Costs, Benefits and Risks of Growth:
Region of Peel

An exercise in regional socio-economic risk management

Research Report
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CANADIAN CENTRE FOR ECONOMIC ANALYSIS

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About This Report

In keeping with Canadian Centre for Economic Analysis's guidelines for funded research, the design and method of research, as well as the content of this study, were determined solely by the Canadian Centre for Economic Analysis. The research was conducted by the Centre.

Statistics Canada data, data obtained from the Region of Peel, and relevant literature was used to inform the computer simulation models used to produce the results of this report. All quantitative methods used are documented herewith.

The interpretation and reporting of the results of the mathematical modelling contained within this report do not necessarily represent policy position or the opinion of the Region of Peel.

Forecasts and research often involve numerous assumptions and data sources, and are subject to inherent risks and uncertainties. This information is not intended as specific investment, accounting, legal, or tax advice.

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PREFACE

The Region of Peel, having experienced robust growth in previous decades, is currently home to over 1.4 million residents and 88,000 businesses. The Region of Peel, comprising Mississauga, Brampton, and Caledon, is expected to continue to experience rapid growth into the decades to come and must carefully plan its investments today in order to chart the trajectory of its development into an increasingly vibrant and prosperous economy. Planning to accommodate significant growth within the Region, however, is a complex task that must be approached with appreciation not only for its objectives for the future; Peel's current socio-demographic, economic, and geographic characteristics—along with the relationship between Peel and its surrounding areas—form the foundation on which Peel will build, develop, and grow.

The Region of Peel is planning and investing to sustain a projected population growth of 41% by 2041. If this population growth is accommodated with appropriate investments in infrastructure today, Peel can expect to reap significant rewards by 2041, such as an increase of 35% in the number of its employed residents, and a 47%

KEY PEEL RESULTS:

BETWEEN 2014 AND 2041

- Regional population expected to grow by 41%
- Number of employed residents of Peel expected to grow by 35%
- Jobs in Peel at risk of growing only 23%
- Provincial and federal tax revenues increase by 62% and 68% respectively
- If Peel plans and services growth according to Places to Grow expectations, overcapitalization on employment lands may leave Peel with over $2 billion in stranded debt

increase in its real, annual regional GDP. The province and the federal government will benefit with respective real, annual tax revenue increases of over 60%. However, Peel's strategic planning must take into consideration the costs associated with sustaining such strong growth, and must acknowledge the risks posed to the process by dependencies in relation to internal and external policies, the national and international macroeconomic climate, and even the planning process itself, particularly the projections to which Peel must plan, which may leave Peel with an inability to pay for its growth.

In addition, Peel must acknowledge the fiscal tools to which it has access and how they allow Peel to stimulate and benefit from growth. Because the region cannot tax consumption, production, or income unlike the provincial and federal orders of government, it relies upon some growth to fund all other types of growth. In relying upon revenue tools such as user fees, property taxes, development charges, and utilities, the region has limited ability to ensure that the revenues it generates equitably correspond to the economic capacity of residents and other non-resident participants in Peel's economy to pay. This lack of correspondence of regional fiscal tools to other measures of economic growth, such as increases in income, allows for misalignment between Peel's revenue streams and the prosperity of the region.

Similarly, on the supply side, these tools must also take into consideration the differential costs associated with developing different service areas. In order to fairly price development, growth in desired areas must be incentivized by means of market-driven forces rather than legislated boundaries. For example, if development charges are uniform across the region, as opposed to varying in price across locations, then there are no economic incentives for growth to manifest as intensification rather than as urban sprawl. If low-density areas are developed at the expense of high-density areas, then growth may cost the region more than it would if development was oriented to more efficient use of existing infrastructure.

In order for Peel to plan for its population to grow according to the projections legislated through the Places to Grow Act, which expects that Peel will have a population of over 1.97 million people by 2041, it must incrementally invest in infrastructure as it continues to support its current population. Peel plans for this through its capital and operational budgets, which features investment schedules that are aligned to Places to Grow population projections. Therefore, in order to accrue the benefits of growth, Peel must incur the associated costs as well. Furthermore, the dependencies that Peel faces both within its own economy and in its relationships to the economies of surrounding areas and the province pose systematic risks to the ability of Peel to achieve the benefits of growth. Managing these risks in relation to the costs and benefits begins with identifying and quantifying them. In order to quantify the costs, benefits, and risks of growth, the economy of Peel and its surrounding regions must be modeled as an interconnected system.

ANALYSIS

In order to determine and analyze the benefits, costs, and risks associated with growth, the Region of Peel has sought the use of the Canadian Centre for Economic Analysis's *Prosperity at Risk* simulation platform. Because the Region of Peel must simultaneously manage and balance its development across multiple, interconnected avenues, including the continued provision of diverse resident services alongside the support of its economic growth, a holistic approach to planning must be undertaken. For this reason, agent-based modeling was employed. Agent-based modeling animates individual agents—comprising businesses, governments, people, and others—using empirically informed behavioural heuristics, historical data, and complete financial accounting against geographic locations in one country-wide consistent model.

Any decision must be made in the context of its impacts on the entirety of the system. Without a holistic appraisal of the complete profile of risks and benefits associated with planning decisions, traditional economic analysis, no matter how accurate, will only capture a fraction of the consequences. A failure to appreciate the complex interdependencies between agents and their environments will generate results that may be inaccurate over the long term, and fail to capture the true value of these connections. Central to overcoming this issue is the understanding that the economy and society are one complete system that must be understood relative to that cohesion. In order to fully understand, therefore, the effects and dependencies of planning decisions on the whole system over time, it is paramount that the analysis emerges from an internally consistent model.

RESULTS AT A GLANCE

Costs of Growth

The population of the Region of Peel is expected to grow by 41% between 2014 and 2041. In order to sustain this population growth, the Region of Peel must increase its operational budget and invest in capital accumulation, financing its expenditures through taxes, utilities, development charge revenues, and other sources, such as user fees and external grants. **If Peel grows according to these projections, it can expect $71 million in outstanding DC debt by 2041, and no DC debt by 2042, and requires the following increases in the various components of its budget as a result of growth only**:

Figure 1   Cumulative Operational and Capital Costs of Growth[1]

$21B Increase in Total Operating Budget
Cumulative from 2014 to 2041

Tax Supported Operating Budget

$3,100
per new resident per annum

$16.8B
total in real terms

Utilities supported Operating Budget
$770
per new resident per annum
$4.2B in total

$16.1B Invested through Total Capital Budget
Cumulative from 2014 to 2041

DC Supported Capital Budget

$5.6B
in total

Transportation $1.9B

Waterworks $1.9B

Wastewater $1.6B

Other $3.6M

Tax Supported Capital Budget
$950
per new resident per annum

$5.2B
In total

Utility Supported Capital Budget
$950
per new resident per annum

$5.2B
in total

Including

SOGR $0.55B

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[1] Operational costs of growth is the sum of the annual excess of the 2014 levels, cumulative over the period 2014 to 2041. SOGR represents estimate of expenditure for new capital build in 2014 and later, only. All sums in Figure 1 represent the budgetary increases as a result of growth only, and excludes budgetary allocations to sustaining the current population levels.

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Benefits of Growth

Providing adequate and appropriate infrastructure generates systematic benefits throughout the provincial economy. It provides Peel with the framework that is conducive to growth, as opportunities for development are discovered by individuals and businesses alike. If growth occurs according to expectations, then revenue streams from development charges will exonerate Peel from capital debt over the course of decades. The development of infrastructure creates jobs through direct, indirect, induced, and system impacts, which leads to additional purchasing power for residents of Peel and Ontario. Private capital further strengthens the positive impacts, stimulating additional economic activity. The federal and provincial orders of government receive additional tax revenue as a result of that economic activity, as well. Table 1 outlines the cumulative benefits attributable to growth from 2014 to 2041, for Peel, as well as the percent changes in annual levels between 2014 and 2041.

Table 1   Benefits of Growth: Peel (in Real, 2014 dollars)

	Economic Indicator		Cumulative Benefit of Growth	Percent Change from 2014 to 2041
If Peel Grows According to Current Expectations	Population	+569,400	Grows from 1.40M to 1.97M, 390,000 more Peel residents aged 60 and younger relative to no growth	41%
	Regional GDP	+$176.3B	Total growth in Peel economy 15% higher than no growth. For every dollar in regional GDP due to growth in Peel, Ontario's GDP increases by $1.63 (inclusive of Peel)	47%
	Employed Residents	+216,200	For every new employed resident in Peel, Ontario gains 1.65 employed residents (inclusive of Peel)	35%
	Jobs in Region	+127,300	For every job created in Peel, 2 are created in Ontario (inclusive of Peel)	23%
	Private Non-Residential Capital Investment	+$46.3B	Grows from $7.8B in 2014 to $14.7B in 2041. $363,700 of private capital per new Peel job.	87%
	Private Residential Capital Investment	+$10.4B	Grows from $4.3B in 2014 to $6.0B in 2041. $18,300 of private residential capital per new Peel resident.	40%
	Federal Tax Revenue Generated	+$31.5B	For every dollar of municipal revenue (operating and DC) in Peel due to growth, Federal revenue increases by $6.22	68%
	Provincial Tax Revenue Generated	+$28.6B	For every dollar of municipal revenue (operating and DC) in Peel due to growth, Provincial revenue increases by $5.70	62%

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Risks of Growth

Prosperity at Risk (*PaR*) simulations of the GTAH had found that evidenced-based job growth expectations across several municipalities could not support Places to Grow reported planning projections. For Peel, the *PaR* and Places to Grow divergence grows to over 171,000 fewer jobs by 2041. If Peel planned and serviced to Places to Grow numbers and such a measured overestimate of job growth were to materialize, Peel would be at risk of carrying over $2 billion in stranded debt by 2041. Such a risk would eventually be passed onto Peel residents and businesses, unnecessarily reducing Peel's socio-economic affordability.

Aside from the internal planning risks associating with servicing growth that may not occur, the Region of Peel experiences significant external risks to its growth as a result of the policies and investment participation of the provincial and federal orders of government. In order for the GTAH to realize its projected growth potential by 2041, the approach to its socio-economic prosperity must be framed like a "neighbourhood watch" process. That is to say, growth in Peel will not manifest without like-minded co-ordination, planning, asset investment and economic development across the GTAH, which must be spearheaded by the provincial government. Therefore, the ability of the provincial government to enact public policy that promotes co-ordinated socio-economic planning and development poses another key risk to Peel's sustainable growth. This includes the appropriate participation of the provincial and federal orders of government in infrastructure investment. Intergovernmental funding and planning co-ordination do not have a history of promoting sustainable growth and equitable distributions of risks and rewards (Smetanin, Stiff, & Kobak, 2014). Therefore, the risks to sustainable regional growth that are associated with co-ordinated planning across multiple regions and orders of government cannot be ignored.

From 2014 to 2041, Peel is expected to invest $16 billion in capital, of which 35% is in direct response to growth. Over that time, to encourage sustainable growth:

- The province will need invest $55 billion in (or around) Peel, of which $4.2 billion is directly due to Peel's growth, $38.7 billion is invested in asset replacement and other GTAH growth that depends upon Peel, and $12 billion is invested in maintenance.
- The federal government should invest $23 billion in (or around) Peel, of which $1.8 billion is directly due to Peel's growth, $15.9 billion is due to federal assets in Peel and other GTAH growth, and $5 billion is invested in maintenance.

Hence, for every real $1 invested in public capital by Region of Peel for growth:

- Ontario needs to invest $7.65 in (or around) Peel for Peel & GTAH growth in addition to maintaining current assets, and
- The federal government needs to invest $3.16 in (or around) Peel for Peel & GTAH growth in addition to maintaining current assets

Despite these shares of infrastructure investment that allow for sustainable growth, past studies have highlighted that current federal government policies surrounding the contribution to infrastructure investment puts Ontario infrastructure funding and co-ordination at risk (Smetanin, Stiff, & Kobak, 2014).

Currently, the federal government supports approximately 12% of the infrastructure funding in Ontario, whereas *PaR* socio-economic simulations suggest a more sustainable policy of a 39% funding contribution. This means that the federal government investment has a shortfall of $7.2B annually (over the next 10 years in constant dollars), which creates risk to the provincial government's plans for much-needed public infrastructure investment. In fact, the current status quo places the Ontario government in the precarious situation of not earning a sustainable rate of return on its infrastructure investments. This fiscal pressure, in turn, creates additional challenges to the ability of the provincial government to engage with Peel's growth policies in a sustainable fashion.

Peel's other risks to growth also arise from the interdependencies within the region, and between the region and the province and country. Central to the risks associated with growth is uncertainty regarding future increases in the population, and therefore the ability of Peel to attract growth to protect the strength of its labour force, its economy, and its financial health because debt must be incurred in anticipation of growth in order to fund it. Table 2 below summarizes some of the risks associated with growth in the Region of Peel. Table 3 summarizes the participation from government and industry that Peel needs to attain its growth objectives.

Table 2   Risks to Growth: Peel

Risk		Economic Impact of Risk
Defunding Waterworks Infrastructure	Waterworks defunded by $1.90B	141,700 (18%) fewer jobs in Peel in 2041. 59,300 (7%) fewer employed residents of Peel in 2041. Peel economic activity lower by 21% by 2041. For every dollar in municipal revenue lost as a result of defunding waterworks, provincial government loses $2.90 and federal government loses $2.27.
Defunding Wastewater Infrastructure	Wastewater defunded by $1.56B	92,500 (12%) fewer jobs in Peel in 2041. 34,900 (4%) fewer employed residents of Peel in 2041. Peel economic activity lower by 14% in 2041. For every dollar in municipal revenue lost as a result of defunding wastewater, provincial government loses $2.39 and federal government loses $1.99.
Defunding Transportation Infrastructure	Transportation defunded by $1.94B	55,800 (7%) fewer jobs in Peel in 2041. 40,600 (5%) fewer employed residents of Peel in 2041. Peel economic activity lower by 8% in 2041. For every dollar in municipal revenue lost as a result of defunding transportation, provincial government loses $1.77 and federal government loses $1.41.
Tax Rates	Increase by 10%	21,700 (3%) fewer jobs in Peel in 2041. Peel economic activity lower by 3% by 2041. This represents approximately the same GDP impact as increasing interest rates by 2.5% above current rates.
National Immigration	Decrease by 10%	15,100 (2%) fewer jobs in Peel in 2041. Peel economic activity lower by 2% by 2041.
Imports	Increase by 10%	48,700 (6%) fewer jobs in Peel in 2041. Peel economic activity lower by 5% by 2041.
Exports	Decrease by 10%	55,900 (7%) fewer jobs in Peel in 2041. Peel economic activity lower by 6% by 2041.
Places to Grow Projections	Job projections overestimate by 171,000 jobs	Over $2B in stranded debt by 2041 as a result of overcapitalization on employment lands

Risks to Growth in Peel

Table 3   Investment Dependencies Associated with Peel's Growth

	Risk		Investment needed
Other Dependency Risks to Growth in Peel	Provincial Capital Investment	$55B in or near Peel	For every dollar invested by Peel in capital, provincial government should invest $7.65 in or near Peel
	Federal Capital Investment	$22.7B in or near Peel	For every dollar invested by Peel in capital, the federal government should invest $3.16 in or near Peel
	Residential Private Capital Investment	$139B	For every dollar invested by Peel in capital to sustain growth, $6.18 is needed in residential private capital investment
	Non-residential Private Capital Investment	$305B	For every dollar invested by Peel in capital to sustain growth, $13.53 is needed in non-residential private capital investment
	Private Capital Investment Industry Mix	Mix of Industries needed	Attracting only transportation and warehousing, only retail, or only office space capital investment has negative implications for Peel's GDP. A portfolio mix of industry sectors' private capital investment should be encouraged.

CONCLUSIONS

The Region of Peel must engage in extensive planning in order to achieve the growth stipulated in it growth plans and to which its capital budget is aligned. The interconnected analysis revealed that Peel's alignment to Places to Grow population projections can lead to significant economic benefits and will support Peel in its objectives to develop in a fiscally responsible and sustainable fashion. However, the process of development is not without its risks to the region. Peel is reliant upon surrounding regions, the provincial and federal government, and the accuracy of its job projections to ensure that it is able to sustain growth. Risks to Peel's growth include its ability to attract private capital investment from an appropriate mix of industry sectors, the policy and regulatory frameworks that are imposed by other orders of government. In addition, Peel's development hinges on the participation of surrounding regions in growth-oriented investment in order to ensure population growth is attracted to the regions in the Greater Golden Horseshoe in proportion to their capacity to accommodate them. Furthermore, inherent risks exist with population projections, as well. If growth does not occur, Peel faces increasing debt and will struggle to maintain fiscal sustainability. The process of development is therefore a complicated task of anticipating costs and benefits while also quantifying and managing risk.

1.0 INTRODUCTION

1.1.1 PEEL AND REGION OF PEEL

The second largest regional municipality in Ontario after Toronto, the Region of Peel, encompasses the area municipalities of Mississauga, Brampton, and Caledon and is situated in the inner ring of the Greater Golden Horseshoe. In 2014, the population of Peel region grew to approximately 1.4 million people. Along with the rest of the GTA, provincial population projections expect Peel to grow faster than the Ontario average over the next several decades (Ontario Ministry of Finance, 2014). The Region of Peel hosts over 88,000 businesses (Region of Peel, 2014).

Mississauga, the southernmost and highly urban city within Peel, is home to approximately 760,000 individuals (Peel Data Centre, 2014). As Mississauga approaches its build-out, it strategically outlined its development trajectory such that urban sprawl can be minimized, intensification is purposeful, and the continued provision of green spaces is respected (City of Mississauga, 2013).

Over half of Peel's population is centered in Mississauga (Peel Data Centre, 2012), but Brampton's recent and projected growth, coupled with its strategic location in terms of its transportation links and industrial diversity, are expected to place particular upward pressure on the demand for infrastructure so that it can sustain its development (Campbell, Reuter, & Epp, 2012). Brampton's current population is approximately 600,000 people (Peel Data Centre, 2014).

Caledon, with approximately 65,000 residents (Peel Data Centre, 2014), is the northernmost of the three cities in the Region of Peel and has maintained its rural heritage amid surrounding urbanization, and has planned for its growth to occur within the Mayfield West, Bolton, and Caledon East areas (Town of Caledon, 2014).

The challenges related to growth within Peel are as diverse as its constituent cities. The slowed economic activity resulting from the 2008 recession has created a climate demanding additional support services against a backdrop of more volatile revenue streams for the municipality (Region of Peel, 2014). Changing demographic profiles, such as Peel's aging population and other emergent health-related issues necessitate careful consideration of the types of services and programs that will be required to adequately serve residents. Peel's infrastructure is aging as well, creating budgetary and service planning challenges in corridors and urban areas where the growth plan for the Greater Golden Horseshoe calls for intensification (Ministry of Public Infrastructure Renewal, 2006). Decision makers therefore must take into consideration not only the complex and interconnected demand pressures that face the region today and in the future, but also the strategies with which Mississauga, Brampton, and Caledon uniquely plan to satisfy the needs of their residents.

Places to Grow

The Places to Grow Act, created in 2005, was designed to assist regions in developing strategic growth plans that guide decision making. (Ministry of Municipal Affairs and Housing, 2013). In particular, its aims are to ensure that (Places to Grow Act, 2005, 2005):

- Existing resources are appropriately leveraged for current and future populations
- The environment is given consideration and conserved
- Communities' values are sustained, and communities are able to offer the necessary amenities to support a high quality of life as demand pressures change
- Growth is integrated across regions, and policies governing growth are co-ordinated

The Places to Grow Act is focused on guiding growth to areas that will promote the creation of jobs, the attraction of investment, and the preservation of the natural environment of the Greater Golden Horseshoe Area as well as Northern Ontario, respectively (Ministry of Municipal Affairs and Housing, 2013). The Act legislates that each area that is designated to accommodate growth must have an associated growth plan, which is to be prepared by an executive municipal council position, such as a Minister of Infrastructure (Places to Grow Act, 2005, 2005). Once a growth plan is approved, the respective region is required to use it to guide its decisions and planning. The growth plans contain policies for allocating the supply of land across various usage types, managing resources, capital spending, planning areas for intensification, and other objectives for the corresponding area.

The growth plan for the Greater Golden Horseshoe Area stipulates population projections for multiple regions, including Peel; Places to Grow projections estimate that Peel's population will grow by 23,650 people each year until 2041 (Region of Peel, 2014). These additional individuals are to be accommodated in the following specific ways, according to the growth plan for the Greater Golden Horseshoe (Ministry of Public Infrastructure Renewal, 2006):

- Designated build-up areas will be intensified such that significant portions of residential and employment development will occur within these areas (particularly within urban growth centres, intensification corridors, and major transit station areas)
- Development will follow a principle of mixed land use, combining residential and employment lands in a way that transit services are supported, walking and pedestrian activity are encouraged, and access to major roadways is supported
- Urban growth centres are linked through transportation networks, acting as hubs for employment, service provision, transit, recreation and other focal community organizations
- Designated greenfield areas will accommodate new development featuring mixed land use, support for multi-modal (including non-vehicular) transport, and minimum density levels, with continued respect for the natural environment

In order to adequately plan for the growth anticipated by the projections, continue to serve the existing population, and promote community and environmental values, Peel must navigate its path from serving the needs of the current population to accommodating the needs of its population decades in the future.

This necessitates a comprehensive understanding of the costs and benefits associated with growth in Peel and the current and projected social and economic conditions within the region. In addition, both internal and external risks to the region must be identified, quantified, and managed effectively.

1.1.2 GENERAL APPROACH

Municipalities must consider multi-layer strategies in order to address diverse priority areas, including responding to resident needs, ensuring financial sustainability with respect to capital investment and operational expenses, and providing adequate and appropriate services. Planning must also anticipate future needs and conform to the legislative directions outlined by regulations and acts outlining growth directives, such as Places to Grow.

In order to address the challenges facing the Region of Peel and plan effectively, an integrated approach must be undertaken to:

- Identify what capital and other investments must be made today in order to support future populations;
- Continue to provide adequate and appropriate services to residents;
- Quantify the costs and benefits associated with the projected growth in Peel;
- Capture unforeseen consequences of budgetary allocations;
- Understand the risks faced by the region, which may impact future costs and benefits to the region resulting from actions taken today; and
- Promote sustainability by understanding the dynamics of risk and reward sharing among stakeholders.

