook-augmented-virtual-reality-linkedin-jobs-charts

[247] Muhammed, A. (2018) 10 Remote Work Trends that will dominate 2019. Forbes. Retrieved at: https://www.forbes.com/sites/abdullahimuhammed/2018/12/21/10-remote-work-trends-that-will-dominate-2019/#f25ba697c72a

What this Means for the Future of Metro Vancouver:

- AR applications for driving vehicles may reduce incidents and collisions, as well as related congestion. As applications are still in their infancy, it is unclear how pervasive this technology will be and how it will coincide with the arrival of autonomous vehicles, where it will essentially be made redundant.
- VR could potential decrease review time for how infrastructure and buildings development is undertaken. Since there are limited examples of this being undertaken, it is premature to assume that improved efficiency in this field can be expected.
- This external force was not incorporated during stakeholder workshops and therefore did not receive feedback from subject matter experts or local representatives.

4 SUMMARY OF ENGAGEMENT

4.1 OVERVIEW OF ENGAGEMENT WITH STAKEHOLDERS

Stakeholder engagement and expert opinion is an essential part of the scenario planning process. This project engaged stakeholders and experts at three separate points to ensure that scenarios were being developed in a way that aligned with regional expectations.

There have been four main touchpoints during this project with local and regional stakeholders, as well as subject matter experts.

APRIL 5, 2018 – REGIONAL STAKEHOLDER WORKSHOP

Regional stakeholders were invited to attend a half day workshop hosted by Metro Vancouver. The session was focused on understanding Metro Vancouver's regional growth projections. There were overview presentations on the long range scenarios, regional growth projections, population projection methods and assumptions, housing demand and land use project methods and assumptions, and employment projection methods and assumptions. Stakeholders had an opportunity to provide comments and ask questions for each of the presentations in order to gain a stronger understanding of the process. A summary of the workshop is available on the Metro Vancouver website.

OCTOBER 18, 2018 – REGIONAL STAKEHOLDER WORKSHOP

Regional stakeholders were invited to attend a half day workshop hosted by staff from TransLink and Metro Vancouver along with presentations and facilitation by WSP. The event focused on the following main points:

- A baseline scenario overview was presented by Metro Vancouver and TransLink to outline current assumptions that are used and the factors that affect regional population, housing and employment growth, land use and transportation. The baseline scenario provides a reference for how factors may affect land use and transportation going forward to year 2050 and beyond using trend-forward assumptions. The baseline growth scenario was prepared using projections for population, housing, and employment from the 2016 Census. Regional transport scenarios are based on the auto and transit networks, prices, land use outputs, surveys and counts.
- An overview of scenario planning was presented to regional stakeholders by WSP. A brief summary describing external forces analysis, scenario generation, implications for action, validation with experts, and resiliency analysis was conveyed.
- The remainder of the workshop was focused on determining the impact and variability of external forces. WSP briefly presented on 21 external forces that were identified by the project team as mega-trends that may have a significant impact on the region over the next 30 years. After the presentations, stakeholders, along with facilitators, discussed the likely impact and variability of each force. This culminated in a vote where each stakeholder had the opportunity to rank each force based on its impact and variability that the force would manifest in a way we expect.

Stakeholder feedback was used to drill down on key external forces that would eventually become the anchor points of the scenario development effort.

FEBRUARY 2019 – SUBJECT MATTER EXPERT INPUT

A set of subject matter experts were identified by the project team from November 2018 to January 2019. Subject matter experts were requested to review preliminary scenario concepts and provide commentary on whether the preliminary scenarios appeared plausible and whether the anticipated implications for each scenario make sense. Subject matter experts were primarily selected from Metro Vancouver and BC to bring local knowledge to the exercise, while some expertise was drawn on from around the world.

Subject matter expert validation of preliminary scenarios was an important way to check that the assumptions and internal mechanics of each scenario were technically sound. Expert feedback was used to refine the scenarios prior to the next regional stakeholder workshop.

FEBRUARY 27, 2019 – REGIONAL STAKEHOLDER WORKSHOP

Regional stakeholders were invited to attend a half day workshop hosted by staff from TransLink and Metro Vancouver along with presentations and facilitation by WSP. Refined scenarios were presented to regional stakeholders. These scenarios included a narrative, as well as implications, opportunities and challenges. Stakeholders were asked to provide comment on whether each

scenario was plausible, whether there were additional implications that should be considered, and whether the opportunities and challenges listed were agreeable, along with providing additional opportunities and challenges that have been missed. The feedback provided was used to further refine the scenarios prior to the development of the final scenarios.

4.2 SUMMARY OF RESULTS FROM ENGAGEMENT ACTIVITIES

4.2.1 OCTOBER 18, 2018 – REGIONAL STAKEHOLDER WORKSHOP

Regional stakeholders were invited to attend a half day workshop hosted by staff from TransLink and Metro Vancouver along with presentations and facilitation by WSP. The main engagement activity during the workshop was focused on determining the impact and variability of the external forces presented. Each force was briefly presented in two segments. After each presentation round, participants along with table facilitators discusses the likely impact and variability for each force. At the end of each discussion period, stakeholders were requested to use their portable devices to login to Mentimeter, an interactive presentation platform that displayed real-time results from stakeholders on impact and variability for each force.

What we heard from the stakeholders:

Facilitators from each table group took notes which have been compiled below in Appendix A. Summaries of impact and variability for each force are listed below:

Table 3: Summary of stakeholder comments on external force impacts and variability

External Force	Impact	Variability
A: Advanced Building Construction Technology	Impacts related to job loss, faster construction, and fewer vehicle trips	High variability, lack of certainty on material applicability, alignment with building codes, precision of tools against custom-builds
B: Internet Of Things & Digital Connectivity	Impacts include smarter transportation (for moving people and goods), and changes to the labour market	There is uncertainty with how telecommuting will develop, and whether privacy concerns will limit IoT.
C: Connected & Autonomous Vehicles	Impacts include improved transport access for unlicensed individuals and increased efficiency of freight.	High variability without knowing how insurance will be determined, and whether ownership will be shared or private.
D: Electric Mobility	Impact on emission reductions and improved air quality.	Lack of clarity on charging capabilities and electricity demand
E: Demographic Attitudes	Impacts include increased population density and requirement for more green space.	Medium variability based on what future generations consider convenient and comfortable in terms of shared services and housing in particular.
F: Increasing Urbanization	Impacts related to servicing infrastructure, deepening the disconnect between urban and suburban, and land affordability.	Lack of clarity on impact of other trends which may work against increasing urban density (e.g., AV's making suburban living more attractive).
G: Aging Population	Impacts include local accessibility planning, healthcare, labour force, and the economy.	High variability related to length and magnitude of impact, particularly related to effects on labour force and the economy.
H: Shared Mobility	Impacts related to land use for parking, transit use, and congestion.	High variability, lack of certainty on timeline or integration of CAV technologies, who passengers will be, and the regulatory regime.
I: Changes in Local Government	Impacts include policy and taxation, provision of local services, and potential privatization of public services.	High variability based on determining adequate number of municipalities and their responsibilities, as well as how to finance services.
J: Energy Transition	Impacts to fossil fuel industries and access to green energy.	Uncertainty around how to transition to a more distributed network of energy production, particularly as AVs gain market share.

External Force	Impact	Variability
K: Agricultural Productivity & Food Security	Impacts related primarily to land use and distribution networks.	High variability depending on how land is managed, how diets develop, if new supply chains develop to meet demand, and availability of water for irrigation.
L: Natural Hazards & Climate Change (Flooding)	Impacts to municipal budget and ability to finance infrastructure repairs and upgrades.	Uncertainty related to impacts caused by lack of infrastructure maintenance in neighbouring regions, and requirement of further water reservoirs.
M: Natural Hazards & Climate Change (Heat & Drought)	Impacts to population and energy consumption, with minor impacts to transportation and land use.	High uncertainty of air quality impacts and affordability for cooling homes and other buildings.
N: Natural Hazards & Climate Change (Earthquakes)	Impacts to social infrastructure (e.g., utilities) and transportation network.	High variability depending on severity of impact and resilience of transportation system and building construction.
O: Global Outsourcing & Re-shoring	Impacts include changes in the labour force and availability of jobs locally, and travel patterns.	High variability, uncertain how many jobs will be outsourced and how many will return which impacts land use requirements.
P: Shifting Global Economy & Trade	Impacts to land use, transportation, and supply chains.	High uncertainty surrounding political decisions impacting trade.
Q: Real Estate Market Dynamics	Impacts to affordability and availability of housing (i.e., access), local economy, and transportation.	Lack of clarity on the elasticity of cost and human preference for urban vs. suburban living, as well as how property taxes will play out, and what a housing crash would look like.
R: Sharing Economy	Impacts primarily to land use for shared housing and working spaces, and transportation modes and patterns.	High uncertainty related to impacts of co-housing, short term rentals, and cross-cultural sharing.
S: E-Commerce	Impacts to industrial and commercial land, repurposing of commercial land in urban centres, and the transportation network.	High variability depending on combination of enabling technologies (e.g., CAV, 3D printing) and space impacts to urban form.
T: Advanced Automation	Major impact to labour force and job loss, with impacts to transportation resulting from job loss, and impacts to health and safety.	Uncertainty around magnitude of job loss, retraining ability, and potential to create new industries to support local employment.
U: The Gig Economy	Major impact to labour force, housing, and public health if individuals cannot find stable or adequately paying employment, with smaller impact to travel patterns.	Uncertainty related to economic inequality as a result of more precarious employment and demand for traditional office space.

How input was used:

- Forces with high impact and high variability were considered for further development**.** These forces were combined where there was subject matter overlap. The four combined themes below were used as the basis of the system dynamics exercise at the follow up Metro Vancouver and TransLink workshop attended by internal stakeholders on October 19th to better understand the interrelationships and implications between the anchor points and other components that would need to be developed during scenario generation. The highlighting of these key themes was the starting point for developing scenarios.

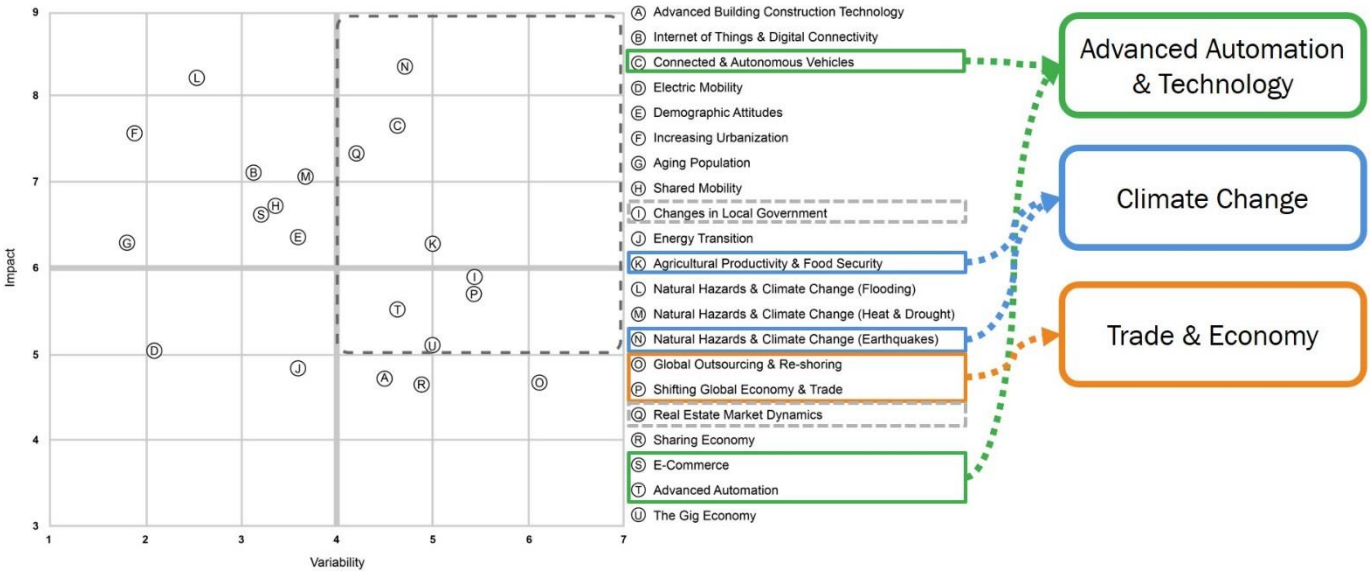


Figure 3: Stakeholder response for external force impact and variability ranking

4.2.2 FEBRUARY 2019 – SUBJECT MATTER EXPERT INPUT

During the month of February, subject matter experts (SMEs) were requested to comment on preliminary scenario concepts to determine whether the scenarios appear plausible, and whether anticipated implications for each scenario make sense.

At this point in the process – there were six preliminary scenario concepts:

1. What if the region keeps going on its current trajectory?
2. What if most of the economy becomes automated?
3. What if we close our doors and borders?
4. What if tourism becomes a main driving economic sector?
5. What if a digital economy takes hold?
6. What if climate change is worse than we think?

See Appendix B for more information on each of the preliminary scenarios along with in-depth expert feedback

What we heard from the experts:

- Most experts commented that the directionality of scenario assumptions were correct, but often the magnitude was potentially implausible. This was noted for automation and immigration in particular.
- The relationship between automation and employment displacement was a point of contention amongst SMEs. Most commenters agreed that the nature of employment would be negatively impacted by automation.
- There were several comments that suggested there needed to be further emphasis on equity and equality in the region, as well as affordability and purchasing power.
- A singular and specialized tourist economy was not seen as plausible by the experts.
- Sea level rise assumptions were at the global scale and need to be adjusted for the local context.
- In the face of climate change, Metro Vancouver would likely be better off than everywhere in the world, and that more focus should be given to climate refugees.

How input was used to refine the scenarios:

- The project team adjusted driver and implication magnitudes to reflect less extreme scenarios.
- Upon further refinement, the project team incorporated conflicting views on impact of automation on employment for two separate scenarios.
- The project team increasingly emphasized equity and affordability while refining scenarios.
- The tourism-focused scenario was removed as a scenario and aspects of the scenario were added to other scenarios during refinement.
- Climate change was adjusted to be constant in each scenario concept as it was seen to detract from the other components of the scenario and create too many variables for each story. The specific climate change scenario was removed at this point. Sea level rise assumptions were adjusted and held constant at the higher end of accepted global and local projections.

4.2.3 FEBRUARY 27, 2019 – REGIONAL STAKEHOLDER WORKSHOP

Scenarios were refined based on subject matter expert feedback. Four scenarios were presented at the regional stakeholder workshop on February 27, 2019.

A. What if we keep going on our current trajectory?

B. What if our economy becomes highly automated?

C. What if the world closes doors and borders?

D. What if we attract rapid growth in the tech economy?

These scenarios were differentiated from each other on two axes:

- Moderate Automation ← → High Automation
- Moderate Regional Economy ← → Strong Regional Economy

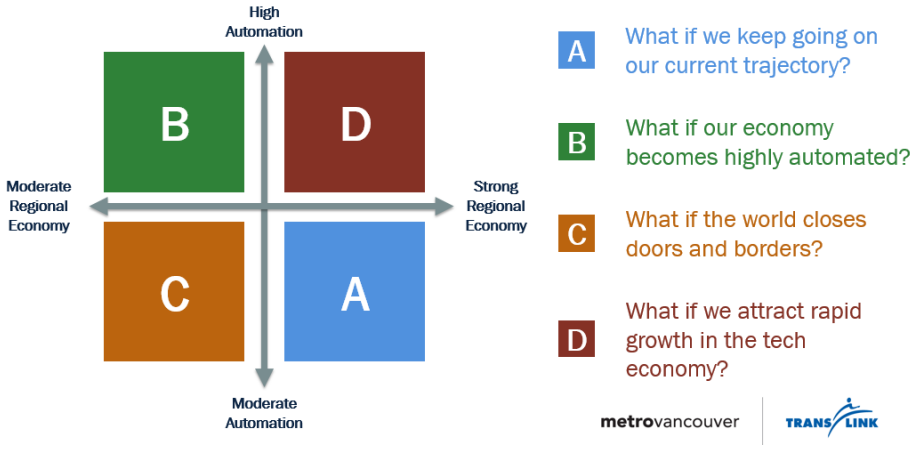


Figure 4: Four Draft Scenarios for Metro Vancouver

Stakeholders were requested to review each scenario's narrative, implications, opportunities and challenges. Stakeholders were asked to provide comment on the following:

- Is the scenario plausible? Why or why not?
- Are there missed implications that are important to consider?

- Do you agree or disagree with the opportunities or challenges listed? Are there any missed opportunities and challenges?

See Appendix C for more information on each of the draft scenarios along with in-depth stakeholder feedback

What we heard from the stakeholders:

- There was a lack of unanimous agreement or disagreement for all scenarios. Some implications were seen as too extreme, particularly around low and high growth scenarios.
- Scenario A was seen as the most plausible among stakeholders. That said, there was disagreement on whether globalization would continue to exist, whether trip rates would increase with increased automation, and a lack of clarity on whether shared or private auto ownership would exist.
- Scenario B was seen as less plausible among stakeholders. There was a lack of agreement that automation would decrease employment and population. Some stakeholders felt that the region would still be desirable even with increased job displacement from automation. Generally, it was difficult for stakeholders to imagine a scenario with a declining population.
- Scenario C was seen as the least plausible among stakeholders. There was not agreement that Canada would adopt protectionist policies even if other countries did. It was believed that Canada would increase its immigration if protectionist policies were increasing elsewhere in the world.
- Scenario D was seen as somewhat plausible by stakeholders. There were concerns about whether affordability would make it difficult to attract talent if local salaries were not competitive with elsewhere in the world. A decrease in trip rate was seen as unrealistic, with the argument that discretionary trips would increase to offset the lack of work trips from telecommuting.

How input was used to refine the scenarios:

- Implications were reviewed for magnitude and directionality. Stakeholder feedback was used to adjust several to be less extreme.
- Additional opportunities and challenges were added to the final Summary Report, using stakeholder feedback to deliver a broader range of services and areas of interest that relate to land use and transportation.
- Scenario narratives were refined using stakeholder feedback where there was disagreement on rationale behind the story.

5 SCENARIO OVERVIEWS

5.1 RANGE OF CONCEPTS COVERED

The Regional Long-Range Growth and Transportation Scenarios Summary Report was presented to the Metro Vancouver Regional Planning Committee on April 5, 2019 and the Mayor's Council on Regional Transportation on April 25, 2019. The final Summary Report is available here online.

The scenario planning process began by identifying and exploring a list of these external forces. As a globally-connected metropolitan region, there are many external forces that will have potential impacts on Metro Vancouver. For many forces, we have a good idea of scale of impact and how they are likely to unfold. For others, we know the impacts will likely be significant, but we have less ability to predict exactly how these impacts will play out in our region.

For the scenario building exercise, 25 external forces were identified. The external forces include emerging trends in technology, the economy, society, the environment, the nature of work and more. Both impact and variability for each external force were explored – looking at the degree to which each force is likely to impact the region as well as the variability in how and when the impacts may unfold.

The external forces were then grouped together into the two categories of forces with the highest impact and the highest degree of variability. These categories helped shape the four scenarios described below. The two categories are:

Automation & Technology - which will likely have profound impacts across every sector of the economy, but in ways that we cannot yet reliably predict; and

Economy & Trade - which is entering a period of greater uncertainty driven by changes in technology and global political developments.

A note about Climate Change -

Climate change is one of the greatest challenges of our time, and one that is already impacting the world and our region. Metro Vancouver is experiencing hotter and drier summers and warmer, wetter winters – both trends are expected to become more severe over time. Detailed climate change projections have been completed for the region and significant work is underway to understand the impacts, including increased flood risk.

There is a higher level of confidence projecting climate change impacts for the region between now and 2050 than beyond 2050. As a result, all four scenarios presented assume that the impacts of climate change will reflect the higher end of accepted global (International Panel on Climate Change) and local (Pacific Climate Impacts Consortium) projections.

Globally, the impacts of climate change have been seen to lead to an increasing number of water shortages, crop failure and food shortages, flooding, famine and armed conflict. These factors are likely to result in increased numbers of migrants seeking to come to Canada and the region to flee these impacts.

While climate impacts are embedded in all four scenarios, each scenario has different assumptions around the ability to afford measures to adapt to climate impacts.

5.2 SCENARIO CONCEPTS AND EXPECTED IMPLICATIONS

Scenarios were further refined based on regional stakeholder and subject matter expert feedback during the spring of 2019. The four scenarios that were presented to the Metro Vancouver Regional Planning Committee and Mayor's Council on Regional Transportation were as follows:

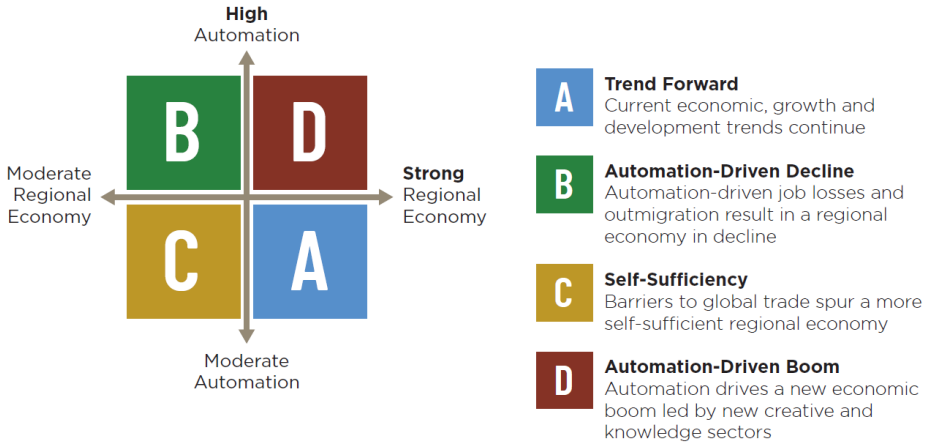


Figure 5: Four Scenarios for Metro Vancouver

A – Trend Forward: Current economic, growth and development trends continue

Narrative

Globally by 2050, artificial intelligence and automation have had significant, diverse impacts on economic competitiveness and employment across sectors and countries. Some countries have harnessed AI to enhance their workforces while others, whether due to caution, popular opposition, or limited investment resources, have incorporated automation in more limited ways.

In the region by 2050, automation is common in repetitive, labour-intensive jobs such as farming, primary manufacturing, and in many retail and service industries. The trends we see today will to continue to materialize as expected.

Improved productivity from automation and continued growth in consumer demand overseas results in increasing global trade through the Metro Vancouver Gateway. Regional goods movement also continues to grow because of economic and population growth, regionally, and the steady growth in e-commerce and just-in-time deliveries. Privately-owned automated vehicles (AVs) become more common in the region.

Overall, the region continues to focus growth in urban centres and corridors, in line with current regional and local plans. Clusters of specialized creative industries and labour, in the areas of film, social media or high-value food and beverage production, are increasingly distributed throughout Metro Vancouver.

Opportunities and Challenges

- Automation improves job productivity and creates new jobs in some sectors, but impacts low-income workers and small businesses.
    - New jobs in technology, creative, and care provider professions are created.
    - The region's population increases at historical rates through strong immigration.
    - Automation disproportionately impacts lower income workers predominantly performing repetitive mechanical tasks.
    - Small businesses are less able to adopt automation due to the costs, and some struggle to keep pace with larger corporations.
- Autonomous vehicles increase traffic congestion, but also allow driving time to be more productive.

- Automated vehicles add efficiency to the transportation system as vehicles are smaller and can communicate with each other.
- Gridlock persists as many AVs travel empty without passengers, and road supply is still limited. Longer travel distances combined with regional population growth continues to increase traffic congestion and overcrowding on roads and transit.
- People are generally less concerned about the congestion, as in-vehicle time becomes usable for work, sleep, or entertainment.
- Walking and cycling decreases, partly as a safety precaution with the significant uptick of vehicles on the road.