In order to address these objectives in a comprehensive fashion, one integrated approach is employed. *Prosperity at Risk* (*PaR*), is an agent-based model that allows for flexibility and captures effects that are not traditionally measured by disjoint economic models. Agent-based modeling, the conceptual framework underlying *PaR*, allows for the following features:

- Fewer *a priori* assumptions, with flexibility in the choice of the assumptions that guide the model;
- Historical evidence replaces theoretical approximations;
- Agents act based on historical behaviour as they compete for scarce resources, creating evidence-based, realistic constraints and boundaries on economic outcomes, which are not always achieved by traditional differential equations;
- Agent heuristics drive the ways in which agents respond to circumstances, allowing for the simulation of adaptability to a dynamic environment;
- Macro-level aggregates are derived from micro-level behaviours, which are informed by heuristics rather than imposed conditions;
- All flows of individuals, money, and goods are entirely accounted for within the model such that:
  - Consumption of goods corresponds to agent incomes
  - Inter-regional migration of individuals is endogenous to the model, whereby the movement of people is consistently accounted for
  - The supply and demand for labour, governed by a labour force model and microeconomic choices related to work
  - All financial transactions register on the balance sheets of all parties involved, so that no asset is created without a corresponding liability

PaR can track over 50 million individual agents for all of Canada, with 1.2 billion attributes for them, spanning across more than 4,000 municipalities in Canada. Agents comprise all entities that are able to make decisions, engage in behaviours, and act, including individual people, non-profit organizations, government institutions, firms, and others. Behaviours in which agents can engage include borrowing, consumption, migration, importing and exporting, choosing to work and hire labour. Agents also each have complete financial statements, including balance sheets that reflect comprehensive financial states and impact their capacities to borrow, consume, and produce.

In the simulation process, *PaR* perceives not only the residents of Peel as agents; the Region of Peel government is an agent, as well. Therefore, *PaR* also simulates over 75 accounts corresponding to the Region of Peel government, modeling the financial transactions that occur both internally and as Peel interacts with neighbouring regions, the rest of the country, and the world. Informed by budgetary documents, the master plans, and other strategic directives that apply to the region, *PaR* appreciates the geographic attributes of Peel alongside its unique characteristics relative to other regions in Canada. Because agent-based modeling does not impose artificial constraints on the system, it allows the dynamics of individual interactions to show how the country adapts to a given scenario over time. Combining complete financial accounting for all of Peel's accounts with demographic modeling and high-resolution

geographic mapping, *PaR* is able to simulate Peel into the future on the basis of its decisions today, while quantifying:

- The various internal and external risks threatening Peel's ability to grow sustainably;
- The costs associated with ensuring that Peel will be able to serve its stakeholders into the future, their sources, and who bears them; and
- The magnitudes, types, and the recipients of the benefits of Peel's growth.

1.1.3 STRUCTURE OF REPORT

This report is structured as follows. In Section 2.0 Baselines and Costs of Growth, the current budget and the financial processes underlying Peel's service provision are outlined. These will be accompanied by projections for the budget up to 2041, coupled with demographic and employment projections. Section 3.0 outlines the benefits and prosperity measures associated with sustainable growth, including the jobs created, the number of residents of Peel that are employed, fiscal revenues, private capital investment generated, and GDP stimulated. This is followed by Section 4.0 Risks of Growth, which discusses the market and policy dependencies facing the Region of Peel that will pose varying degrees of risk to the region, including economic outcomes expected if baseline projections are not achieved.

2.0 BASELINES AND COSTS OF GROWTH

2.1 ANNUAL BUDGET AND BASELINES

2.1.1 ANNUAL BUDGET

The annual budget captures all of the expected expenditures associated with operations, capital maintenance and capital investment. The annual budget also outlines all of revenue sources that are expected to fund the respective capital and operations expenditures.

The annual budget can be broken down into four components:

- Tax-Supported Operations Budget
- Utility-Supported Operations Budget
- Tax-Supported Capital Budget
- Utility-Supported Capital Budget

The tax and utility supported capital budget can further be split into:

- Capital Reserve (Tax and Utility supported) Supported Capital Budget
- Development Charges (DC) Supported Capital Budget

2.1.1.1 TAX-SUPPORTED OPERATIONAL BUDGET

The tax-supported operational budget reflects costs associated with regionally-controlled programs offered by the region, which deliver an array of services to the residents (Region of Peel, 2014). Of the total tax-supported operational budget, approximately 59% is funded through property taxes, while other portions are funded by non-property tax revenues, including external grants, subsidies, and user fees (Region of Peel, 2014). These regionally-controlled programs include:

- Transportation
- Roads and traffic
- Waste management
- Community health services
- Social programs, including housing
- Development services, including early learning and childcare
- Environmental and cultural services

In addition, Peel also finances a number of external organizations through the tax levy, such as:

- Policing and 911 (including regional police and OPP)
- Conservation authorities
- Other services such as property assessment

Operational costs for the programs are driven by several external risk parameters, such as volatility in the costs of intermediate goods and services required to deliver regional services. This includes, for instance, the price of gasoline, materials, or fees, as well as other costs that the region does not control. An increase in the operational costs of any of the programs will result in an increase in the tax rates for residents of Peel and businesses within the budget year.

2.1.1.2 UTILITY-SUPPORTED OPERATIONAL BUDGET

The utility-supported operational budget is allocated to deliver water and wastewater services to residents and businesses operating in Peel. It lists all costs associated with the operational expenditures of regionally controlled water and wastewater programs. Utility supported operational budget extends to service provision in parts of York Region, the costs for which are entirely covered by York Region. Although the majority of the costs associated with these programs are funded through regional utility revenues, other funds are recovered externally. An increase in the operational costs for must be recovered through increased utility rates within the same budget year.

2.1.1.3 TAX-SUPPORTED CAPITAL BUDGET

The tax-supported capital budget covers the costs of programs associated with capital improvement expenditures that benefit the existing population, including state of good repair investments and any new infrastructure build to support the existing population. The funding for these projects is drawn from a tax supported reserve fund. The remainder of the financing is drawn from capital reserves, development charge (DC) reserve funds, and external sources. Capital reserves support the maintenance schedule through state of good repair (SOGR) expenditures. If the reserve fund is insufficient to cover the necessary expenditures, then tax levy increases and the interest that is earned on the reserve fund are used to supplement it.

Currently, the fund supports capital expenditures in:

- Road improvements and maintenance
- Social programs, including housing and shelters
- Healthcare, including paramedic services and public health
- Police, including infrastructure and facilities that complement police services
- Other programs, including children's services and TransHelp

2.1.1.4 UTILITY-SUPPORTED CAPITAL BUDGET

The utility-supported capital budget covers costs associated with water and wastewater capital improvement expenditures which benefit the existing population, as well as investments that support public works operations. This includes SOGR investments as well as the construction of new infrastructure that supports the existing population. These investments are financed using a utility-supported capital reserve fund, which is maintained to conform to 20-year projections for capital expenditure levels. If actual capital expenditure levels are greater than the projected levels, then the reserve fund is replenished

through increases in the tax levy and interest rates that are earned on the fund. The utility-supported capital budget is financed by the capital reserves.

2.1.1.5   DEVELOPMENT CHARGE SUPPORTED CAPITAL BUDGET

The portion of the capital budget supported by development charge revenues covers the costs associated with the capital improvement expenditures for the purpose of accommodating expected growth. Such expenditures are funded through debt issuance in anticipation of the growth. The debt is financed through tax and utility capital reserve funds, which are largely supported by taxes and utilities paid by residents and are maintained at 10-year capital expenditure levels. If these funds are insufficient to cover expenses, tax levies and the interest that is earned on the invested reserve fund are used to replenish them. Once growth occurs and development takes place, the funding is recovered through development charges. Interest payments on the debt issued are also funded through development charges.

2.1.1.6   RESERVES

In order for the municipality to fund the required capital investments and repairs, it must maintain the following cash reserves:

- **Tax-Supported Capital Reserves**: These are cash reserves that are equivalent to the projected 10-year equivalent costs of maintenance and new projects, which benefit the existing population only. The reserve does not pay for capital investments or maintenance to water and wastewater infrastructure.

- **Utility Supported Cash Reserves**: These are cash reserves equivalent to the projected 20-year equivalent costs of maintenance and new water and wastewater projects, which benefit the existing populations only.

- **Development Charge Reserves**: These cash reserves are financed through debt and repaid through the collection of future development charges. The fund is used to finance capital investments that support population growth.

The tax and utility supported capital reserves, whose primary purpose is to fund future capital expenditures, are financed through tax levies and utility rates. They can be used directly to fund capital expenditures that are aimed at supporting the existing population, or they can finance capital expenditures through debt, which supports population growth. That debt is repaid when development charges are collected. The interest earned on the debt is placed back into the reserve fund, while the principal is placed in a sinking fund that is reinvested at low risk. The sinking fund is used to repay the debt balance, usually as a lump payment at the end of each debt issuance period. However, in the event that income from development charges is lower than was expected, the gap must reconciled through increases in the tax and utility rates.

2.1.2 BASELINES

In order to analyze the costs, risks, and benefits of investments to a region, it is paramount to contextualize outcomes to the mix of infrastructure, plans, policy frameworks, economy, and other aspects of the socio-demographic and physical topography specific to the region in which the investments are to occur. Baseline projections are used to construct that context and therefore serve as a foundation for setting expectations regarding the future. In this way, a baseline projection illustrates what the Region of Peel can expect given historical trends, current plans, and empirically known information.

Once the baseline is generated, additional scenarios can be projected for comparison. In the additional scenarios, various parameters can be changed, including parameters that are within the control of the Region, such as how much is invested in infrastructure, and parameters that are not entirely controlled by the Region, such as how much immigration is expected to occur. The impact of a given scenario can therefore be quantified by the difference between the baseline outcomes and that scenario's outcomes.

The Region of Peel is planning to accommodate the population growth stipulated through Places to Grow, and has planned their capital expenditure levels up to 10 years in the future, after which the budget is subject to revision and approval. The baselines discussed in the following sections align with the existing expectations of the region with respect to population growth and council-approved budget projections, using municipal planning forecast data. In addition, the model was parameterized using the operational dynamics of the long-term financial model (LFTM). Therefore, the baselines include the needs of the current population and the expected growth, as well as the budgetary projections that conform to those expected needs.

2.2 REGIONAL DEMOGRAPHIC BASELINES

2.2.1 POPULATION BASELINES

Population projections are used to inform multiple facets of the budget, especially the capital budgets, which are planned to serve future residents and accommodate growth, and operating budget projections, which must meet the annual needs of residents as they grow in number. Population projections also impact job projections, which are then used in tandem to project development charge revenues. As the Region of Peel plans its budgets to council-approved growth plans, which are based on Places to Grow projections, all projections of the budget and the population within the region of Peel have been calibrated to align with these expectations. Figure 2 below demonstrates the conformity between *PaR* and Places to Grow (P2G).

Figure 2   Population Projections for Peel: PaR and P2G
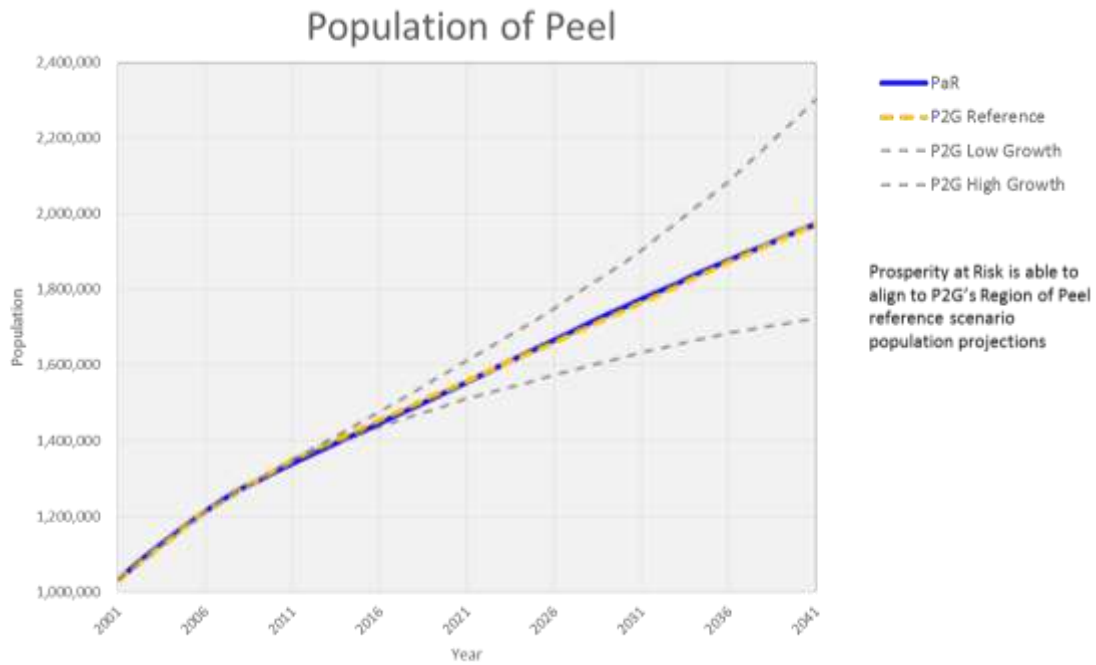
The population of Peel is expected to increase by 41% between 2014 and 2041, or by approximately 569,000 individuals. The GTAH overall is expected to grow by approximately 40% as well over the same time period. The population growth of the GTAH and the Region of Peel respectively is illustrated in Figure 3 below.

Figure 3   Population Projections: Peel and GTAH
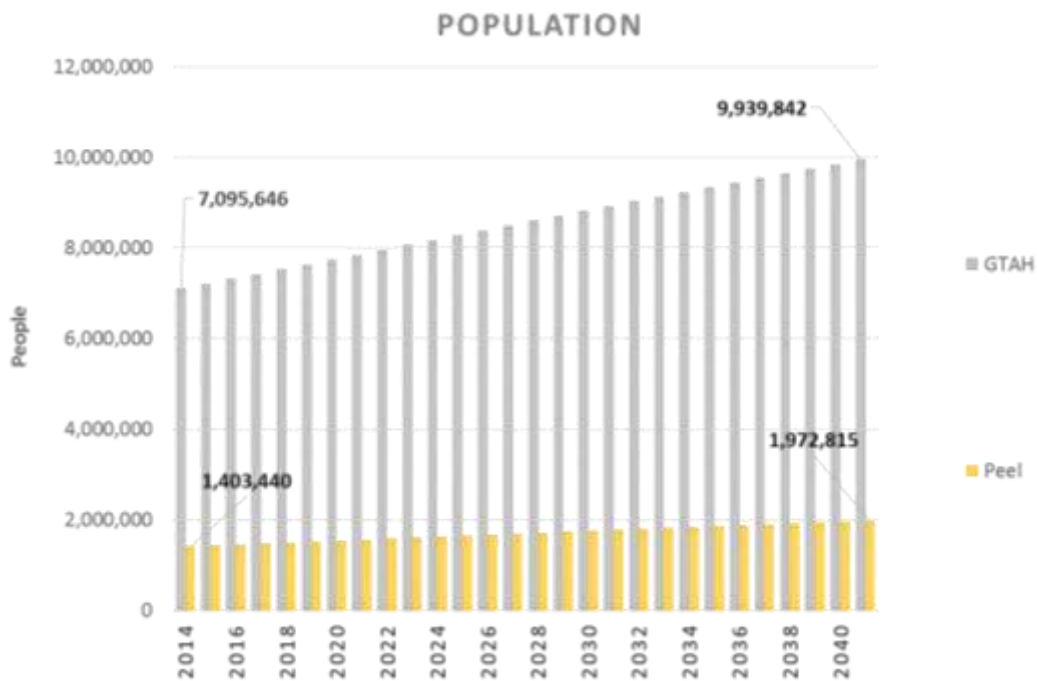
In fact, similar trends can be observed in terms of population growth rate for Canada, Ontario, the GTAH and Peel, with the greatest amount of growth being observed in the near future and with diminishing (albeit persistently positive) growth rates over time. Figure 4 below demonstrates the expected rates of change in the population of these respective regions.

Figure 4   Population Rates of Change: Canada, Ontario, GTAH, Peel
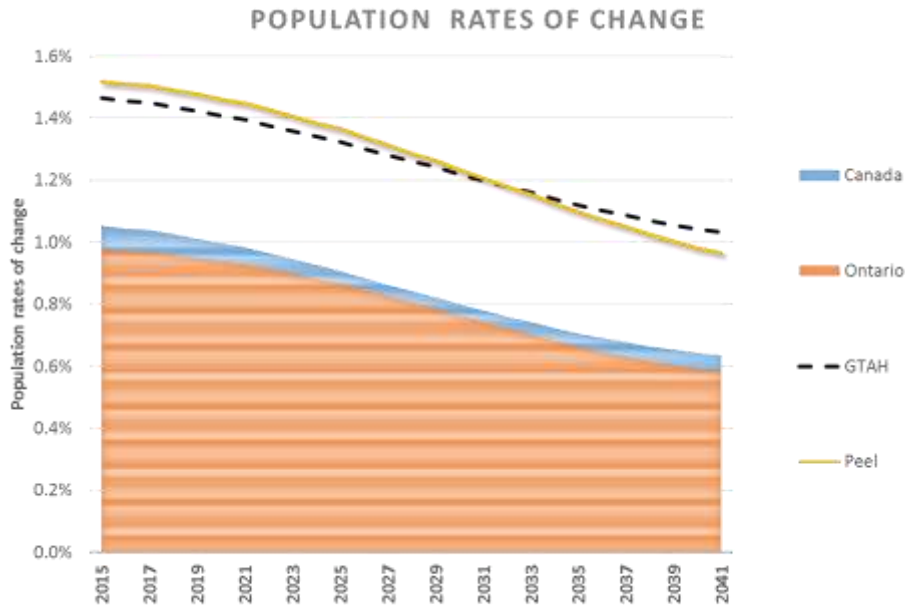
Along with growth in the overall population, the age distribution of Peel's population is expected to change between 2014 and 2041. Most notably, age cohorts under the age of 61 are expected to shrink, while the population proportions of individuals that are aged 61 and older will grow. Therefore, Peel will experience an aging population into the future, which has implications on the functionality and design needs of infrastructure into the future, and which must be planned for today. In addition, the shrinking working-age population will translate into added pressure on Peel's economy in its ability to support dependents, which are defined by Statistics Canada to be individuals under the age of 19 and individuals above the age of 65 (Statistics Canada, 2010).

Figure 5   Age Distributions of Peel's Current and Projected Population
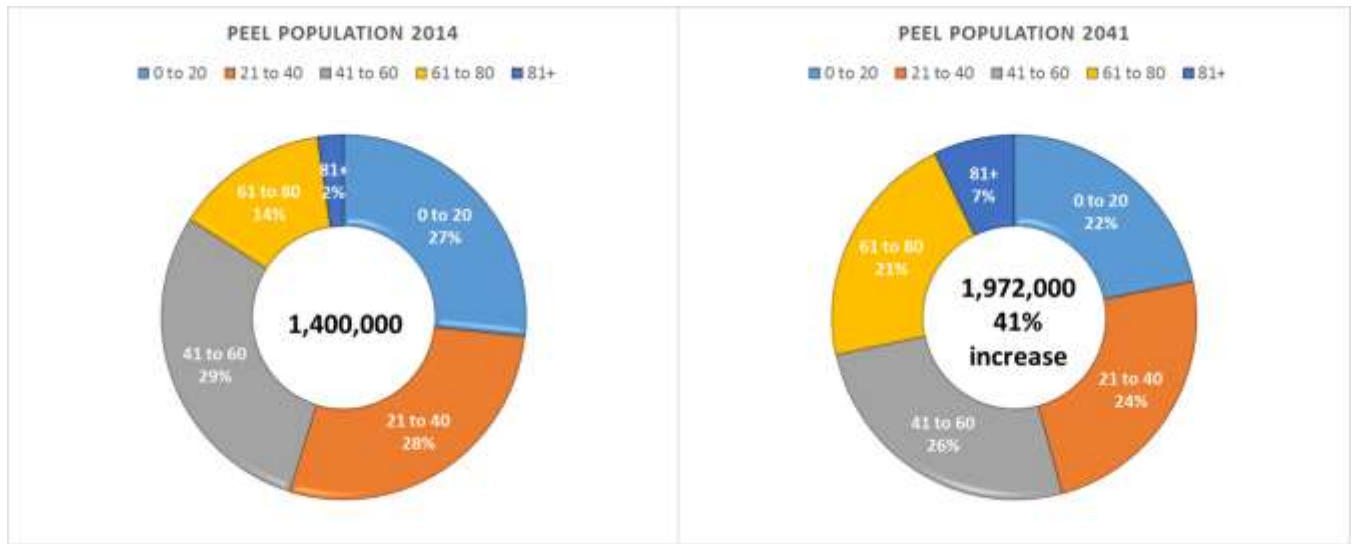
Similar patterns can be observed in the changes among the male and female populations between 2014 and 2041. The population of those aged 61 to 80 is projected to more than double from 2014 to 2041, rising from 192,200 individuals in 2014 to 416,000 individuals in 2041. The population of individuals above the age of is expected to increase to over 4.4 times its 2014 levels, from 32,000 in 2014 to 141,700 in 2041. This is illustrated in Figure 6 below. This echoes the larger Canadian trends in demographic changes. The baby boom cohort, once slowing the rate of aging of the national population, will progress into increasingly advanced age cohorts over time and contribute to accelerating aging. Aging populations are expected to be accompanied by a series of economic ramifications, including:

- Decreases in labour supply
- Decreases in real aggregate income and output, given that productivity levels and labour force participation do not dramatically increase
- Decreases in the ability of Peel's population to financially sustain the adequate provision of services to its population cohorts that are not in the labour force

Figure 6   Population Change from 2014 to 2041 by Males and Females
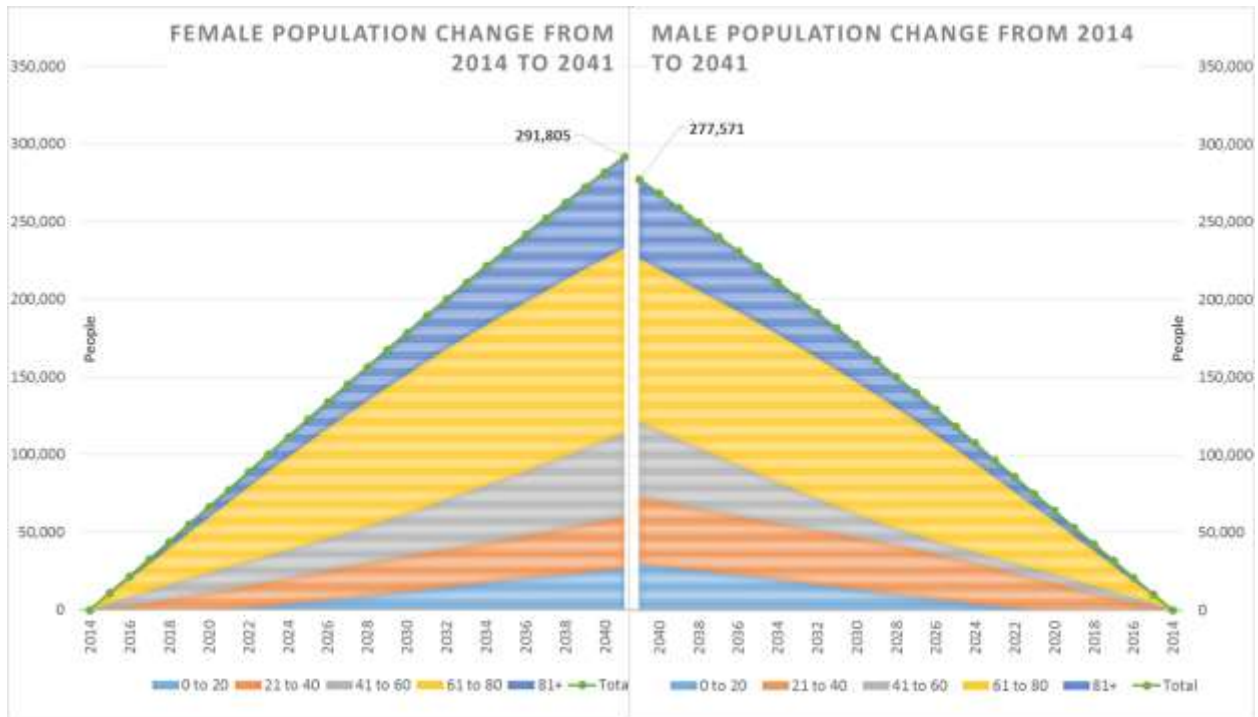
2.2.2   JOB BASELINES[2]

As Peel's population grows, the number of jobs that the region hosts and the number of employed residents living in Peel will also grow[3]. The majority of the jobs in Peel are what can be considered traditional jobs with a fixed location outside of the workers' homes, such as at a physical firm. These types of jobs also increase most drastically from 2014 to 2041. A small proportion of jobs in Peel are held by residents who work from their homes; the number of jobs that are performed in resident homes do not increase significantly between 2014 and 2041. Similarly, positions that have no fixed location are relatively small in proportion and do not increase drastically in number over time. When aggregating all of these job types within Peel, they are expected to **increase from 634,600 in 2014 to 782,500 in 2041, representing an increase of 23%. 86% of this total increase, 127,300 jobs are due to Peel's investment to accommodate growth[4]**. Figure 7 below demonstrates the change in the number of jobs in Peel.

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[2] Job and employment projections are reported from the results of *Prosperity at Risk* simulations, not Places to Grow projections. For additional details, refer to section 4.2.4 Places to Grow.

[3] In this report, jobs in Peel refer to positions hosted in Peel that are filled by individuals that may live within or outside the Region of Peel. Conversely, employment refers to the number of residents that are employed that live within Peel. These individuals may work within Peel or outside of it. For jobs in Peel that are considered not to have a fixed location, the employee's address is used as a proxy for determining the location of the work. It is assumed that if a resident of Peel has a position with no fixed location, then the work performed is located at various points throughout the region.

[4] The remaining 14% increase in the number of jobs in Peel occur as a result of other dynamic effects within the economy over time and are not a result of Peel's capital investment to accommodate growth.

Figure 7   Jobs in Peel
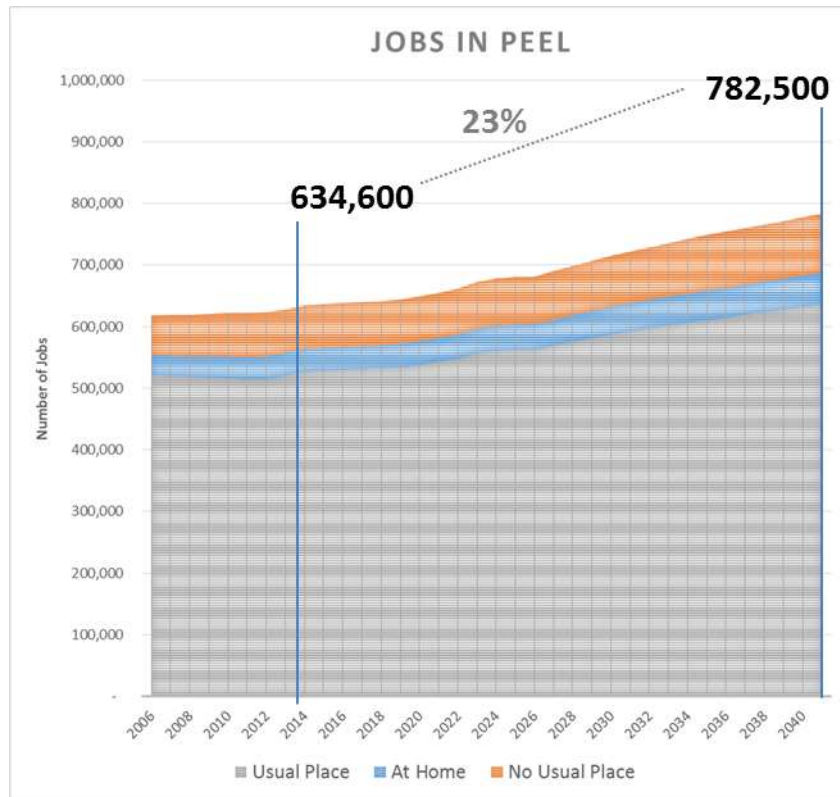
The number of employed residents in Peel include individuals that:

- Work from home
- Do not have a fixed location, or usual place of work
- Have a fixed location, or usual place of work within Peel
- Have a fixed location, or usual place of work outside of Peel

The number of employed residents living in Peel is expected to increase by 35.5%, from 656,800 in 2014 to 889,900 in 2041. 93% of this increase, or 216,200 employed residents are a result of Peel's investments to accommodate growth. Significant proportions of this increase are driven by increases in employed residents that have a fixed place of work, either within or outside of Peel. Figure 8 below demonstrates the increases in the number of employed residents in Peel over time.

Figure 8   Employed Residents of Peel
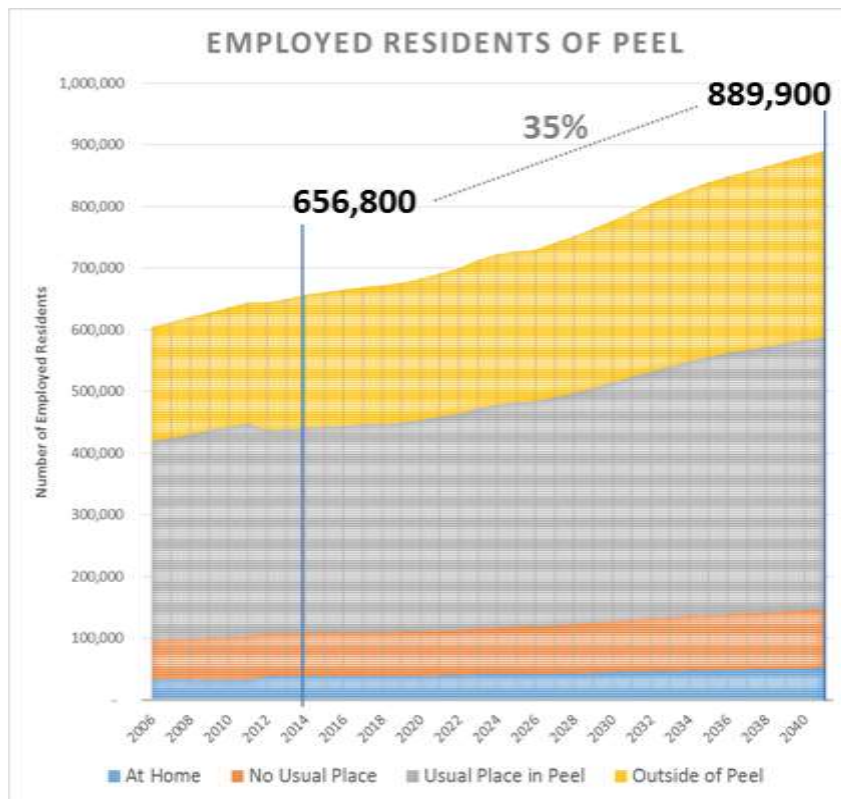
Although all projections were calibrated to existing budgetary and planning expectations, particularly as they revolve around Places to Grow population forecasts, the number of jobs projected by Places to Grow for Peel tends to be significantly greater than that projected by *PaR*. This discrepancy is already visible in the job projections for 2014, which are 11% greater than currently observed in Peel. Additional details regarding disparities in job projections between Places to Grow and *PaR* are available in section 4.2.4 Places to Grow. In addition, the Places to Grow numbers include a diverse mix job types in a single total, including:

- Part-time positions
- Full-time positions
- At-home positions
- Positions that have a fixed location (such as an office or manufacturing plant)
- Positions that do not have a fixed location (such as independent contractors)

The nature of the jobs that Peel should expect is important for the purpose of planning, particularly for determining the demand pressures that will be placed on different types of infrastructure, and planning to that demand accordingly. For example, the increase in the number of residents that are expected to work outside of Peel implies that not all of these jobs can be relied upon to generate sufficient DC revenues if Peel plans and services to the projected number of employed residents in 2041, even if Places to Grow projections are not the ones used for planning purposes.

2.3 OPERATING BASELINES AND COSTS OF GROWTH

2.3.1 TOTAL OPERATING BASELINES

In accordance with the current expectations and modeling parameters of the Region of Peel, the total operating expenses outlined in the budgets are expected to increase from $2.1 billion in 2014 to $3.4 billion in 2041, in terms of real, 2014 dollars. There is no significant change in the distribution of the operating budget between the utility-supported portions and tax-supported portions. Figure 9 below illustrates the composition of the operating budgets for the Region of Peel in 2014 and in 2041.

Figure 9   Region of Peel Total Operating Budget: 2014 and 2041
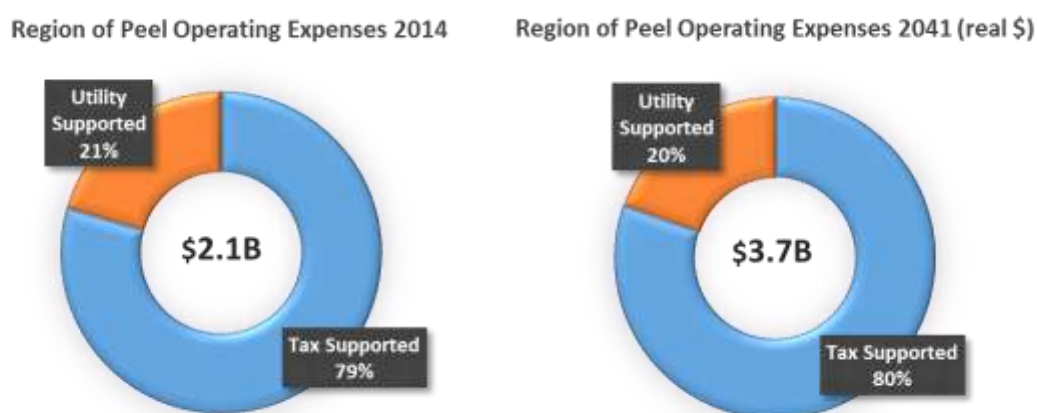
The current and projected operating budgets can further be split into program categories corresponding to the type of services funded, and their respective funding sources, taxes and utilities respectively. The utility supported operating budget contains, broadly:

- Utility supported public works
- Utility external services

The tax-supported budget is subdivided into the following categories:

- Tax supported human services
- Tax supported health services
- Tax supported internal services
- Tax supported public works
- Tax supported external services
- Tax

One significant change in the program category composition of the operating budget over time is the decline in the share of the budget allocated to tax-supported human services, illustrated in Figure 10

below. Note that cost and volume drivers for the operating budgets are aligned with Region of Peel's long-term financial model assumptions.

Figure 10   Region of Peel Total Operating Budgets by Program Category
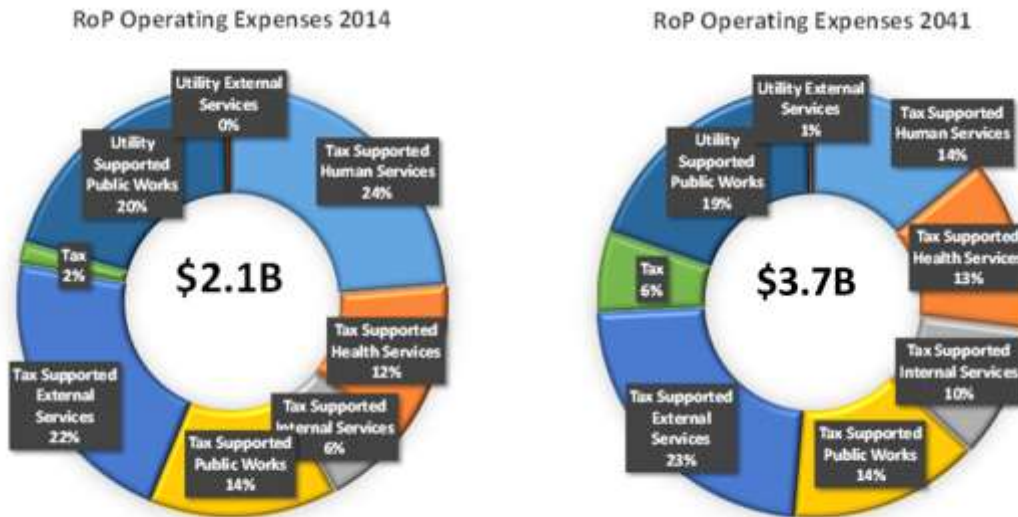
Each of the sub-categories displayed in Figure 10 above correspond to a variety of individual programs; projections were performed to a high degree of granularity. More specifically, all 24 expense categories, 21 revenue categories, 79 programs corresponding to the operating budget were modeled over time drivers provided by the Region of Peel to parametrize the projections. Figure 11 below demonstrates the growth in various components of the operating budget. Figure 11 also illustrates that the tax supported human services category does not, in fact, shrink in size. It grows more slowly than other operating budget components and therefore registers as a smaller portion of the 2041 operating budget.

Figure 11   Operating Budget by Program Category Over Time
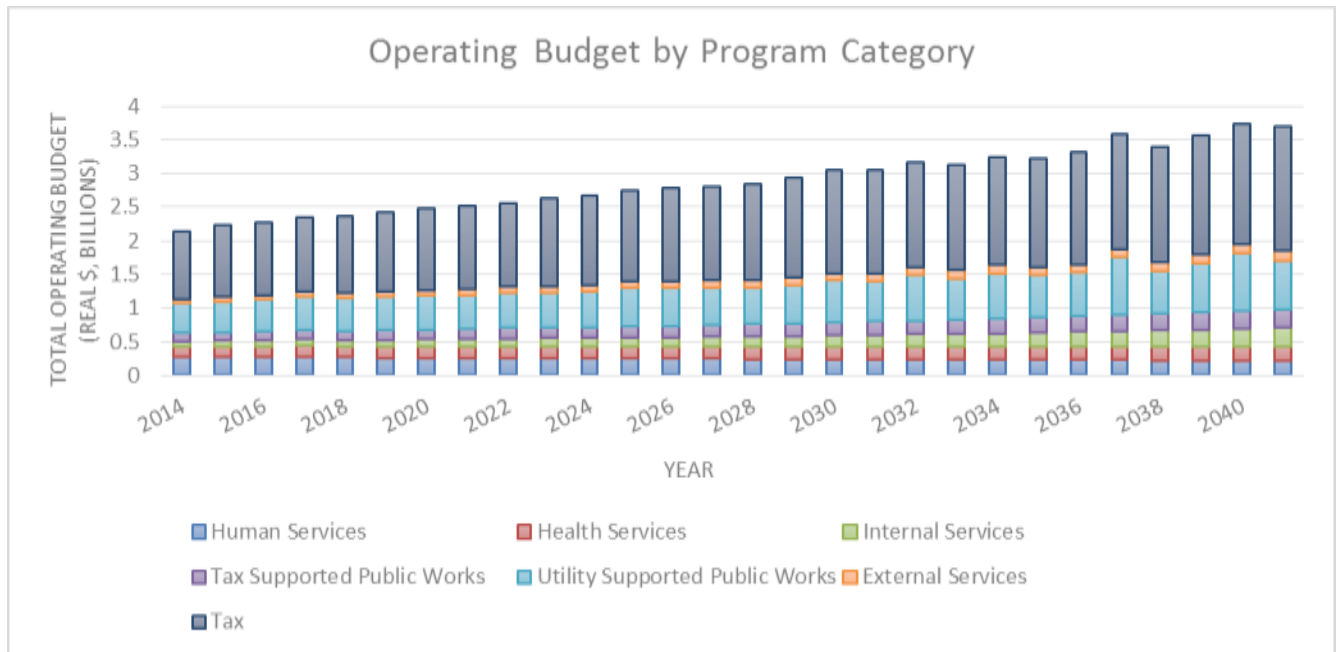
Additional details regarding budget projections are available in Appendix E.

2.3.1.1 OPERATING COSTS OF GROWTH

Cumulatively over the period between 2014 and 2041 inclusive, in real 2014 dollars, the operating budget will total approximately $80 billion if Peel invests to accommodate growth.

Of this $80 billion total cumulative operating budget:

- **$64 billion is allocated to the tax supported operating components**
- **$16.5 billion is allocated to the utility supported operating components**

If Peel's population does not grow, the operating budget can be expected to stay relatively stable, in real terms, in relation to its 2014 levels. Therefore, the increase in the operating budget above its 2014 levels in each year can be understood as the annual operating cost of growth. Relative to 2014 levels, the increase in the operating budget summed over the period between 2014 and 2041, inclusive, in real, 2014 dollars is $21 billion.

Of the $21 billion cumulative increase in the operating budget:

- **$16.8 billion represents the increase in the tax supported operating component**
- **$4.2 billion represents the increase in the utility supported operating component**

Figure 12 below demonstrates the annual, additional operating costs[5] associated with growth.

Figure 12   Additional Operating Costs of Growth
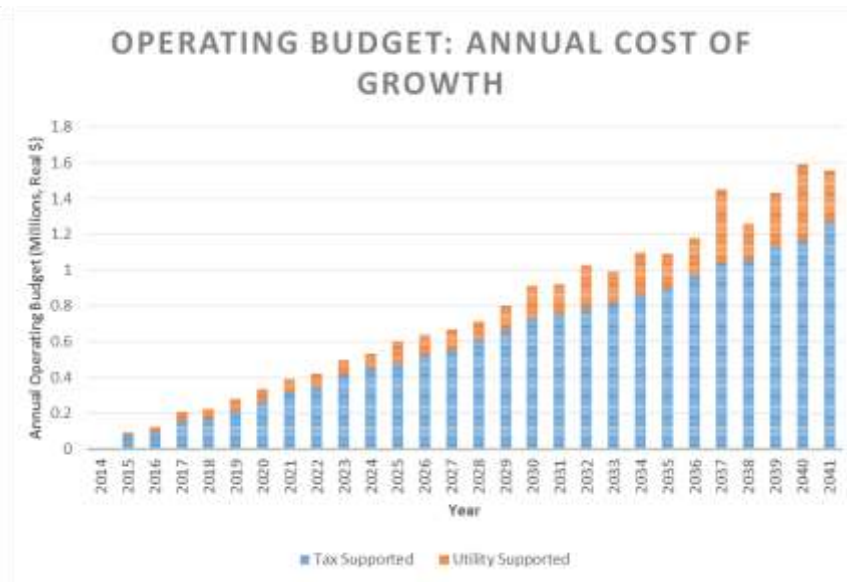
The residents of Peel Region will experience moderate increases in the cost of living over time as a result of the increased operating expenditures for Peel Region. Cost of living indices can be understood in two ways:

1. **Region of Peel Operating Expenses per Employee**: This index is calculated as the ratio between the total annual operating expenses in Peel and the number of employed residents of Peel. This demonstrates the capacity of Peel's employed population to sustain revenues needed for the operating budget each year from 2014 to 2041.

2. **Region of Peel Operating Expenses per Capita**: This index is calculated as the ratio between the total annual operating expenses in Peel and the total number of residents of Peel. This ratio spreads the burden of supporting operating expenses across all residents of Peel, and can also be understood as the value of operation goods and services provided by the Region of Peel, on average, to each resident.

Figure 13 below demonstrates the evolution in both of these indices over time. Some volatility is observed in 2037 due to volatility in the projected expenses associated with utility supported public works. Figure 13 also shows the rates of change in the two indices relative to the base year of 2014.

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[5] The operating costs and operating revenues are assumed to be identical in each year as deficits are not run for operating expenses

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Figure 13   Cost of Living Indices and Rates of Change: Operating expenses
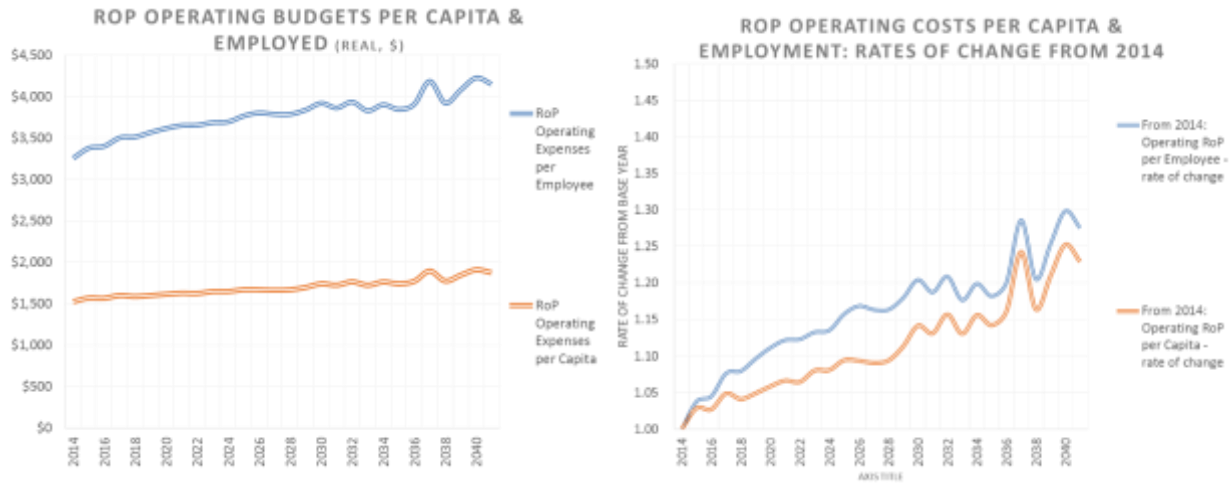
In addition to the operating expenses per employee and operating expenses per resident indices, a household cost index was calculated to quantify the cost of living faced by households in Peel, who face significant affordability benefits if Peel grows. This was measured as the ratio between household income less all taxes and utilities relative to that in the base year. The household cost index is a broad-based measure of the disposable income enjoyed by households relative to all taxes and utilities, including non-local taxes and utilities. Figure 14 below illustrates the rate of change in the household cost index.