- People choose or are forced to seek housing outside the region and commute longer distances.
  - Continuing challenges with housing affordability lead to more people living in more affordable places like the Fraser Valley, Sea-to-Sky corridor, the Sunshine Coast and even Vancouver Island.
  - The region continues to be an attractive place to live, however the cost of living and housing remains high, particularly in urban centres.
- People continue to locate in flood prone areas which increases vulnerability.
  - Population continues to grow in flood prone areas which increases vulnerability during flooding from rivers and due to sea level rise.

B – Automation-Driven Decline: Automation-driven job losses and outmigration result in a regional economy in decline

Narrative

Globally by 2050, automation is common across most economic sectors. Artificial intelligence (AI) and advanced robotics are regular parts of the workplace. Workers move beyond repetitive, labour-intensive jobs into professions like teaching, healthcare delivery, and research & development. No job types are left untouched by AI and robots.

In the region by 2050, automation in the workplace has resulted in significant job displacement. A small number of foreign companies have automated entire supply chains in BC's abundant natural resources sector in the areas of forestry, mining, and oil and gas. From resource extraction to shipping, a small number of workers will do the work that previously employed thousands. Similarly, in retail and services, companies have continued to automate most jobs and online retailing continues to dominate local businesses.

While the owners and investors of the major companies operating in BC have profited, overall wealth in the region has declined. Median household income has decreased due to limited and precarious employment opportunities for most people. This also has created an unbalanced trade market, with far more wealth and goods leaving the region, compared to what is being invested and consumed locally. There is a higher volume of export-oriented goods movement traffic through the region, primarily of raw materials shipping overseas. There is less regionally-focused economic activity, and so local goods movement is primarily oriented around consumer goods and e-commerce deliveries. There is an increasing share of automated trucks on the road, as there is still significant movement of goods from the few companies that have automated their supply chains.

With decreased employment and wealth in the region, there is less trip demand and congestion. Transport equity is of concern, with an increased emphasis on transit, but limited ability to provide transit services across the region due to decreased government funding.

Opportunities and Challenges

- With lower population and employment, the region struggles to provide essential services.
  - With fewer employment opportunities available, regional population growth slows as immigration rates decrease sharply. In addition, residents move to other regions / provinces with lower costs of living and better employment opportunities.
  - A high proportion of remaining residents are over 65 years old, and the labour force shrinks. The aging population requires additional services, including higher demands on the health care system. But a reduced tax base decreases investments in social programming and reduces benefits and services for retirees.
  - With declining population and employment, reduced government revenues make climate change adaptation more challenging.
- Housing affordability improves, but wealth inequity persists.

    - Slower population growth allows the housing supply to catch up with demand and housing prices stabilize.
    - Income inequality remains high owing to precarious employment and low wages for the majority. Automated production increases value to the regional economy, but there are fewer jobs and lower incomes, and most wealth is captured by a limited few.

- There is less travel throughout the region, but some individuals need to travel a lot more.
    - With decreased employment and wealth in the region, there are fewer trips occurring. However, some workers travel significantly more, tying multiple contract jobs together in a day.
    - Trips to multiple jobs are generally undertaken by a reduced-service transit system or by privately-owned automated vehicles.
    - Some lower-income households require owning a vehicle to work multiple jobs.
- Automation allows for cheaper goods production and movement.
    - There is a higher volume of export-oriented goods movement traffic through the region, primarily of raw materials shipping overseas.
    - Local goods movement is primarily oriented around e-commerce deliveries. There are more automated trucks on the road, as there is still significant movement of goods from the companies that have automated their supply chains.

C – Self-Sufficiency: Barriers to global trade spur a more self-sufficient regional economy

Narrative

Globally by 2050, in response to discontent about rising unemployment and income inequality, many countries adopt policies that restrict trade and limit immigration. These political shifts, combined with technological developments such as 3D printing, support the return of manufacturing to Canada, but in the form of smaller, more localized production. Small-scale artisans, makers, and producers deploy automation to enhance their productivity.

In the region by 2050, there is an increased pressure to diversify the economy as the region has previously relied on international trade for many goods and services. Some trade continues, though heavy tariffs make importing and exporting more expensive. A decline in global inter-connectedness changes how business is conducted. Changes to global immigration policies reduce opportunities for migrants seeking refuge from climate change impacts. Canada continues to rely on immigration and it remains a driver of growth in Metro Vancouver. Median household income is relatively flat, with a higher cost of goods due to new import tariffs and a weakened Canadian dollar. Economic growth continues at a sustained pace.

With less global trade, there is greater incentive to transition to a more sustainable circular economy that uses fewer resources and produces less waste. Access to imported goods and services are impacted. New technologies such as automation and 3D printing are leveraged, enabling local manufacturing and more distributed production. Many local workers are required to shift their occupations, particularly those who worked for companies elsewhere in the world, as well as those who worked in jobs dependent on international trade. Short-term contract work (i.e. gig work) is more common.

There are fewer truck kilometres travelled on the road owing to less global trade and more integrated regional production. There is a lower AV adoption rate due to lack of global investment here and limited manufacturing capabilities to advance the technology within Canada.

Opportunities and Challenges

- Protecting agricultural land becomes more essential.
    - Regional food supply may be compromised by increased trade barriers. Agricultural lands become more important in meeting the region's food needs as the cost of food imports increase.
    - Climate change impacts may further stress the ability to produce food and threaten food security in the region.
- Repurposing industrial lands.
    - With less need for port and trade-enabling lands, demand for locally-serving commercial and industrial land increases along with local production.

- Motor vehicle travel becomes more expensive and shared-use travel increases.
    - Motorized vehicle travel is relatively more expensive due to rising fuel costs, and there is a lower AV adoption due to lack of global investment here and limited manufacturing capabilities to advance the technology within Canada.
    - At the same time, there is greater focus on self-reliance and low-cost solutions that leads to an increase in demand for active and shared-use modes.
- Housing becomes more affordable and infrastructure becomes overbuilt.
    - With slowing population growth, housing affordability improves in the region, as housing supply catches up with demand and recalibrates to local wages.
    - Existing infrastructure becomes overbuilt relative to the reduction in global trade, especially marine-based trade infrastructure. Provincial and national trade increases, requiring more land-based trade infrastructure.

D – Automation-Driven Boom: Automation drives a new economic boom led by new creative and knowledge sectors

Narrative

Globally by 2050, advances in digital connectivity and immersive technologies like virtual reality have reshaped where people choose to live and work. It is common to live in one region while working for a company elsewhere in the world. Major advances in zero-marginal-cost renewable energy systems combined with high levels of automation across most sectors dramatically improves productivity and consumption and global trade increases accordingly.

In the region by 2050, Metro Vancouver remains an attractive place to live relative to much of the world and is sought after for its livability. It continues to attract a larger share of a now highly mobile global workforce welcomed to Canada through a more ambitious federal immigration policy. While population and employment both grow significantly as a result, much of the primary work that people do is for larger knowledge and creative sector companies headquartered elsewhere in the world.

A type of guaranteed income system administered at the national level ensures that all residents in the region have their basic needs met especially as some workers displaced by automation struggle to find a new job in emerging sectors. Jobs in this new economy are more distributed around the region – closer to peoples' homes resulting in somewhat shorter commutes. The increase in wealth also means that some people choose to privately own AVs but many more choose to subscribe to their mobility needs as a service, taking advantage of the many shared-use options.

There is an increase in on-demand delivery of goods and services, reducing personal trips but increasing local delivery traffic. There are also more (non-work related) discretionary trips resulting from the increased wealth in the region.

Opportunities and Challenges

- Growing population and changing work locations increases demand on infrastructure and services.
    - Significant population growth provides more resources for major infrastructure upgrades. These resources greatly help to adapt to climate change and invest in transportation.
    - At the same time, infrastructure like roads, storm-water management and sewage treatment struggle to match the pace of population growth.
    - Distributed work locations require more distributed infrastructure to support it through expanding transportation networks, utilities, fibre optics and high-speed internet.
- Housing affordability and income equality issues persist.
    - The increase in professional global workers that call Metro Vancouver home contributes to a higher average income, while the median household income remains relatively flat.
    - However, significant population growth and a higher share of high-income earners results in continued housing affordability issues. This is further exacerbated with an increased wage gap between professional workers and those with lower incomes, driving more social equity challenges.

- Congestion and overcrowding continue but is more spread throughout the day.
    - People use shared mobility for most of their travel, which, despite the significant population growth, results in relatively similar traffic congestion to decades prior.
    - Global workers operate on other time zones for companies headquartered elsewhere, reducing peak travel congestion in the region, but also require more 24-hour services. The 9-5 work pattern is still seen but is less emphasized from previous decades.
    - With decreased vehicle traffic, particularly at peak periods, parts of the road network (and parking lots) are repurposed for higher and better uses, creating opportunities for wider sidewalks, and protected cycling lanes.

Scenario Implications

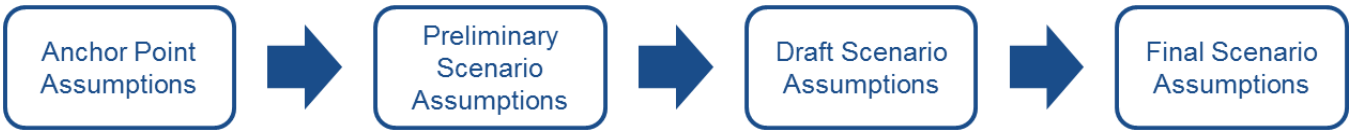
Table 4: Magnitude and Directionality for Indicators for each Scenario

Indicator	Today	SCENARIO A: Trend Forward	SCENARIO B: Automation-Driven Decline	SCENARIO C: Self-Sufficiency	SCENARIO D: Automation-Driven Boom
Regional Population	**2.57** million	**+40%** (3.6 million)	**-0%** (2.6 million)	**+20%** (3.1 Million)	**+80%** (4.6 million)
Distribution of Housing	**55%** in Urban Centres and Corridors	More dispersed	More concentrated	More concentrated	No change
Total Jobs	**1.34** million	**+35%** (1.8 million)	**-20%** (1.1 million)	**+10%** (1.5 Million)	**+60%** (2.1 million)
Distribution of Jobs	--	More concentrated	More concentrated	More dispersed	More dispersed
Unemployment Rate	**4.3%**	No change	↑↑	No change	↓
Median Household Income	**$73,000**	↑	↓	↓	No change
Income Equality	--	↓	↓↓	↑	No change
Daily Travel Demand	**2.8** trips per person/day	↑	↓	↑	↓
Trip Length	Average length **9 km**	↑	↓	↑	↓
Share of Passenger Vehicles that are Autonomous	None	**50%**	**50%**	**30%**	**70%**
Mode Share	Private motorized: 73% Shared motorized: 15% Active: 12%	Private motorized: ↑↑ Shared motorized: ↓ Active: ↓	Private motorized: ↓ Shared motorized: ↑ Active: ↑	Private motorized: ↓ Shared motorized: ↑ Active: ↑	Private motorized: ↓ Shared motorized: ↑↑ Active: ↑↑
Federal Government Funding	--	↑	↓	↓	↑
Flood Risk	--	Significant increase	Significant increase	Significant increase	Significant increase

The values in this chart from the Summary Report are generalized and more detailed modelling is required.

5.3 KEY ASSUMPTIONS WHILE BUILDING THE SCENARIOS

Developing the long range scenarios built on a number of assumptions at multiple stages of the project.



- Assumptions for anchor points were nested under the hierarchy below. Related external forces were tied to anchor points, and then potential impacted areas were identified for each external force. From here, bookend assumptions were developed on available literature and research. Table 5 below displays the structure for developing assumptions. For the full spreadsheet of 2050 impact bookends and assumptions, please see Appendix E: Anchor Point Impacts and Scenario Assumptions for additional documentation. These were adjusted to fit the preliminary scenario narratives developed.
- Preliminary scenario implication assumptions and rationale are listed in Appendix B as presented to subject matter experts. These were adjusted upon feedback from experts, particularly for indicators that were too extreme based on existing research undertaken.
- Draft scenario implication assumptions and rationale are listed in Appendix C as presented to regional stakeholders. These were adjusted upon feedback from experts, again primarily for indicators that were too extreme based on existing research undertaken.
- Final scenario assumptions and notes are listed in the summary report.

Table 5: Anchor point hierarchy for building assumptions

Anchor Point	Related External Force	Potential Impact
Advanced Automation and Technology	Advanced Automation	Employment by Industry (NAICS)
		Employment by Location
		Industrial Land Change
	Connected and Autonomous Vehicles	Employment by Industry (NAICS)
		Employment by Location
		Population by Location
	Real Estate Market Dynamics	Employment by Location
		Population by Location
		Housing by Location
Climate Change	Natural Hazards and Climate Change (Flooding)	Land Availability
		Employment by Location
		Population by Location
	Natural Hazards and Climate Change (Heat & Drought)	Land Availability
		Employment by Location
		Population by Location
	Real Estate Market Dynamics	Employment by Location
		Population by Location
		Housing by Location
Trade and Economy	Global Outsourcing & Re-shoring	Employment by Industry (NAICS)
		Employment by Location
	Real Estate Market Dynamics	Employment by Location
		Population by Location
		Housing by Location

6 NEXT STEPS

6.1 HOW SCENARIOS CAN BE USED FOR LONG RANGE PLANNING

The Long-Range Growth and Transportation Scenarios project considers a range of external forces, identifying and exploring those which are likely to have the most significant and least predictable impacts on the future of the region. The scenarios focus on external forces related to economic change, automation and technology, and our changing climate, each with implications for population, employment, where people live and how they travel. Moving forward, TransLink and Metro Vancouver are now better positioned to shape a more resilient vision for growth and transportation in the region and to begin updating or drafting new long-term transportation and growth management plans.

Scenarios can be used to inform future transportation and land use projects, policies and programs for TransLink's Regional Transportation Strategy update and Metro Vancouver's Regional Growth Strategy update. By thinking through alternative futures, a robust set of strategies can be developed. This in combination with the insights from the Subject Matter Experts can help identify a range of strategies and actions that can be explored beyond the constraints of our anticipated future.

6.2 USE IN SUBSEQUENT STEPS TO BUILD RESILIENCE

For this project, scenario inputs were not directly modelled using Metro Vancouver's Regional Growth Model or TransLink's Regional Travel Demand Model. Instead, effort was placed on identifying trends within external forces that could be taken under consideration by respective modelling teams for future model runs that may align with the values that were identified in the scenarios themselves.

Resiliency analysis was not undertaken within the scope of this current project. Resiliency analysis could be undertaken at a future point in time should the respective agencies be interested in leveraging the existing scenario development work that has already been undertaken. Resiliency evaluation would assess how a portfolio of strategies and actions would perform under the stressors of different scenarios. Qualitative assessment can be undertaken to determine if portfolios of strategies and actions addresses key opportunities and challenges identified in the Summary Report. Additionally, travel demand modelling and population and employment growth modelling could be undertaken against base case forecasts. The model outputs can then be used to inform the evaluation of investment portfolios against an established set of criteria in the form of key performance measures, such as mode share, vehicle kilometres travelled, income equality, and other similar indicators. Some of these were qualitatively assessed as part of the scenario implications section of the Summary Report. In order to generate additional value to the scenario planning process, qualitative assessment and/or quantitative modelling could be used when assessing the resilience of different investment portfolios for future transportation and growth infrastructure. Refinement to projects, programs and policies can be undertaken based on the resiliency evaluation undertaken between scenarios and investment portfolios.

APPENDIX A – EXTERNAL FORCE STAKEHOLDER FEEDBACK

Summary of External Force Stakeholder feedback:

Each external force was discussed at the October 18th workshop with table facilitators keeping notes.

The external force note taking was divided into the following segments:

- **Theme**: Captures the general discussion highlights and areas that were covered
- **Impact**: Captures the directionality and magnitude that participants discussed, along with some implications.
- **Variability**: Captures discussion of the likelihood that the force will manifest in a way we expect.
- **Parking Lot**: Captures discussion of related topics but ones not directly tied to the external force.

Stakeholders notes from the 21 external forces presented at the workshop are summarized below:

A: Advanced Building Construction Technology

B: Internet Of Things & Digital Connectivity

C: Connected & Autonomous Vehicles

D: Electric Mobility

E: Demographic Attitudes

F: Increasing Urbanization

G: Aging Population

H: Shared Mobility

I: Changes in Local Government

J: Energy Transition

K: Agricultural Productivity & Food Security

L: Natural Hazards & Climate Change (Flooding)

M: Natural Hazards & Climate Change (Heat & Drought)

N: Natural Hazards & Climate Change (Earthquakes)

O: Global Outsourcing & Re-shoring

P: Shifting Global Economy & Trade

Q: Real Estate Market Dynamics

R: Sharing Economy

S: E-Commerce

T: Advanced Automation

U: The Gig Economy

A: Advanced Building Construction Technology

Themes: modular and pre-fab housing, affordability, job impacts, development context and policy

Impact:

- There will be an impact from labour changes
- Likely job loss
- There will be a change in the pace of development with advanced building construction technology – but not changing where development occurs. However – these timelines could lead to increased density happening faster, increasing the population.
- There will be fewer trips by construction works. There will also be fewer jobs in this field, or jobs will become more IT focused of running the systems, and less about being on-site.
- Most cost in advanced building construction technology is in the servicing, not in the construction, therefore this will have a relatively low impact from a cost perspective.
- Advanced technology may change how fast we construct, but not how much we grow, this is more tied to immigration.
- Augmented reality in building technology will allow for safer construction
- Transportation of large loads (pre-fab houses) could create different issues in the transportation system if aggressively pursued.
- Excavations and building foundations are jobs that require low-skill labour for now.
- There could be an impact on trade – for new equipment.

Variability

- Construction pricing might shift with different and taller building forms – this will create uncertainty.
- New/different materials are difficult to predict
- Might allow for more infill development (garden suites or laneway houses)
- There's the possibility that decrease time/cost could be a driver towards affordable housing. Conversely, advanced building construction technology does not necessarily equate to a lower end cost.
- Warehousing areas may be needed for space to construct
- There will be a need for transition and retraining of existing workers in this field.
- With decrease in cost, it could keep more young people in the region. This could also mean more traffic if there is more aggressive development in the suburbs.
- An increase in regulation may counteract efficiency savings (time and money).
- Will require significant changes to the building code. Building codes are slow to change.
- It's unclear whether these advances in technology will be able to be low energy buildings.
- Not likely suitable for rental apartment development
- Market interest in customization may dampen uptake of pre-fab/modular projects
- Does not solve municipal review/approval process – still takes time to get approval.

Parking Lot (related ideas)

- Modular housing
- 3D printing high-rise towers

B: Internet of Things & Digital Connectivity

Themes: Intelligent transportation system, drone delivery, telecommuting, global labour pool, aging in place,

Impact

- IoT will allow for increased efficiency over time.
- Transportation platforms will change. Intelligent transport systems will allow for changes to mobility.
- Industry may have smaller and more distributed sites.
- Drone delivery could become a thing. E-Commerce otherwise may allow for smaller delivery vehicles.
- Digital connectivity will change the labour pool. You can hire someone from a different continent, this is already being seen today.

- Mapping improvements will allow for improvements in delivery.
- Vehicle speeds and locations will be tracked at all times, allow for municipalities and jurisdictions to identify key pinch points to systems and figuring out how to work around them.
- Right now there are 21 traffic systems across Metro Vancouver that don't effectively talk to one another. Integrated and connected systems will improve these boundary inefficiencies.

Variability

- Regarding telecommuting, there will continue to be a tension between remote work and need for social interaction. There still appears to be value in face-to-face contact. An increase in remote work would reduce travelling.
- Economic agglomeration will continue to be a driving force, making it tough to determine if remote work will take off.
- There are privacy concerns with AI (facial recognition), especially with private companies and intermediaries.
- There may be a disconnection of people from traditional physical spaces (e.g. workplace/grocery store)
- Due to telework, there will be more flexibility for people to either live close to their office, or far away. There will also be a change in working hours, especially if you opt to work on the other side of the planet for your company and change away from traditional working hours. This will have an impact on transportation, it's unclear how yet.
- Something you see already is 24/7 access to employees and always being 'on'. Effects on mental health of employees unclear, something to monitor. Conversely – this level of flexibility is seen as being a requisite for staff retention.
- Digital connectivity may provide additional value to being able to age in place.
- Access to digital connectivity will become paramount.
- We may see an increased imbalance and inequality when it comes to access.
- People may move away from Metro Vancouver in search of smaller towns with less traffic and/or affordability issues. This could be achieved through digital connectivity.
- Need to think about cyber-security and collection of personal information.
- How will some commercial establishments be impacted if there are more people working from home? Any difference?
- There may be more online retail opportunities as people spend more time connected. This may reduce in-person interactions. Also there may be more on the front of virtual reality.

Parking Lot (related ideas)

- Mobility as a Service will allow for efficient integrated mode planning and payment.

C: Connected & Autonomous Vehicles

Themes: goods movement, safety, insurance, curb space, access, first and last mile

Impact

- As there is a transition to CAVs, there will be safety issues
- Freight efficiency will improve – which may equate to more trucks on the road. Conversely – there will also be more opportunities for overnight trucking, more so than today.
- Older adults will have more access to mobility through CAVs, compared to currently relying on ride-hailing and HandyDART services
- Narrower lanes may be possible, which could potentially allow for repurposed road space.
- Will extend transit services by providing opportunities for the first and last mile, potentially to be paired with appropriate policy controls to incentivize this behaviour.
- Infrastructure may need to plan to match this technology – e.g. smart parking garages.
- There will be impacts on other road users (cyclists/pedestrians).

Variability

- Insurance issues will be relevant for both shared and private ownership models – e.g. who is at fault in collisions?
- There will likely be changes to roads, developments, curb space, parking demand, parking requirements
- Potential to inform good policy to reduce private vehicles. Also a threat to public transit.
- Private ownership models will change housing design to potentially require the need of a garage.
- If there is individual ownership, there will be more vehicles on the road and lower transit ridership.
- Overall VKT may increase if there are more zero-occupancy (zombie) vehicles circulating on the road, either waiting to pick up a passenger or looking for parking spaces.

- CAVs may revive the auto-centric dream of suburbia – with the increase incentive of driving as it could be seen as productive time.
- Unclear how weather will impact CAVs. Can automated vehicles be better than humans with undesirable conditions?

Parking Lot (related ideas)
- Flying taxis in Yukon

D: Electric Mobility

Themes: charging infrastructure, GHG emissions, induced demand, electric pricing, fuel tax revenues.

Impact
- There will be greenhouse gas emission reductions if continuing this trend
- As gas prices increase, the demand for EVs will increase
- There will still be congestion issues with EVs, only helps GHG emissions. Conversely – as more people switch to electric vehicles, the current fuel tax in place will not be as robust. Significant impact on fuel revenues for TransLink
- Positive impact on local air quality
- Current pricing of electricity could incentivize more driving.

Variability
- There's a lack of clarity on how much time is needed to give cars a full charge.
- It's unclear where the charging stations for EVs will go
- There will be an impact to homes, and higher demand on electricity from towers.
- Unclear how electric active modes will flourish – e-scooters, e-bikes, etc.
- Further development of 'electric highways' required to ensure that people feel comfortable with their ability to find charges beyond their city.
- Closing of gas stations may create opportunities for infill (but also often contaminated sites).
- 24 hr electric demand (from overnight charging) is a hot topic with BC Hydro
- Will people switch to EVs for in-city trips and a 2nd vehicle for recreation and longer trips? It's unclear if/how charging infrastructure will exist throughout less dense parts of the province to support electric mobility.

Parking Lot (related ideas)
- Consider alternative fuels along with this trend (CNG, Fuel Cells)

E: Demographic Attitudes

Themes: density, shared spaces and services,

Impact
- Denser living in smaller units. Younger generations are more open to shared spaces, less interested in large homes with a back yard.
- There is an increase of immigration in the region, and urban density is generally more tolerated. Conversely, people of some demographics do not prefer urban living. This along with the younger generation becoming more tolerant of density.
- There will be an increased demand and requirement for green space for young and old generations.