Figure 14   Region of Peel Household Cost: Rate of Change
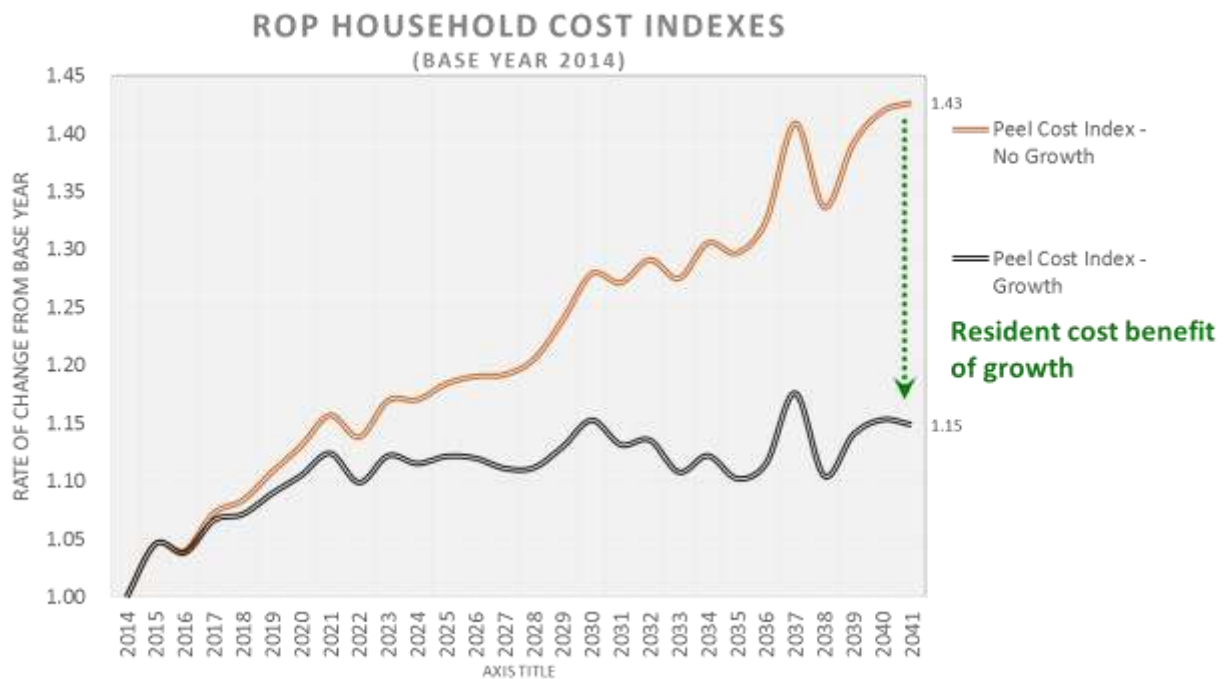
2.4 CAPITAL BASELINES AND COSTS OF GROWTH

2.4.1 TOTAL CAPITAL BASELINES

The capital budget is projected with the assumption that the average rate of investment will grow with inflation. Cumulatively, between 2014 and 2041, the total capital budget for the Region of Peel totals $16.1 billion if Peel invests to accommodate the expected growth, and is split approximately evenly between the utility supported, DC supported, and tax supported budget components. Figure 15 below demonstrates the distribution of the cumulative capital budget over this time period.

Figure 15   Cumulative Capital Budget, real 2014 dollars
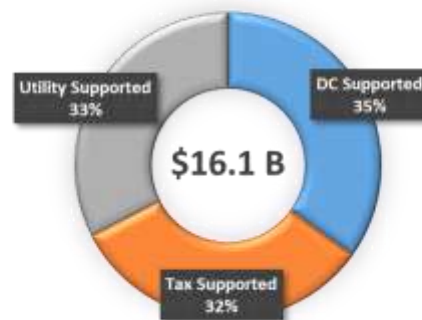
The tax and utility supported components comprise the capital reserve. Cumulatively between 2014 and 2041, the tax supported capital budget and the utility supported capital budget respectively sum to approximately $5.2 billion each. Therefore, the capital reserve, which is comprised of these two components, totals $10.4 billion cumulatively.

Like the operating budget, the capital budget was projected in terms of its constituent program categories and associated accounts. Figure 16 below demonstrates the annual capital budget by program category.

Figure 16 DC Capital Budget by Program Category, real 2014 dollars
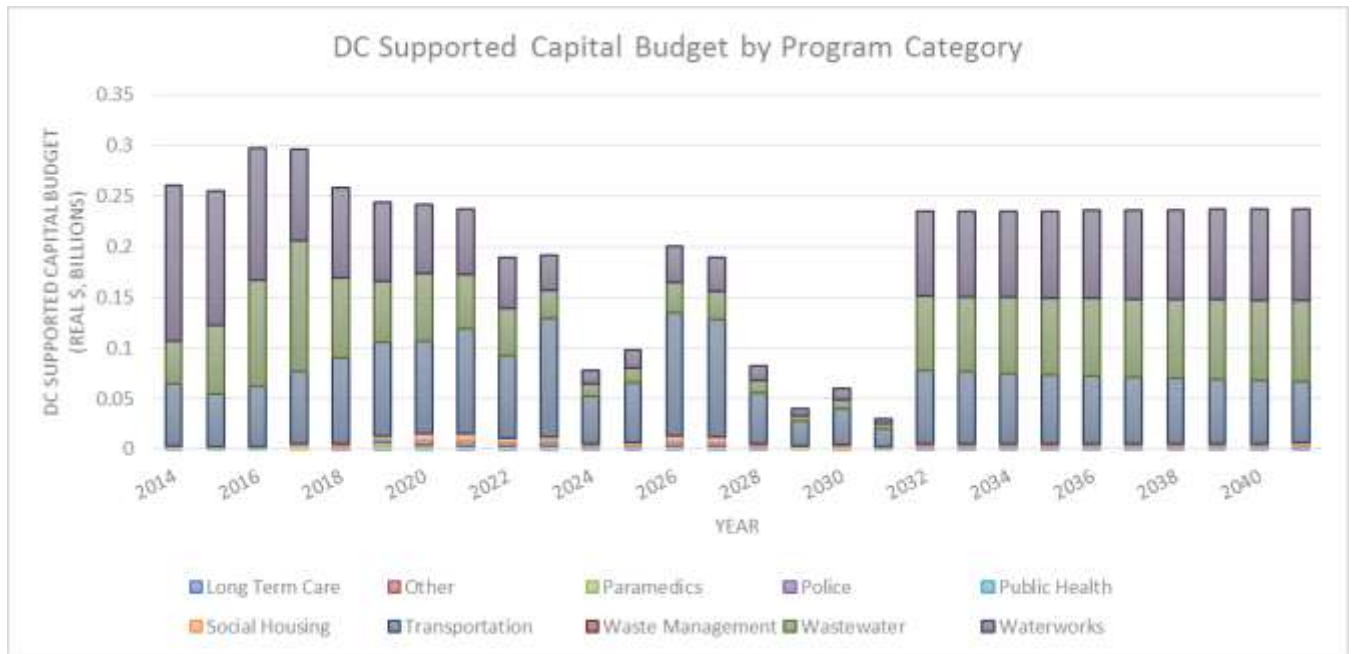
Generally, cumulative capital spending follows the same trends as the growth in Peel's population. Figure 17 below illustrates the process of capital accumulation in Peel by capital budget component relative to the change in the population relative to 2014.

Figure 17 Cumulative Capital Spending and Cumulative Population Change
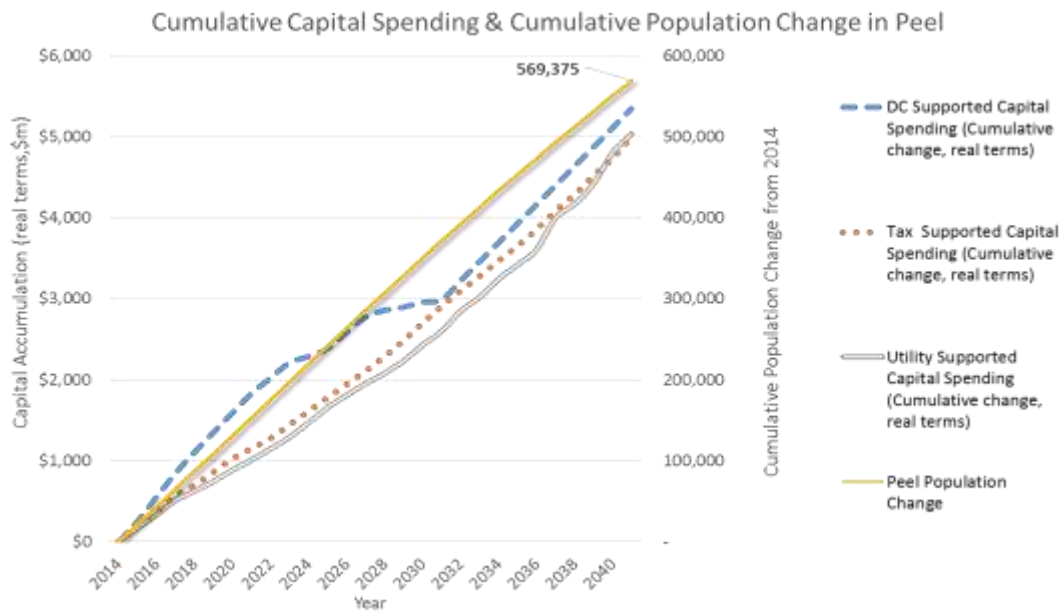
DC revenues, which represent Peel's ability to pay down its debt, will shift in composition between 2014 and 2041 such that there will be proportionally less revenue drawn from the development of both

industrial and non-industrial non-residential buildings, and proportionally more revenue drawn from residential buildings. Figure 18 below illustrates the change in composition of DC revenues.

Figure 18   DC Revenues by source: 2014 and 2041
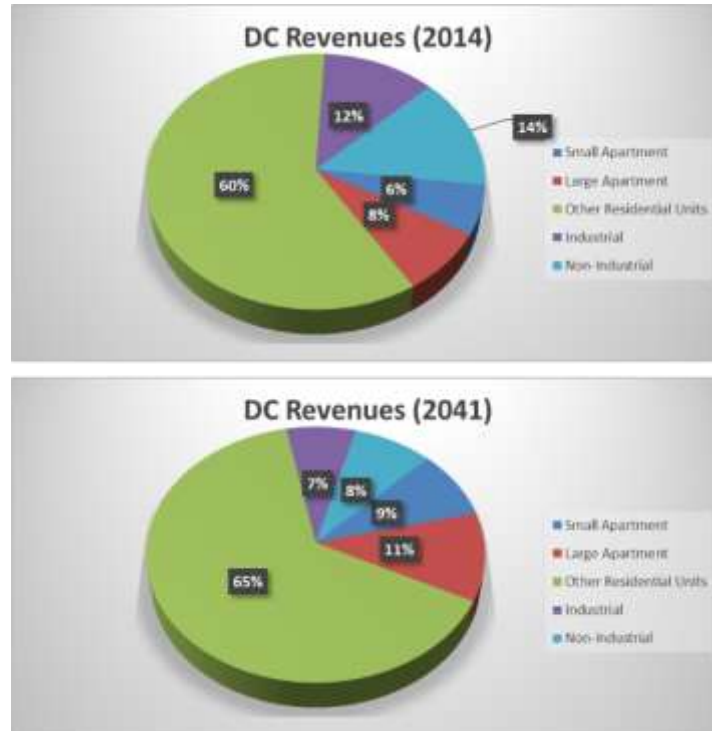
The DC revenues received by the Region of Peel supports its ability to pay down its outstanding debt. Given appropriate capital investments today and adequate population growth, Peel is projected to pay its net outstanding debt entirely by 2041. Gross debt represents the amount of debt that the Region of Peel would hold annually if it did not repay any of it over time.

In order to sustain growth, $130 million[6] in debt must be issued. **The cumulative expected debt reserves by 2041 total $240M**. Figure 19 below demonstrates the net and gross outstanding debt of the Region of Peel over time.

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[6] Nominal dollars

Figure 19   Gross and Net Outstanding Debt
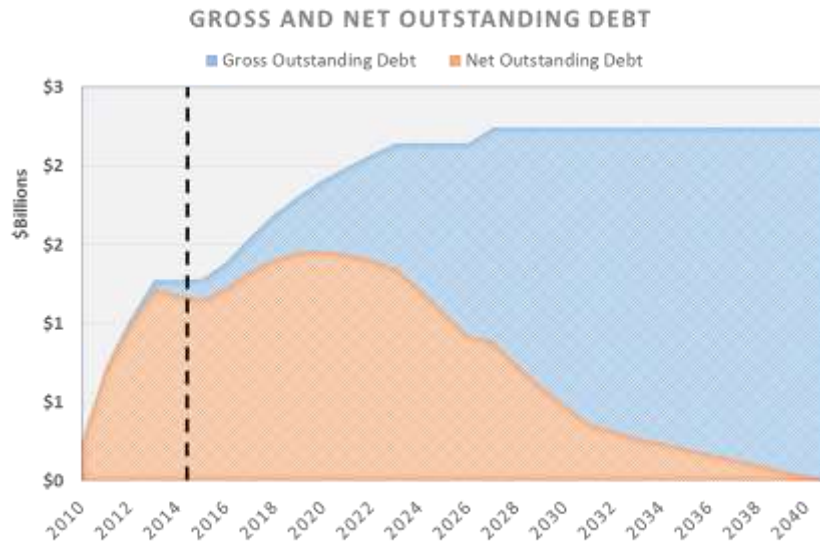
Additional details are available in Appendix E.

2.4.1.1   CAPITAL COSTS OF GROWTH AND DEVELOPMENT CHARGES

With respect to the capital budget, the DC supported component represents the capital cost of growth. The DC supported component sums to $5.6 billion in 2014 real dollars, and represents 34.9% of the cumulative capital budget between 2014 and 2041 inclusive.

This $5.6 billion includes expenditures for the following program categories, cumulatively:

- **$1.9 billion for Transportation**
- **$1.9 billion for Waterworks**
- **$1.6 billion for Wastewater management**
- **$3.6 million for Other infrastructure**

In addition to the capital costs associated with building new infrastructure, the new infrastructure that is built over time is subject to state of good repair (SOGR) investments. Considering only new infrastructure that is built in 2014 and later, the total estimated SOGR investment that must be made to sustain it until 2041, inclusive, is $0.55 billion.

Additional details are available in Appendix E.

2.5 BASELINE AND COSTS OF GROWTH: CONCLUSIONS

As the Region of Peel plans to accommodate population growth as stipulated by its growth plan and as is mandated by Places to Grow legislation, it is required to allocate scarce resources to support its new residents and the economy in which they participate.

The population of Region of Peel is expected to grow significantly between 2014 and 2041, by over 569,000 individuals or 41%. The number of employed residents in Peel will increase by over 233,000 between 2014 and 2041, or 35.5%. As Peel aligns its plans and investments to this expected population, it is expected to support an additional 226,000 jobs by 2041, representing an increase of 34.5% relative to 2014.

This growth will also translate into growing operating budgets (and corresponding revenues) as a larger number of residents will place upward demand pressures on the services offered by the Region of Peel. Between 2014 and 2041, annual operating expenses will increase by $1.3 billion, or 61.9%. Cumulatively over this time period, Peel is expected to spend approximately $80 billion on operation-related programs and services, of which $21 billion is a result of the growth occurring in Peel.

Peel must also plan to build and sustain infrastructure that will allow its population growth to flourish. Cumulative capital expenses will total $16.1 billion for the period, 2014 to 2041. Of that $16.1 billion, $5.6 billion cumulatively represents the DC supported component of the budget, which directly supports Peel's growth. The DC supported component can be further subdivided into $1.9 billion for Transportation, $1.9 billion for Waterworks, $1.6 billion for Wastewater management, and $3.6 million for other growth-related capital expenses. Figure 20 below illustrates the costs and investments associated with growth between 2014 and 2041.

Figure 20   Costs & Investments from 2014 to 2041
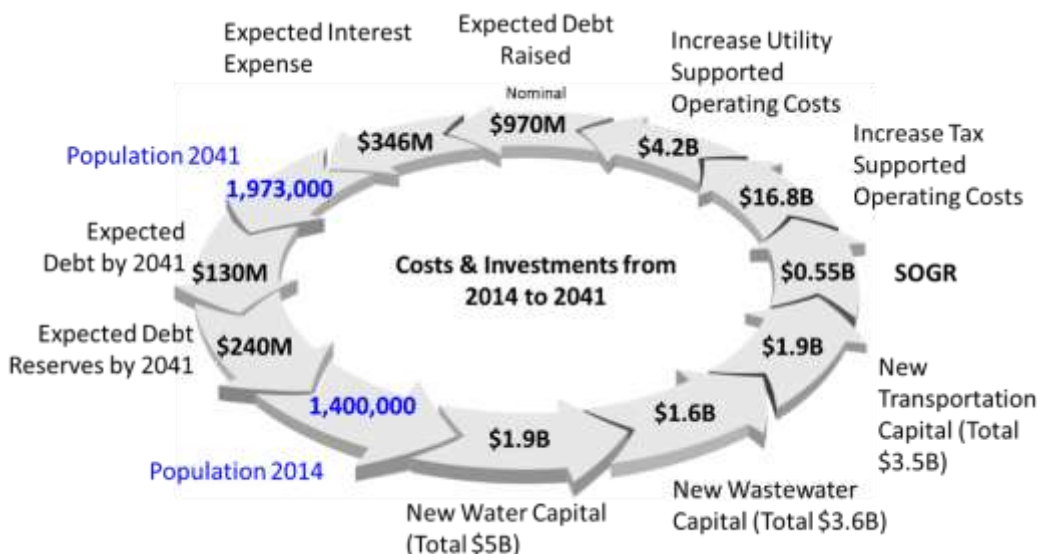
3.0 BENEFITS OF GROWTH

Growth in the Region of Peel can be accommodated by appropriate planning and execution of capital investments. If expectations and reality converge into the future, then Peel can expect to see strong economic performance across a variety of indicators between present day and 2041. However, if Peel does not invest in growth-supporting capital, it cannot accommodate population growth and the economic activity that it can generate.

In order to assess the benefits of growth, a possible future for the Region of Peel is considered wherein Peel does not invest in growth-supporting capital and infrastructure, and therefore new immigrants do not settle in Peel[7]. Peel does continue to invest in social programs and infrastructure that support the current population, however. In this scenario, the growth that would have been attracted to Peel if the appropriate capital investments were made is not distributed to the surrounding GTAH regions.

This scenario is contrasted to the scenario where Peel continues to accommodate growth by investing in new infrastructure and capital aimed at supporting new in-moving migrants. As Peel invests, it attracts immigrants into the area, along with economic activity, leading to population and regional economic growth. The economic indicators considered within the scope of this study are:

- Population dependency
- Regional jobs
- Regional employment
- Senior government fiscal revenues
- Private capital investment
- GDP

3.1 POPULATION DEPENDENCY

Population dependency ratios measure the proportion of the population that is considered outside of the age range for participating in labour. The dependency ratio thus reflects a more robust ability of the economy to sustain individuals who do not work. For instance, if fertility drops, the dependency ratio will initially fall as fewer children are born. After some time, the dependency ratio will increase again as the population (whose fertility remains low) ages. Aging populations, which may be artefacts of changes in mortality, fertility, or migration patterns, induce changes in the population dependency ratio. This may be an indication that service planning should also change to reflect the demand pressures for different types and amounts of social support in Peel.

If Peel fails to grow as expected, it will feature less robust dependency ratios than it would if baseline expectations are met. The reason for this is that growth is expected to occur primarily in the working-age

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[7] For the purposes of this report, immigration is not reduced to zero for the Region of Peel, even in the no growth scenario. Immigration is reduced such that the population of the Region of Peel remains relatively constant through time. Therefore, there may be some small numbers of individuals moving into Peel to replenish the population over time.

cohorts. Irrespective of whether Peel accommodates population growth, the cohort of individuals aged 81 and older will increase approximately four-fold. The population of individuals between the ages of 61 and 80, as well will approximately double. Significant differences begin to emerge when analyzing the other, younger cohorts, namely those aged 0 to 20, those aged 21 to 40, and those aged 41 to 60. All of these cohorts are expected to shrink in size if there is no growth in Peel. However, if Peel grows, then the following population benefits will emerge[8]:

- The population of youth aged 20 and under will be greater by approximately 123,000 individuals
- The population of young adults aged 21 through 40 will be greater by approximately 137,000 individuals
- The population of adults aged 41 through 60 will be greater by approximately 130,000

Figure 21   Peel Population Age Distribution by Growth Scenario

PEEL POPULATION IMPACT OF NOT GROWING ('000 OF PEOPLE)

■ 2014   ■ 2041 No Growth   ■ 2041 Growth

Age	2014	2041 No Growth	2041 Growth
0 TO 20	374	307	430
21 TO 40	395	336	473
41 TO 60	410	382	512
61 TO 80	192	365	416
81+	32	132	142
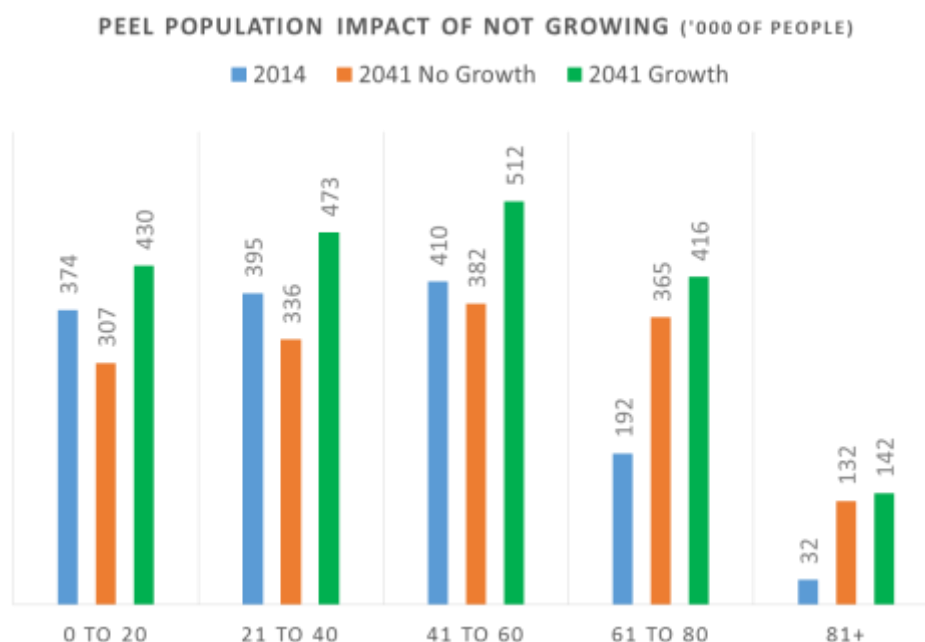
3.2 REGIONAL JOBS

Regional jobs refer to the new positions that are generated and filled in a given location or region, but are not necessarily filled by residents of that location. In the case of the Region of Peel, regional jobs are those which are based within Peel and may belong to a mix of individuals who live in Peel and those who commute into Peel to work.