Variability
- Unclear if lower licensing rate will continue in the region as the next generation starts having children.
- Everyone is becoming more active – this will have land use impacts.
- There will continue to be a desire of convenience, these may become shared convenient services, as opposed to private (in-house) convenience.
- Transit and housing stock isn't necessarily planned for these changing demographic attitudes.
- Divergent perspectives on whether we need more Urban Centres to meet the demand for urban, dense living versus outflow of people looking for less dense environments (e.g. Vancouver Island).

Parking Lot (related ideas)
- Additional considerations include car seats for children being required for (some) car-share vehicles

F: Increasing Urbanization

Themes: pressure/change of regional land use, food security, servicing, accessibility

Impact

- Increased shift to regional centres.
- There will be a major pressure on park spaces.
- Massive impact on servicing: sewers, water, storm-water
- Economic impacts on businesses in more rural areas – people will see urban centres as places to do business, making it more difficult for those on the outside.
- Major impacts on education centres. Will be difficult for schools who can't afford to buy new land. Keeping the teacher: student ratio in line will partially depend on sufficient facilities around the region.
- Spot zoning instead of city-wide zoning may have issues as increased urbanization takes place.
- Parks and greenspaces are critical. The ratio of ha per residents need to be reviewed

Variability

- May impact ALR and urban containment dependent on political values
- Major impact on transit
- Who will produce food if everyone lives in cities?
- For all the increase in urbanization, there is also a shift away from urban areas.
- Unclear if there will be social and mental health impacts from increased urbanization
- Aging population may be interested in this increased urbanization due to improved walkability
- There may be a polarization of urbanization in combination with autonomous vehicles: dispersed clusters of communities connected with autonomous mobility

Parking Lot (related ideas)

- Rethinking of institutional sites and uses – opportunity for shared use of parking for instance

G: Aging Population

Themes: aging in place, housing stock, affordability, pensions, land use, accessibility

Impact

- There is a desire to age in place – less interest in moving.
- We still have a long way to go with accessibility planning. Furthermore, there will be services that need to improve (recreation and community centres). There will be need for more and programming to potentially change (e.g. conversion of tennis courts to pickle ball).
- There will be an impact on the labour force and economy.
- Seniors are getting poorer – less disposable income – transportation will need to adapt.
- Housing stock will be impacted – there are fewer areas to downsize into. More missing middle housing types (low-mid rise) and more apartments needed to allow boomers to age in place in their communities.
- Healthcare sector will be impacted along with how we deliver healthcare (if aging in place becomes more commonplace).

Variability

- Transfer of wealth (from old to young) is delayed with aging population. This may impact changes in lifestyle.
- This is a demographic bulge – the profile could look different again in 30 years.
- Older generations buy fewer goods – the local economy may decrease.
- There's the possibility of untapped free labour and volunteerism
- As there is a transition towards more rental and less ownership – combined with poorer older adults, there may be a situation that puts more seniors on the edge of homelessness.
- With an aging population, will there be enough people to people in the workforce to attract companies to locate in MV?
- Traditional retirement age may change.
- Uncertainty around sustainability of pension funds.
- Parents may move in with children, as with immigrant housing modifications / assisted living location near centres.

Parking Lot (related ideas)

- N/A

H: Shared Mobility

Themes: first and last mile, parking, bike-sharing, fuel costs

Impact:

- Less parking will be needed – no need to own a car.
- Change required to minimum parking requirements in development permits for buildings.
- Can help improve access to transit (first and last mile problem)
- Will continue to be an important consideration alongside advent of CAVs.
- Cost issue: not cheaper than transit.
- Huge regulatory impact and enforcement requirements
- Likely to increase congestion
- Improves access for people with mobility challenges.

Variability:

- Some cities are ready for this but haven't seen demand for it. They are either too small geographically or too dispersed.
- Unclear on where passengers will come from – previously those who drove, or used transit, or biked/walked?
- Provincial regulations may change how it impacts our region compared to others.
- E-bikes could bridge the gap between bike + car – shared e-bike systems are being deployed elsewhere in the world. Increased demand for bike lanes if e-bikes become more common.
- Shared mobility may be more commonplace because of energy rates changing

Parking Lot (related ideas)

- Home-grown ride-hailing solution as opposed to Uber/Lyft

I: Changes in Local Government

Themes: taxation, responsibility, risk, services

Impact:

- Cities can impact others through policy and taxation differences between them.
- Success will be dependent on other sources of money.
- Municipalities are being burdened with more responsibility. However – they can also respond faster than higher levels of government.
- There is high demand in cities for services but generally a low tax base.
- If privatization of public services is within scope, then there could be high impacts

Variability:

- Does 21 municipalities for the region make sense – should there be an amalgamation.
- Potential inequity between how much municipalities have to pay and the services they are required to offer.
- Climate change impacts differ between municipalities. Those on flood plains need to do more to adapt to climate change.
- Immigration is generally a federal issue where municipalities are required to provide many of the services.
- Financial exposure is really high for municipalities.
- Scope of local governments may change from time to time, but local governments have shown the capacity to adapt

Parking Lot (related ideas)

- Cannabis related programming
- How do you plan for constant pressure to keep municipal budget low – disconnect between others and long term trends.

J: Energy Transition

Themes: BC energy base, carbon tax, distributed network, future considerations, electrification benefits

Impact:

- This is globally taking place, but North America is slow due to political climate
- Carbon tax will shift things but will face push back from oil industry
- This force is market driven, but there are policies that can help this shift
- Community benefit of reduced noise and pollution with switch to electrification
- Energy transition less impactful in BC due to largely hydroelectric already (especially after Site C)

Variability:

- Need to consider how AVs will be powered (under shared and private ownership models)
- Need to move to a more distributed network of energy production
- There may be an impact on revenue but not so much on transportation planning.

Parking Lot (related ideas)

- Policies support anaerobic digests

K: Agricultural Productivity & Food Security

Themes: policy change, vertical farming, climate change, security/production, import/exports

Impact:

- Vertical farming could shorten distances travelled from farm to table
- New crops and policy will create changes in land use (e.g. cannabis). Also how will these relate to food security – with this example in particular but could be applied elsewhere.
- Sea level rise will create salinity issues – irrigation infrastructure will need to be upgraded/expanded to flush out the salt. (ALR is generally in low lying lands in MV)
- Low impact on transportation, there will always be a need of distribution.
- Global food system will have an impact to import/exports/distribution/processing
- With climate change considered, it's likely there will be an expanded growing season for MV. There will be value to growing more food here in the future, but will there be the land to make it happen?

Variability:

- Diets may need to change. Hay cannot grow in vertical farms, which will complicate animal feeding.
- Growing food outside the region may happen if Agricultural Land Reserve isn't maintained.
- Unclear if vertical farming will be able to find land to build on in Metro Vancouver – already very expensive.
- ALR could be expanded to ensure more locally grown food.
- There could be policy to encourage more farming in non-farm areas
- There may be more dependence on food production outside of BC/Canada, making the region more vulnerable.
- There may be an increasing dependence on imported food – impact on transport
- The existing amount of agriculture grown is not meeting the food security needs of the region, may not be able to meet future needs.
- Current agricultural spread in the region is not diverse enough.
- There may be an impact on water resources in the region as agriculture is water-intensive. This can/should be considered if there is an expansion of local agriculture.
- New pests and diseases will need to be considered with changes in climate/temperature.
- There will be ups and downs but overall food security will be stable as long as ALR remains intact.

Parking Lot (related ideas)

- look at industrial water usage trends in the Okanagan and how this could be applied to MV.

L: Natural Hazards & Climate Change (Flooding)

Themes: sea level rise, infrastructure, adaptation, resilience, climate refugees,

Impact:

- Cost of dyke construction and maintenance has largely been downloaded to cities, where property tax is not enough for the financial requirements.
- Parts of the region are vulnerable to sea level rise, and there is high certainty on the areas of impact

- Evacuation route planning and simulations will be required

Variability:
- A lot of land is being used/will need to be used for dykes – are there other ways to address sea level rise?
- What if one city does not maintain dykes and there are impacts to another city?
- Unclear if there's a need for additional water reservoirs
- Risk of climate refugees coming to the Region from areas that are more heavily impacted elsewhere in the world.
- Saltwater in the Fraser will continue further upstream from where the brackish point is today.
- Difficult to undertake a managed retreat from certain low-lying areas.

Parking Lot (related ideas)
- King tides are happening more and more which is an early warning shot of how sea level rise will impact parts of the region

M: Natural Hazards & Climate Change (Heat & Drought)

Themes: heat impacts, air quality, energy use, climate refugees

Impact:
- There may be an increase in local refugees from wildfires (displaced residents from elsewhere in BC)
- Major energy impact if all homes are retrofitted with air conditioning units. Need to rely less on A/C and more on passive heating/cooling. Unclear if there will be affordability issues.
- Minimal impact on land use and transport. At higher temperatures, rail systems may become warped from heat. Some agriculture may do well while other crops may find hotter temperatures less viable.

Variability:
- Air quality impacts not well understood from heat, drought, and wildfires. Air quality advisories may increase.

Parking Lot (related ideas)
- Passive House may not be suitable in a warming climate as Passive House is suited for minimize heating needs in a cool environment

N: Natural Hazards & Climate Change (Earthquakes)

Themes: building standards, resilience, mitigation, utilities, transportation systems

Impact:
- Seismic retrofits – generally seen to cost significantly less money pre-quake than redevelopment post-quake
- Buildings that are 4-6 stories tall are most impacted by earthquakes
- Need a resilient transportation network to be able to recover after a megathrust earthquake
- Utilities will be impacted

Variability:
- Emergency response will depend on severity of earthquake
- Changes to building code now to ensure seismic resilience could make a difference

Parking Lot (related ideas)
- use examples from other regions to determine impact on growth, infrastructure, heritage, etc. This will also help with costing.

O: Global Outsourcing & Re-shoring

Themes: sector-specific outsourcing and re-shoring, multi-national companies, employment, automation

Impact:
- Already happening, especially with the knowledge sector (e.g. engineering design). Previously – manufacturing has been moving elsewhere.
- The balance of population and jobs will change if more jobs are outsourced from the region.
- Satellite offices of big multinational corporations are coming to Metro Vancouver.
- More people may choose (or be required) to work from home – this could decrease congestion.

- Automation will remove cost of labour; cost of transportation will become more important.

Variability:
- May not change overall planning decisions but could change land use of designated space.
- With tech and knowledge-related jobs, there's low certainty on how long people will want to live in the region – can move at any time.
- If those who become unemployed by outsourcing are retrained for other jobs, negative impacts may be limited.
- Some jobs can't be outsourced, there is a social component.
- It may be a skill and service based economy
- Strive towards keeping a diverse regional economy so that a dip in one sector does not disproportionately affect the regional economy on the whole.

Parking Lot (related ideas)
- Amazon's new HQ suggests company trends towards re-shoring.
- Take stock of the regions' tourism economy of natural resources.

P: Shifting Global Economy & Trade
Themes: goods movement, trade deals, politics, industrial land, natural resources

Impact:
- Base resources are key for development, if price of steel goes up, budgets become uncertain.
- Lack of warehousing in the region forces goods to move outside the region, only to be shipped/delivered back to the region when needed.
- Major infrastructure decisions will significantly impact how resources are moved and traded (e.g. pipeline decisions)
- Large impact on transportation and land use if other countries/regions take a bigger piece of the pie.
- Industrial land needed for transportation logistics

Variability:
- Dependent on trade agreements and business opportunities. Lots of political factors.
- Pressure to support goods movement
- Relationship with Prince Rupert to accommodate trade with Asia
- There could be impact to supply building materials and local industries.

Parking Lot (related ideas)
- HSR opportunity through Cascadia corridor (BC, WA, OR, CA)

Q: Real Estate Market Dynamics
Themes: income disparity, wealth gap, transport impacts, movement in/out of region, affordability

Impact:
- As demand increases, so does wealth of property owners which is mostly local equity growth
- People are taking properties off the market until prices go up
- There are significant displacements due to "renovictions" (renovation evictions)
- There is growth land ownership class distinction – e.g. the haves and the have nots
- Significant human impact on access to housing
- High impact on areas that were not thought of as urban (e.g. Township of Langley)
- There is a lack of economic diversity in the region – so the housing sector carries more weight (shallow economy)
- There will be transportation impacts if more people moves to less urban parts of the region. This growth will be less well served by transit and may force more people to drive, furthering congestion in the region.

Variability:
- Unclear on elasticity of cost, whether more people will move outside the region in hopes of more affordable places to live or if people will continue to move to urban centres. Demand will continue to increase, it's unclear how much worse (more expensive) it can get

- Commuter shed is getting bigger and bigger and will continue to grow as people are pushed outside the region by affordability.
- Unclear on how property taxes will play out.
- Unclear what a housing crash would look like in the region.
- People are changing homes more frequently.
- Wages are somewhat competitive in the Region but less purchasing power due to high cost of housing and transport.
- Region's real estate market is connected with the global market – so there are aspects outside the region's control

Parking Lot (related ideas)
- Unlikely that market will continue to rise for 50 years due to limited supply.

R: Sharing Economy

Themes: policy and regulation, ride-sharing, bike-sharing, employment application,

Impact:
- Younger generations own less and share more
- Co-working industry is growing – but it's expensive to rent space in downtown Vancouver. Lack of options elsewhere in the region.
- Mobility will be impacted most by sharing economy (also covered under shared mobility external force). Curbside space will need to be considered. Positive impact for access.
- E-bike sharing is a trend to watch as it may bridge a mobility gap. Sidewalk space may need to be considered.
- There is an uneven playing field amongst service providers. AirBnb may eventually be regulated the same way as hotels or BnBs; Uber/Lyft are not that different than a taxi, unclear how regulation and policy will see it.

Variability:
- Unclear how people will group together for housing – and how much co-housing will take off.
- Smaller housing units may mean less ability to share.
- Unclear what impact short term rentals (e.g. AirBnb) will have and whether there will be
- Unclear if there will be cross-cultural sharing

Parking Lot (related ideas)
- Plant and seed libraries/exchanges
- Connected to IoT

S: E-Commerce

Themes: brick and mortar stores, goods movement and logistics, industry-specific, supply chain management

Impact:
- Impact to commercial and industrial lands. There will be more warehousing required.
- Mini-distribution centres may be a new land requirement, especially in urban centres.
- There may be a requirement for storage/holding rooms in larger buildings – e.g. amazon rooms in condo towers.
- There will be less brick and mortar retail outlets. Malls are declining.
- Delivery will be impacted. There will be more delivery required than before. This may impact overall transportation congestion. Significant changes required for shipping and goods movement.
- Will affect the viability of standalone shopping centres; need to become mixed-use centres

Variability:
- There could be 3D printing in/on trucks to create roving retail beyond JIT delivery.
- With less commercial/retail in neighborhoods, there could be a negative impact on urban form, walkability, vibrancy. Companies may opt for multi-platform of both providing a store front but also doing much of their business online.
- Curbside management will need to be reviewed for increased amount of local deliveries.

Parking Lot (related ideas)

- "Amazonification" of supply chain --> changing nature of demand would have uncertain impacts on industrial lands --> big box stores won't be part of future landscape

T: Advanced Automation

Themes: industry impacts, employment impact, worker transition, land use impacts

Impact:

- Major impact on labour force, there will be some shift in jobs, and some jobs eliminated.
- If there are less jobs to go to, there will be less people traveling for work, decreasing congestion.
- There will be a loss of lower skilled jobs.
- Could bring back industries to Metro Vancouver – but not necessarily jobs.
- Improved safety and quality in manufacturing and other sectors. That said, there is less manufacturing in the region so less impact.
- TransLink may move to an automated fleet (Skytrain system is already automated)
- Union and labor structure will change significantly
- Land demands will remain static or increase.

Variability:

- Job loss may be offset with baby boomers retiring
- May result in humans having shorter work days – but it hasn't happened yet.
- Dependent on global automation, jobs may be offshored if other countries automate earlier/faster and it's of value to a company.
- Need for creativity to invent new jobs.
- There will be higher expectations for cleaner streets, quality parks, etc.
- There will be a window where it will be difficult for certain industries to recruit works as jobs in that field become automated (e.g. manufacturing, ride-hailing, goods movement).
- If there is automation in manufacturing, then could re-shore activity into the region, no incentive to rely on foreign manufacturing unless cost of base materials is lower.

Parking Lot (related ideas)

- Humans have adapted to increasing automation in the past, no reason that it will be different going forward.

U: The Gig Economy

Themes: Casual employment, trip linking, work from home, office space, transport impacts

Impact:

- Likely to see more casual employment
- More revenue going to corporations and less to employees. Employees will likely have less benefits, this will exacerbate the wealth gap.
- Access to stable employment will have individual health impacts, access to stable employment will also impact housing market – potentially less opportunity to accrue enough wealth for a deposit on a house.
- Peak traffic may be moderately affected but not extensively. It may increase VKT on the whole from more people driving to connect different jobs (precarious work, multiple jobs). Risk of rush hours blending peak travel periods to make it busy all the time.
- Trip linking may be offset by increased amount of people who work from home.
- Some gig jobs may be lower paying, while others will be high paying specialist positions.
- There will be more gigs in city centres and less in rural areas (employment density follows population density).

Variability:

- Aging population may be interested in more part time work
- There will be a switch from a traditional 9-5 working patter to a 24/7 economy.
- Economic inequality is a big factor that needs to be considered
- There may be less demand for traditional office space. There may be more co-working spaces, and companies may switch to a more hoteling style to decrease overhead costs when employing a more precarious work force.

Parking Lot (related ideas)

- N/A

APPENDIX B – PRELIMINARY SCENARIO CONCEPTS & EXPERT FEEDBACK

There were six preliminary scenario concepts that were reviewed and commented upon by subject matter experts during February 2019. Each included driving questions, a narrative, scenario implications, and assumptions. The scenarios at this point were named:

- Scenario 1: What if the region keeps going on its current trajectory?
- Scenario 2: What if most of the economy becomes automated?
- Scenario 3: What if we close our doors and borders?
- Scenario 4: What if tourism becomes a main driving economic sector?
- Scenario 5: What if a digital economy takes hold?
- Scenario 6: What if climate change is worse than we think?

SCENARIO 1 - WHAT IF THE REGION KEEPS GOING ON ITS CURRENT TRAJECTORY?

Driving Questions:

- What if climate change occurs according to the high end of what models project?
- What if moderate automation can be leveraged to contribute to increased productivity?
- What if some forms of production can be reshored?

Narrative:

Differing approaches to automation around the world results in shifting populations as people migrate in search of opportunities.

In 2050, the world is struggling to balance the impact that automation has on competitiveness and employment. While some regions have pursued extensive automation in all sectors up to and including some knowledge-based work, other regions have taken a more conservative approach and allowed automation only where it works alongside people. The differing approaches have resulted in changes to global dynamics that see significant unemployment in some parts of the world, and major population shifts as people migrate in search of employment opportunities.

Moderate uptake on automation retains jobs and attracts people to Metro Vancouver, but also results in moderate economic competitiveness.

Metro Vancouver is among the regions that take a more moderate approach to automation, limiting it to just the primary and secondary sectors, with automation in agriculture, manufacturing, and processing, as well as in warehousing, transportation, and distribution. Improved productivity and cost effectiveness from automation allows some production to return to the region, at least for consumption by local markets. On the whole, Metro Vancouver is not as competitive globally from an economic standpoint, but the availability of jobs alongside some automation makes the region an attractive place for people to live, work and do business. As a result, immigration into the region continues, resulting in continued increase in the regional population.

Reduced land availability from climate change in the region puts further pressure as the regional population continues to grow.

Sea level rise and river flooding from climate change have started to impact land availability in the region, leaving some low-lying areas no longer being suitable for living. Coupled with the increase in regional population size, the region experiences significant land constraints. As a result, some people in the region move to adjacent regions (such as Fraser Valley, Squamish-Lillooet, Vancouver Island, and Sunshine Coast). For some, the availability of AVs has made long commutes easier, and helped to incentivize living further afield.

Increased regional population and more inter-regional travel, particularly by automated vehicles, contributes to increased congestion.

With more people in the region, travel demand increases both within Metro Vancouver and between the region and those adjacent to it. Transit continues to be used by a large portion of the region, but overall population growth, combined with a rapid uptake in privately-owned AVs and limited road supply has created significant road congestion. Surface transit has limited priority measures and struggles to maintain travel time reliability due to this significant congestion. Grade separated SkyTrain is heavily relied upon and crowding is an issue, particularly at peak times. Transit mode share increases from today's numbers along with overall daily ridership. Road infrastructure is relatively unimpacted by sea level rise, with the exception of parts of the network situated in low-lying areas where there is frequent flooding.

Implications:

Implications	Present Day Metro Vancouver	2050 Metro Vancouver - S1
Population	2,463,431	+40%
Population distribution	-	More distributed
Immigration (/yr)	30,000	+15%
Jobs	1,337,370	+30%
Employment distribution	-	Consistent with Today
Land availability (ha)	285,925	-10%
Daily VKT	33,400,000	+85%
Daily Transit Riders	344,880	+90%

Assumptions:

Implications	Rationale & Assumptions	Source
Population	Assumes growth occurs in line with Metro Vancouver growth projections.	Metro Vancouver Growth Projections
Population distribution	It is assumed that the value of travel time savings will decrease with autonomous vehicle uptake, leading to longer distance commuting, and a more distributed population.	Steck, Kolarova, Bahamonde-Birke & Trommer, 2018, 14.
Immigration (/yr)	Assumes one-half the rate of national projected migration (.65% = .32%) due to lack of employment opportunities in the region. High likelihood of more attractive places to immigrate/live/work across Canada.	Statistics Canada, 2018.
Jobs	Assumes growth occurs in line with Metro Vancouver growth projections.	Metro Vancouver Growth Projections
Employment distribution	No driver to indicate change in distribution from today.	
Land availability (ha)	Assumes 1.5 degree warming by 2050 (midpoint RCP4.5) leading to 3m SLR. No considerations of additional flooding factors. Spatial impact interpretation from Climate Central.	IPCC, 2014, 10.

Implications	Rationale & Assumptions	Source
Daily VKT	It is assumed that the value of travel time savings will decrease with autonomous vehicle uptake leading to longer distance commuting by 31%. Based on VKT/capita rates of today * 1.31 * projected population.	Steck, Kolarova, Bahamonde-Birke & Trommer, 2018, 14.
Daily Transit Riders	Increase of travel mode share of 5% from today through successful TDM measures and strategies to align with Transport 2040 proposed goals and targets of 50% sustainable transportation modes.	TransLink, 2013.

Subject Matter Expert Feedback

A majority of the comments received talked about the automation driver, followed by the climate change and trade & economy drivers.

These implications were highlighted the most by the SMEs:

- Land availability
- Daily VKT and daily transit riders
- Employment and employment distribution

Putting the implications against the three drivers, these themes were brought up the most by the SMEs:

Agree	Disagree	Mixed/Other Commentary
AVs and population/distribution	Climate change and land impact	Climate change and land impact
All anchors and employment/distribution	AVs and employment/distribution	AVs and employment/distribution AVs and immigration
All anchors and immigration	AVs and VKT/ridership	AVs and population/distribution

The following points and actions were most frequently brought up by the SMEs:

- Commenters agreed that the automation scenario (moderate automation) is plausible, notably that there would be continued population growth and dispersion. However, commenters differed on the magnitudes of the two, arguing that population and immigration rates will likely grow faster, with dispersion only at a moderate scale.
- Employment was a significant point of contention, but most commenters agreed that the nature of employment would be negatively impacted by automation. Inequality was a recurring topic amongst some commenters, and some have commented that our employment projection underestimates, or fails to fully capture, the transition of primary and secondary sector jobs towards knowledge or service sector employment.
- Climate change and land availability were also points of contention. Two commenters who focused specifically on this interaction argued that a 3m Sea Level Rise (SLR) with a -10% decrease in land was unjustifiable and excessive, suggesting an adjustment to the assumption to around 0.5m to 1m. They also remarked that while a 3m SLR wasn't credible, it would be more plausible to suggest 3m of occasional flooding, which would make coastal regions less habitable but not completely uninhabitable. In addition, a third noted that the real amount of land available is smaller by about 20% or so, when accounting for the mountainous portions of the region that aren't available for use.

SCENARIO 2 - WHAT IF MOST OF THE ECONOMY BECOMES AUTOMATED?

Driving Questions:

- What if extensive automation results in significant job loss across most sectors, limiting jobs to those that are knowledge-based or require a human touch?

- What if climate change occurs according to the high end of what models project?
- What if economic productivity becomes decoupled from jobs in the region?

Narrative:

Pervasive automation across sectors leaves many people unemployed across the globe.

In 2050, the world has adjusted as the boom of automation has become pervasive across sectors. There is significant adoption of automation and robotics across primary, secondary, and tertiary sectors, from resource extraction, to manufacturing and processing, and even examples of automation across service industries and retail, as well as wholesale distribution along with automated vehicles (AVs) moving goods and people. While jobs in the knowledge sector, along with institutional work in governments, universities, and non-profits remain, there is still considerable unemployment across the globe.

Metro Vancouver—a frontrunner on this economic wave—sees greater economic productivity, but with fewer jobs available.

Metro Vancouver welcomes this wave of economic change, and is on the forefront of automation in the workplace. There is reshoring of manufacturing as automation makes local production more cost effective, and consumer preference for just-in-time deliveries change supply chain models, making continued outsourcing less desirable. High automation across sectors has also permeated into the transport sector, with a high uptake of AVs across the region in both the movement of goods and people. Despite the increase in regional productivity, automation has resulted in a net loss of jobs in the region as technologies displace workers.

Alongside this automation revolution, climate change impacts have also become more noticeable, particularly for coastal regions.

Climate change has manifested in the form of sea level rise and river flooding in the region, and has resulted in some low-lying areas no longer being suitable for living. There is a general retreat from these lands both for living and employment. People who had previously lived in these low-lying areas are either pushed to other parts of the region, or leave the region all together.

The combination of job loss and climate change impacts make Metro Vancouver less desirable overall.

The lack of jobs and climate change impacts make the region less desirable compared to other parts of Canada and the world, resulting in a decrease in immigration, increased emigration out of the region, and an overall decline in the regional population. The region takes on a more distributed form as the population that remains becomes more reliant on private AVs for their daily travel, which—combined with decreased congestion from the smaller regional population—has made commuting long distances less stressful. The jobs that continue to exist remain predominantly concentrated in urban centres as this is where knowledge-based positions have previously been based.

More automated vehicles are on the roads, but with fewer people living in the region, the overall travel demand is decreased.

AV mode share increases and vehicle kilometres travelled (VKT) per capita increases substantially due to AVs. However, overall VKT decreases from today's numbers due to declines in population and employment. Transit mode share and transit daily ridership both decrease as there is a preference towards using AVs for most trips. Road infrastructure is relatively unimpacted by sea level rise and decreased VKT and congestion is a further incentive to use AVs for travel.

Implications:

Implications	Present Day Metro Vancouver	2050 Metro Vancouver – S2
Population	2,463,431	-40%
Population distribution	-	More distributed
Immigration (/yr)	30,000	-85%
Jobs	1,337,370	-55%
Employment distribution	-	More concentrated
Land availability (ha)	285,925	-10%
Daily VKT	33,400,000	-25%

Implications	Present Day Metro Vancouver	2050 Metro Vancouver – S2
Daily Transit Riders	344,880	-50%

Assumptions:

Implications	Rationale & Assumptions	Source
Population	Dependency ratio of 2:1 people to jobs held from MV growth projections. Population calculated on assumption that 53% of jobs will continue to exist while the rest are automated.	Frey & Osborne, 2013, 37-38.
Population distribution	It is assumed that the value of travel time savings will decrease with autonomous vehicle uptake leading to longer distance commuting.	Steck, Kolarova, Bahamonde-Birke & Trommer, 2018, 14.
Immigration (/yr)	Assumes one-half the rate of national projected migration (.65% = .32%) due to lack of employment opportunities in the region. High likelihood of more attractive places to immigrate/live/work across Canada.	Statistics Canada, 2018.
Jobs	53% of jobs will continue to exist while the rest are automated.	Frey & Osborne, 2013, 37-38.
Employment distribution	Transportation, Manufacturing, and Wholesale are sectors with higher rates of expected automation. These are also found on more employment lands. Employment distribution of human related services will tend to concentrate around existing urban cores.	PWC, 2018, 3-20.
Land availability (ha)	Assumes 1.5 degree warming by 2050 (midpoint RCP4.5) leading to 3m SLR. No considerations of additional flooding factors. Spatial impact interpretation from Climate Central.	IPCC, 2014, 10.
Daily VKT	It is assumed that the value of travel time savings will decrease with autonomous vehicle uptake leading to longer distance commuting by 31%. Based on VKT/capita rates of today * 1.31 * projected population.	Steck, Kolarova, Bahamonde-Birke & Trommer, 2018, 14.
Daily Transit Riders	Decrease in transit mode share by 2.5% due to impacts of Automated vehicles on travel behaviours.	Soteropoulos, Berger & Ciari, 2019, 41.

Subject Matter Expert Feedback

A majority of the comments received talked about the automation driver, followed by the climate change and trade & economy drivers.

These implications were highlighted the most by the SMEs:

- Employment and employment distribution
- Population and population distribution
- Daily VKT and daily transit riders

Putting the implications against the three drivers, these themes were brought up the most by the SMEs:

Agree	Disagree	Mixed/Other Commentary
AVs and employment	AVs and employment	AVs and employment

Agree	Disagree	Mixed/Other Commentary
All anchors and employment/distribution	AVs and VKT/ridership	Trade and employment
Trade and immigration Climate change and land impact	AVs and population/distribution Climate change and land impact	AVs and VKT/ridership Climate change and land impact

The following points and actions were most frequently brought up by the SMEs:

- Automation and employment was the most discussed topic amongst the SMEs. Some commenters agreed that high automation will have a negative impact on jobs in Metro Vancouver, and that jobs will be concentrated. However, the argument against our predictions for employment was much more amplified, with several commenters believing that whilst job loss is most pronounced in primary and secondary sectors, the magnitude of unemployment is offset by the region's growth in jobs that are not automated, such as service-sector or knowledge-sector jobs.
- AVs were also discussed frequently amongst the SMEs: several commenters argued that the increase in AV travel is unrealistic, and that it is highly improbable that private AVs will drive people out of transit; commenters also noted that the categorization of AVs was flawed, implying that there were possibilities unexplored for greater shared AV intake. Finally, commenters made note that limitations in geography, commute times, and current technological trends will limit the uptake of AVs amongst residents in the region.
- A third subject that was discussed frequently was immigration and population growth, which many commenters believed would increase rather than decrease given Vancouver's desirability and attractiveness in terms of climate and as a knowledge-sector hub. Some commenters elaborated on this continued population growth to predict that there will be a greater influx of high-income individuals and climate refugees.

SCENARIO 3 - WHAT IF WE CLOSE OUR DOORS AND BORDERS?

Driving Questions:

- What if climate change slows and its effect is closer to the low end of what models project?
- What if protectionist policies take hold over global trade and the economy?
- What if moderate automation can be leveraged to contribute to increased productivity?
- What if some forms of production can be reshored?

Narrative:

Protectionist policies take hold of countries around the world, leading to a sharp drop in global trade and increased efforts towards self-sufficiency.

In 2050, global protectionism leads to efforts towards self-sufficiency among countries and regions. There is a sharp drop in global trade because of this, leaving many coastal port regions (like Metro Vancouver) and major logistics hubs with a significant overbuild of port and trade-related infrastructure. Likewise, immigration and emigration slow as countries become more inward-looking. At the same time, climate change trends towards the lower end of model predictions and impacts are only minimally felt around the world.

Automation is leveraged in Metro Vancouver as a way to enable increased reshoring of previously outsourced work.

There is an increased emphasis on reshoring of previously outsourced work due to protectionist policies in Canada. Automation is leveraged in Metro Vancouver alongside people to help maximize efficiency. Most companies that are headquartered in Metro Vancouver bring all of their work back to the region. Metro Vancouver is only mildly impacted by climate change, and sees slightly warmer temperatures. This has resulted in longer growing seasons, which has contributed to increased agricultural productivity and enabled the region to be somewhat more self-sufficient in the production of food for the local population.

Both population and jobs decrease as immigration slows, and jobs are lost to automation and retreat from the region.

Immigration to the region drops sharply and Metro Vancouver (and the rest of Canada) experience a negative natural increase resulting in further population decline. However, because this is coupled with some replacement of jobs by automation—as well as loss of jobs by repatriation as a result of protectionist policies elsewhere in the world—the ratio of jobs to people in the region remains largely the same. What is left of employment in the region tends to be in sectors that demand creativity and originality. The distribution of population and jobs across the region remains relatively similar to what exists today as land availability has not changed, and the decreased population has actually put less strain on the land that is available.

Fewer people and less trade leads to less movement of both people and goods in the region.

A decrease in employment and population lead to a decrease in daily VKT and VKT/capita. While there is travel for work across the region, the self-sustaining lens adjusts the culture towards more sustainable transport modes. With limited local vehicle manufacturing, there is not a significant uptick in AV adoption. Less global trade results in less goods movement. Transit mode share increases significantly across the region as part of the self-sustaining effort. There is limited crowding with a decrease in population, and limited congestion on surface transit, resulting in high quality service across most parts of the region. Slight warming results in higher rates of active transportation year-round.

Implications:

Implications	Present Day Metro Vancouver	2050 Metro Vancouver - S3
Population	2,463,431	-20%
Population distribution	-	Consistent with Today
Immigration (/yr)	30,000	-100%
Jobs	1,337,370	-20%
Employment distribution	-	Consistent with Today
Land availability (ha)	285,925	Consistent with Today
Daily VKT	33,400,000	-40%
Daily Transit Riders	344,880	+5%

Assumptions:

Implications	Rationale & Assumptions	Source
Population	Protectionism leads to no immigration along with negative natural increase of .8% annually.	Johnson, 2011.
Population distribution	No driver to indicate change in distribution from today.	
Immigration (/yr)	Global protectionism leads to zero immigration policies. Assume net out for provincial emigration/immigration.	Correa-Cabrera and Payan, 2018.
Jobs	Holds true to current dependency rate projections at 2:1 ratio with population.	Metro Vancouver Growth Projections
Employment distribution	No driver to indicate change in distribution from today.	
Land availability (ha)	Assume <RCP2.6 by 2050 leading to nominal increase in coastal sea level rise and river based flooding. Land availability kept same as today.	IPCC, 2014, 10.

Implications	Rationale & Assumptions	Source
Daily VKT	As a self-sustaining region, less goods movement for international trade. Also a cultural shift towards more sustainable modes. Decreased Daily VKT/capita by 4km.	
Daily Transit Riders	A cultural shift towards more sustainable modes.	TransLink, 2013.

Subject Matter Expert Feedback

A majority of the comments received talked about the trade & economy driver, followed by the climate change and automation drivers.

These implications were highlighted the most by the SMEs:

- Employment & employment distribution
- Immigration
- Land availability

Putting the implications against the three drivers, these themes were brought up the most by the SMEs:

Agree	Disagree	Mixed/Other Commentary
Climate change and land impact	Trade and immigration	Trade and employment/distribution
Trade and population/distribution	Climate change and land impact	Trade and immigration
Trade and VKT/ridership	Trade and employment/distribution	Climate change and VKT/ridership

The following points and actions were most frequently brought up by the SMEs:

- The majority of commenters could not envision a world where protectionism would be the norm, as it would be contradictory to how Metro Vancouver and how the world has positioned itself in trade. One commenter noted that the region and the nation are less nationalistic/protectionist than other nations, making the possibility of protectionism to prevail unlikely. That said, commenters did agree that given the scenario were to be realized in the future, the implications would make sense, but that it would lead to catastrophic consequences for MV.
- There were several other points of contention that were mentioned, notably the following:
    - Current models suggest that climate change is unlikely to be at the lower end of model predictions; this suggests that commenters are leaning towards the mid- or upper-range of climate change bookends.
    - Some of the narratives and implications contradict a protectionist scenario, for example the growth of creative-class and niche employment (which would contract with the market and would suffer from closed borders), or the transportation "culture shift" towards sustainable transportation (of which self-sufficiency would in fact reduce the pressure to transition to sustainable modes), among others.
    - The protectionism narrative misses a critical perspective that sees a smaller economy and sharply reduced living standards, and as with previous scenarios, does not elaborate on increased income inequality nor the implications for sustaining the cost base of public transit with a smaller population.

SCENARIO 4 - WHAT IF TOURISM BECOMES A MAIN DRIVING ECONOMIC SECTOR?

Driving Questions:

- What if climate change slows and its effect is closer to the low end of what models project?
- What if the region is unable to keep pace with the next wave of economic change?
- What if automation occurs elsewhere in the world but not in Metro Vancouver?

Narrative:

Regions around the world become divergent between highly-automated or not. Those that "are not" have to seek other competitive advantages.

In 2050, the world has significant examples of automation across primary, secondary, and tertiary sectors. A handful of places are at the forefront of automation adoption, while most others lag behind. There is also a global specialization of sectors as automated powerhouses are able to monopolize in different fields, leaving limited need to have economic diversity globally.

Lagging behind the automation frontier, Metro Vancouver leverages its proximity to the outdoors, and positions itself as a major tourist destination.

Unable to position itself as a specialist in any sectors that are heavily automated, Metro Vancouver as a region lags behind on the automation frontier.

However, the region continues to be an attractive place for people to live and visit due to its natural beauty and access to nature and activities. While the region has seen some climate change impacts, it has not drastically impacted the regional landscape. Leveraging this attractiveness, Metro Vancouver positions itself as a resort region with tourism and supporting industries leading the way for employment.

With mostly unsteady and seasonally variable employment, the region becomes less desirable as a place to live long term.

Despite being desirable for tourism, unsteady and seasonally variable employment makes the region less attractive as a place to settle. Potential immigrants see the region as a risk and choose to locate elsewhere, and locals who are unable to find sustained employment also emigrate. Those who remain in the region tend to concentrate towards urban centres where they are able to access transit and amenities. Employment similarly concentrates in urban centres as there is less competition for space across the region.

Increased tourism leads to more out-of-region travel.

Daily VKT decreases with the lower population and employment, though the number of tourists trips increase. More trips are to and from outside of the region for tourist activities, towards the north shore mountains, up the sea to sky highway, to ferry terminals, and towards the Fraser Valley. These longer trips add to the overall travel demand, but are less focused around traditional peak travel windows. Transit mode share and ridership increase from today, as unsteady jobs have lead to lower incomes that put car ownership out of reach for many. The transit system is able to accommodate the increase in trips, in part because there is less peak period travel and trips are made periodically throughout the day with less traditional employment.

Implications:

Implications	Present Day Metro Vancouver	2050 Metro Vancouver - S4
Population	2,463,431	-55%
Population distribution	-	More concentrated
Immigration (/yr)	30,000	-70%
Jobs	1,337,370	-50%
Employment distribution	-	More concentrated
Land availability (ha)	285,925	Consistent with Today
Daily VKT	33,400,000	-40%
Daily Transit Riders	344,880	-30%

Assumptions:

Implications	Rationale & Assumptions	Source
Population	Holds true to current dependency rate projections at 2:1 ratio with employment.	

Implications	Rationale & Assumptions	Source
Population distribution	Assumption in line with narrative that there is more specific interest to live closer to rapid transit stations.	
Immigration (/yr)	Assuming less interest in immigrating to the region with lack of available employment.	Statistics Canada, 2018.
Jobs	Assuming 50% of employment disappears with focus on resort tourism, impact of automation elsewhere, lack of regional competitiveness, and talented employees seeking out other opportunities.	PWC, 2018, 3-20.
Employment distribution	Assumption in line with narrative that there is more specific interest to work close to rapid transit stations. Assuming industrial and manufacturing work outside of cores are no longer globally competitive. Much less work in these fields.	PWC, 2018, 3-20.
Land availability (ha)	Assume <RCP2.6 by 2050 leading to nominal increase in coastal sea level rise and river based flooding. Land availability kept same as today.	IPCC, 2014, 10.
Daily VKT	In line with scenario narrative - increased focus on tourism, increases daily VKT per capita with more and longer driving trips in and out of the region to attractions. Less focus on peak travel windows.	
Daily Transit Riders	Higher reliance on public transit, more concentrated population and employment around urban centres allows for easier access to transit.	TransLink, 2013.

Subject Matter Expert Feedback

A majority of the comments received talked about the trade & economy driver, followed by the automation and climate change drivers.

These implications were highlighted the most by the SMEs:

- Employment and employment distribution
- Population and population distribution
- Daily VKT and daily transit riders

Putting the implications against the three drivers, these themes were brought up the most by the SMEs:

Agree	Disagree	Mixed/Other Commentary
All anchors and employment/distribution	Trade and employment/distribution	Trade and employment/distribution
All anchors and population/distribution	All anchors and population/distribution	Trade and population/distribution Trade and VKT/ridership
All anchors and VKT/ridership Climate change and land impact	All anchors and VKT/ridership	AVs and employment

The following points and actions were most frequently brought up by the SMEs:

- Neither tourism-driven economy nor negative growth are likely plausible in Metro Vancouver.

- Many commenters did not take great comfort in the extremities of this scenario, whether it be the premise of a singularized, specialized tourist economy (which is not only highly implausible but also highly unsustainable), or the numbers that come out of it (which, as one commenter put it, makes this a Detroit scenario for Metro Vancouver). Many commenters added that the narrative and numbers are contradictory to current trends:
    - The numbers suggest that the Metro Vancouver region is unable to adapt economically to new and emerging sectors, yet current demographic and employment trends suggest otherwise.
    - Extreme population declines would make it questionable for a sustainable tourist economy to exist.
    - There is no reason for why the region would fail to catch the automation wave, nor for automation to only penetrate certain sectors; as one commenter put it, automation would impact all parts of the economy, whether they benefit from it or not.
- Some commenters took the liberty of painting the picture of what a tourist economy would look like for the region, which could be summed up to the following three points:
    - Low-wage, precarious work for locals, some including personal service occupations that would satisfy the needs of the many tourists that choose to become part-time residents.
    - An intensely unequal landscape, with retirees and young service workers overrepresented and requiring very different housing and transit needs.
    - A resort economy with package groups arriving for all-expenses paid vacations.

SCENARIO 5 - WHAT IF A DIGITAL ECONOMY TAKES HOLD?

Driving Questions:

- What if climate change slows and its effect is closer to the low end of what models project?
- What if economic productivity becomes decoupled from jobs in the region?
- What if technological advancements in communications technology makes connecting across the globe even more seamless?

Narrative:

Truly seamless digital connectivity makes the global worker phenomena commonplace.

In 2050, digital connectivity is pervasive around the world. This connectivity is a major catalyst that reshapes where people choose to live and work. The global worker phenomenon becomes commonplace; to telecommute and live in one region while working for a company elsewhere in the world. Climate change is towards the lower end of model predictions and impacts are only minimally felt across the world.

As a desirable place to live, Metro Vancouver draws an influx of people who work remotely for companies headquartered elsewhere.

Only mildly impacted by climate change, Metro Vancouver remains largely attractive as a place to live and reaps the benefits of this global work phenomena as the region is seen as a lifestyle mecca among the professional class who are able to leverage telecommuting. Economic productivity becomes decoupled from jobs in the region as much of the work undertaken in the region is actually for companies elsewhere in the world.

The region sees an overall increase in the regional population, with minor seasonal fluctuations as people move from place to place.

The increase in immigration of global workers to the region leads to an increase in the regional population. However, the population fluctuates seasonally as people move in and out, and from place to place to accommodate their personal lifestyle preferences. The regional population distribution continues to be relatively similar to today. However, the prolific use of teleworking has made employment vastly more distributed. Many people choose to work from home or at nearby co-working locations. There is less emphasis on commuting to specific parts of the region for work. Land availability is not drastically changed from climate change impacts and does not impact population or employment distribution.

Increased telecommuting results in a decrease in work-related travel.

Daily VKT drops by almost half from what we see today. Telecommuting takes away from the traditional peak travel times and further to this, teleworkers who use co-working spaces may adjust their schedules to other time zones to match their employers. Transit ridership also decreases substantially. There are fewer trips made in the first place and because there is a lack of congestion on roads, people often chose private vehicles to travel when and if they need to.

Implications:

Implications	Present Day Metro Vancouver	2050 Metro Vancouver - S5
Population	2,463,431	+50%
Population distribution	-	Consistent with Today
Immigration (/yr)	30,000	+35%
Jobs	1,337,370	+55%
Employment distribution	-	More distributed
Land availability (ha)	285,925	Consistent with Today
Daily VKT	33,400,000	-45%
Daily Transit Riders	344,880	+5%

Assumptions:

Implications	Rationale & Assumptions	Source
Population	Assuming higher than current MV growth projections, largely from professionals who immigrate to the region.	Metro Vancouver Growth Projections
Population distribution	No driver to indicate change in distribution from today.	
Immigration (/yr)	The lifestyle attractiveness drives immigration higher than projections, affordability is still an issue, therefore it is largely professionals who immigrate.	Statistics Canada, 2018.
Jobs	Dependency ratio of 1.8:1 - assumes more opportunity for gig work through telecommuting. Connectivity allows for less restriction in employment.	
Employment distribution	As stated in the narrative - employment is spread across the region, as many choose to telework from home or nearby in coworking locations.	
Land availability (ha)	Assumes <RCP2.6 by 2050 leading to nominal increase in coastal sea level rise and river based flooding. Land availability kept same as today.	IPCC, 2014, 10.
Daily VKT	Tied to employment distribution in narrative, significantly less driving (1/3rd daily VKT/capita as today) due to increased teleworking.	
Daily Transit Riders	Lower mode share as there is AV penetration in the region, but higher than current day total amounts due to increased population.	

Subject Matter Expert Feedback

A majority of the comments received talked about the automation driver, followed by the trade & economy and climate change drivers.

These implications were highlighted the most by the SMEs:

- Land availability
- Population and population distribution
- Employment and employment distribution

Putting the implications against the three drivers, these themes were brought up the most by the SMEs:

Agree	Disagree	Mixed/Other Commentary
AVs and population & employment / distribution	AVs and VKT/ridership	AVs and employment Trade and immigration
Trade and immigration Climate change and land impact	All anchors and VKT/ridership	All anchors and population/distribution
AVs and VKT/ridership	AVs and population/distribution Trade and VKT/ridership	All anchors and VKT/ridership

The following points and actions were most frequently brought up by the SMEs:

- This scenario received the most amount of support, mainly because Metro Vancouver – commenters stated – is well-positioned, or already is, a hub for telecommuting. Furthermore, commenters noted that the different components hang together here better than the other scenarios, and that the numbers make sense for a plausible high growth scenario. Finally, several commenters touted Vancouver as being extremely desirable and, being well-positioned for climate change, would be a prime candidate for 'digital nomads'.
- Commuting was the most frequently discussed issue of this scenario for a number of reasons:
    - Many commenters raised a critical perspective that working from home is not for everyone – people have social and personal needs to tend to that motivate them to travel from place to place. By extension, the telecommuting professional class (TPCs) will still find merit in shared work spaces, and the majority of local employment will be directed towards service-sector jobs such as restaurants, schools, and hospitals, which are essentials for TPCs. Therefore, commenters believed that transit in particular would not decrease to the numbers proposed, and may in fact increase.
    - Some commenters raised concerns of inequality within the region, as this scenario runs the risk of regional decision-makers overinvesting and over-relying on the airport-downtown-UBC transport axis to serve telecommuters, forsaking other regions and local commuters. Furthermore, since TPCs have location choices, they will likely push to make the region work for them.
    - Because telecommuting will likely decrease city travel but will increase airport and intercity traffic, transit planners will need to focus on different needs ranging from long-distance inter-hub travel to highly-efficient inter-core transit systems.
- An additional comment that was made involved the notion of decoupling work and productivity as being somewhat odd, since people work for national and global companies from Metro Vancouver today. Telecommuting, the commenter argued, is not much different from this, except that people may work from slightly different physical spaces, but it's still work done here by a (intermittent) resident.

SCENARIO 6 - WHAT IF CLIMATE CHANGE IS WORSE THAN WE THINK?