If Peel invests in growth-supporting infrastructure, it generates a capacity to support jobs through direct, indirect, induced, and system impacts. The number of jobs in the region grows as a result of growth in the population, the attraction of private capital investment to Peel, and the unique productivity that Peel

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[8] Relative to the scenario in which Peel does not grow

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supplies to markets. For instance, the initial investment will require labour to build the infrastructure and move goods to where they are demanded. These jobs translate into added purchasing capacity, which boosts consumption and contributes to the incomes of firms that support that consumption. However, regional jobs do not only belong to residents of the region; many individuals living outside of Peel will commute into the region for work as a result of the infrastructure's stimulus to local businesses, their ability to invest, and their capacity to hire labour. In addition, the Region of Peel projects its DC revenues against the number of jobs it expects in the region.

However, if growth does not occur in Peel as expected, then by 2041, Peel will not be able to cover the costs of growth already incurred because the development charge revenue stream will fall below expectations. A material departure in the job growth trends occurs just after 2018 and persists through 2041, with the gap widening over time. By 2041, Peel will support virtually the same number of jobs within the region as it had in 2014 if capital investments are not made; jobs in Peel in 2041 will be just 3.3% higher than they were in 2014. This is contrasted with the scenario in which growth is supported, which features a much stronger 23% difference between the jobs supported in Peel in 2014 (634,600) and 2041 (782,500), respectively. **Therefore, approximately 86% in the projected growth in jobs from 2014 to 2041 in baseline projections is a result of growth-supporting investments and the economic activity caused by them. Over 127,300 jobs within Peel in 2041 can be attributed to the investment that Peel makes to support growth.**

The number of jobs in Ontario is expected to increase by 23% from approximately 6,250,000 jobs in 2014 to over 7,690,000 in 2041. However, roughly 219,000 jobs, or 15% of the increase in jobs in Ontario is at risk if Peel does not grow. Figure 22 illustrates the trends in the number of jobs within Peel between 2014 and 2041, inclusive, under the two scenarios.

Figure 22   Jobs in Peel
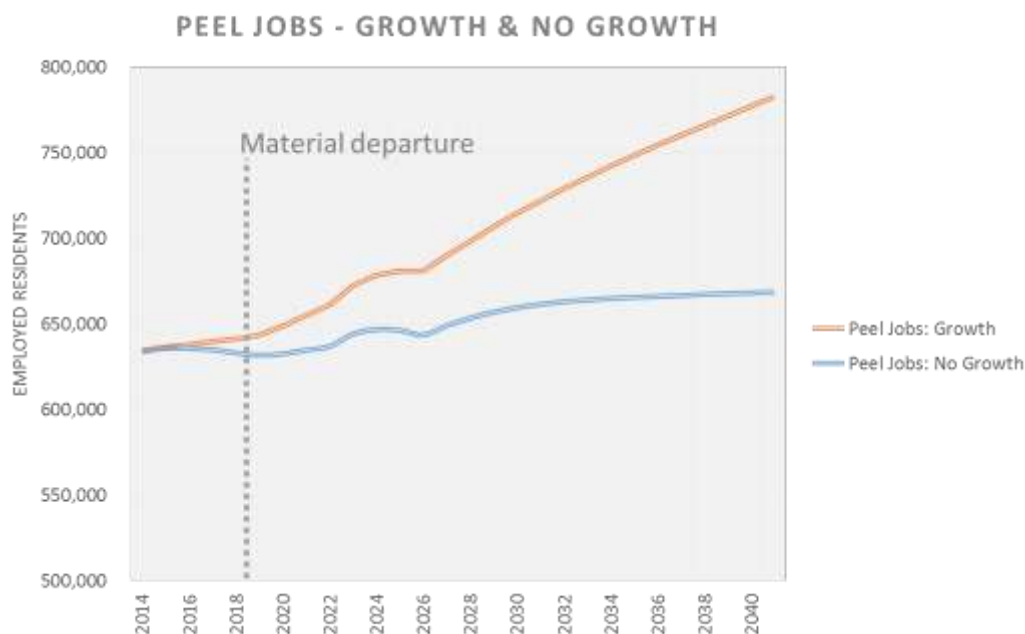
Benefits will also accrue to Ontario if Peel grows relative to the scenario that it doesn't grow and that potential growth is not redistributed instead to the surrounding GTAH. **For every job created within the Region of Peel 2 jobs are created in Ontario (inclusive of the Region of Peel)**.

3.3 REGIONAL EMPLOYMENT

Regional employment, which is contrasted with jobs, refers to the employment years gained among Peel's residents. These individuals may work within Peel or may leave Peel to work, but they all reside within the Region of Peel. Employment demonstrates how Peel's population shares in the economic prosperity of the region as it is generated by investments in growth-supporting capital.

The distinction is made between jobs and employed residents, as jobs within a region identify the demand for employment by local firms, government, and other enterprises that can hire labour, therefore demonstrating the positive economic impact of growth upon the region and impact the region's capacity to cover previously incurred costs of growth. Meanwhile, the number of residents that are employed also demonstrates the positive economic impact of the investment on the Region's residents, and measures the residents' capacity to pay taxes and utilities. The growth in the number of employed residents in Peel is driven by population growth, the demand and supply of productivity in and around the region, and private capital investment in and around the region.

Between 2014 and 2041, the number of employed residents annually in Peel is expected to increase by 35%, from 656,800 to 889,900. 93% of that increase, representing 216,200 residents is a direct result of regional growth. If Peel does not grow as expected, the number of employed residents in 2041 will be just 2.6% higher than the corresponding figure in 2014—an immaterial increase.

Figure 23   Employed Residents in Peel
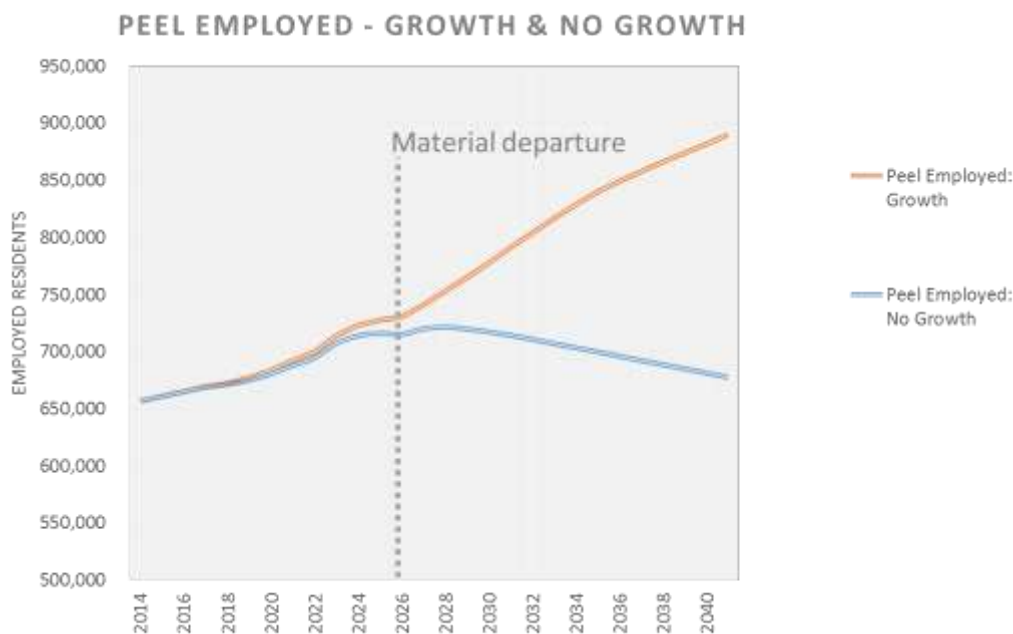
For every employment year gained in Peel as Peel grows, Ontario gains 1.65 employment years relative to the scenario when Peel does not grow.

It is important to note that neither the projections for the number of jobs nor the number of employed residents in Peel in 2041 reach the 970,000 jobs forecasted by Places to Grow. In addition, there is a significant difference in the number of jobs in Peel relative to the number of employed residents in Peel, highlighting that many Peel residents will commute out of the region for work. In fact, the net number of Peel residents who work outside of Peel is 21,400 in 2014, or approximately 3% of Peel's employed residents. By 2041, this figure increases to 106,500, or approximately 12% of Peel's employed residents.

This shift of the employment from within Peel to outside of it has implications on the source composition of the tax revenue collected by the region and municipalities, with greater emphasis on residential sources of tax revenue relative to non-residential sources. This is corroborated by the projection for DC revenues discussed in section 2.4.1, which also show increasing dependence on residential DC revenues in 2041 relative to 2014. Figure 24 below illustrates the projections generated by *Prosperity at Risk* for jobs within Peel and for the number of employed residents of Peel. Additional discussion regarding Places to Grow is available in section 4.2.4 of this report.

Figure 24   Jobs vs. Employed Residents Projections
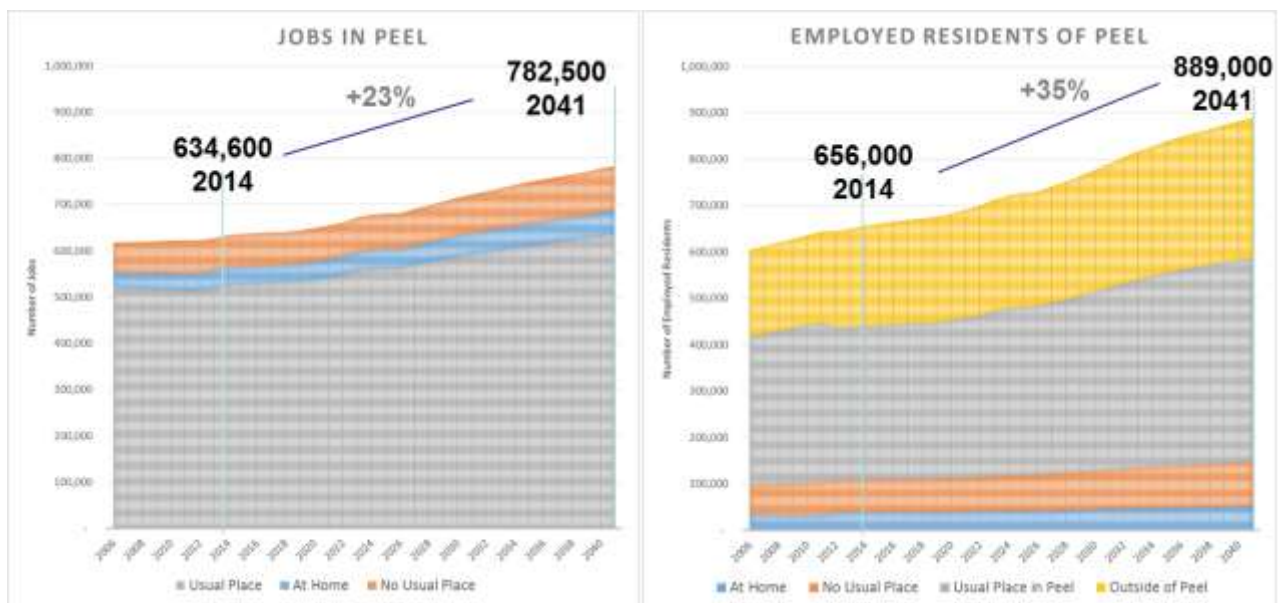
3.4 SENIOR GOVERNMENT FISCAL REVENUES

Between 2014 and 2041, the provincial government can expect to receive over $255 million in tax revenue if Peel does not invest in growth. If growth is sustained by the capital investments within Peel then the provincial government stands to receive approximately $284 million in tax revenue.

In 2014, the provincial government is estimated to have drawn approximately $8 billion in tax revenue from the Region of Peel. By 2041, this figure is expected to rise to approximately $12.9 billion,

representing a 62% increase in annual provincial tax revenue from Peel alone. 55% of this increase is attributable to Peel growing according to expectations. **Between 2014 and 2041 inclusive, growth in Peel is expected to generate $28.6 billion in provincial tax revenue**.

Similar results were found for the federal government. The annual tax revenue received by the federal government is expected to increase by 68% between 2014 and 2041, from $8 billion to approximately $13.9 billion. 55% of this increase is lost if Peel fails to grow to expectations. This illustrates that both the provincial and federal governments are significant beneficiaries of not only the economic activity that is created within Peel, but of the growth that stands to occur within Peel. **The federal government can expect to receive over $31.5 billion in tax revenue cumulatively between 2014 and 2041 resulting directly from growth in Peel**.

The stimulated economy throughout the province will translate into additional revenues for the provincial and federal governments as follows:

- Ontario (inclusive of Peel) will generate $35.5 billion in provincial tax revenue
- Ontario (inclusive of Peel) will generate $38.8 billion in federal tax revenue

For every additional real dollar of municipal revenue in Peel:

- Provincial revenue increases by $5.70
- Federal revenue increases by $6.22

However, these revenues are contingent upon the provincial and federal government's adequate ad appropriate contribution to infrastructure investment. Further details are available in section 4.2.1.

3.5 PRIVATE CAPITAL INVESTMENT

Private investment in capital is attracted to a region when industry identifies lucrative opportunities for growth. Infrastructure spending by government entities has significant augmenting benefits in terms of aggregate incomes, employment, and productivity; however, the favourable economic outcomes stimulated by public investment in capital creates an environment that attracts private capital investment, as well. In the Region of Peel, appropriate investment in capital that accommodates expected growth attracts over **$139 billion in residential capital investment and approximately $305 billion in non-residential capital investment, totalling $444 billion[9] cumulatively between 2014 and 2041**. This implies that:

- $363,700 in private non-residential capital is attracted for each new job in Peel; and
- $18,300 in private residential capital is attracted for each new Peel resident.

Of the cumulative non-residential capital investment in Peel of $305 billion, 15.2% can be attributed to growth. Similarly, 7.5% of the $139 billion in residential capital investment attracted to Peel is due to growth. **Therefore, approximately $46.3 billion in non-residential private capital investment and $10.4**

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[9] Real 2014 dollars

billion in residential private capital investment would be lost if Peel did not accommodate growth. As well, as a result of Peel's growth, the province can expect the following benefits.

Private capital investment is a main driver of growth. The co-ordinated investment into Peel's economic development generates benefits not only throughout Peel, but also throughout the province. For every dollar of private capital investment, residential and non-residential respectively, attracted to Peel as a result of growth:

- $1.65 is attracted to Ontario (inclusive of Peel) in residential private capital investment
- $1.35 is attracted to Ontario (inclusive of Peel) in non-residential private capital investment

Figure 25 below demonstrates the trends in non-residential private capital investment among the growth scenarios.

Figure 25   Peel Non-Residential Private Capital Investment by Scenario
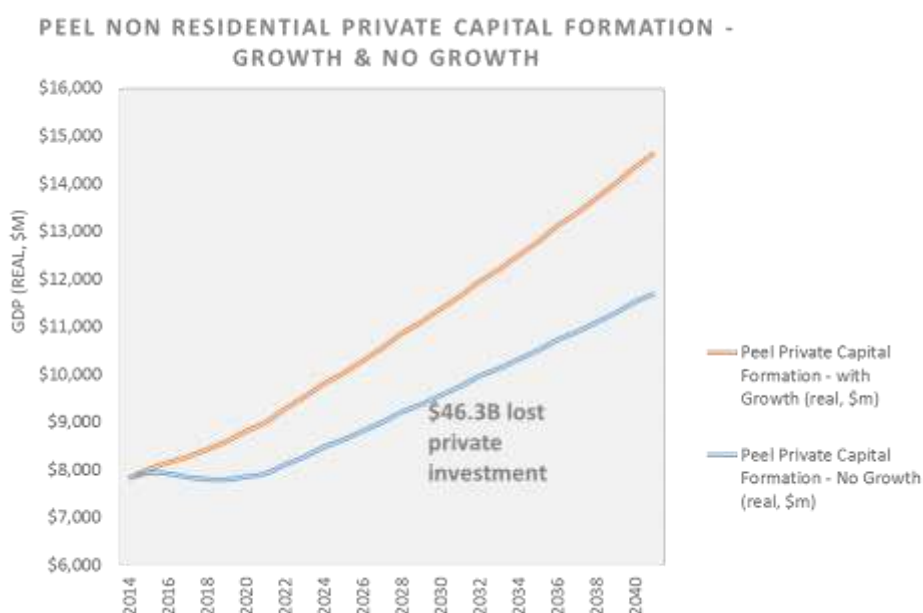
3.6 GDP

Increases in real GDP and real GDP per capita can be expected as a result of growth meeting baseline expectations. **Peel's appropriate investment in capital is expected to generate over $176 billion in regional GDP for Peel cumulatively between 2014 and 2041**. This represents approximately 7.8% of the total cumulative growth in real regional GDP over that time period. In real, 2014 dollars, annual GDP increases by 47% between 2014 and 2041, from approximately $67 billion to $99 billion. If growth does not occur, however, Peel's regional GDP will increase from $67 billion in 2014 to $85 billion in 2041. Therefore, over 44% in the growth of real annual GDP for the Region of Peel results from Peel's accommodated economic and population growth.

Ontario similarly benefits from Peel's growth, with approximately 7% of the growth in annual GDP from 2014 to 2041 attributable to growth in Peel. Cumulatively between 2014 and 2041, Peel's growth will contribute approximately $287 million to Ontario's GDP[10]. National real GDP for Canada[11] is expected to increase from approximately $1.83 trillion in 2014 to $2.77 trillion in 2041, representing a 52% increase. Of this increase, approximately 3% is a result of growth in Peel.

For every real $1 of regional GDP stimulated by growth in the Region of Peel:

- Ontario's GDP increases by $1.63 (inclusive of Peel); and
- Canada's GDP increases by $1.62 (inclusive of Ontario)[12]

Figure 26 below demonstrates the change in regional GDP under the two growth scenarios.

Figure 26   Regional GDP in Peel
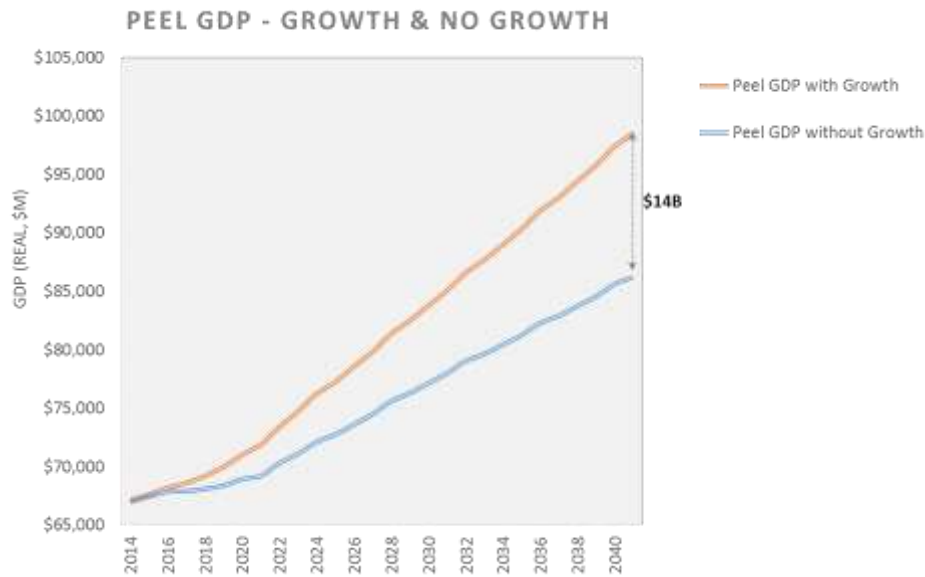
3.7 BENEFITS OF GROWTH: CONCLUSIONS

Appropriate investments in infrastructure are a key driver of economic prosperity. Population growth, if adequately supported through the continued investment in infrastructure, generates significant benefits in terms of regional GDP initially through the injection of capital into the system, and subsequently through a series of multiplier effects as the growing population benefits from the infrastructure in terms of its productivity. The combined effects of population growth, productivity enhancement, and capital accumulation symbiotically create an environment that is conducive to economic expansion in terms of jobs within the region in which the infrastructure invested, as well as the number of employed residents.

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[10] Inclusive of Peel's regional GDP
[11] Inclusive of Ontario
[12] Although Canada does not gain additional GDP over Ontario, the growth in Peel still represents a net positive change in GDP for the country.

The processes and impacts surrounding sustainable growth, however, do not end in the region in which the investment is made. Appropriate growth-supporting investments and planning have powerful augmenting effects on a wide geographic scale, with increases in provincial GDP, employment, jobs, private capital investment, and the generation of federal and provincial revenues as a result of that economic activity. If Peel invests to according to its current expectations and growth occurs, it can expect:

- A 47% increase in its real GDP from $67.1B in 2014 to $98.5B in 2041
- A 35% increase in the number of its employed residents from 656,800 in 2014 to 889,900 in 2041
- A 23% increase in the number of jobs in Peel from 634,600 in 2014 to 782,500 in 2041
- An 87% increase in non-residential private capital investment from $7.8B in 2014 to $14.7B in 2041
- A 40% increase in residential private capital investment from $4.3B in 2014 to $6B in 2041
- A 68% increase in the federal tax revenue generated from Peel, from $8.3B in 2014 to $13.9B in 2041
- A 62% increase in the provincial tax revenue generated from within Peel, from $8.3B in 2014 to $13.9B in 2041

In addition, the following benefits accrue to Ontario (inclusive of Peel) if Peel plans and invests adequately to support growth:

- A 49% increase in its real GDP from $661.4B in 2014 to $985.7B in 2041. Of this total growth, 7% is supported by the growth in Peel
- A 23% increase in the number of its jobs[13] from 6.2 million in 2014 to 7.7 million in 2041. Of this total growth, 15% is supported by the growth in Peel.
- An 89% increase in its annual private non-residential capital investment from $77.3B in 2014 to $146.5B in 2041. Of this total growth, 7% is supported by the growth in Peel.
- A 41% increase in residential capital investment from $42.4B in 2014 to $59.8B in 2041. Of this total growth, 8% is supported by the growth in Peel.
- A 58% increase in federal tax revenues generated from within Ontario from $79.9B in 2014 to $126.4B in 2041. Of this total growth, 7% is supported by the growth in Peel
- A 54% increase in provincial tax revenues generated from within Ontario from $76.8B in 2014 to $117.4B in 2041. Of this total growth, 8% is supported by the growth in Peel

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[13] For aggregate Ontario measures, the number of jobs and the number of residents are identical. The reason for this is that employed residents of a region may commute to another region to work much more readily than an employed resident of Ontario commutes outside of the province to work.

4.0 RISKS OF GROWTH

Demonstrably, the region of Peel, its residents, and the province gain significant economic benefits over time by investing appropriately to accommodate growth. However, Peel's success in its ability to accommodate growth is not assured as a result of internal and external dependencies in the economies of Peel and the surrounding regions, which give rise to systematic risks.

4.1 POLICY DEPENDENCIES WITHIN PEEL

4.1.1 SENSITIVITY ANALYSIS: INFRASTRUCTURE DEFUNDING

Within Peel, planning to accommodate growth requires not just adequate quantities of capital investment, but also the co-ordinated investment across infrastructure types with careful consideration for anticipated demand pressures and economic impacts.

In order to demonstrate the impact of risks associated with infrastructure planning within Peel, multiple scenarios were designed. Each scenario featured complete capital defunding of one type of infrastructure, while keeping capital investments in all other infrastructure types aligned with baselines. That is to say, the funds were not re-allocated to other infrastructure types. In these case, population growth and immigration were allowed to respond dynamically to the infrastructure investment (or defunding) that occurred; therefore any changes in the population reflect a change in the ability of Peel to attract new residents. Figure 27 below demonstrates how each of the impacts of infrastructure types was calculated.

Figure 27   Method for Determining Growth Impact of Infrastructure Types
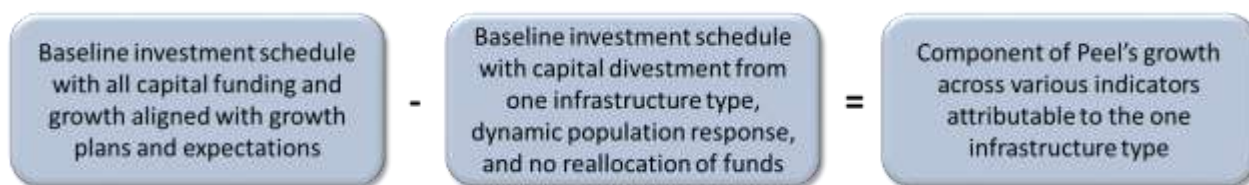
This method was repeated for the following infrastructure types:

- Waterworks
- Wastewater management
- Transportation
- Other Infrastructure

It is important to note that summing the various growth components of each infrastructure type will not necessarily yield the totals observed in the baselines for any given indicator, such as GDP, employment, jobs, private capital investment, or provincial and federal revenues. The reason for this is that in the baselines, *PaR*'s agent-based modeling engines create a dynamic response to the specific mix of infrastructure funded through Peel's capital investment. The same is true for each of the scenarios in which a given infrastructure type is defunded in terms of growth spending. Therefore, each of the scenario

impacts must be understood in relation to the specific circumstances associated with that scenario, namely a hypothetical impact of entirely defunding a given infrastructure type.

Adequate transportation infrastructure allows for efficient movement of goods and people. In particular, Peel's strategic location as a hub for the movement of goods generates additional, idiosyncratic dependencies for national and even international trade. For instance, Peel's concentration of logistics and freight industries is the largest in Canada, and the share of Peel's transportation industry jobs is twice that of other regions (Region of Peel, n.d.). In addition, as Peel is home to 31% of the Greater Toronto Area's industrial and manufacturing activity (Wilbur Smith Associates and IBI Group, 2004), the provision of adequate transportation infrastructure serves to (National Economic Council and the President's Council of Economic Advisers, 2014):

- Reduce costs associated with inventory management;
- Improve access to employment for residents of Peel and for those who may commute into Peel;
- Lower congestion;
- Ensure stability in supply chains and shipping times; and
- Lower average household costs (due to lower fuel consumption, for example) and improve property values for residences near transit hubs.

The treatment of wastewater and provision of water are also vital to the prosperity of Peel, regions around Peel, and Ontario. In absence of new technologies mitigating the demand for water and wastewater infrastructure, investing in such infrastructure allows for reliable access to water for industry, which is particularly crucial for meeting demand that frequently cannot be resolved through self-supply mechanisms, which can often support only low levels of demand. Water and wastewater infrastructure supports lower operating costs for businesses, lower household costs, reduced risks of waterborne illnesses, and environmental conservation (Economic Development Research Group, Inc., 2011).

Generally speaking, failing to allocate adequate capital investments to accommodate growth across the diverse types of infrastructure in Peel has a series of dampening effects on Peel's ability to generate economic activity, as measured by regional GDP. Lower regional GDP implies lower output and aggregate income, and therefore fewer jobs and lower employment among residents. The depressed economic activity will also attract less private capital investment, as businesses find fewer lucrative opportunities in a less strong economy. Lower aggregate incomes also result in less taxation revenue for the provincial and federal governments through both income and consumption tax avenues. Therefore, adequate investments must be made across all necessary infrastructure types in order to ensure that Peel and the larger economy in which it is situated can benefit from the individual benefits associated with an infrastructure type, as well as the systemic interaction of adequate and appropriate infrastructure mixes and the economy. Table 4 demonstrates the baseline projections for Peel, and the impacts of defunding each respective infrastructure type relative to the baseline.

Table 4   Impact of Defunding Various Infrastructure Types: Peel[14]

		Type of Infrastructure Defunded			
		Waterworks	Wastewater	Transportation	Other
Economic Indicator	GDP loss (cumulative, real $)	-$263B	-$170B	-$96B	-$5B
	Reduction in Peel's economic activity in 2041	-21%	-14%	-8%	-0.4%
	Employed Residents	-59,300	-34,900	-40,600	-42
	Jobs	-141,700	- 92,500	-55,800	-1,400
	Private Capital Investment	-$91B	-$58.9B	-$32.7B	-$994M
	Provincial Tax Revenue	-$19.5B	-$12.4B	-$8.4B	-$302
	Federal Tax Revenue	-$18.1B	-$11.3B	-$8.2B	-$224
	Federal Infrastructure Investment	-$2.6B	-$1.7B	-$961M	-$51M
	Provincial Infrastructure Investment	-$6.2B	-$4B	-$2.2B	-$120M
	Municipal Infrastructure Investment (All Tiers)	-$4B	-$2.9B	-$2.6B	-$1.8B

This illustrates the relative importance to Peel of Waterworks capital, as both Waterworks and Transportation are expected to be allocated the same cumulative capital budget of $1.9 billion each between 2014 and 2041. Wastewater as well is a crucial investment avenue for Peel, as it has strong negative impacts across all economic indicators, despite having been projected to require a capital budget of $1.6 billion.

The defunding of various infrastructure types will also impact Peel's debt levels. Figure 28 below demonstrates the different levels of debt accrued by the Region of Peel by 2041.

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[14] All dollar sums are represented in 2014 real dollars. Figures for jobs and employed residents represent the differences in 2041 relative to baseline

Figure 28   Region of Peel Debt in 2041 by Infrastructure Defunding Scenario

DEBT IN 2041

The impacts of Peel not investing in its various forms of infrastructure, respectively, will be felt throughout the province, as well. Table 5 summarizes the negative impacts to surrounding regions if Peel defunds waterworks, Wastewater management, or transportation infrastructure, respectively.

Table 5   Impact of Defunding Various Infrastructure Types: Ontario (inclusive of Peel)[15]
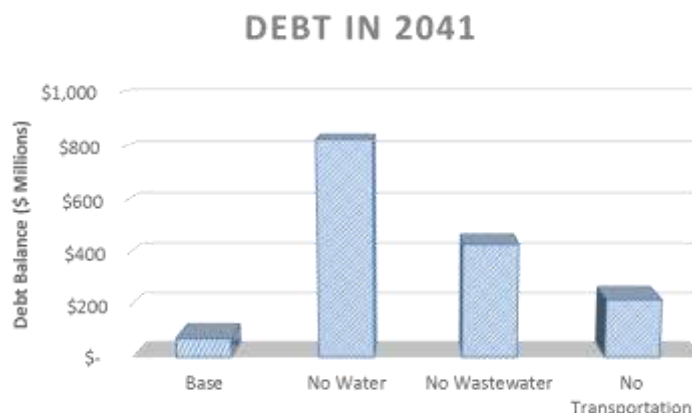
<table>
<tr><th colspan="6">Type of Infrastructure Defunded</th></tr>
<tr><th rowspan="11">Economic Indicator</th><th></th><th>Waterworks</th><th>Wastewater</th><th>Transportation</th><th>Other</th></tr>
<tr><td>GDP (cumulative, real $)</td><td>-$123.7B</td><td>-$79.6B</td><td>-$48.5B</td><td>-$2.5B</td></tr>
<tr><td>Jobs</td><td>-43,500</td><td>-30,000</td><td>-24,000</td><td>-1,000</td></tr>
<tr><td>Private Capital Investment</td><td>-$64.4B</td><td>-$41.5B</td><td>-$23.5B</td><td>-$504M</td></tr>
<tr><td>Provincial Tax Revenue</td><td>-$12.7B</td><td>-$8.1B</td><td>-$5.2B</td><td>-$305</td></tr>
<tr><td>Federal Tax Revenue</td><td>-$10.8B</td><td>-$6.8B</td><td>-$4.7B</td><td>-$253</td></tr>
</table>

4.2 POLICY DEPENDENCIES EXTERNAL TO PEEL

4.2.1   FEDERAL AND PROVINCIAL CAPITAL INVESTMENT

For Peel's infrastructure to be able to generate material benefits not only for the Region of Peel itself, but also for Ontario, it is imperative that surrounding municipalities as well as the federal and provincial government invest appropriately in capital. If this necessary investment does not occur, the productivity of Peel's infrastructure will not meet that projected through baselines. In addition, it is important that the provincial and federal government invest in the appropriate types of infrastructure, at the correct times and of adequate quality in order to realize baseline projections. In addition, the provincial and federal governments will only realize their returns outlined in section 3.4 if the necessary contributions are made

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[15] All dollar sums are represented in 2014 real dollars

to infrastructure. Public infrastructure funding features optimal risk and return apportionment when at approximately 5% of GDP (Smetanin, Stiff, & Kobak, 2014). Of this total:

- The federal government should invest 2% of GDP, bearing 39% of the investment risk; and
- The provincial government should invest 3.1% of GDP, bearing 61% of the investment risk.

Currently, infrastructure is funded at 3.1% of GDP by the provincial and federal government, with:

- The federal government investing 0.37% of GDP, bearing 12% of the investment risk; and
- The provincial government investing 2.8% of GDP, bearing 88% of the investment risk.

In order to allow Peel to grow sustainably, for every dollar invested by Peel in capital:

- The federal government should invest $3.16 in or near Peel
- The provincial government should invest $7.65 in or near Peel

Fiscal revenues and GDP at the optimal levels of infrastructure investment increase by a minimum of 20%. Figure 29 below demonstrates the current and optimal levels of infrastructure investment as a percentage of GDP.

Figure 29   Current and Optimal Infrastructure Investments
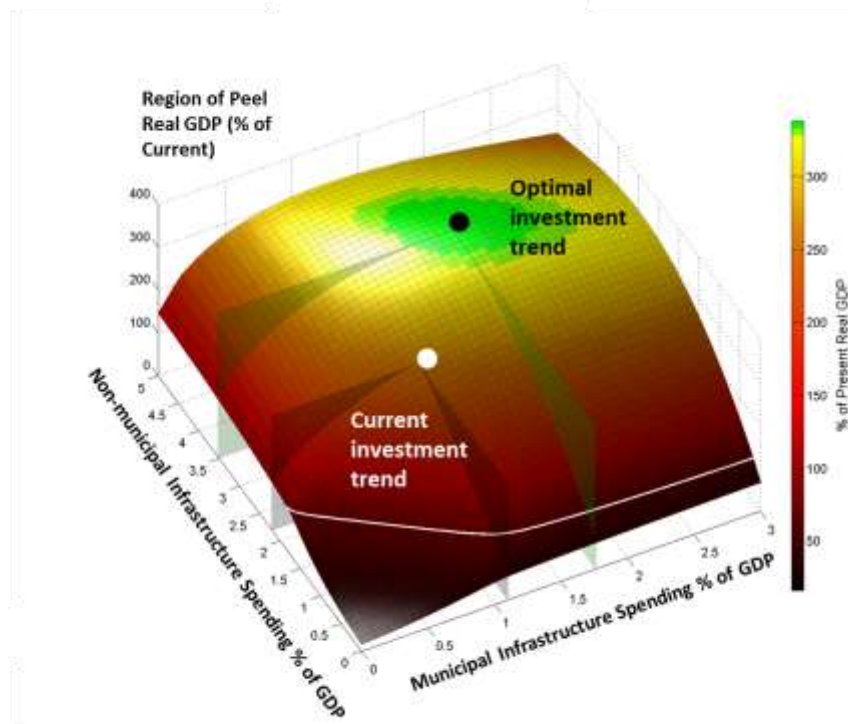
Aside from adequate investments made by the provincial and federal levels of government, as Peel invests $16 billion in capital from 2014 to 2041, inclusive, other investments must be made to sustain growth in the areas surrounding Peel, including:

- $55 billion total invested by Ontario in capital in or near Peel, of which $4.2 billion is directly due to Peel's growth, $38.7 billion is invested in asset replacement and other GTAH growth that depends upon Peel, and $12 billion is invested in maintenance.
- $22.7 billion total invested by the federal government in capital in or near Peel, of which $1.8 billion is directly due to Peel growth, $15.9 billion is due to federal assets in Peel and other GTAH growth, and $5 billion is invested in maintenance.
- $305 billion invested in non-residential private capital in Peel
- $139 billion invested in residential private capital in Peel

In addition, Peel must attract the appropriate mix of industry sectors in order to ensure that GDP increases according to baseline projections. Although an optimal mix of industry sectors is possible, the following figure demonstrates the impact of different types of private capital investment, assuming each industry sector increased private capital investment at the expense of all others. For instance, if the only industry sector investing in Peel was the office sector, GDP would suffer. Conversely, if the manufacturing sector increased its private capital investment relative to all other sectors, cumulative GDP could be expected to increase, which illustrates Peel's strong reliance upon and competitive advantage in the manufacturing industry that is also supported by transportation and logistics sectors. The reason for this lies in inherent differences in the patterns of intermediate consumption by various industry sectors in the context of Peel region. It is important to note, however, that different industries within each sector may exhibit different impacts on GDP. Figure 30 below illustrates the various impacts of attracting a single industry's sector's capital investment.

Figure 30   Growth and Capital Investment Scenarios in Peel
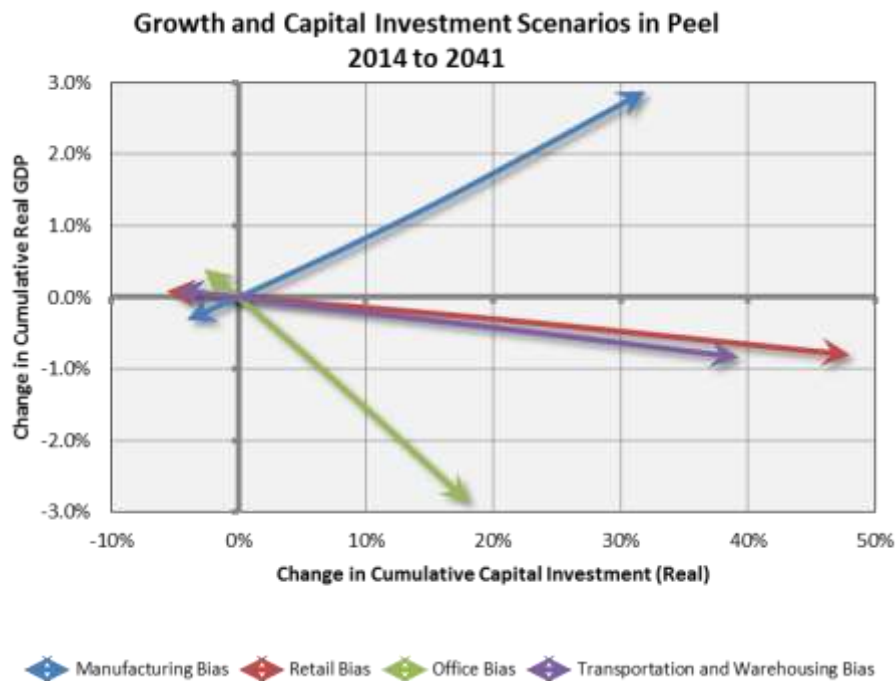
4.2.2   IMPORT AND EXPORT DEMAND

A variety of policies external to Peel have material impacts on the ability of Peel to accommodate growth. For instance, international demand for exports or imports can affect local economic growth. If the Canadian dollar increases in value relative to other currencies, for example, then foreign goods are relatively cheaper and Canada's demand for imported goods increases, provided that there no other significant macroeconomic pressures. The reverse is true if the Canadian dollar falls in value relative to other currencies; the demand for Canadian exports to other countries is expected to increase. Because net exports are a component of GDP, a change in the Canadian price level or value of the dollar can generate a series of macroeconomic effects. As Peel functions like a transportation hub and hosts a variety of industries that support both national and international trade, the impact of export and import demand translates directly into changes in the economic activity within Peel.

Relative to baseline projections, wherein Peel invests appropriately to accommodate growth, the following impacts can be expected upon the economy of Peel. Generally speaking, if **imports increase** or **exports decrease**, **Peel's economy will suffer** in terms of jobs in Peel, cumulative real GDP, and as a result, cumulative real provincial and federal tax revenues. Additional imports represent an outflow of funds to foreign countries, as domestic firms purchase goods from abroad. Conversely, additional exports bring foreign funds to domestic firms and stimulate consumption spending, along with the systemic effects that arise thereof. Table 6 below summarizes the cumulative expected impacts between 2014 and 2041 of changes in the imports or exports.

Table 6   Impact of International Import and Export Demand: 2014 to 2041 [16]

Outcome	Exports down 10%	Imports up 10%
Jobs in Peel	-55,900	-48,700
GDP (cumulative real $)	-$117B	-$108.9B
Reduction in Peel's economic activity in 2041	-6%	-5%
Provincial taxation revenues (real 2014 $)	-$16.9B	-$15.7B
Federal taxation revenues (real 2014 $)	-$19.7B	-$18.4B

4.2.3   IMMIGRATION AND TAX RATES

Federal regulations are subject to change, and those changes are difficult to predict as a result of the convolution between economic forces and political agendas. Immigration sustains the growth in the Canadian population. However, if immigration is reduced, Peel will be unable to attract the same population and economic growth as it would if current projections are realized. Peel's capital investment schedule remains the same as in the baseline projections under the various immigration scenarios, but private and provincial infrastructure investments vary according to the level of growth.

Similarly, the national tax structure generates effects ranging from variations in the redistribution of wealth, to a possible shift in aggregate demand. If taxes are increased, Peel's economy has less freedom to allocate the money that would have been spent on taxes to engage in other activities, such as hiring

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[16] Figures for Jobs represent the difference in 2041 levels relative to baseline.

and paying labour, increasing investment, or increasing consumption. However, the provincial and federal governments, under those circumstances can expect increased taxation revenues. **In fact, a 10% increase in taxation rates has the same GDP impact on Peel as a 50% interest rate increase.** Table 7 below outlines the impacts 10% increases in tax rates or decreases in the immigration, respectively.

Table 7   Impact of Immigration and Tax Rates: 2014 to 2041

Outcome	Immigration down 10%	Tax Rates up 10%
Jobs in Peel	-15,100	-21,700
GDP (cumulative real 2014 $)	-$18.4B	-$49B
Reduction in Peel's economic activity in 2041	-2%	-3%
Provincial taxation revenues (real 2014 $)	-$3B	+$6.3B
Federal taxation revenues (real 2014 $)	-$3.4B	+$14B

4.2.4   PLACES TO GROW

Places to Grow provides regions with concrete projections and assists with the planning process, including estimates for where new populations will settle throughout the GTAH. Understanding how the population will evolve over time is an integral aspect of the planning process; however, there are also material risks associated with growth when reality diverges from those projections.

 Prosperity at Risk was able to recover the population projections generated under Places to Grow legislation, but some regions' projections did not align as closely as those for Peel's population. For instance, for Durham Region to reach the growth targets stipulated by Places to Grow, its immigration must increase 20-fold. *Prosperity at Risk* features variance limits on parameters such as immigration, which are based on historical data, and this necessary increase in Durham's immigration lies outside the variance limits of *Prosperity at Risk*. In addition, *Prosperity at Risk* was unable to recover the job projections forecasted by Places to Grow. By 2014, Places to Grow overestimated the number of jobs in Peel by 11%. By 2041, this gap is expected to widen to an overestimation of 171,200 jobs in total.

Job projections are central to the ability of Peel to cover its debt, by generating revenue through development charges. If job projections are not realized, Peel cannot generate sufficient revenue from development charges to cover the debt it accrued in anticipation of job growth. **If Peel plans and services the region according to Places to Grow, it is at risk of being overcapitalized on employment lands development, exposing the risk to the region of over $2 billion in stranded debt by 2041.**

If this does not occur, the population that is expected to settle in Durham according to Places to Grow may have to settle elsewhere in the GTAH. Additionally, for instance, the Ministry of Finance features its own demographic projection models, which estimate higher levels of growth for the city of Toronto. The method and model by which projections are performed are crucial for Peel and other regions to be able to adequately quantify the investments it must make today. Figure 31 below demonstrates the projections *Prosperity at Risk* (*PaR*) has generated for the populations of Durham and Toronto, respectively, relative to those generated by Places to Grow (P2G).