Driving Questions:

- What if climate change is significantly worse than the high end of what models project?
- What if the region loses its competitive edge as a logistics hub and economic centre against other places around the world?
- What if automation occurs elsewhere in the world but not in Metro Vancouver?

Narrative:

Climate change accelerates beyond what models have projected, bringing major changes to regions around the world.

In 2050, climate change impacts are felt globally and outcomes are greater than what most models anticipate. Many coastal communities are not properly prepared for sea level rise and flooding results in significant property loss and decrease in land availability. There is a shift in populations that is seen across the world to areas that appear to be less immediately impacted. This creates significant poverty in the process, with job loss and inability to find work in cities and region that are not prepared to facilitate these transactions.

As a coastal region, Metro Vancouver becomes one of the hardest hit regions in Canada.

In Metro Vancouver, climate change has a significant regional impact. Coastal sea level rise and river flooding decrease available land area and undercut key transportation infrastructure that is relied upon to get around the region. Food security in the region is also compromised, with flooded agricultural land. There is a lack of automation investment in the region as climate change is seen to be a major risk in developing business and supply chain resilience is questioned. Coastal port infrastructure is no longer reliable with sea level rise and frequent river flooding. Goods movement and global trade struggle.

The regional population decreases substantially as people move out in search for more stability.

As a result of climate change, part of the regional land base has disappeared. Immigration to the region is limited as the region is seen as a less desirable place to live. Even among the existing residents, there is a mass exodus from the region in hopes of finding a place to live that is less impacted by climate change. The regional population has decreased substantially as a result. Of the population that remains, most are concentrated around urban centres with better access to amenities, and away from coastal areas. Employment has also decreased substantially; what is left largely concentrates around urban cores, with good access to transit.

The road network becomes much less reliable due to frequent flooding in coastal areas, making grade-separated transit a more popular choice.

With fewer people and fewer jobs, daily VKT drops substantially. The road network is made less reliable due to frequent flooding in coastal areas and this impacts commuting patterns. This level of disconnect changes how people get around. Transit mode share increases as elevated parts of the SkyTrain network are seen as more reliable and less likely to be impacted by flooding. Surface transit is impacted alongside personal vehicles, due to limited clearance and lack of ability to overcome flooded parts of the transportation network.

Implications:

Implications	Present Day Metro Vancouver	2050 Metro Vancouver - S6
Population	2,463,431	-30%
Population distribution	-	More concentrated
Immigration (/yr)	30,000	-95%
Jobs	1,337,370	-35%
Employment distribution	-	More concentrated
Land availability (ha)	285,925	-20%
Daily VKT	33,400,000	-50%
Daily Transit Riders	344,880	+25%

Assumptions:

Implications	Rationale & Assumptions	Source
Population	30% of current day population leaves the region in line with high level American estimates of most impacted cities in a no	Hauer, 2017, 4.

Implications	Rationale & Assumptions	Source
	adaptation scenario. Further assumption of region seeing little to no growth going forward with more concern over climate impacts in the region.	
Population distribution	Assumes retreat from low lying coastal areas (flooding).	
Immigration (/yr)	.01% of total population. Assumes little desirability for immigration in a region that is impacted heavily by CC.	Statistics Canada, 2018.
Jobs	Holds true to current dependency rate projections at 2:1 ratio with population.	Metro Vancouver Growth Projections
Employment distribution	Assumes retreat from low lying coastal areas (flooding).	
Land availability (ha)	Based on Fraser Basin Council Lower Mainland Flood Management Strategy Scenario A + C, along with spatial impact interpretation of land availability.	Fraser Basin Council, 2015, 2-2 - 4-3.
Daily VKT	Assumes transit has higher reliability than vehicle travel with many roads being flooded, congesting other aspects of the network. Most of the Skytrain network is unaffected.	
Daily Transit Riders	Assumes transit has higher reliability than vehicle travel with many roads being flooded, congesting other aspects of the network. Most of the Skytrain network is unaffected.	

Subject Matter Expert Feedback

A significant majority of the comments received talked about the **climate change** driver, followed by the trade & economy and automation drivers.

These implications were highlighted the most by the SMEs:

- Land availability
- Daily VKT and daily transit riders
- Population and population distribution

Putting the implications against the three drivers, these themes were brought up the most by the SMEs:

Agree	Disagree	Mixed/Other Commentary
Climate change and VKT/ridership	Climate change and land impact	Climate change and land impact
Climate change and land impact	Climate change and population/distribution	Climate change and VKT Climate change and immigration
All anchors and population/distribution	Climate change and VKT/ridership	Climate change and employment/distribution

The following points and actions were most frequently brought up by the SMEs:

- Though there is no consensus, most commenters were either neutral or positive to the possibility that climate change may be worse than predicted, or at least on the upper end of model predictions. Whilst commenters did not take issue with the outline of the scenario (i.e. severe climate change would lead to negative outcomes for Metro Vancouver and many other regions), they felt that a discussion on how Metro Vancouver is differentially affected by climate change compared to other regions, and where Metro Vancouver would be positioned relative to other regions was noticeably missing.

- A key challenge that many commenters brought attention to was a likely mass influx of climate refugees to Metro Vancouver, since commenters stood by Metro Vancouver as having the adaptive and mitigative capacity to respond to climate change issues, especially flooding. Almost universally, commenters paid particular attention to comparing Metro Vancouver against other Canadian and international cities, suggesting that they have strong feelings about Metro Vancouver being 'better than the rest' in a high climate-change scenario.
- Some other comments of note were brought up by the SMEs:
    - As with every scenario preceding this, commenters who focused on analyzing our climate and land assumptions pinpointed and proposed questions regarding our numbers, such as the inconsistency between the 1m SLR used in this scenario versus the 3m SLR used in the other scenarios; river flooding as being noticeably missing from the analysis; the lack of considering adaptive measures that have already been proposed by Metro Vancouver for the future; etc.
    - As with some of the other scenarios, commenters had wished to see more mention and incorporation of policies as a factor of how Metro Vancouver will play out and respond to the scenario.

APPENDIX C - DRAFT SCENARIO CONCEPTS & STAKEHOLDER FEEDBACK

Scenarios were refined based on subject matter expert feedback. Four draft scenarios were presented at the regional stakeholder workshop on February 27, 2019.

A. What if we keep going on our current trajectory?

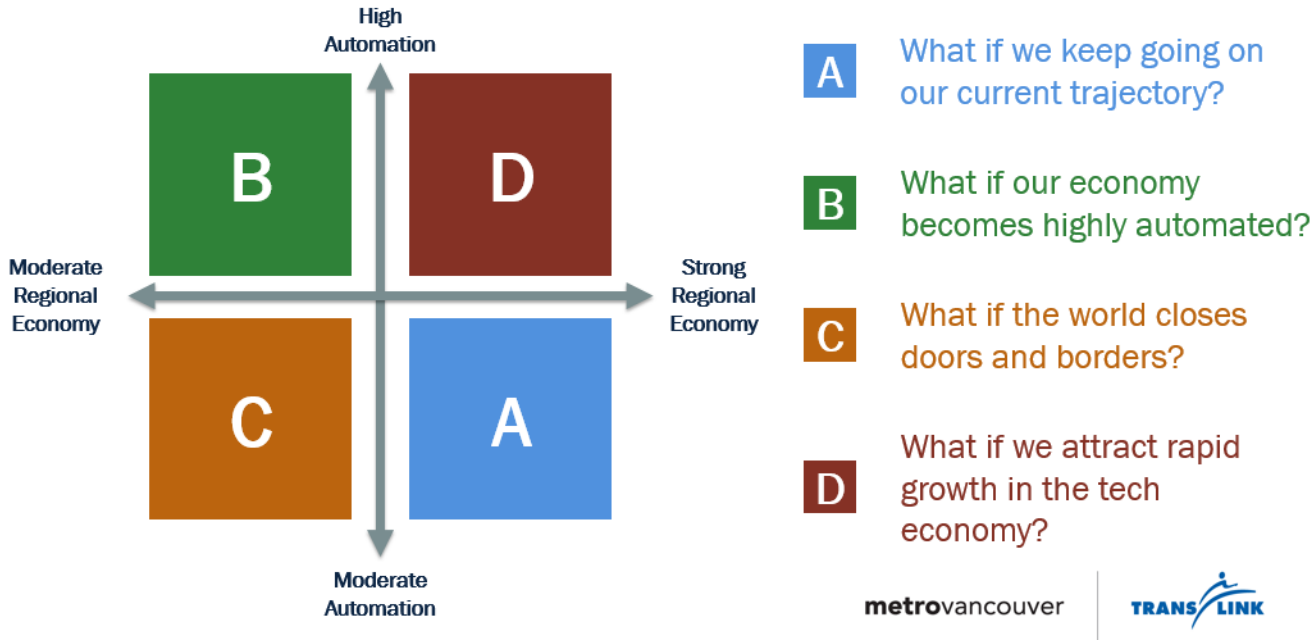
B. What if our economy becomes highly automated?

C. What if the world closes doors and borders?

D. What if we attract rapid growth in the tech economy?

These scenarios were differentiated from each other on two axes:

- Moderate Automation ← → High Automation
- Moderate Regional Economy ← → Strong Regional Economy



Stakeholders were requested to review each scenario's narrative, implications, opportunities and challenges. Stakeholders were asked to provide comment on the following:

- Is the scenario plausible? Why or why not?
- Are there missed implications that are important to consider?
- Do you agree or disagree with the opportunities or challenges listed? Are there any missed opportunities and challenges?

Stakeholder comments below are primarily verbatim from the workshop and edited only for grammar.

A. What if we keep going on our current trajectory?

The story

- The pace of automation continues to increase, reducing job growth globally. The trend toward globalization and decreasing trade barriers continues.

- The region retains and grows key sectors of the economy, with continued automation of repetitive tasks in some sectors and continued growth of the knowledge economy.
- Increased regional population and more inter-regional travel, particularly by automated vehicles, contributes to increased congestion.

Implications, Rationale, & Assumptions

Implications	Today	Scenario A	Rationale & Assumptions	Source
Regional Population	**2.57 Million**	**+40%**	Assuming growth occurs in line with Metro Vancouver growth projections.	Metro Vancouver Growth Projections
Immigration (/yr)	**30,000**	**+10%**	Assuming slight increase based on employment growth opportunities.	Statistics Canada. 2018. Canadian Megatrends - Population growth: Migratory increase overtakes natural increase
Number of Jobs	**1.34 Million**	**+40%**	Assuming growth occurs in line with Metro Vancouver growth projections.	Metro Vancouver Growth Projections
Daily Trip Rate (pp/day)	**2.7**	**+75%**	It is assumed that the value of travel time savings will decrease with autonomous vehicle uptake leading to more frequent auto trips.	Steck, Kolarova, Bahamonde-Birke & Trommer. 2018. How Autonomous Driving May Affect the Value of Travel Time Savings for Commuting. P14
Median Household Income	**$73,000**	**+20%**	Based on increased population and jobs and continued prosperity	

Opportunities and Challenges

- Automation would disproportionately impact low-income workers, decreasing equity in the region.
- Increased ease of travelling by AVs may lead to an increase in housing demand beyond regional boundaries. As such, average trip length would increase, as would congestion.
- With population increase, and a more dispersed inter-regional population, transit services may need to be reconfigured.
- Billions would need to be invested to protect the region from flooding. Urban areas are more likely to be protected while agricultural and industrial lands could see regular flooding.

Stakeholder Comments

Is this scenario plausible? What or why not?

Yes:

- Yes, but implications (increase in jobs) may be overstated
- Currently we are exploring high disparity in wealth distribution (housing) that changes where people live.
- This seems to be the most plausible outcome given the 'incremental changes and response' due to politics
- Daily trip rate seems out of step- what is this assumption based on? Why? The rest of the scenario seems okay.
- Yes- Natural balance of humanity between new and emerging trends and resistance to change.

- Yes- most likely scenario of the four presented. Incremental change is the most likely course.
- Yes, population growth has been constant, including interprovincial, due to desirability of the region. And automation has the possibility to impact several sectors.
- Seems plausible as a base case.
- Continued growth of knowledge industry will moderate effects of automation and over reliance on key sectors.
- While automation increases, is there any proof that jobs will be lost? Perhaps operational jobs, but tech jobs and maintenance of these systems would increase. The degree of job loss to job gain is a question.

Middle ground:

- Would automation outpace job growth in other sections? Net gain or net lose?
- If status quo economic polarization continues, will have a significant impact on this scenario.
- This model assumes increase in tech, thus price of tech would decrease. As a region we should be able to afford more transit options for population. i.e.: bullet trains etc. Would congestion still hold?
- Just wonder about the daily trip rate increase of 75%. If we keep going on our current trajectory, with more population I see moderate increases on daily trip, not significant like 75%. Other increased projections seem plausible.

No:

- Globalization is in retreat. Trade may be more volatile based on bilateral/regional ad hoc agreements, rather than a 'Global rules based order".
- I disagree that trade barriers are decreasing. Protectionist policies in the US (our greatest trade partner) are changing global trade significantly. Other markets are available, but could still have an impact on a business as usual model.
- Too much growth in trips/day. Maybe 25% to 30%?
- I think the current trajectory suggests continued increase in transit services so less growth potential for automated vehicles for single riders.
- Scenario not plausible and not sustainable.
- Automation will INCREASE global growth.
- Public demands for transit will only increase - AV will only serve the few
- Increased use of automated vehicles should decrease congestions.
- People will not accept congestion impacts of AVs - need policies to prevent congestion (road pricing)
- More automated interregional transit or high speed rail (not cars)
- New jobs created by automation. AVs may reduce congestion not add, daily trip rate increase not realistic.
- Population growth is too high and immigration is too low; birth rates are falling and most of our growth will be people coming here. Better economy = less children.
- Over reliance on key sectors leads to less resiliency and large economic swings
- Trip rate increase is quite huge with respect to population increase and job increase
- Not sure that we will continue to see strong population and job growth given affordability constraints.

Are we missing any key implications?

- Impact on regional housing prices x2
- Possible/important to include changes to commute time as an implication?
- Climate migration will increase immigration more rapidly
- I think the rise in teleworking will decrease or dampen the growth in daily trip rates, as will the trends of deliveries (grocery, amazon, etc.) - unless you are counting those trips in these numbers.
- Daily trips are too aggressive
- What is driving the higher trip number? I can see high trip time as folks sprawl out further.
- Labour participation rate
- Immigration will likely be higher as economic polarization continues and middle class declines
- We need to track impact on equity. i.e. Track lowest 20% in scenario not just average
- Congestion pricing will have major impact on uptake of AVs.

- All 4 scenarios appear to assume expansion of global economy, even though we are already in an ecological overshoot situation.
- Climate change impacts may be incorporated in 4 scenarios but 2050 timeline is not capturing anticipated worsening impacts from 2050 onwards.
- Unlike scenario B this scenario presumes automation won't negatively impact knowledge economy. This could impact number of jobs growth.
- Relationship between median income and trip generation should be tested. Active mode trips will increase if we build more equity into system.
- Should capture cost of living income. I.e. Global investment in real estate.
- Housing need and response to equity.
- Housing affordability- decrease population?
- Immigration will be higher, population growth should reflect that increase
- Network but paid trips haven't budged in past with changes in median income
- I think trip rates will increase in all scenarios not just this one.
- How does this scenario impact palpable priorities/ bread and butter RGS/RTS issues? Need indicators (Qual + Quant), e.g. Employment lands, agricultural lands, VKT/PKT, GHGs, Affordability, SRS Housing… Somewhere/ somehow we need to engage on these.
- AV & EV needs to be explored in this scenario. Market acceptance of EV's will occur prior to AVs.
- What if AVs make people stop taking transit, then what happens?
- Need to consider growth of sharing economy, decreases in car ownership - may lead to decreasing congestion (fewer card on road).
- Trip increase is quite high. Even with connected trips here to see more than 3.5 per day
- Would be good to include a sub-scenario that considers high adoption of shared-use AVs
- Increased congestion reduces productivity and economic growth.
- Need to look at beyond international boundaries Cascadia (Portland to Vancouver). What if high speed rail happens.
- To paint a more complete picture, need to estimate VKT change (trip distance)
- Consider adding land base as another 'implication' indicator. Would help compare climate change impacts to 2050, if none anticipated, have a caveat to 2100.
- Interprovincial migration could impact population and growth assumptions.
- Visualizing the implications of all 4 scenarios on land use and evolution of built environment would be very helpful.
- Does the automated vehicles number include commerce and transit (busses)?
- Job growth assumptions might be too high, even with moderate automation.
- Realistic scenario- with likely continued inequality.
- Affordability is a key issue which has been missed and will affect population and employment growth.
- Automation and increasing inequity will decrease median household income.
- Consider augmenting indicators to be more reflective of a concentric circle model.
- I would expect that better ability to telecommute would offset rideshare impact on daily trip rate.

Opportunities and Challenges

Automation would disproportionately impact low-income workers, decreasing equity in the region:

- People will choose alternatives as jobs are automated.
- Automation would impact not only low-income workers; many other areas would be impacted.
- Agree - Also I'm concerned about the ability of workers in certain sectors to transition to other sectors. For example, someone who makes a living as a delivery driver or bus operator may not be able to retrain as a programmer or web developer. Different, non-transferable skill sets.
- Impacts service-based and trade-based jobs. (Do not assume these are low-income workers.)
- Also affects highly paid tech workers (think outsourcing).
- Agree - however automation could potentially impact all workers, not just low-income workers.
- Decreasing equity makes it difficult for middle class to continue to expand.

Increased ease of travelling by AVs may lead to an increase in housing demand beyond regional boundaries. As such, average trip length would increase, as would congestion:

- Even if AVs don't get the uptake expected, long commutes are already ingrained in MV culture.
- Don't think people will want to commute for longer just because they don't physically drive - not willing to give up urban lifestyle.
- The increase in AV use including trips via vehicles, not necessarily by people. This assumption in A is not applied to the other scenarios which all indicate a reduction with AV adoption.
- Disagree that AV will increase housing demand. Pop growth will increase housing demand as well as housing affordability.
- Agree - AV increases with increase trips and congestion to a point. But then I think it will hit a maximum and then decline or flatten out.
- Maybe - are AVs shared or privately owned?
- Isn't this happening already? Why argue trip length would increase beyond what we have now? There are still too many barriers to adoption of AVs for this to be plausible. i.e. manually operated vs. fully automated vehicle dynamic insurance.
- Is assumption that AVs will be a 'thing' outside of trials as foregone conclusion as it presented here? I.e.; does "business as usual necessarily result in AVs?"
- Should also be considered potential for cuts - billions to transit in this scenario
- Disagree with average length trip. Movement towards the 45 min commute will limit this inefficiency of space.
- Strong regional growth policy most keep it focused. Saw what happened with the rise of gas cars. Learn from the past…
- EV acceptance impacts transit/walk. Cycle mode share and return to auto dependency based on "green" transport.
- Automation creates unequal job density in region leading to great congestion.
- Transit network will need to be expanded in the SE region
- Migration of jobs (and population) east and south

With population increase, and a more dispersed inter-regional population, transit services may need to be reconfigured.

- Disagree - AVs will not necessarily ease congestion; more efficient travel and use of roadways.
- Maybe - We should counter the dispersion with more high quality frequent transit spines.
- Mass transit needs to be more cost effective than AV (SOV) travel to avoid this happening
- Billions will need to be invested in communal transportation. AV will only benefit the few.
- Cost effective transit will be required. Need to continue investment in transit services where it has the most impact.
- Agree - TransLink will need to prioritize trunk services and explore new mobility solutions to supplement local services and gaps.
- Increased congestion could increase acceptance and need for increased density near RTCs. i.e.; redevelopment of single family residential in these areas.
- Agree - need more cross-regional transit services
- Sprawl is the future and that is not good.

Billions would need to be invested to protect the region from flooding. Urban areas are more likely to be protected while agricultural and industrial lands could see regular flooding:

- This is true of all scenarios. Current trajectory…
- 1) Low-income jobs already displaced by automation, 2) Automation poised to displace professional services such as lawyers, paralegal etc.
- To increase stability and security in all scenarios all lands need to be protected, not just housing areas but also employment lands.
- Presumes governments will not prioritize or protect industrial and agricultural lands.
- This assumption does not appear to be consistently applied nor questioned in employment terms across all four scenarios.
- Investment in flood protection will be needed in all scenarios.
- Agree - but unclear why ag/industrial loads would be left to flood? Need food/jobs for people who live here.
- Agree - with inequality
- Critical infrastructure passes through flood plains e.g. loads in the Fraser Valley (Hwy 1, 7, 9, oil & gas pipelines, rail lines) which will need to be protected.

- Need to intensify industrial uses on limited waterfront, I would argue that flood protection needs to extend to these uses as well.
- Better design for flood prone areas. How do we design for adaptability at a local level and make this the norm? Function over form.
- Investment to protect region from flooding is common to all scenarios, not just A. Unlikely that agriculture and industrial would see regular flooding - municipalities already addressing.
- Investment in adaptation would need to happen under all scenarios.

Additional Opportunities and Challenges

- Missing - We must assume a future where road-based congestion pricing in place and decreased vehicle trips and increased sustainable choices - what is the baseline assumption here?
- Missing - Millennial culture change away from personal vehicles towards mass transit.
- Impact on regional housing prices?
- Infrastructure spending increases. Opportunity to renew and improve infrastructure.
- Impact on ALR land with population increase.
- Opportunity - Increased AV use may lead to new land becoming available for other uses. E.g. parking lots in urban areas. Decreasing need for industrial land as industries intensify and FAR increases.
- Can small business afford to adapt to automation - job impacts, cultural impacts, unaffordability.
- Further and more dispersed transit infrastructure would be required.
- What about trade for some jobs to telecommuting? Reduced estimate for increased daily trips.
- Climate refugees and economic immigration associated challenges
- Impact of increasing commuting on an individual's health and community cohesion. Increase time in travel and decreased time for volunteering etc.
- Suggest to include mental health in all of the analysis and decision making.
- Challenge: Increased population and densification in established settled areas across the region will continue to drive increasing risks to extreme flooding and catastrophic earthquakes. This trend, coupled with decreased equity across the region will negatively impact the capacity of communities to absorb and recover the impact of a disaster event.

B. What if our economy becomes highly automated?

The story

- Advanced robotics and artificial intelligence lead to automation across most sectors, resulting in significant job loss. National immigration rate is decreased in response.
- Metro Vancouver sees greater economic productivity through automation, but there are fewer jobs available. The lack of job opportunities, and inequitable distribution of money makes the region less desirable.
- More automated vehicles are on the roads, but with fewer people living in the region and less employment, trip rates fall.

Implications, Rationale, & Assumptions

Implications	Today	Scenario B	Rationale & Assumptions	Source
Regional Population	2.57 Million	-20%	- Many jobs that are at a high risk of automation are indeed automated in the region, decreasing employment opportunities and forcing the population to look for opportunities elsewhere in the province and country. - Dependency ratio of 2:1 people to jobs held from MV growth projections.	Frey & Osborne. 2013. The Future of Employment: How Susceptible are Jobs to Computerisation? P37-38.

Implications	Today	Scenario B	Rationale & Assumptions	Source
Immigration (/yr)	30,000	-50%	- Assuming half of national projected migration rate (.65% = .32%). Halving due to lack of employment opportunities in the region, high likelihood of more attractive places to immigrate/live/work across Canada.	Statistics Canada. 2018. Canadian Megatrends - Population growth: Migratory increase overtakes natural increase
Number of Jobs	1.34 Million	-40%	- Many jobs that are at a high risk of automation are indeed automated in the region, decreasing employment opportunities and forcing the population to look for opportunities elsewhere in the province and country.	Frey & Osborne. 2013. The Future of Employment: How Susceptible are Jobs to Computerisation? P37-38.
Daily Trip Rate (pp/day)	2.7	-40%	Decreased daily trip rate due to less employment, and less purchasing power for discretionary trips.	Steck, Kolarova, Bahamonde-Birke & Trommer. 2018. How Autonomous Driving May Affect the Value of Travel Time Savings for Commuting. P14
Median Household Income	$73,000	-40%	Based on decreasing population and employment opportunities.	