Figure 31   PaR and P2G Population Projections: Durham and Toronto
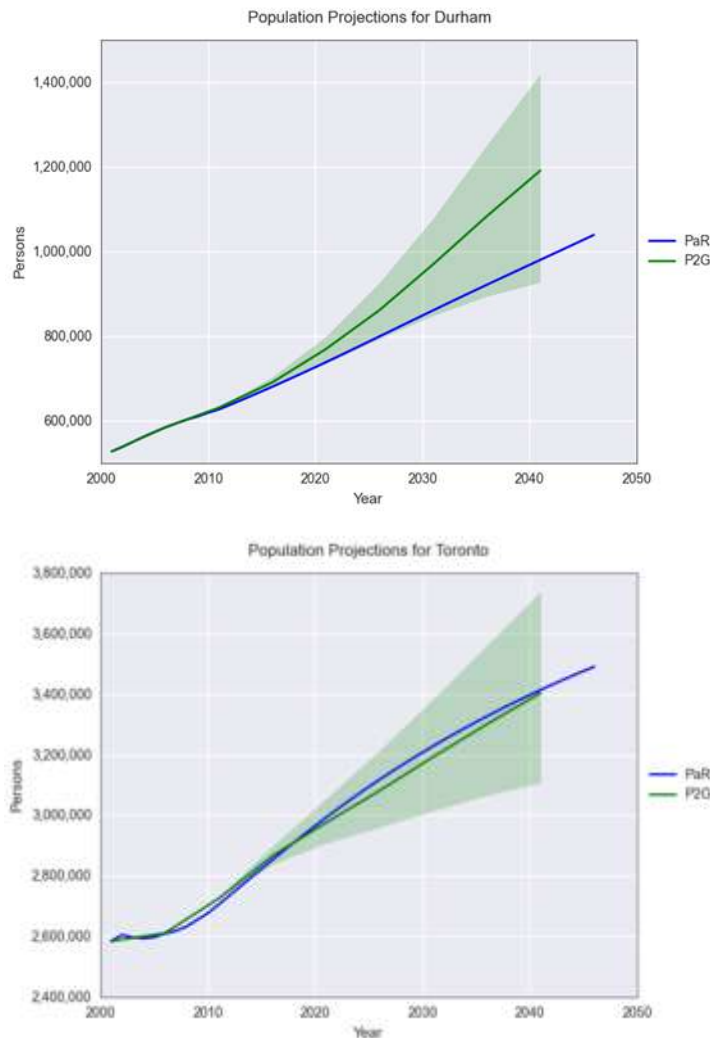
Furthermore, although *Prosperity at Risk* was able to conform to the population projections created through Places to Grow for the Region of Peel, it was unable to recover the projection job and employment numbers. Because of this, the Region of Peel does not face significant risk associated with its planned investment in residential lands, as it is projected to accrue sufficient revenue from associated development charges to cover the cost of the investment. However, there are significant implications on land use planning and revenue streams associated with non-residential development charges.

Unlike Places to Grow, *Prosperity at Risk* creates a distinction between employed residents living within Peel and the jobs that Peel hosts within the region. The Places to Grow projections for jobs exceeds both of these measures projected through Prosperity at Risk, as is evidenced in Figure 32 below. Additionally, unlike *Prosperity at Risk*, Places to Grow does not distinguish between full-time and part-time work, as well as between jobs that have a fixed location, jobs that are performed from the workers' homes, and jobs that have no fixed location.

Figure 32   P2G and PaR Job Projections: Peel

PEEL JOBS & EMPLOYMENT
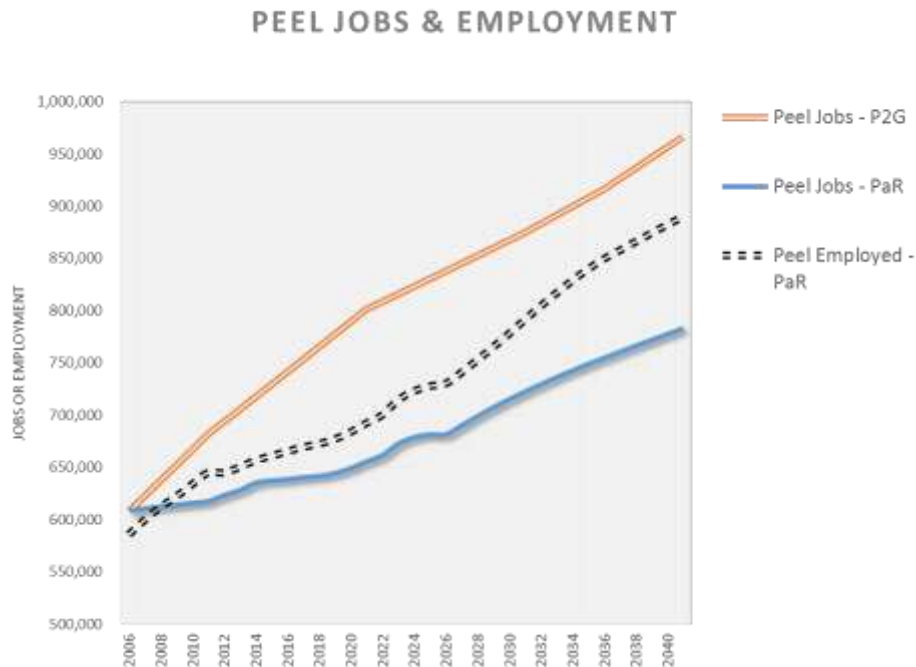
Figure 33 below illustrates the cumulative difference in the job projections of Places to Grow and *Prosperity at Risk*. By 2014, the cumulative number of jobs in Peel projected by Places to Grow was over 70,000 greater than that projected by *Prosperity at Risk*. By 2041, this gap widens to over 171,000 jobs. As Peel must borrow in order to finance the development of employment lands to conform to Places to Grow projections, it inherits all of the risk associated with this potential overestimate. Peel can expect growing reliance on residential tax revenue as a result, which means that the risk is transferred to residents of Peel in the form of larger tax levies.

The transfer of risk to residents of Peel is to be expected as well if Peel plans and services employment lands in accordance with Places to Grow projections. By 2041, the inability of Peel to recover the DC revenues to finance the infrastructure investments associated with planning to those projections will result in outstanding debt. The only way this debt can be covered at that time is through increases in taxes upon residents.

However, increases in taxes, utility rates, development charges, or user fees in order to cover regional expenditures are not without their economic impacts, either. For instance, expanding service provision to less developed areas will increase the property values of those areas, which encourages increases in density, possibly contributing to urban sprawl; however, if property taxes are increased to match the value of the services provided, then the positive impacts of service provision on land value will be neutralized by the tax levy (Slack, 2006). User fees such as road tolls, if they are set to the marginal cost of service provision, or the cost of offering the service to one additional user, lead to efficiency in the allocation of

resources, and efficient levels of consumption and production[17]. If user fees are charged at average cost per user, then residents of less developed areas of the region receive a subsidy on the service, as they pay less than the marginal cost of providing that service to an area where service provision is relatively more expensive (Slack, 2006). Although developing a municipal finance plan and designing fiscal tools is outside the scope of this study, the Region of Peel must consider the capacity of their financial instruments to help the region achieve its development goals, which are not always limited to the quantity of growth, but also include the location and type of growth.

Figure 33   P2G and PaR Job Projections, Difference: Peel
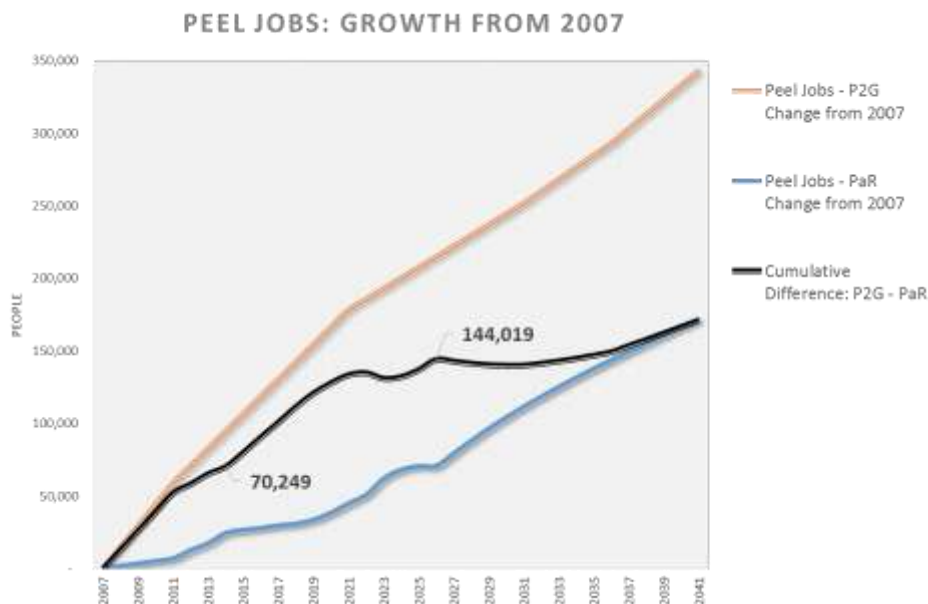
4.3 RISKS OF GROWTH: CONCLUSIONS

The internal and external dependencies surrounding Peel's economy give rise to diverse risks that jeopardize Peel in its ability to achieve all of the benefits of the growth described in Section 3. Understanding the economy of Peel and its surrounding areas as a cohesive system allows for the identification of diverse dependencies from which these risks arise. Although not exhaustive, these include strategic risks, such as the appropriate allocation of capital spending across infrastructure types, the participation of the provincial and federal orders of government in capital accumulation and development, national immigration and taxation policies, and the industry sector mix whose private

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[17] Marginal cost pricing will not always cover the cost of providing the service. For example, if the region has a natural monopoly, then marginal cost pricing of user fees will not also cover the fixed costs associated with service provision. In cases like these, subscription fees along with the per-unit user fees at marginal cost can be employed to ensure both efficient consumption of resources and adequate regional revenue to cover service delivery costs. (Dewees, 2002)

capital investment Peel attracts. Economic shocks also present risks to the growth of Peel, including import and export demands, and shocks to the costs of intermediate materials required by Peel in order to deliver capital and operational goods and services. Finally, there are planning risks associated with the realization of employment and population growth projections. Many of these risks are difficult to mitigate without co-ordination with decision-makers governing bodies outside of the Region of Peel; however remaining cognizant of the various risks facing Peel's own decisions, as well as any irrevocable external risks, can allow the Region of Peel to engage in informed decision-making and planning.

5.0 CONCLUSIONS

5.1 OVERVIEW

Modeling the Region of Peel as a cohesive system is integral to capturing the dependencies that give rise to a more comprehensive measurement of costs, benefits, and risks associated with the growth in Peel's population and economy between 2014 and 2041. Agent-based modeling was employed in order to analyze the value of Peel's growth-oriented investments in the present as they allow the region to develop according to growth objectives. This systems-oriented approach combines the Region of Peel's internal budget projection methodology, the long-term financial model, and complete data on Peel's financial accounts with *Prosperity at Risk*'s vast databases on historical economic trends, behavioural heuristics, and geographic mapping, in the context of its interconnected analytical framework. This holistic approach has allowed for results to appreciate that plans and decisions made today not only have pervasive impacts over time, but also across many individuals, firms, government organizations, and other stakeholders both within and outside the Region of Peel.

The Region of Peel is required to plan to population growth projections stipulated under the Places to Grow Act, 2005, which forecasts that Peel will grow by 41%, or an additional 569,400 individuals between 2014 and 2041, reaching total population of approximately 1.97 million. In order to accommodate these individuals, Peel must invest in its infrastructure to accumulate and maintain the necessary capital. Based on regional budget projections, growth-related capital spending between 2014 and 2041 will sum to approximately $5.6 billion for new capital, with an additional estimated $0.55 billion for state of good repair investments on the new infrastructure built within this timeframe. If these investments are made and growth occurs as expected, the Region of Peel will benefit from a strengthened economy, including a 47% increase in regional GDP between 2014 and 2041, a 35% increase in employed residents, an 80% increase in private non-residential capital investment, and a 40% increase in private residential capital investment.

In addition, the province and Canada overall are significant beneficiaries of Peel's growth. As a result of increased economic activity in Canada, the provincial government can expect an additional $35.5 billion in tax revenues that are directly attributable to the Region of Peel investing and growing according to expectations. Provincial GDP will increase as well; for every dollar increase of GDP in Peel, Ontario's GDP will increase by $1.63 (inclusive of the Region of Peel). Similarly, for every job created within the Region of Peel as a result of its growth, 2 are created within Ontario (inclusive of the Region of Peel). Demonstrably, the accommodation and attraction of population growth within Peel generates wide-reaching benefits; however, these benefits are not assured.

Peel's demographic and economic development faces internal and external risks. For instance, if Peel fails to allocate capital investment optimally across water, wastewater, and transportation infrastructure, it jeopardizes much of the benefits it stands to accrue from growth in terms of regional GDP, employment, jobs, and private capital investment. Particularly water and wastewater infrastructure are central to Peel's ability accommodate growth and prosper. Furthermore, Peel must ensure that it attracts private capital investment from the correct mix of industry sectors. The reason for this is that different sectors, such as

offices and manufacturing, have different patterns of consumption of intermediate goods, and therefore have different impacts upon the economy once indirect, induced, and system effects are taken into consideration. Therefore, attracting the same quantity of private capital investment from different sectors may not generate the same number of jobs and the same quantity of other economic activity overall. Policy frameworks also pose risks to the economic development of Peel, with decreases in the national immigration rate and increases in national taxation rates inspiring dampened growth within Peel despite local adequate and appropriate growth-oriented investment. Finally, the budgetary structure in which Peel must accrue debt in anticipation of growth relies on the growth to occur for that debt to be paid. If growth does not occur as expected, the residents of Peel must bear the burden of increased tax levies and utility rates in order to repay the debt. As regional financial instruments must reflect appropriate pricing in order to encourage growth to occur in the right quantity, in the right location, and of the right type, such an increase in costs to residents may also pose extraneous risks in the ability of Peel to meet its future growth objectives if it manipulates its fiscal tools without assessing the associated impacts.

The federal and provincial government must also participate in supporting growth in Peel and surrounding areas in order to not only assist Peel in meeting its growth objectives, but also to ensure that the provincial and federal orders of government receive the full magnitude of taxation revenue benefits associated with Peel's growth. The current, suboptimal apportionment of risks and rewards with respect to infrastructure investment creates an inequitable distribution of investment risk between the municipal, provincial, and federal orders of government, and also threatens the sustainability of the municipal economies. In order to ensure continued development as well as equitable sharing of the benefits of infrastructure investment, the provincial and federal government must acknowledge their roles as stakeholders in the process of growth, whose participation in ensuring that growth occurs is invaluable to themselves, the municipal government, and most of all, individual residents across the province.

5.2 LIMITATIONS

Although all projections and analyses were completed with the best data and the appropriate methods, it is important to note that budgets were projected according to the Region of Peel's methodologies, and population projections were parameterized to align with existing Places to Grow legislation. Some of the projections—such as for jobs in Peel—that were stipulated under Places to Grow are far in excess of what results from *Prosperity at Risk* projections would suggest. The precision of these projections must be understood in this context.

5.3 FUTURE RESEARCH

Additional work may be performed to model the process of land use allocation as the economy of Peel and surrounding regions evolve over time. Some features that would improve the precision and accuracy of economic impacts of development include adding friction into the current land use model. Additionally, Places to Grow legislation centers on environmental conservation in tandem with development. Expanding the existing model to take environmental impacts and trade-offs into consideration may expand the scope of analysis.

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C. DATA SOURCES

The following table outlines data sources used within Prosperity at Risk, in conjunction with budgetary data provided by the Region of Peel.

Quantity	Description	CANSIM Table
DEMOGRAPHIC TABLES		
Population	The population of Canada by age and sex	051-0001
Births	The number of births in Canada by sex	051-0013
Deaths	Number of deaths in Canada by age and sex	051-0002
Immigration	Immigration into Canada by age and sex	051-0012
Emigration	Emigration from Canada by age and sex	051-0012
ECONOMIC TABLES		
National Balance Sheet Accounts	National Balance Sheet Accounts quarterly	378-0121
Current and Capital Accounts	Current and capital accounts - Households (quarterly)	380-0072
	Current accounts - Households, provincial and territorial (annual)	384-0040
	Provincial and territorial consumption of fixed capital at replacement cost, by sector (annual)	384-0043
	Current and capital accounts - Non-profit institutions serving households (quarterly)	380-0075
	Current and capital accounts - Corporations (quarterly)	380-0076
	Current and capital accounts - General governments (quarterly)	380-0079
	Current and capital accounts - Non-residents (quarterly)	380-0082
Financial Flow Tables	Financial Flow Accounts (quarterly)	378-0119
	Financial Flow Accounts (quarterly)	378-0119
	Flows and stocks of fixed residential capital (annual)	030-0002
	Flows and stocks of fixed non-residential capital, by North American Industry Classification System (NAICS) and asset, Canada, provinces and territories (annual)	031-0002
	Flows and stocks of fixed residential capital (annual)	030-0002
Balance of International Payments	Balance of international payments, current account, investment income, by type and sector (quarterly) (dollars x 1,000,000)	376-0013
Income Tables	Income of individuals, by sex, age group and income source, 2011 constant dollars (annual)	202-0407
	Property income of households (quarterly)	380-0087
	Property income of households, provincial and territorial (annual)	384-0044

Input-Output Tables	Input-output tables, inputs and outputs, detailed level, basic prices	381-0022
	Provincial gross domestic product (GDP) at basic prices, by sector and industry (annual)	381-0030
	Provincial input-output tables, inputs and outputs, summary level, basic prices (annual)	381-0028
	Input-output tables, final demand, detailed level, basic prices (annual)	381-0023
	Provincial input-output tables, final demand, summary level, basic prices (annual)	381-0029
	Provincial input-output tables, international and interprovincial trade flows, summary level, basic prices (annual)	386-0003
	Inputs and outputs, by industry and commodity, S-level aggregation and North American Industry Classification System (NAICS) (annual)	381-0013
Labour Force Statistics	Labour force survey estimates (LFS), by sex and detailed age group (annual)	282-0002
	Labour force survey estimates (LFS), by North American Industry Classification System (NAICS), sex and age group (annual)	282-0008
	Labour force survey estimates (LFS), by provinces, territories and economic regions based on 2006 Census boundaries (annual)	282-0055
	Labour statistics consistent with the System of National Accounts (SNA), by province and territory, job category and North American Industry Classification System (NAICS) (annual)	383-0031
	Labour force survey estimates (LFS), retirement age by class of worker and sex (annual)	282-0051
	Labour force survey estimates (LFS), retirement age by class of worker and sex (annual)	282-0051
Other	Capital and repair expenditures, by sector and province (annual)	029-0005
	Consolidated federal, provincial, territorial and local government revenue and expenditures (annual)	385-0001

D. PROSPERITY AT RISK OVERVIEW

In highly simplified terms, the economic portion of the model is driven by four constituent components: a Production Model; a Labour Force Model; an Economic Account Model and the Municipal Accounts Model

1. **The Production Model** simulates industries that consume inputs and produce both consumption and intermediate goods as outputs. Industries are able to hire workers, pay wages, or fire them, as needed in order to produce market-determined levels of respective commodities. They are constrained by the productivity of capital and labour, and can invest in capital and financial assets. Total output is driven by consumer demand and informed by consumer demand data from Statistics Canada. GDP is calculated, therefore, by the relationship of inputs and outputs aggregated over all industries.

2. **The Labour Force Model** follows individual agents as they age, make decisions related to labour, earn and spend income, consume goods, and comprise populations.

3. **The Economic Account Model** incorporates Canada's System of Macroeconomic Accounts, ensuring that aggregate economic activity is consistent with Statistics Canada's information, such that micro-level behaviours comprise and follow realistic aggregates. This information includes financial statements, balance of payments data, input/output information, and data on income and expenditure.

4. **The Municipal Account Model** simulates the municipal budgets within the more general context of Canada's System of Macroeconomic Accounts. These include the operational and capital expenditures as well as all sources of funding. The production output along with labour force movements are used to generate comprehensive results for economic conditions within all municipal regions in Canada. Debt is generated on the basis of specific capital expenditures and the influx of development charge revenues. A closed system of municipal accounts is used to simulate future annual budgets.

To obtain further information on the key technical details of the Prosperity at Risk simulation platform, please contact:

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E. MUNICIPAL BUDGET TECHNICAL DETAILS

1. The model simulated the evolution of the municipal budget
2. The budget information consists of:
   - Operations (Discussed in section E.1.)
   - Capital (Discussed in section E.2.)
   - Debt (Discussed in section E.3.)
   - Reserves (Discussed in section E.4.)

The general structure of the model is illustrated in Figure 34, below.