Opportunities and Challenges

- With declining population and jobs, reduced government revenues make climate adaptation more challenging.
- Lower employment changes the worker-to-retiree ratio, reducing benefits for retirees.
- Automated production may result in a lack of value-add to the regional economy, with most wealth being captured by few individuals.
- Fewer overall trips, high AV adoption rates, and lower farebox revenue may create pressure for a decrease of regional transit services.

Stakeholder Comments

Is this scenario plausible? What or why not?

Yes:

- Plausible - But need to look at level of impact. Too many variables
- More automated vehicles- yes proportionally more demands for transit.
- Automation will see a decline in repetitive jobs but a rise in new jobs we can't even imagine.
- Why the default to more automated vehicles on the road rather than other modes (e.g. very good, automated transit)?
- Yes- we are on this trajectory already.
- We are already here. Lots of migration within BC to Metro Vancouver from resources jobs. Outcome unlikely.
- Shifting of jobs from one segment to another (is occurring already) Need a better lens on each segment to determine the impacts.
- It is plausible but will the region really be less desirable? Especially in relative terms.
- People in the core will be the rich with high tech jobs. People with less will move further to the edge of the region. Population will not decrease.

Middle ground:

- Automation is already occurring but the outcomes may be different from what is desirable.
- A change in job opportunities rather than lack job opportunities.
- A lack of companies that develop automation work as of right now. Therefore, likely to not attract these companies in the future too.
- Not fewer jobs - different jobs that will require new ideas around employment areas.
- It is already here
- Why would the region become less desirable? Surely job loss and related impacts would be national/international. Attractiveness would be relative.
- Automation means job loss for businesses that can afford it, but more jobs in education sector - more small business development (include knowledge & service industries)
- Canadian labour productivity is poor relative to other developed economies but the level of automation seems high in this scenario.
- Metro Vancouver is a highly desirable place to live. Not sure that lack of jobs would result in such a large population decrease.
- Question impacts of automation on our local service-based on economy.

No:

- No - assume that high automation is more on transit that automated cars (already have SkyTrain)
- No - not less jobs but a change in the type/ quality/ $ of jobs.
- No - the region will not be seen as less desirable due to fewer jobs/ inequitable distribution.
- Doesn't anticipate the market credibility that often results in downturns. New jobs/ markets will likely be created.
- Despite automation across the world, region is still a desirable place (safety net).
- Somehow scenario implausible even 30 years out - at least to the degree described. Perhaps a more moderate shift?
- Question the extent of immigration - if no jobs in lower mainland there won't be jobs elsewhere. If people are out of work this will likely come to the more temperate Metro Vancouver.
- Don't feel the region would become less desirable if considering people from outside of the country.
- The decreases are pretty significant. There may be a shift from manual workers to professionals in tech & research. Suggest to study some countries with high automation and examine if the decreases are as significant as projected.
- Immigration rate likely will not decrease - doesn't account for climate induced immigration, socio-economic and politically motivated immigration.
- Telecommuting? Still expect pop growth
- More migration, improved health care etc. to serve against population decrease… balancing jobs numbers
- Yes, automation will increase but results won't be as drastic as pictured
- Jobs will likely shift, not disappear.
- People will find alternative job opportunities.
- Even without jobs, Metro Vancouver will still be desirable.
- Historically there is not much evidence that technological advancements have led to long term decline in job or population growth.
- A longer time frame will be needed to reach this level automation development.
- Economic specialization and growth in local or small businesses to respond to changing economy.
- No - increased automation unlikely to lead to significant job loss. More likely to see changing industries and adaption of skills as labour force responds.
- No - lower mainland will attract people from Canada and world because of where we are, climate etc. Housing costs will decline in such a scenario, making the region more attractive.
- No - true AV is outside 30 years + public distrust social acceptance of it.
- Unlikely to see decreased population, jobs are not a primary driver to livability or desirability of the region.
- Where are people going to go that is better?
- No- job loss from automation will be offset by new emerging sectors such as AV maintenance and data management.

Are we missing any key implications?

- How does this scenario impact palpable priorities/ break and butter RGS/ RTS issues? Need indicators (Qual + Quant), e.g.: Employment land, agricultural Land, VKT/PKT, GHGs, Affordability, SRS Housing
- Regardless – Metro Vancouver will always be a desirable place to live for the rich (foreign buyers)
- Person trips may decrease, but vehicles and congestion may increase - what about discretionary trips?
- What if the cost of living also decreases? Interprovincial migration should be looked at and potentially included as part of immigration.
- Consider adding "Land Base" as another indicator. This would help capture climate impacts to land base. If none anticipated by 2050, have to caveat to 2100.
- Humans are social creatures and trip rate reduction from job sector change will be offset with discretionary trips.
- Immigration decline is drastic.
- The notion automated vehicles are going to be prevalent does not deal with large costs associated with delivering this infrastructure. What about automated high-speed rail or other similar transit factored in.
- Hard to imagine this level of population decrease? Maybe people move back to Van region because it's still less bad than the Kelowna region.
- Immigration is dependent on what is happening everywhere else in the world more than local economy. Climate will have great impact on economy.
- Likely longer trip distances for remaining working class people who are displaced from core areas.
- Hard to see how population declines.
- Disagree population - 20% but people still need to move and AV +/= congestion. Transit might stay same or increase.
- Manual labor workers would work where?
- Climate change indicators and migration.
- Perhaps differentiate between Quantity and Quality of jobs.
- Would local government have to change? Would the region need to be governed by different municipalities?
- Any way to capture things like sprawl/location of housing (&/or affordable housing; might be too detailed for this stage?)
- Immigration decreases by 50% of the federal immigration policy doesn't change, the rate is too high. Still lots of people would feel the region is desirable as a living place/home location.
- Would incomes decrease drastically if remaining jobs are higher paying jobs i.e. technology, information jobs.
- What about job/skills disconnect?
- Climate change immigration to Metro Vancouver.
- Inequality increasing - some make more, some make less. Not necessarily income decrease for all.
- Small businesses can't all afford to adopt to automation - will they leave? They are what makes MV special.
- I think there won't be as much of a decline in household income and daily trip rate as this indicates. If people are struggling they may have several part time jobs, and need to commute more between them. I think with the rise of AVs trips, it won't decrease as much as predicted.
- Connecting migrants with jobs.
- Hard to imagine a scenario with declining population.
- Does automation affect the genders disproportionately?
- Age of population (and connection to likelihood of skill shifting).
- Could these projections be disaggregated? (e.g. number of jobs (M/F) median income (M/F) daily trip rates (M/F) job markets, number of trips (as care givers etc.) all gendered.
- Does the lack of low-skilled jobs create a new class of artists? How do they travel? Does society value them?
- A lower degree of decrease in jobs.
- Population decrease too drastic. Would automation not be simultaneously affecting elsewhere too? Plus, climate refugees.
- Income inequality different between median and average income.
- Quality vs. Quantity of jobs
- Doesn't capture what happens in housing market/cost of living - only has income.
- The affordability challenge will increase in this scenario.
- Immigration only speaking to labor demand, but another factor are immigrants who are not dependent on the labour market. MV will still be seen as desirable.

Opportunities and Challenges

With declining population and jobs, reduced government revenues make climate change adaption more challenging.

- Disagree - New market opponent will lobby government to invest - Think New Green Deal.
- Depends - Could take advantage of "retreat" scenarios that are currently cost prohibitive due to high land value.
- Fewer jobs and lower incomes on average will drive trend to denser more affordable residential development.
- If population dropped this much - excess housing supply would lead to lower housing costs and in turn be attractive for migrants
- Disagree: Population will not decline. Even with reduced jobs, the region will remain attractive (relatively) to other regions and countries. The result will be a desire to move here, regardless of our economic decline/.
- Lack of revenues would force a resign of systems which would create more effective systems that cost less and are easier to maintain.
- Government revenue will need to shift tax burden through policy- money will have to come from somewhere.
- Yes - as the significant revenues it will take to upgrade and maintain infrastructure will not be available. (Think old infrastructure aging out)

Lower employment changes the worker-to-retiree ration, reducing benefits for retirees:

- Disagree - Retirees (to 2050) will get their benefits based on standard political policy, perhaps fewer services for retirees?
- Challenge: will be challenging to accommodate changing demographics. Aging population will require additional services.
- The economy is already highly automated. We can only assume that the current trends in employment/services will remain the same. When disruptive tech emerges it may cause problems for some but increases new opportunities elsewhere.
- Certainly possible but perhaps the nuance is that there will be fewer good, solid paying jobs relative to the retiree levels. Imbalance?

Automated production may result in a lack of value-add to the regional economy, with most wealth being captured by few individuals.

- Agree- already happens.
- Higher quality jobs will emerge over time
- Automation will create new jobs even if we don't yet know what they are.
- I agree that the wealth gap will continue to increase, and that wealth may be based elsewhere and not captured by our government.
- Poverty level increase: low education families may not be able to leave the city. Their population will grow jobless.
- All 4 scenarios appear to assume expansion of global economy, even though we are already in an overshoot situation.
- Inequality issues - certainly impacts this?

Fewer overall trips, high AV adoption rates and lower farebox revenue may create pressure for a decreased of regional transit services.

- Opportunity to improve transit service (with AV) to better match ridership and trips - may lead to increased transit use.
- Would decrease equity across region lead to increased use of transit as lower cost travel choice?
- Cut backs to transit would worsen inequality.
- Fewer jobs may reach more people working multiple jobs or starting own businesses leading to: more trips, more demand on transit.
- We'll be worst with asset management. With less money, we'll likely not do long-range planning and focus on immediate needs only.
- Not sure about the link between decreased jobs and decreased immigration
- Need to think about impacts on AV model - Private or shared- these are different!
- No to fewer trips. Trips will just change to become discretionary.
- This is countered by lower costs of operating transit with automation.
- Those who struggle will make ends meet with travel more to jobs that do still exist and those who are wealthy make more recreational trips.
- Increase AV might increase cars on roads.
- Mobility pricing is coming to this region. That will impact this scenario. Inherent assumption (like climate change)

- Increased poverty and unemployment might reduce AV uptake and increase transit significantly.
- More advanced/sophisticated busy lives lead to increase in mental health issues.
- Missing: assume that mobility pricing is part of a high automation scenario (its already policy).

Additional Opportunities and Challenges

- Autonomous vehicles dramatically reduce cost of transit service allowing for broader coverage with high quality with high quality (frequent speed) transit.
- Climate migrants
- Opportunity to rebuild/ rethink infrastructure.
- Government structure different to regional structure?
- Still need to sustain infrastructure as they are and provide equitable living for people of all incomes.
- Costs for all social programs – greater inequities lead: together social investment reg!
- Climate change impacts may be incorporated in 4 scenarios but onto 2050. We may see significantly larger impacts post 2050.
- Housing- affordable housing? Greater need.
- Decrease in investment for all social programs.
- Assume transit used in some way. What about MaaS?
- Opportunity: Reduced growth rate across the region may open space for reducing existing vulnerabilities to extreme flooding and catastrophic earthquakes events through strategic redevelopment and mitigation investments.

C. What if the world closes doors and borders?

The story

- Countries around the world adopt protectionist policies, leading to a sharp drop in global trade and an increased need for regional self-sufficiency.
- Moderate automation and 3D printing are leveraged, enabling local manufacturing and a diversification of goods and services produced in the region.
- The population stagnates as immigration slows and jobs decrease accordingly. Employment also decreases with lack of global connectedness.
- Less trade and reduced number of jobs leads to fewer trips in the region.

Implications, Rationale, & Assumptions

Implications	Today	Scenario C	Rationale & Assumptions	Source
Regional Population	2.57 Million	+/- 10%	- Protectionism leads to limited immigration along with negative natural increase of .8% annually.	Johnson. 2011. Natural Decrease in America: more coffins than cradles.
Immigration (/yr)	30,000	-70%	- Global protectionism leads to fewer immigration opportunities. - Assume net out for provincial emigration/immigration.	Correa-Cabrera and Payan. 2018. Political Turpitude: The negative impact of zero-tolerance immigration policies on irregular labor markets
Number of Jobs	1.34 Million	-20%	- Proportionately tied roughly to population at 2 persons: 1 job	Metro Vancouver Growth Projections

Implications	Today	Scenario C	Rationale & Assumptions	Source
Daily Trip Rate (pp/day)	2.7	-30%	- As a self sustaining region, less goods movement for international trade. - Also a cultural shift towards more sustainable modes.	
Median Household Income	$73,000	-10%	- Fewer global opportunities and headquarters position themselves in Metro Vancouver due to protectionist policies and trade limitations.	

Opportunities and Challenges

- Metro Vancouver has relied on other countries for trade. A reduction in trade could impact jobs and access to goods and services.
- Infrastructure could be overbuilt relative to reduced global trade.
- Local manufacturing could increase demand for industrial land.
- Regional food supply may be compromised from lack of trade. Climate change may further stress the food security in the region.
- Lack of immigration would result in a slowing of population growth and a more rapidly aging population.

Stakeholder Comments

Is this scenario plausible? Why or why not?

Yes:

- Yes - Increase geopolitical instability is already evident. Holding climate change assumptions constant will increase the likelihood of political instability.
- Yes - but was interprovincial migration taken into account? Decrease in population seems unlikely.
- Global connectedness may not be lost with internet etc. Technology is creating different connections.
- Yes - local manufacturing will increase demand for industrial land. Think about where this extra land is located and how people will get there. A lot of residential areas around industrial so there's not much room to expand where it is already located. Will need to find a way to use industrial land more efficiently.
- Should identify as Climate Change Refugee Scenario (Sea level rise, drought etc.)

Middle Ground:

- Possibly exporter nations would likely develop mechanisms for reprised trade.
- Possible - Economic upheaval and rising taxes would self-correct. Depression in 30's was exacerbated by protectionism, huge migration.
- Regional self-sufficiency or domestic self-sufficiency?
- Not sure that local manufacturing is realistic. Can't see us producing iPhones in Metro Vancouver, we will still rely on global trade.
- Not sure - Huge decrease immigration seems hard to fathom.

No:

- Not possible scenario. If some countries close their doors we will likely adapt and find resources from other countries.
- I wondered about the highlighting of 3D printing this scenario. Is that widely regarded as a solution in this scenario? Fair enough if so, it just struck me as odd.

- Not sure a 70% decrease in immigration is realistic given climate and existing multicultural nature of the region.
- I question whether in-migration would slow except in true catastrophe.
- Trade could definitely slow, but doubt out-migration would drop that much (unless terrorism/war policy) - if we have to become more self-sufficient, we will need more labour.
- No - Global trends for countries have shown the world is becoming smaller - information sharing, knowledge transfer, travel, human capital etc. Other countries always form alliances where borders close.
- Assumes immigration slows and jobs decrease. Jobs may become more available to local population.
- More likely Canada will house climate/political refugees leading to increases in the population despite unlikely policy to decrease immigration.
- Seems like the least likely scenario of the four. Given immigration/population/job scenarios to vet here, other assumptions more pessimistic.
- Too much foreign investment exists already. Highly unlikely for neoliberals to let this occur.
- If anything, global shift towards more closed borders may increase Canada's role in accommodating refugees etc. increasing immigration.
- Unlikely to happen. There is too much vested interest cross borders for severe protectionist policies to be adopted.
- Drop in exports discourages investment in technology.
- This scenario feels highly unlikely to develop to the extent described here. Perhaps to a degree.
- Unlikely automation would really progress, regional economy may maintain at current level or without support of proper economic drive, slow down.
- Not very likely - people have developed reliance on global trade.

Are we missing any key implications?

- Because borders are closed, immigration/refugee activities may not reduce migration population to the region.
- How is it possible that income only decline -10% with -20% job decline?
- As a stable region (Climate and politically) there will still be desire to locate to Metro Vancouver. Climate related immigration will be high. Income disparity will increase as those more affluent will be able to migrate.
- Hard to imagine a situation with no Canadian immigration.
- Value in tracking income disparity/gap in addition to just median income?
- Close borders and doors (i.e. processes such as foreign work laws) is plausible
- The federal government may buck the trend and use immigration policy to target high-potential immigrants to relocate to Canada.
- I think we may continue to allow immigration throughout the Americas at least. What about climate refugees? Would Canada stop allowing all together?
- What about Cascadia? Wouldn't we be ok in terms of self-sufficiency and therefore be able to create new jobs and travel more within region? Why would jobs and daily trips decrease? Climate related conflicts will increase refugees regardless.
- Trip rate is unlikely to decline with population stagnation. Why is it declining by 30%? Discretionary trips will go up or remain constant.
- Movement of people because countries may still not decrease - refugees etc.
- Housing: decreasing demand may lead to increase availability - prices decrease.
- Need more indicators to understand implications - affordability, agricultural land, employment land, infrastructure costs.
- Will people in global trade-related jobs be able to transition to new jobs?
- Don't agree with median income drop.
- Decreased immigration would have major impact on rest, construction which is a big part of regional GDP. Median income could fall by more than 10%.
- Aging population - decreased labour force, decreased revenues to deal with climate change and infrastructure costs.
- Loss of jobs can stimulate small business development and/or holding multiple jobs - will affect daily trip rate.
- Wouldn't there be "on-shoring" of jobs that would offset export-oriented jobs?
- If immigration drops that much, it will make for an increase in aging population. How will that impact job economy?
- What would the impact be on economic disparity in this scenario?

- Implications for affordability? (e.g. housing prices, scenarios effects on transportation)
- Labour impacts?
- Climate change cost will significantly reduce regional economy.
- Consider adding Land Base as another implication indicator. Would help capture climate change impacts to 2050. If non anticipated, have a caveat to 2100 (when we will see a ramping up of impacts).
- A diverse regional economy could be considered a strong economy although not strong in terms of growth.
- Just because wealth may not be "leaving the region" doesn't mean it will actually be distributed to those living here. I think its optimistic to think that a lot of it will be reinvested this heavily in the regional economy.
- How temporary would this scenario be?
- Affordability + wealth gap
- Cost of goods, especially food.
- Number of jobs decrease = will people be travelling/ commuting more to jobs that are available?
- Implication to land use as products have to be produced locally.
- Population increase from climate related immigration.

Opportunities and Challenges

Metro Vancouver has relied on other countries for trade. A reduction in trade could impact jobs and access to goods and services.

- Trade across country would increase to make up for loss of goods and services that were global.
- May still have increase jobs because need local labour for local production. (this scenario has mod. automation)
- We could be self-sufficient as a region more easily that other areas of the country. Wouldn't we increase regional production and trade?
- Re-training will be required as demand shifts for different kinds of employment.
- Loss of jobs (or good jobs) can stimulate small business development and shift to service and knowledge industries.
- Is the drop in number of jobs realistic? If you need to be more self-sufficient and also with aging population (and no more immigration) there would possibly be more jobs needed to provide for all and also requirement to care for the old.

Infrastructure could be overbuilt relative to reduced global trade.

- If population is projected to decline, less demands on existing infrastructure, but is existing infrastructure overbuilt for current needs.
- Significant resistance from industries that have a vested interest in maintaining Metro Vancouver as a global gateway. Reluctance to downsize infrastructure (assuming global economy rebounds.)
- Major opportunity for repurposed infrastructure.
- Does this model factor increase to domestic trade?
- Yes, to resource trade. New jobs (manufacturing) will be created.
- Climate change - Decreased revenues may pose a challenge for investment in resilience.
- Good point - even with a slowdown in trade we would be overbuilt.

Local manufacturing could increase demand for industrial land

- This assumption is incorrect, if global trade stops, opens up industrial warehouses, demand for trade would not increase.
- Most manufacturing opportunities would occur south of the Fraser and East of the Pitt.
- Likely leads to the agricultural-industrialization of the ALR.
- Agree - increase in local manufacturing may replace warehousing & other existing industrial uses that were based on a global economy. May not result in more demand for industrial land. May stay the same.
- How realistic is local manufacturing given labour costs?

Regional food supply may be compromised from lack of trade. Climate change may further stress the food security in the region.

- Agree that food supply could be compromised - especially if more land needed for manufacturing.
- Agricultural land in BC is currently generally under-utilized and policies could be put in place to limit impact.
- Given increase to local production goods movements shift from ports. Impact on trip rate?

- Would crease the opportunity to build a strong local food system. Cuba has had a closed system for decades. Might build the local economy, we have had a more closed system in the past.
- Type of infrastructure changes and jobs/skills needed to address (tech, construction, services).
- Yes - an initial change in agricultural trade affects type of crops produced.
- Agriculture load has been kept and restricted. Food security will not be compromised.

Lack of immigration would result in a slowing of population growth and a more rapidly aging population.

- Inflation could be a big impact on this scenario (tariffs, etc.)
- Importance of protecting and enhancing our food growing and processing capacity.
- Aging population = increased health care costs for overall population = decrease in median income.
- Implication for political system? Outcomes would depend a lot on policy response.

Additional Opportunities and Challenges:

- Potential opportunity related to driving transition to a more circular economy (increased resilience, decrease wastes etc.).
- Agree that we need severe external force to drive change in this direction. Otherwise too much inertia in keeping status quo.
- Only advantage is the potential for more sustainable focus.
- Resiliency planning provides opportunity to think about healthy zero-growth economy.
    - Agree since we are leaders in this as a region
- Loss of jobs provides fuel for education sector.
- The climate change scenario plays a larger challenge in terms of climate migration and infrastructure investment to combat effects.
- Maybe least likely scenario to occur. May be periods of more protectionist policies but will it be sustained? Climate change might supersede everything.
- Job numbers are too high. Not reflecting workers.
- Challenge: The shock of a sudden extreme flood and/or catastrophic earthquake would have a more significant social impact in this scenario. Demographic profile and reduced economic security would significantly impact capacity to absorb and recover following a disaster.
- Opportunity to rethink the growth model of capitalist economy to more sustainable ecological model of meeting needs.
- This scenario suggests lots of inequality - refugees, undocumented people, vs. insiders.
- Question: What impact will this scenario have on local production? If protectionism increases and the cost to ship goods around the world rises, are we able to meet the needs of the region by growing our food locally? Make protecting ALR more important.
- Closed borders but interprovincial trade?
- We will need to use land more efficiently if we need to produce more locally, may have/need higher density instead of sprawl which will better support more efficient transportation.

D. What if we attract rapid growth in the tech economy?

The story

- Seamless digital connectivity makes the global worker phenomena commonplace.
- As a desirable place to live, Metro Vancouver attracts more immigrants, many of whom work remotely for companies headquartered elsewhere.
- The region sees an overall increase in population, with minor seasonal fluctuations as people move from place to place.
- Increased telecommuting results in a decrease in work-related travel.

Implications, Rationale, & Assumptions

Implications	Today	Scenario D	Rationale & Assumptions	Source
Regional Population	2.57 Million	+80%	Assuming higher than current MV growth projections, largely from professionals who immigrate to the region.	Metro Vancouver Growth Projections
Immigration (/yr)	30,000	+90%	The lifestyle attractiveness drives immigration higher than projections, affordability is still an issue, therefore it is largely professionals who immigrate.	Statistics Canada. 2018. Canadian Megatrends - Population growth: Migratory increase overtakes natural increase
Number of Jobs	1.34 Million	+80%	- Assume more opportunity for gig work through telecommuting. Connectivity allows for less restriction in employment.	
Daily Trip Rate (pp/day)	2.7	-50%	- Tied to employment distribution in narrative, significantly less driving due to increased teleworking. - Some discretionary trips still apply.	
Median Household Income	$73,000	+30%	- Increase in specialized positions with higher rate of pay.	

Opportunities and Challenges

- Significant growth may provide more resources for major infrastructure upgrades. These resources could greatly help to adapt to climate change. At the same time, infrastructure and services may struggle to match the pace of population growth.
- An increase in telecommuting may moderate the pace of growth in demand for office space and change the culture of urban centres.
- With decreased vehicle traffic, parts of the road network (and parking lots) could be repurposed for higher and better uses.
- Global workers may operate on other time zones, reducing peak travel windows, but also requiring more 24-hour services.

Stakeholder Comments

Is this scenario plausible? Why or why not?

Yes:

- Yes - Tech economy will evolve and grow even if we do not especially attract rapid growth. Number of jobs may not grow so high though.
- Agree - overall with this as a plausible scenario but with not as high % change.
- Population, GNP, immigration with advanced tech makes sense as scenario.
- Tech industry spins off many small businesses therefore increasing specialization of knowledge and service industries.
- Yes - this is already occurring across all industries
- Increase in telecommuting - very likely with “seamless digital connectivity”
- Yes, and could/would exacerbate economic disparity. Seems like it would be more akin to a tourist economy than a balanced economy.
- Extremely plausible, should this just be built into base assumptions?

- Yes, many of these factors can be seen today.
- Plausible - Private sectors can adapt to climate change much quicker by adopting decrease work week and increase telecommuting.
- Yes- Metro Vancouver - desirable place to live and already attracting tech industry.
- Yes - Daily trip rate will be higher – millennial's culture/social and recreational leisure activities.
- All four scenarios appear to assume expansion of global economy, even though we are already in an ecological overshoot. Can't grow forever.

Middle Ground:

- Cost and affordability? Under this scenario we are not attracting tech investment - it seems - just workers.
- Increased telecommunication means increased connection and more international travel and movement of populations.

No:

- Despite telecommuting people will still have meetings - may result in more business related travel.
- May see increases in more local movement as people more likely to make short trips during "work day"
- High cost of living will limit population growth, especially in light of growing income disparities (add the expectation for high cost of goods and services)
- Huge amounts of telecommuting not realistic. People are already shifting away from this.
- While being a desirable place to live, the region would be competing with other world-class cities that already have infrastructure in place and may be more desirable due to living costs.
- Housing affordability - difficulty to attract talent when higher incomes are available elsewhere (currently). May need a policy change.
- Why wouldn't tech companies outsource more outside N. America to maintain/increase margins?
- Tech companies would likely also buy up land by outbidding other users.
- Can increase vehicle/delivery (Amazon Prime, etc.) trips to multiple locations that we don't normally see there (i.e. Single Family Residential).
- Trip rate reduction is way too high. People will still be moving around, just for different purposes at different times.
- What's the drive of strong regional economy? Except for hot housing market.
- Increase telecommuting trends are more 1x or 1x per week. For many employees not 5x per week.
- Increased digital connectivity could result in greater attraction of HQs to major urban centers. Will affect daily trip rates positively.
- Increase telecommuting will NOT greatly decrease daily trip rate- shift to shared offices.
- Increased telecommuting leasing to a decrease in work-related travel will be relevant regardless. Should be captured more in other scenarios too.

Are we missing any key implications?

- All four scenarios appear to assume expansion of global economy, even though we are already in an ecological overshoot.
- Would the daily trip rate actually increase? Flexibility in work may result in more leisure or social trips.
- Trip rate decrease seems unrealistic
- Do assumptions around decrease in vehicle traffic (despite increase population) account for increase to goods movement to support increase population? Assumption seems based purely on reduction of commute trips.
- Would be helpful to understand implications of projected growth on land use and built form.
- In this scenario are we attracting more tech workers or a larger share of the global tech economy? If the latter, we may not have many people working for companies located elsewhere.
- Very likely that income/wealth inequality will increase significantly.
    - Likely would be high in nominal terms.
    - Spread between high/low income. Median/average spread will be further apart.
- Increase in disparity - more need for social services (e.g. housing)
- If labour is easier to find, wouldn't that drive down wages?
- Trip rate of 1.35 is too low. We are social beings and will want to leave home or work outside it.
- What is driving increase to median incomes? Increase tech/automation has not increased overall median incomes.

- People trips vs. vehicle trips - and empty vehicle trips.
- Provincial, interprovincial migration to access the tech jobs/sector.
- More discretionary trips - because not limited by 9-5.
- What impact would AVs as mobile workplaces have on trip rates?
- Income tax implications for a highly mobile global population?
- Daily trip rate seems too low. Discretionary trips (non 9-5) will likely increase substantially with a more mobile work force. Biggest change is the reduction in peaks.
- Vehicle traffic may increase with rising inequalities/unaffordability. People will have to travel further for work.
- Housing affordability will be an issue. Longer commutes to downtown.
- May have to outsource more which will drive down local wages and incomes.
- Housing affordability implications with high population growth. Urban sprawl impacts.
- Is sustained population growth realistic given assumption it is based on digital nomadic workers?
- Is the daily trip rate accounting for walking and cycling? These trips would likely go up with an increase in working from home.
- Income tax implications for a highly mobile, global population.
- Not convinced that daily trip rate will fall by 50% if there is such growth in population and jobs
- Global investment in real estate.
    - Look into other cities like Seoul.
- Changes in household income should be contextualized with potential changes in housing costs, which may increase disproportionally in this scenario.
- Consider adding land base as another implication indicator. Would help capture climate change impacts to 2050, if none anticipated; caveat for 2100.
- Don't think telecommuting results in trip reduction of this magnitude - too aggressive
- Housing inequality
- Growth in tech and high paying jobs for some might make affordability worse for others.
- Economy + job growth may be less - permanent jobs decrease due to less headquarters here.
- It would be useful to track impact on most vulnerable population (i.e. first quartile)
- Implications on social connections (and health) of those servicing/working in this scenario; would be travelling further. Meanwhile, telecommuting may be in areas close to transit so higher trip rate.
- Daily trip rate may increase due to tech increase in online shopping (more trucks/parcels etc.) e.g. London
- What about the rise of trips made for Amazon deliveries and returns, grocery deliveries, uber eats etc.? People may take less trips but those trips will still happen.
- Population demographic - travel type, frequency and timings will direct future plans e.g. aging population
- Work related travel might decrease however travel for entertainment, shopping, personal purposes would increase with strong economy as a base.
- Social interactions are still needed and therefore more travel. E.g. growth in shared work spaces.
- Inequality measures.
- Job numbers too high. Not reflecting worker displacement from automation assumption.

Opportunities and Challenges

Significant growth may provide more resources for major infrastructure upgrades. There resources could greatly help to adapt to climate change. At the same time, infrastructure and services may struggle to match the pace of population growth.

- Less diversified economy means more risk and vulnerability from other global events.
- Are jobs being matched to talent?
- A less diverse economy is not necessarily a "strong regional economy".
- Consequences for affordable housing a significant challenge.
- Unaffordability, increase population requires an increase in services. Can automation fully replace low paying jobs? Who will be able to do these jobs and live in Metro Vancouver? Small business impacts.
- Will all municipalities (i.e. urban, suburban, large, small) be able to invest in infrastructure upgrades (and adapt fast enough)?

- Trip frequencies will flatten (decrease peaks and valleys) due to less 9-5 work. As a result, we can change capacity assumptions. Less need to plan for "peak capacity".
- Perhaps the need for office space won't change, only the type of space and how it's used will.
- Agree - will bring cause more acute housing/cost of living challenges.
- Would there be more growth in regional "downtowns" where there is better land availability? E.g. Surrey, Fraser Valley.
- Agree - increased investment in rapid transit but increase in house prices may force longer commutes - increase demand for infrastructure.
- What type of infrastructure? – water, sewers, roads, fibre, soft infra (schools, hosp. etc.)?
- We are already dealing with an inability to build infrastructure that meets demand. I do not see this variable changing and may even improve our ability to build infrastructure and accommodate services that meets demand.
- Distributed work locations will require more distributed infrastructure to support it. (e.g. fibre optics, high speed internet)
- The infrastructure upgrades will generate their own impact to jobs/travel within the region.
- The number of trips may not decrease in this scenario, but where, when and how people travel may change.
- Yes - infrastructure will lag behind population growth especially in more rural/exurban locations to which lower income people are displaced.

An increase in telecommuting may moderate the pace of growth in demand for office space and change the culture of urban centers.

- Need for office space for collaboration and social connection will remain. Esp. since this scenario shows 80% job growth.
- Lack of economic diversity could leave the region susceptible to other shocks.
- Unlikely due to social nature of humans' current day, there is sufficient tech to do this, but still issue of saturation in all sectors to telecommute and culture shift unlikely.
- Shifts office demand to connecting firms, demand still there for space, just using it differently.
- Agree - office space change could result in increased available residential land use opportunities.
- Telecommuting does not connect well with the knowledge economy. This economy is about ideation and people coming together to be creative, much like retail, more office space might not be required.
- Agree - More hot desking and shared office spaces. Increase demand for specialized services and retail.
- Might just change the design of the office buildings, not decrease demand.
- Changing in routine of work place- e.g.: WeWork.
- Innovation will create other opportunities for people to come together - humans are social creatures.

With decreased vehicle traffic, parts of the road network (and parking lots) could be repurposed for higher and better uses.

- Opportunity for personal vehicle traffic to be replaced my mass transit especially with millennial culture.
- What about vehicle ownership change? Overall there may not be significant change to the total number of personal vehicles which means vehicle parking spaces are still required not likely to be repurposed for building use.
- This is already happening in city cases parking lots and space requirements declining; opening space for more development.
- Yes - Assume wider sidewalks, more protected bike lanes and transit lanes.
- Disagree - unlikely to see reduction in traffic in a robust economy which attracts immigration. Other industries such as construction will have an impact on material transport.
- This is happening anyway- highest and best use
- Movement may increase due to AVs + increased leisure time + increasing…?
- Hard to see daily trips going down with change in work - to be more flexible to travel = at least equal trips
- Repurpose space from private vehicle ownership. Needs to account for shared/on-demand uses (Uber, Amazon, Skip the dishes)
- Will we really have reduced congestion? Open roadways and transport may run better but I don't believe we will eliminate bottlenecks and queuing at key destinations and within the vicinity of the locations. This also depends on AV fully or partially adopted.
- Amount of vehicle traffic highly dependent on degree to which population adopts "shared" AV use. Need to clarify assumption.

Global workers may operate on other time zones, reducing peak travel windows but also requiring more 24- hour services.

- Yes - and not just global workers - telecommutes and changing economies and aging demographic.
- Yes - and congestion/mobility pricing will help spread demand outside peak hours.
- Global workers may choose countries with lower tax rates.
- Growth of tech sector will make Metro Vancouver a more desirable place to live and place investment in urban centers, traffic congestion, I would assume would increase, so long as we don't plan for it.
- Impact climate change immigration worldwide across all scenarios.
- People are very social in nature. They will want to work in shared places. New patterns will form - change in 9-5 work patterns.

Additional Opportunities and Challenges:

- Big tech companies will take up a lot of industrial land. Can also suppress competition and entrepreneurship.
- Demand for employment space in downtown Vancouver and heritage/industrial areas will increase given tech sector's worker preferences.
- Tech companies look for livability and contribute to gentrification pressures.
- Will policy/government be able to adapt/stay current with tech innovation challenges, if it continues on exponential scale?
- Create great talent not cheap talent.
- Shocks: Higher concentration of people and financial assets in regions that are susceptible to shocks of extreme flooding and/or catastrophic earthquakes may stress capacities for recovery.
    - Residents impacted by disaster events would likely relocate to other regions as they are not dependent on job location.
- Head office vs. back office
- Industrial/agricultural/employment lands located in flood planes
- How do we collect taxes from a highly mobile workforce? Income? Rental?
- Opportunity for infrastructure funding etc.
- Access to data privatized
- Does this take into account the digitization of existing industries such as manufacturing and agriculture? Not just coding.
- Big tech employers may want big floorplate style places but their workers will want amenities and rapid transit. Implications for Metro Vancouver.
- Automation is already affecting tech companies through outsourcing of labour to places where workers receive lower wages. I don't think tech will grow at the same rate here forever.
- More disconnected population, decrease in human contact both within/outside family - mental health implications.
- More high tech, busier lives, increase in mental health issues - depression etc.
- Increase in affordability. Increase in inequality. Increase in challenging social issues. Increase polarity. Increased tax revenue may have to go solve these.
- Housing interventions to address inequality.
- Decrease job opportunities for low educational workers. Increase poverty and bigger gap between low income groups and mid/high income groups.
- What about the idea of transit as essential service for unemployed or low income? Maybe need to prevent social unrest/ or part of social services.
- High automation and strong growth will also (likely) mean high technology innovation and disruption. Alternative mass transit system options?

APPENDIX D – GLOSSARY

Process-Related Terminology:

External Forces - External forces comprise trends and disruptors that could potentially change the trajectory or future of Metro Vancouver land use and transportation from a variety of perspectives. E.g. Climate change and natural hazards is an external force.

Impact (of external force) – Impact refers to the effect that an external force will have on land use and transportation for Metro Vancouver in 2050. E.g. Connected and Autonomous vehicles were expected to have a significant impact while the Sharing Economy was not expected to have much of an impact.

Variability (of external force) – Variability refers to the degree of confidence that an external force will manifest in a way which we expect. E.g. The force Shifting Global Economy & Trade has a high degree of variability as determined by stakeholders on how the force will manifest, while the force Aging Population has a low degree of variability.

Anchor Points - Anchor points are a subset of external forces selected to start each of the scenarios. These are defined as external forces that characterize the scenario and set off the chain reaction within the system dynamics. For example, a scenario focused around a future of intense climate change would use the conditions of a changing climate (rising water levels, etc.) as the anchor point. You would then branch out from the anchor point to figure out what the trickle-down impact would be on all the other factors within the system.

Scenarios - A narrative describing a possible future using a consistent and realistic package of assumptions, relationships and implications. Scenarios are a projected set of conditions built off an anchor point that makes an assumption on what the future is going to look like and how this will impact the Metro Vancouver area in 2050. E.g. A scenario may be focused around Extreme Climate Change that will incorporate forces and conditions related to the anchor point. Changing climate is associated with more extreme weather events, possible flooding, and changes to average temperatures. Narratives and indicators are used to describe the conditions for each scenario.

System Dynamics - System dynamics is a simplified model used to describe how multiple factors are impacted by each scenario and how these factors in turn would influence transportation and land use issues. This is a preliminary idea of what a scenario ecosystem would look like. E.g. a shift to climate change and natural hazards may impact where and when jobs will be located which will in turn alter demand for the transport system.

Indicators - Scenario indicators are a translation of quantitative and qualitative considerations from the scenario narrative on how it is anticipated that these will impact different scenarios based on the developed narrative and underlying assumptions.

APPENDIX E – ANCHOR POINT IMPACTS AND ASSUMPTIONS

Assumptions for anchor points in this appendix are organized using the hierarchy below. Related external forces were tied to anchor points, and then potential impacted areas were identified for each external force. From here, bookend assumptions were developed on available literature and research. These were adjusted to fit the preliminary scenario narratives developed.

Anchor Point	Related External Force	Potential Impact
Advanced Automation and Technology	Advanced Automation	Employment by Industry (NAICS)
		Employment by Location
		Industrial Land Change
	Connected and Autonomous Vehicles	Employment by Industry (NAICS)
		Employment by Location
		Population by Location
	Real Estate Market Dynamics	Employment by Location
		Population by Location
		Housing by Location
Climate Change	Natural Hazards and Climate Change (Flooding)	Land Availability
		Employment by Location
		Population by Location
	Natural Hazards and Climate Change (Heat & Drought)	Land Availability
		Employment by Location
		Population by Location
	Real Estate Market Dynamics	Employment by Location
		Population by Location
		Housing by Location
Trade and Economy	Global Outsourcing & Re-shoring	Employment by Industry (NAICS)
		Employment by Location
	Real Estate Market Dynamics	Employment by Location
		Population by Location
		Housing by Location

Anchor Point	Related External Force	Potential Impact
Advanced Automation and Technology	Advanced Automation	Employment by Industry (NAICS)

NAICS (2-digit codes)	Book End 1	Rationale	Source	Bookend 2	Rationale	Source
Sector 11: Agriculture, Forestry, Fishing Hunting	Decrease 10%	There has been a long-term transition away from agriculture/forestry/fishing as automation becomes more sophisticated and machines are able to undertake more work	McKinsey (2017) Jobs lost, jobs gained: workforce transitions in a time of automation. P9.	Decrease 30%	There has been a long-term transition away from agriculture/forestry/fishing as automation becomes more sophisticated and machines are able to undertake more work	McKinsey (2017) Jobs lost, jobs gained: workforce transitions in a time of automation. P9.
Sector 21: Mining, Quarrying, and Oil and Gas Extraction	No change off baseline	Already quite reliant on machinery to undertake work in combination with human oversight. Less aggressive shifts anticipated with specialized labour	C.D. Howe Institute (2017) Future shock? The Impact of Automation on Canada's Labour Market. P13.	Decrease 5%	Already quite reliant on machinery to undertake work in combination with human oversight. Less aggressive shifts anticipated with specialized labour	C.D. Howe Institute (2017) Future shock? The Impact of Automation on Canada's Labour Market. P13.
Sector 22: Utilities	Decrease 22%	Low amount of full-time equivalents are in employed in utilities. Automation could improve forecasting, optimization of operations and enhance customer experience.	McKinsey (2017) Jobs lost, jobs gained: workforce transitions in a time of automation. P62, 126	Decrease 26%	Low amount of full-time equivalents are in employed in utilities. Automation could improve forecasting, optimization of operations and enhance customer experience.	McKinsey (2017) Jobs lost, jobs gained: workforce transitions in a time of automation. P62, 126

NAICS (2-digit codes)	Book End 1	Rationale	Source	Bookend 2	Rationale	Source
Sector 23: Construction	Decrease 16%	If more construction work is undertaken due to automation efficiencies, this will also boost demand for human labour in less mature markets	PwC (2018) Will robots really steal our jobs? An international analysis of the potential long term impact of automation. p3.	Decrease 38%	Longer term, it's anticipated that construction jobs will be automated to boost productivity	PwC (2018) Will robots really steal our jobs? An international analysis of the potential long term impact of automation. P18.
Sector 31-33: Manufacturing	Decrease 35%	Moderately high automatability with routine tasks	PwC (2018) Will robots really steal our jobs? An international analysis of the potential long term impact of automation. P18.	Decrease 50%	Moderately high automatability with routine tasks	PwC (2018) Will robots really steal our jobs? An international analysis of the potential long term impact of automation. P18.
Sector 42-45: Wholesale and Retail Trade	Decrease 25%	Moderately high automatability with routine tasks	PwC (2018) Will robots really steal our jobs? An international analysis of the potential long term impact of automation. P18.	Decrease 40%	Moderately high automatability with routine tasks	PwC (2018) Will robots really steal our jobs? An international analysis of the potential long term impact of automation. P18.
Sector 48-49: Transportation and Warehousing	Decrease 45%	Transportation and storage are anticipated to have a high share of existing jobs that could potentially be automatable.	PwC (2018) Will robots really steal our jobs? An international analysis of the potential long term impact of automation. P18.	Decrease 55%	Transportation and storage are anticipated to have a high share of existing jobs that could potentially be automatable.	PwC (2018) Will robots really steal our jobs? An international analysis of the potential long term impact of automation. P18.

NAICS (2-digit codes)	Book End 1	Rationale	Source	Bookend 2	Rationale	Source
Sector 51: Information	Decrease 22%	Communications are already seeing simple computational task automation occurring. Data processing will also become a field that is highly automatable.	PwC (2018) Will robots really steal our jobs? An international analysis of the potential long term impact of automation. p3.	Decrease 26%	Communications are already seeing simple computational task automation occurring. Data processing will also become a field that is highly automatable.	PwC (2018) Will robots really steal our jobs? An international analysis of the potential long term impact of automation. p3.
Sector 52: Finance and Insurance	Decrease 25%	Likely to be more automatable in the short term due to simple computational tasks.	PwC (2018) Will robots really steal our jobs? An international analysis of the potential long term impact of automation. P21	Decrease 40%	Likely to be more automatable in the short term due to simple computational tasks.	PwC (2018) Will robots really steal our jobs? An international analysis of the potential long term impact of automation. P21
Sector 53: Real Estate and Rental and Leasing	Decrease 32%	Increased efficiencies developed in real estate industry through automation decreasing human requirement in process	C.D. Howe Institute (2017) Future shock? The Impact of Automation on Canada's Labour Market. P13.	Decrease 45%	Increased efficiencies developed in real estate industry through automation decreasing human requirement in process	C.D. Howe Institute (2017) Future shock? The Impact of Automation on Canada's Labour Market. P13.
Sector 54: Professional, Scientific, and Technical Services	Decrease 22%	May be most automatable in the short term but still will retain specialized and non-routine tasks	PwC (2018) Will robots really steal our jobs? An international analysis of the potential long term impact of automation. P21-37	Decrease 25%	May be most automatable in the short term but still will retain specialized and non-routine tasks	PwC (2018) Will robots really steal our jobs? An international analysis of the potential long term impact of automation. P21-37

NAICS (2-digit codes)	Book End 1	Rationale	Source	Bookend 2	Rationale	Source
Sector 55: Management of Companies and Enterprises	Decrease 5%	Lower risk due to higher emphasis on social and literary skills and more complex tasks that are less automatable	PwC (2018) Will robots really steal our jobs? An international analysis of the potential long term impact of automation. P23	Decrease 10%	Lower risk due to higher emphasis on social and literary skills and more complex tasks that are less automatable	PwC (2018) Will robots really steal our jobs? An international analysis of the potential long term impact of automation. P23
Sector 56: Administrative and Support and Waste Management and Remediation Services	Decrease 20%	Routine administrative and clerical work is expected to have significant automation impacts	C.D. Howe Institute (2017) Future shock? The Impact of Automation on Canada's Labour Market. P13.	Decrease 30%	Routine administrative and clerical work is expected to have significant automation impacts	C.D. Howe Institute (2017) Future shock? The Impact of Automation on Canada's Labour Market. P13.
Sector 61: Educational Services	No change off baseline	While administrative work may find automated efficiencies, there will continue to be an expanded emphasis on educational institutions.	C.D. Howe Institute (2017) Future shock? The Impact of Automation on Canada's Labour Market. P1.	Decrease 10%	While administrative work may find automated efficiencies, there will continue to be an expanded emphasis on educational institutions.	PwC (2018) Will robots really steal our jobs? An international analysis of the potential long term impact of automation. p23.
Sector 62: Health Care and Social Assistance	Decrease 16%	lowest estimated future automation rates, corresponding potential for net job gains in the long run	PwC (2018) Will robots really steal our jobs? An international analysis of the potential long term impact of automation. P18.	Decrease 22%	lowest estimated future automation rates, corresponding potential for net job gains in the long run	PwC (2018) Will robots really steal our jobs? An international analysis of the potential long term impact of automation. P18.

NAICS (2-digit codes)	Book End 1	Rationale	Source	Bookend 2	Rationale	Source
Sector 71: Arts, Entertainment, and Recreation	Decrease 25%	Reduction in clerk/support/admin type work to support industry. Limited anticipated reduction in arts/entertainment with professionals	C.D. Howe Institute (2017) Future shock? The Impact of Automation on Canada's Labour Market. P13.	Decrease 30%	Reduction in clerk/support/admin type work to support industry. Limited anticipated reduction in arts/entertainment with professionals	C.D. Howe Institute (2017) Future shock? The Impact of Automation on Canada's Labour Market. P13.
Sector 72: Accommodation and Food Services	Decrease 20%	Efficiencies anticipated through automation, while still retaining human labour force.	PwC (2018) Will robots really steal our jobs? An international analysis of the potential long term impact of automation. P18.	Decrease 35%	Efficiencies anticipated through automation, while still retaining human labour force.	PwC (2018) Will robots really steal our jobs? An international analysis of the potential long term impact of automation. P18.
Sector 92: Public Administration	Decrease 30%	Supporting effort for government will be able to find efficiencies through automation while senior public servants will continue to exist.	C.D. Howe Institute (2017) Future shock? The Impact of Automation on Canada's Labour Market. P13.	Decrease 40%	Supporting effort for government will be able to find efficiencies through automation while senior public servants will continue to exist.	C.D. Howe Institute (2017) Future shock? The Impact of Automation on Canada's Labour Market. P13.

Anchor Point	Related External Force	Potential Impact
Advanced Automation and Technology	Advanced Automation	Employment by Location

Book End 1	Rationale	Source	Bookend 2	Rationale	Source
Shift 25% of NAICS codes 31-33, 42-45 within or adjacent to urban areas.	Decentralized manufacturing and trade: greater interest in manufacturing, distribution, and retail to be closer to central infrastructure to service customers quickly.	Westac (2018) Fall Forum Report. P9.	Shift 25% of NAICS codes 31-33, 42-45 and move to outside the region	Centralized manufacturing and trade (outside region): Manufacturing and wholesale and retail trade moves outside the region for centralized facilities on less expensive land; existing space consumed by other sectors and land use types.	Industry Today (2017) Centralized vs Decentralized Manufacturing. Vol 17 Issue 10 P28.

Anchor Point	Related External Force	Potential Impact
Advanced Automation and Technology	Advanced Automation	Industrial Land Change

Book End 1	Rationale	Source	Bookend 2	Rationale	Source
No change off baseline	Increase in automated efficiency occurs to offset need to expand industrial land	Metro Vancouver (2013) Opportunities for the Intensive Use of Industrial Land. P10.	Decrease 20%	Higher intensity occurs through automation, improved goods movement loading and unloading through automated vehicles. Decrease in land requirement.	Metro Vancouver (2013) Opportunities for the Intensive Use of Industrial Land. P10.

Anchor Point	Related External Force	Potential Impact
Advanced Automation and Technology	Connected and Autonomous Vehicles	Employment by Industry (NAICS)

NAICS (2-digit codes)	Book End 1	Rationale	Source	Bookend 2	Rationale	Source
Sector 11: Agriculture, Forestry, Fishing Hunting	Decrease 10%	There has been a long-term transition away from agriculture/forestry/fishing as automation becomes more sophisticated and machines are able to undertake more work	McKinsey (2017) Jobs lost, jobs gained: workforce transitions in a time of automation. P9.	Decrease 30%	There has been a long-term transition away from agriculture/forestry/fishing as automation becomes more sophisticated and machines are able to undertake more work	McKinsey (2017) Jobs lost, jobs gained: workforce transitions in a time of automation. P9.
Sector 21: Mining, Quarrying, and Oil and Gas Extraction	No change off baseline	Already quite reliant on machinery to undertake work in combination with human oversight. Less aggressive shifts anticipated with specialized labour	C.D. Howe Institute (2017) Future shock? The Impact of Automation on Canada's Labour Market. P13.	Decrease 5%	Already quite reliant on machinery to undertake work in combination with human oversight. Less aggressive shifts anticipated with specialized labour	C.D. Howe Institute (2017) Future shock? The Impact of Automation on Canada's Labour Market. P13.
Sector 22: Utilities	Decrease 22%	Low amount of full-time equivalents are in employed in utilities. Automation could improve forecasting, optimization of operations and enhance customer experience.	McKinsey (2017) Jobs lost, jobs gained: workforce transitions in a time of automation. P62, 126	Decrease 26%	Low amount of full-time equivalents are in employed in utilities. Automation could improve forecasting, optimization of operations and enhance customer experience.	McKinsey (2017) Jobs lost, jobs gained: workforce transitions in a time of automation. P62, 126

NAICS (2-digit codes)	Book End 1	Rationale	Source	Bookend 2	Rationale	Source
Sector 23: Construction	Decrease 16%	If more construction work is undertaken due to automation efficiencies, this will also boost demand for human labour in less mature markets	PwC (2018) Will robots really steal our jobs? An international analysis of the potential long term impact of automation. p3.	Decrease 38%	Longer term, it's anticipated that construction jobs will be automated to boost productivity	PwC (2018) Will robots really steal our jobs? An international analysis of the potential long term impact of automation. P18.
Sector 31-33: Manufacturing	Decrease 35%	Moderately high automatability with routine tasks	PwC (2018) Will robots really steal our jobs? An international analysis of the potential long term impact of automation. P18.	Decrease 50%	Moderately high automatability with routine tasks	PwC (2018) Will robots really steal our jobs? An international analysis of the potential long term impact of automation. P18.
Sector 42-45: Wholesale and Retail Trade	Decrease 25%	Moderately high automatability with routine tasks	PwC (2018) Will robots really steal our jobs? An international analysis of the potential long term impact of automation. P18.	Decrease 40%	Moderately high automatability with routine tasks	PwC (2018) Will robots really steal our jobs? An international analysis of the potential long term impact of automation. P18.
Sector 48-49: Transportation and Warehousing	Decrease 45%	Transportation and storage are anticipated to have a high share of existing jobs that could potentially be automatable.	PwC (2018) Will robots really steal our jobs? An international analysis of the potential long term impact of automation. P18.	Decrease 55%	Transportation and storage are anticipated to have a high share of existing jobs that could potentially be automatable.	PwC (2018) Will robots really steal our jobs? An international analysis of the potential long term impact of automation. P18.

NAICS (2-digit codes)	Book End 1	Rationale	Source	Bookend 2	Rationale	Source
Sector 51: Information	Decrease 22%	Communications are already seeing simple computational task automation occurring. Data processing will also become a field that is highly automatable.	PwC (2018) Will robots really steal our jobs? An international analysis of the potential long term impact of automation. p3.	Decrease 26%	Communications are already seeing simple computational task automation occurring. Data processing will also become a field that is highly automatable.	PwC (2018) Will robots really steal our jobs? An international analysis of the potential long term impact of automation. p3.
Sector 52: Finance and Insurance	Decrease 25%	Likely to be more automatable in the short term due to simple computational tasks.	PwC (2018) Will robots really steal our jobs? An international analysis of the potential long term impact of automation. P21	Decrease 40%	Likely to be more automatable in the short term due to simple computational tasks.	PwC (2018) Will robots really steal our jobs? An international analysis of the potential long term impact of automation. P21
Sector 53: Real Estate and Rental and Leasing	Decrease 32%	Increased efficiencies developed in real estate industry through automation decreasing human requirement in process	C.D. Howe Institute (2017) Future shock? The Impact of Automation on Canada's Labour Market. P13.	Decrease 45%	Increased efficiencies developed in real estate industry through automation decreasing human requirement in process	C.D. Howe Institute (2017) Future shock? The Impact of Automation on Canada's Labour Market. P13.
Sector 54: Professional, Scientific, and Technical Services	Decrease 22%	May be most automatable in the short term but still will retain specialized and non-routine tasks	PwC (2018) Will robots really steal our jobs? An international analysis of the potential long term impact of automation. P21-37	Decrease 25%	May be most automatable in the short term but still will retain specialized and non-routine tasks	PwC (2018) Will robots really steal our jobs? An international analysis of the potential long term impact of automation. P21-37

NAICS (2-digit codes)	Book End 1	Rationale	Source	Bookend 2	Rationale	Source
Sector 55: Management of Companies and Enterprises	Decrease 5%	Lower risk due to higher emphasis on social and literary skills and more complex tasks that are less automatable	PwC (2018) Will robots really steal our jobs? An international analysis of the potential long term impact of automation. P23	Decrease 10%	Lower risk due to higher emphasis on social and literary skills and more complex tasks that are less automatable	PwC (2018) Will robots really steal our jobs? An international analysis of the potential long term impact of automation. P23
Sector 56: Administrative and Support and Waste Management and Remediation Services	Decrease 20%	Routine administrative and clerical work is expected to have significant automation impacts	C.D. Howe Institute (2017) Future shock? The Impact of Automation on Canada's Labour Market. P13.	Decrease 30%	Routine administrative and clerical work is expected to have significant automation impacts	C.D. Howe Institute (2017) Future shock? The Impact of Automation on Canada's Labour Market. P13.
Sector 61: Educational Services	No change off baseline	While administrative work may find automated efficiencies, there will continue to be an expanded emphasis on educational institutions.	C.D. Howe Institute (2017) Future shock? The Impact of Automation on Canada's Labour Market. P1.	Decrease 10%	While administrative work may find automated efficiencies, there will continue to be an expanded emphasis on educational institutions.	PwC (2018) Will robots really steal our jobs? An international analysis of the potential long term impact of automation. p23.
Sector 62: Health Care and Social Assistance	Decrease 16%	lowest estimated future automation rates, corresponding potential for net job gains in the long run	PwC (2018) Will robots really steal our jobs? An international analysis of the potential long term impact of automation. P18.	Decrease 22%	lowest estimated future automation rates, corresponding potential for net job gains in the long run	PwC (2018) Will robots really steal our jobs? An international analysis of the potential long term impact of automation. P18.

NAICS (2-digit codes)	Book End 1	Rationale	Source	Bookend 2	Rationale	Source
Sector 71: Arts, Entertainment, and Recreation	Decrease 25%	Reduction in clerk/support/admin type work to support industry. Limited anticipated reduction in arts/entertainment with professionals	C.D. Howe Institute (2017) Future shock? The Impact of Automation on Canada's Labour Market. P13.	Decrease 30%	Reduction in clerk/support/admin type work to support industry. Limited anticipated reduction in arts/entertainment with professionals	C.D. Howe Institute (2017) Future shock? The Impact of Automation on Canada's Labour Market. P13.
Sector 72: Accommodation and Food Services	Decrease 20%	Efficiencies anticipated through automation, while still retaining human labour force.	PwC (2018) Will robots really steal our jobs? An international analysis of the potential long term impact of automation. P18.	Decrease 35%	Efficiencies anticipated through automation, while still retaining human labour force.	PwC (2018) Will robots really steal our jobs? An international analysis of the potential long term impact of automation. P18.
Sector 92: Public Administration	Decrease 30%	Supporting effort for government will be able to find efficiencies through automation while senior public servants will continue to exist.	C.D. Howe Institute (2017) Future shock? The Impact of Automation on Canada's Labour Market. P13.	Decrease 40%	Supporting effort for government will be able to find efficiencies through automation while senior public servants will continue to exist.	C.D. Howe Institute (2017) Future shock? The Impact of Automation on Canada's Labour Market. P13.

Anchor Point	Related External Force	Potential Impact
Advanced Automation and Technology	Connected and Autonomous Vehicles	Employment by Location

Book End 1	Rationale	Source	Bookend 2	Rationale	Source
Decrease employment in industrial lands by 20%	Significant employment in goods movement and storage have the potential to be automatable, largely due to CAVs along with robotics.	PwC (2018) Will robots really steal our jobs? An international analysis of the potential long term impact of automation. P18.			

Anchor Point	Related External Force	Potential Impact
Advanced Automation and Technology	Connected and Autonomous Vehicles	Population by Location

Book End 1	Rationale	Source	Bookend 2	Rationale	Source
Increase population in urban centres by 10% from suburban areas	Hypermobile City: emphasis on shared AV transport, and the importance of populations being near goods and services.	Heinrichs (2016) Autonomous Driving and Urban Land Use. Pp 213-224.	Decrease urban population by 25% (to suburban and beyond region)	Endless City: low density dispersal and fragmented settlement structure in suburbs and beyond	Heinrichs (2016) Autonomous Driving and Urban Land Use. Pp 213-224.

Anchor Point	Related External Force	Potential Impact
Advanced Automation and Technology	Real Estate Dynamics	Employment by Location

Book End 1	Rationale	Source	Bookend 2	Rationale	Source
Decrease employment in commercial and institutional areas by 10%, redistributed across residential areas	Employment across sectors 51, 52, 53, 54, 55, 56, 61, 92 are already showing increase telecommuting, affecting traditional employment by location.	Ipsos (2011) Telecommuting: Citizens in 24 Countries Assess Working Remotely for a Total Global Perspective.	Decrease employment in commercial and institutional areas by 20%, redistributed across residential areas	Employment across sectors 51, 52, 53, 54, 55, 56, 61, 92 are already showing increase telecommuting, affecting traditional employment by location.	Ipsos (2011) Telecommuting: Citizens in 24 Countries Assess Working Remotely for a Total Global Perspective.

Anchor Point	Related External Force	Potential Impact
Advanced Automation and Technology	Real Estate Dynamics	Population by Location

Book End 1	Rationale	Source	Bookend 2	Rationale	Source
Increase population in urban centres by 10% from suburban areas	Hypermobile City: emphasis on shared AV transport, and the importance of populations being near goods and services.	Heinrichs (2016) Autonomous Driving and Urban Land Use. Pp 213-224.	Decrease urban population by 25% (to suburban and beyond region)	Endless City: low density dispersal and fragmented settlement structure in suburbs and beyond	Heinrichs (2016) Autonomous Driving and Urban Land Use. Pp 213-224.

Anchor Point	Related External Force	Potential Impact
Advanced Automation and Technology	Real Estate Dynamics	Housing by Location

Book End 1	Rationale	Source	Bookend 2	Rationale	Source
Increase housing in urban centres by 10% from suburban areas	Hypermobile City: emphasis on shared AV transport, and the importance of populations being near goods and services.	Heinrichs (2016) Autonomous Driving and Urban Land Use. Pp 213-224.	Decrease urban housing by 25% (with remainder in suburban and rural areas within and beyond regional bounds)	Endless City: low density dispersal and fragmented settlement structure in suburbs and beyond	Heinrichs (2016) Autonomous Driving and Urban Land Use. Pp 213-224.

Anchor Point	Related External Force	Potential Impact
Climate Change	Natural Hazards and Climate Change (Flooding)	Land Availability

Book End 1	Rationale	Source	Bookend 2	Rationale	Source
Decrease of 54,700 ha as demonstrated in Coastal Flood Scenario Overview Map A	Coastal Flood Scenario A is a 1-in-500 year storm surge flood at current sea level with .6m allowance for uncertainties in site variation.	Fraser Basin Council (2016) Lower Mainland Flood Management Strategy Phase 1	Decrease of 99,300 ha as demonstrated in Fraser River Flood Scenarios Overview Map C	Coastal Flood Scenario C is based on 1894 flood of record with high tide conditions.	Fraser Basin Council (2016) Lower Mainland Flood Management Strategy Phase 1

Anchor Point	Related External Force	Potential Impact
Climate Change	Natural Hazards and Climate Change (Flooding)	Employment by Location

Book End 1	Rationale	Source	Bookend 2	Rationale	Source
Decrease of 54,700 ha as demonstrated in Coastal Flood Scenario Overview Map A.	Coastal Flood Scenario A is a 1-in-500 year storm surge flood at current sea level with .6m allowance for uncertainties in site variation. Redistribute employment from impacted area to rest of region.	Fraser Basin Council (2016) Lower Mainland Flood Management Strategy Phase 1	Decrease of 99,300 ha as demonstrated in Fraser River Flood Scenarios Overview Map C	Coastal Flood Scenario C is based on 1894 flood of record with high tide conditions. Redistribute employment from impacted area to rest of region.	Fraser Basin Council (2016) Lower Mainland Flood Management Strategy Phase 1

Anchor Point	Related External Force	Potential Impact
Climate Change	Natural Hazards and Climate Change (Flooding)	Population by Location

Book End 1	Rationale	Source	Bookend 2	Rationale	Source
Decrease of 54,700 ha as demonstrated in Coastal Flood Scenario Overview Map A.	Coastal Flood Scenario A is a 1-in-500 year storm surge flood at current sea level with .6m allowance for uncertainties in site variation. Redistribute residential population from impacted area to rest of region.	Fraser Basin Council (2016) Lower Mainland Flood Management Strategy Phase 1	Decrease of 99,300 ha as demonstrated in Fraser River Flood Scenarios Overview Map C	Coastal Flood Scenario C is based on 1894 flood of record with high tide conditions. Redistribute residential population from impacted area to rest of region.	Fraser Basin Council (2016) Lower Mainland Flood Management Strategy Phase 1

Anchor Point	Related External Force	Potential Impact
Climate Change	Natural Hazards and Climate Change (Heat & Drought)	Land Availability

Book End 1	Rationale	Source	Bookend 2	Rationale	Source
No change off baseline	No land availability changes anticipated due to drought and heatwaves in MV				

Anchor Point	Related External Force	Potential Impact
Climate Change	Natural Hazards and Climate Change (Heat & Drought)	Employment by Location

Book End 1	Rationale	Source	Bookend 2	Rationale	Source
Increase Sector 11 on agricultural lands by 15%	Increased (short-term) agricultural productivity in the region due to longer growing seasons and warmer climate	Metro Vancouver (2018) Climate 2050 Discussion Paper. p47	Decrease Sector 11 on agricultural lands by 15%	Rising average temperatures may introduce and exacerbate pest and disease problems.	Metro Vancouver (2018) Climate 2050 Discussion Paper. p47

Anchor Point	Related External Force	Potential Impact
Climate Change	Natural Hazards and Climate Change (Heat & Drought)	Population by Location

Book End 1	Rationale	Source	Bookend 2	Rationale	Source
No change off baseline	No land availability changes anticipated due to drought and heatwaves in MV				

Anchor Point	Related External Force	Potential Impact
Climate Change	Real Estate Market Dynamics	Employment by Location

Book End 1	Rationale	Source	Bookend 2	Rationale	Source
4m vertical setback from coastal and river areas for all sectors (aside from Sector 11). Redistribute across region.	Retreat from coastal and river areas for non-industrial, non-agricultural employment.	Fraser Basin Council (2016) Lower Mainland Flood Management Strategy Phase 1			

Anchor Point	Related External Force	Potential Impact
Climate Change	Real Estate Market Dynamics	Population by Location

Book End 1	Rationale	Source	Bookend 2	Rationale	Source
Decreased demand in Richmond, Delta, Pitt Meadows, Port Coquitlam.	Retreat from coastal and river areas as well as low-lying areas prone to liquefaction.	GeoMap Vancouver (1998) Geological Map of the Vancouver Metropolitan Area.			

Anchor Point	Related External Force	Potential Impact
Climate Change	Real Estate Market Dynamics	Housing by Location

Book End 1	Rationale	Source	Bookend 2	Rationale	Source
4m vertical setback from coastal and river areas for all residential zoned land.	Retreat from coastal and river areas for residential.	Fraser Basin Council (2016) Lower Mainland Flood Management Strategy Phase 1			

Anchor Point	Related External Force	Potential Impact
Trade and Economy	Global Outsourcing & Re-shoring	Employment by Industry (NAICS)

NAICS (2-digit codes)	Book End 1	Rationale	Source	Bookend 2	Rationale	Source
Sector 11: Agriculture, Forestry, Fishing Hunting	No change off baseline	Limited overlap between industry and global outsourcing and re-shoring				
Sector 21: Mining, Quarrying, and Oil and Gas Extraction	No change off baseline	Limited overlap between industry and global outsourcing and re-shoring				
Sector 22: Utilities	No change off baseline	Limited overlap between industry and global outsourcing and re-shoring				
Sector 23: Construction	No change off baseline	Construction jobs require workers present locally; bringing in foreign workers could be costly and require visa applications, which would be an unlikely path to follow.				

NAICS (2-digit codes)	Book End 1	Rationale	Source	Bookend 2	Rationale	Source
Sector 31-33: Manufacturing	Increase 10%	Protectionist policy and global relations may lead to re-shoring of manufacturing work that has been commonly outsourced in the past.	Deloitte (2015) The reshoring option: Maybe it's time	Decrease 30%	The flexibility and customization that 3D printing brings to manufacturing will make it easy for companies to maintain smaller, decentralized factories in different parts of the world.	Industry Today (2017) Centralized vs Decentralized Manufacturing. Vol 17 Issue 10 P28.
Sector 42-45: Wholesale and Retail Trade	Increase 10%	Focus on local suppliers to accelerate speed to market	KPMG (2017) The reshoring opportunity.	Decrease 10%	Outsource supply chain of production for cost savings. Online wholesale and retail limits local trade.	EY (2013) Retail Operations - Six success factors for a tough market. P8.
Sector 48-49: Transportation and Warehousing	No change off baseline	While outsourcing from company to company may occur for transport and warehousing, these will still largely need to exist within the region for delivery of goods and services.				
Sector 51: Information	Decrease 5%	There is limited outsourcing in the telecommunication industry though this is largely limited due to cybersecurity threats to national information and communication	CBC (2017) Spying, industrial espionage, and the arrest of Huawei's CFO (podcast)			

NAICS (2-digit codes)	Book End 1	Rationale	Source	Bookend 2	Rationale	Source
Sector 52: Finance and Insurance	Decrease 5%	Finance is a legacy function that is already being outsourced successfully for companies	Deloitte (2016) Deloitte's 201 6 Outsourcing Survey.	Decrease 20%	Finance is a legacy function that is already being outsourced successfully for companies	Deloitte (2016) Deloitte's 201 6 Outsourcing Survey.
Sector 53: Real Estate and Rental and Leasing	No change off baseline	Limited overlap between industry and global outsourcing and re-shoring				
Sector 54: Professional, Scientific, and Technical Services	Decrease 5%	Jobs that are labour-intensive, information based and can be routinized or coded, are at risk of being sent abroad	New York State Department of Labour (2010) The Offshore Outsourcing of Information Technology Jobs in New York State. Pg 13	Decrease 15%	Jobs that are labour-intensive, information based and can be routinized or coded, can be sent abroad	New York State Department of Labour (2010) The Offshore Outsourcing of Information Technology Jobs in New York State. Pg 13
Sector 55: Management of Companies and Enterprises	No change off baseline	Limited overlap between industry and global outsourcing and re-shoring				

NAICS (2-digit codes)	Book End 1	Rationale	Source	Bookend 2	Rationale	Source
Sector 56: Administrative and Support and Waste Management and Remediation Services	Decrease 10%	Admin and support is a legacy function that is already being outsourced successfully for companies	Deloitte (2016) Deloitte's 2016 Outsourcing Survey.			
Sector 61: Educational Services	No change off baseline	Limited overlap between industry and global outsourcing and re-shoring				
Sector 62: Health Care and Social Assistance	No change off baseline	Limited overlap between industry and global outsourcing and re-shoring				
Sector 71: Arts, Entertainment, and Recreation	No change off baseline	Limited overlap between industry and global outsourcing and re-shoring				

NAICS (2-digit codes)	Book End 1	Rationale	Source	Bookend 2	Rationale	Source
Sector 72: Accommodation and Food Services	No change off baseline	Limited overlap between industry and global outsourcing and re-shoring				
Sector 92: Public Administration	No change off baseline	Limited overlap between industry and global outsourcing and re-shoring				

Anchor Point	Related External Force	Potential Impact
Trade and Economy	Global Outsourcing & Re-shoring	Employment by Location

Book End 1	Rationale	Source	Bookend 2	Rationale	Source
Increase 5% 31-33, 51, 52, 54 in commercial, retail, light industrial zones	Re-shoring focus: a re-shoring effort due to local efficiencies and international trade uncertainty	KPMG (2017) The reshoring opportunity.	Decrease 10% 31-33, 51, 52, 54 in commercial, retail, light industrial zones	Outsourcing focus: a trend towards outsourcing functions that are commonly outsources by companies in present day.	Deloitte (2016) Deloitte's 201 6 Outsourcing Survey.

Anchor Point	Related External Force	Potential Impact
Trade and Economy	Real Estate Market Dynamics	Employment by Location

Book End 1	Rationale	Source	Bookend 2	Rationale	Source
Increase 5% 31-33, 51, 52, 54 in commercial, retail, light industrial zones	Re-shoring focus: a re-shoring effort due to local efficiencies and international trade uncertainty	KPMG (2017) The reshoring opportunity.	Decrease 10% 31-33, 51, 52, 54 in commercial, retail, light industrial zones	Outsourcing focus: a trend towards outsourcing functions that are commonly outsources by companies in present day.	Deloitte (2016) Deloitte's 201 6 Outsourcing Survey.

Anchor Point	Related External Force	Potential Impact
Trade and Economy	Real Estate Market Dynamics	Population by Location

Book End 1	Rationale	Source	Bookend 2	Rationale	Source
Redistribute population and increase by 10% in existing industrial zones,	Increased outsourcing may result in decreased industrial land needs; repurposing some of these buildings and sites for residential is something that is being seen in other parts of the world	Megusoglu & Boyacioglu (2013) Reuse of industrial built heritage for residential purposes in Manchester.	Increase population 5% across the Region	A reshoring effort could result in substantial employment opportunities, and an increase in population matching these jobs.	Reshoring Initiative (2017) Reshoring initiative 2017 Data Report

Anchor Point	Related External Force	Potential Impact
Trade and Economy	Real Estate Market Dynamics	Housing by Location

Book End 1	Rationale	Source	Bookend 2	Rationale	Source
No change off baseline	Limited impact on housing location demand due to movement in outsourcing and/or re-shoring.				