Figure 34   Municipal Budget Flows
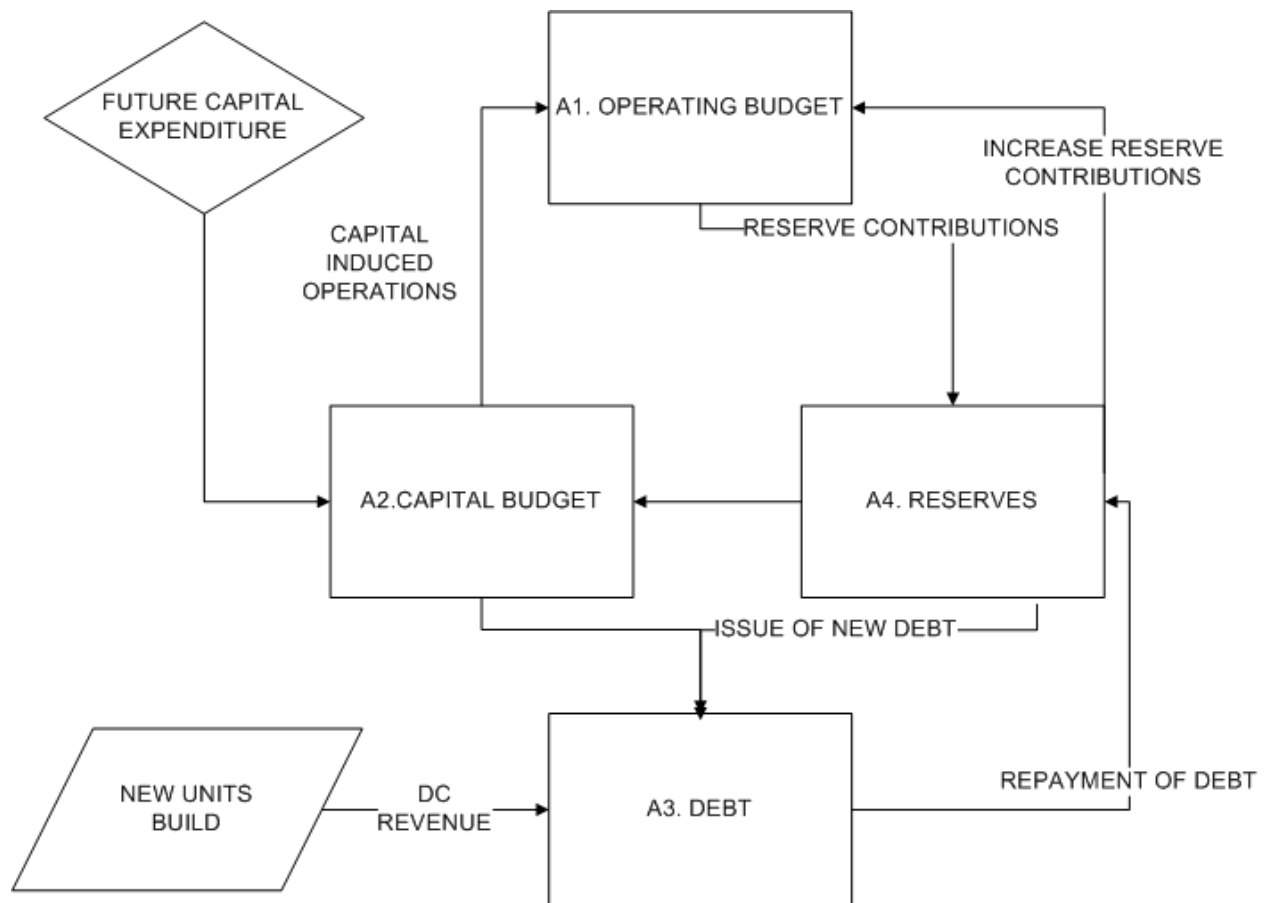
3. The budget is composed of two main categories:
   - Operations Budget: Used to support program operations i
   - Capital budget: Used to supports capital expenditures such as maintenance and repairs (covered under the state of good repairs) and new capital expenditures for programs i
4. Each of the two categories is funded by two main sources:
   - k = Taxes Funded
   - k = Utility Rate Funded
5. In addition, the capital budget is also supported by:
   - k = Developmental Charges (DC)
6. The operations (Section E1) supports the day to day operations of a set of N programs, indicated by index i
7. The Operations Budget consists of expenditure $EO_{i,k}^{j}(t)$ and revenues $RO_{i,k}^{j}(t)$
8. The portion of the budget which is supported strictly by the residents and local industry is given by $FO_{i,k}^{j}(t)$ (This represents the annual tax and utility rate contributions of the residents/industries of the region). The remainder of the revenues $RO_{i,k}^{j}(t)$ consists of grants, fines and other funding sources (not incurred by the residents/local industries)
9. The capital budget (Section E2) supports all capital expenditures, consisting of:
   - Capital expenditures supporting existing populations. These include improvements, maintenance and repair (SOGR) and are funded through the existing reserves
   - Capital expenditures supporting new populations. These are funded through the collection of development charges (DC)
10. The expenses and funding are simulated within the model
11. The capital expenditures which are DC eligible are funded by the municipality through debt, in anticipation of growth and prior to the collection of DC revenues
12. That is, the debt is incurred by the municipality, in anticipation of new growth, before the DC charges are paid by the developers
13. The issuance and repayment of debt is modeled in section E3
14. Each issuance of debt carries with it a schedule of principal and interest payments, given by $\Pi_{DC}(t_{Issue}, t)$ and $O_{DC}(t_{Issue}, t)$
15. The total debt at any point in time consists of the total of the combined interest and principal payments over all historical issues
16. The principal payments can be placed in a sinking fund $\Upsilon_{DC}(t_{Issue}, t)$ for each debt issue $\Sigma_{DC}(t_{Issue})$
17. The sinking fund can be allowed to be invested to earn an additional $\delta\Upsilon_{DC}(t_{Issue}, t)$ which can be used to pay down the net debt
18. The capital expenditures are supported by capital reserves $\Omega_{k}(t)$
19. These are modelled in section E4

20. A minimum reserve level of $R_k(t)$ is imposed on each reserve k. When the levels are not meet by the amount $\Delta_{new}(t)$, the revenue must increase by the same amount

$$FO_{i,k}^j(t) \rightarrow FO_{i,k}^j(t) + \beta_{i,k}^j \Delta_{new}(t)$$

21. Development charges $\tilde{\Gamma}_{DC}^h(t)$ are paid by developers to cover the costs of new structures h, aimed at supporting the growing population

22. These include, residential and non-residential units

23. The lag between the incurrence of capital expenditures (related to the future construction) and the payment of the development charges is financed by the issuance of new debt $\Sigma_{DC}(t)$ at time $t = t_{Issue}$

24. The debt is issued from the capital reserves such that, the amount of debt and the current capital expenditures is always less than the minimum reserve level of $R_k(t)$

E.1. OPERATING BUDGET (REGION OF PEEL)

25. The municipality is responsible for providing operational funding to a number of programs
26. The operational budget consists of an expense account and a revenue account
27. The expense account outlines the expected costs associated with each program i (CC1-CC79)
28. The revenue account outlines the expected sources of funding to cover the expected operational expenses. These consist of four key sources:
    - Program revenues (such as fees, client charges, etc.)
    - Grants from other governments
    - Tax levy collected from residential and non-residential properties
    - Utility rate from residential and non-residential properties
29. Utility rate is used to finance the water and wastewater operations (as well as a limited number of other operations such as parts of conservation, for instance)
30. Tax levy is used to finance all other (non-utility rate financed) operations
31. In theory, the operational budget cannot run deficits. As a result, we assume that the operating expenses and revenues always equal
32. A deficit in funding from program revenues and grants is always covered by regulating the tax levy and utility rate (for the specific year)

Table 8   Operating Budget Model Definitions

Variable	Description
t_{Base}	Base year, with respect to which the future budget computations are performed.
$EO_{i,k}^{j}(t)$	Annual (year t) cost of financing an account j of program's i operations which are supported by k
$RO_{i,k}^{j}(t)$	Annual (year t) revenue (which excludes property tax and utility rates) from account j of program's i operations which are supported by k
$FO_{i,k}^{j}(t)$	Annual (year t) available funding from property tax and utility rates from account j of program's i operations which are supported by k
$FO_{Adj,i,k}^{j}(t)$	Annual (year t) available funding from property tax and utility rates from account j of program's i operations which are supported by k which is adjusted for reserve funding sufficiency
$V_i(t_{Base},t)$	Volume driver at time t for program i, with respect to the base year t_{Base} such that $V_i(t_{Base},t_{Base})=1$
$C_{\Phi}^{j}(t_{Base},t)$	Cost driver ($\Phi=\{E,R\}$ at time t for account j, with respect to the base year t_{Base} such that $C_{\Phi}^{j}(t_{Base},t_{Base})=1$
$\pi_k(t)$	Funding gap for year t. This represents the amount of funding for program of type k which needs to be raised from property taxes and/or utility rates
$\beta_{i,k}^{j}(t_{Base})$	Funding contribution matrix, providing the proportions of the total funding $\pi_k(t)$ which is attributed to a specific program i and account j
$\alpha_{67,\text{Utility}}(t_{Base})$	Proportion of funding of $i=CC67$ which comes directly from utility rate
$r_{\pi.k}$	The annual tax (k=Tax) and utility (k=Utility) increases which are used to fund the capital reserves
$KE_{i,k}^{j}(t)$	Capital induced expenditures
$KR_{i,k}^{j}(t)$	Capital induced revenues

- The volume drivers can be separated into categories:
- Computed in the model:

$$V_{i=CC13}(t_{Base},t)=V_{i=CC14}(t_{Base},t)=100\frac{P_{0-4}(t)}{P_{0-4}(t_{Base})}$$

$$V_{i=CC16}(t_{Base},t)=V_{i=CC17}(t_{Base},t)=V_{i=CC18}(t_{Base},t)=100\frac{P_{20-59}(t)}{P_{20-59}(t_{Base})}$$

$$V_{i=CC29}(t_{Base},t)=100\frac{P_{70+}(t)}{P_{70+}(t_{Base})}$$

$$V_{i=CC35}(t_{Base},t)=100\frac{P(t)+E(t)}{P(t_{Base})+E(t_{Base})}$$

$$V_{i=CC21}(t_{Base},t) = V_{i=CC30}(t_{Base},t) = V_{i=CC31}(t_{Base},t) = 100\frac{P(t)}{P(t_{Base})}$$

- $V_i(t_{Base},t)$ with i={CC20,CC33,CC37-38,CC42} (description provided below)

$$V_i(t_{Base},t) = 100\frac{H(t)}{H(t_{Base})}$$ with i={CC48-CC52}

$$V_i(t_{Base},t) = 100(1.015)^{(t-t_{Base}-1)}$$ with i={CC75-CC77}

$$V_i(t_{Base},t) = 100\frac{\sum_l\left(P_l(t)+E_l(t)\right)}{\sum_l\left(P_l(t_{Base})+E_l(t_{Base})\right)}$$ with i={CC53,CC55} and

$$l = \{\text{Brampton, Mississagua}\}$$

- Provided as input:
  - Capital Induced drivers (i={CC10,CC15,CC78,CC36} are provided as needed (when data is unavailable assume a value of 0)
  - All other Volume Drivers are provided as input for $t \le 2041$ while for $t > 2041$:

$$V_i(t_{Base},t) = \text{average}\left\{\left(\frac{V_i(t_{Base},t)}{V_i(t_{Base},t-1)}\right),10\right\}V_i(t_{Base},t-1)$$

  - In the above, the average function takes the average of last n terms:

$$\text{average}\left\{\left(\frac{V_i(t_{Base},t)}{V_i(t_{Base},t-1)}\right),n\right\} = \frac{1}{10}\left(\sum_{i=t-n}^{i=t-1}\frac{V_i(t_{Base},i)}{V_i(t_{Base},i-1)}\right)$$

- The index i identifies the program (CC1-CC79)
- The index j identifies the specific account (E1-E24 for expenditure accounts and R1-R21 for revenue accounts)
- The index k identifies the source of funding as $k = \text{Tax}$ if funding is from taxation revenue and $k = \text{Utility}$ if funding is from utility rate revenue
- The index k is used to distinguish between quantities which are supported by either tax or utility rate

Computation of $EO_{i,k}^j(t)$

- At time t, the cost drivers $C_E^j(t_{Base},t)$ are computed as:

$$C_E^j(t_{Base},t) = 100(1+\lambda_I)^{(t-t_{Base})}$$

- For $j = \{E1, E2\} \cup \{E4, E5, E6\} \cup \{E8, E9, ..., E13\}$ and $\quad$ are $\quad$ provided $\quad$ as $\quad$ input $\quad$ for $j = \{E3, E7\} \cup \{E14, E15, ..., E23\}$

- Cost drivers for which $C_E^j(t_{Base}, t) = 100 \; \forall t \le 2041$ remain $C_E^j(t_{Base}, t) = 100 \; \forall t > 2041$

- At time t, the drivers $V_i(t_{Base}, t)$ are provided from input (see description above about instruction for t>2041) for $i = \{CC1, CC2, ..., CC19\} \cup \{CC21, CC22, ..., CC32\}$ and $i = \{CC34, ..., CC36\} \cup \{CC39, ..., CC41\} \cup \{CC43, ..., CC79\}$

- Compute:

$$EO_{i,k}^j(t) = EO_{i,k}^j(t_{Base})\left[V_i(t_{Base}, t)/100\right]\left[C_E^j(t_{Base}, t)/100\right] + KE_{i,k}^j(t)$$

given the inputs $KE_{i,k}^j(t)$ and $EO_{i,k}^j(t_{Base})$ for:

$$i = \{CC1, CC2, ..., CC19\} \cup \{CC21, CC22, ..., CC32\}$$
$$\cup \{CC34, ..., CC36\} \cup \{CC39, ..., CC41\} \cup \{CC43, ..., CC79\}$$

and:

$$j = \{E1, E2, ..., E23\}$$

- Compute the driver:

$$V_{CC33}(t_{Base}, t) = 100 \frac{\sum_{j=E1}^{E23}\left(\sum_{i=CC34}^{CC36} EO_{i,k}^j(t)\right)}{\sum_{j=E1}^{E23}\left(\sum_{i=CC34}^{CC36} EO_{i,k}^j(t_{Base})\right)}$$

- Compute:

$$EO_{CC33,k}^j(t) = EO_{CC33,k}^j(t_{Base})\left[V_{CC33}(t_{Base}, t)/100\right]\left[C_E^j(t_{Base}, t)/100\right] + KE_{CC33,k}^j(t)$$

for $j = \{E1, E2, ..., E23\}$

- Compute the driver:

$$V_{CC20}(t_{Base}, t) = 100 \frac{\sum_{j=E1}^{E23}\left(\sum_{i=CC21}^{CC36} EO_{i,k}^j(t) + EO_{CC78,k}^j(t)\right)}{\sum_{j=E1}^{E23}\left(\sum_{i=CC21}^{CC36} EO_{i,k}^j(t_{Base}) + EO_{CC78,k}^j(t_{Base})\right)}$$

- Compute:

$$EO_{CC20,k}^j(t) = EO_{CC20,k}^j(t_{Base})\left[V_{CC20}(t_{Base}, t)/100\right]\left[C_E^j(t_{Base}, t)/100\right] + KE_{CC20,k}^j(t)$$

for $j = \{E1, E2, ..., E23\}$

- Compute the driver:

$$V_{CC42}(t_{Base},t) = 100 \frac{\sum\limits_{j=E1}^{E23}\left(\sum\limits_{i=CC43}^{CC47} EO_{i,k}^{j}(t)\right)}{\sum\limits_{j=E1}^{E23}\left(\sum\limits_{i=CC43}^{CC47} EO_{i,k}^{j}(t_{Base})\right)}$$

- Compute:

$$EO_{CC42,k}^{j}(t) = EO_{CC42,k}^{j}(t_{Base})\left[V_{CC42}(t_{Base},t)/100\right]\left[C_{E}^{j}(t_{Base},t)/100\right] + KE_{CC42,k}^{j}(t)$$

for $j = \{E1, E2, ..., E23\}$

- Compute the driver:

$$V_{i}(t_{Base},t) = 100 \frac{\sum\limits_{j=E1}^{E23}\left(\sum\limits_{i=CC1}^{CC36} EO_{i,k}^{j}(t) + \sum\limits_{i=CC39}^{CC55} EO_{i,k}^{j}(t) + \sum\limits_{i=CC68}^{CC69} EO_{i,k}^{j}(t) + EO_{CC78,k}^{j}(t)\right)}{\sum\limits_{j=E1}^{E23}\left(\sum\limits_{i=CC1}^{CC36} EO_{i,k}^{j}(t_{Base}) + \sum\limits_{i=CC39}^{CC55} EO_{i,k}^{j}(t_{Base}) + \sum\limits_{i=CC68}^{CC69} EO_{i,k}^{j}(t_{Base}) + EO_{CC78,k}^{j}(t_{Base})\right)}$$

for $i = \{CC37, CC38\}$

- Compute:

$$EO_{i,k}^{j}(t) = EO_{i,k}^{j}(t_{Base})\left[V_{i}(t_{Base},t)/100\right]\left[C_{E}^{j}(t_{Base},t)/100\right] + KE_{i,k}^{j}(t)$$

given the inputs $K_{i,k}^{j}(t)$ and $EO_{i,k}^{j}(t_{Base})$ for $i = \{CC36, CC37\}$

- Finally, compute the cost driver $C_{E}^{24}(t_{Base},t)$ as:

$$C_{E}^{E24}(t_{Base},t) = 100 \frac{\sum\limits_{j=E1}^{E23}\left(\sum\limits_{i=CC1}^{CC79} EO_{i,k}^{j}(t)\right)}{\sum\limits_{j=E1}^{E23}\left(\sum\limits_{i=CC1}^{CC79} EO_{i,k}^{j}(t_{Base})\right)}$$

- Compute:

$$EO_{i,k}^{E24}(t) = EO_{i,k}^{E24}(t_{Base})\left[V_{i}(t_{Base},t)/100\right]\left[C_{E}^{E24}(t_{Base},t)/100\right] + KE_{i,k}^{E24}(t) \quad \forall i$$

Computation of $RO_{i,k}^{j}(t)$

- The values of $V_{i}(t_{Base},t)$ are used from the previous step (not computed again)

- At time t, the cost drivers $C_{R}^{j}(t_{Base},t)$ are computed as:

$$C_{R}^{j}(t_{Base},t) = C_{E}^{E24}(t_{Base},t)$$

For $j = \{R1, R11, R12, R13\}$

- The cost drivers are given by:

$$C_R^j(t_{Base},t) = 100\left(1+\lambda_I\right)^{(t-t_{Base})}$$

For $j = \{R14, R15, R16\}$

- The remaining drivers are provided from the input
- Compute:

$$RO_{i,k}^j(t) = RO_{i,k}^j(t_{Base})\left[V_i(t_{Base},t)/100\right]\left[C_R^j(t_{Base},t)/100\right] + KO_{i,k}^j(t)$$

For all values except the collected Utility rate

$$RO_{i,k}^{R19}(t) = 0 \quad \text{with} \quad i = \{CC58,...,CC61\}$$

and collected tax levy:

$$RO_{i,k}^j(t) = 0 \quad \text{with} \quad i = \{CC75,...,CC77\} \quad \text{and} \quad j = \{R17, R18\}$$

33. In the above, $KE_{i,k}^j(t)$ represents the capital induced expenditures and $KO_{i,k}^j(t)$ represent capital induced revenues which are due to individual (scheduled) projects. The values are provided as inputs

34. The volume V_i and C_E^j cost drivers are either:
    - Provided as input (based on LTFM specifications)
    - Computed within the model

35. We identify the annual funding gap as the difference between the expenditures and revenues as:

$$\pi_k(t) = \sum_{i,j} EO_{i,k}^j(t) - \sum_{i,j} RO_{i,k}^j(t)$$

36. The gap for each type k is provided by the taxation revenue ($k = \text{Tax}$) and utility rate revenue ($k = \text{Utility}$)

Table 9   Tax and Utility supported Program Definitions

Tax Supported	Utility Supported
$i = \{CC1 - CC52\}$	$i = \{CC53 - CC63\}$
$i = \{CC66 - CC78\}$	$i = CC67 \cup CC79$

37. The only current exception is $i = CC67$ (Conservation Authorities) which is partially supported by the utility rate and partially by the tax levy

38. The proportion of utility rate support of program $i = CC67$ is given by $\alpha_{67,\text{Utility}}(t_{Base})$ and is provided as input, based on its value in $t = t_{Base}$.

39. We then identify:

$$EO^j_{CC67,\text{Utility}}(t) = \alpha_{67,\text{Utility}}(t_{Base}) \sum_k EO^j_{CC67,k}(t)$$

and:

$$EO^j_{CC67,\text{Tax}}(t) = \left(1 - \alpha_{67,\text{Utility}}(t_{Base})\right) \sum_k EO^j_{CC67,k}(t)$$

40. All other $\alpha_{i,k}(t_{Base}) = 0$ if $i \neq CC67$

41. We define $\beta^j_{i,k}(t_{Base})$ which represents the funding contribution matrix, providing the proportions of the total funding gap $\pi_k(t)$ which is attributed to a specific source i and account j such that (all the sources are identified in red in the INPUT Operation Revenue (2013)):

$$\beta^j_{i,k}(t_{Base}) = \frac{FO^j_{i,k}(t_{Base})}{\displaystyle\sum_{i,j} FO^j_{i,k}(t_{Base})}$$

42. When an account j, associated with a program i does not contribute to the funding of the gap $\pi_k(t)$, its coefficients are given by $\beta^j_{i,k}(t_{Base}) = 0$

43. The reserve unadjusted resident funding taxation (k=Tax) and Utility (k=utility) revenue is determined according to:

$$FO^j_{i,k}(t) = \overline{FO}^j_{i,k}(t) + \beta^j_{i,k}(t)\pi_k(t)$$

- The above funding $FO^j_{i,k}(t)$ represents the base funding which is required to cover the gap $\pi_k(t)$ between the required operational expenditures $\displaystyle\sum_{i,j} EO^j_{i,k}(t)$ and operational revenues $\displaystyle\sum_{i,j} RO^j_{i,k}(t)$

- The above funding does not account for any additional financial requirements from the tax and utility based reserves

- We identify the capital reserves as $\Omega_k(t)$ which are funded from $FO^j_{i,k}(t)$ in order to maintain a minimum level of $R_k(t)$

- The amount of this contribution is considered in the later sections

E.2. CAPITAL BUDGET (REGION OF PEEL)

44. **NOTE:** The index i is now used to specify capital programs, rather than the operational programs (CC1-CC79)
45. The municipality is responsible for providing funding to a various capital programs
46. These include:
    - State of Good Repair costs
    - New capital acquisitions or construction projects. These can be further divided into municipality supported programs as well as development charges supported programs
47. The capital programs are supported using:
    - Capital Reserves: Financed from tax and utility supported contributions
    - DC Reserves: Financed through debt issuance and paid using collected development charges (DC)

Variable	Description
t_{Base}	Base year, with respect to which the future budget computations are performed.
$FC_{i,k}^*(t_{Base}+1,t)$	Expected Capital expenditures during the year for program i which are supported by reserves of type $k=\{Tax,Utility,DC\}$, based on council approved capital budget in $t_{Base}+1$ dollar values
$FC_{i,k}(t_{Base}+1,t)$	Expected Capital expenditures during the year for program i which are supported by reserves of type $k=\{Tax,Utility,DC\}$, based on council approved capital budget in $t_{Base}+1$ dollar values and adjusted for model population P(t)
$FC_{i,k}(t)$	Expected Capital expenditures during the year for program i which are supported by reserves of type in nominal terms
$\Delta_{i,k}(t)$	The reserve contribution from source k
$\Delta_{i,k}(t_{Base})$	
t_Δ	Projection horizon for council approval
$\Omega_k(t)$	The available cash in capital reserve $k=\{Tax, Utility, DC\}$
$\pi_k(t)$	Funding gap for year t. This represents the amount of funding for program of type k which needs to be raised from property taxes and/or utility rates
$r_{\pi.k}$	Increase rate in contribution to the reserve k from $\pi_k(t)$
$S_{i,k}(t)$	Projected value of SOGR in year t in nominal dollars
$S_{i,k}(t_{Base},t)$	Projected value of SOGR in year t in the $t_{Base}+1$ year dollars

$P_{Base}(t)$	Base Population used by the municipality to determine and approve the capital and operational budgets
$\omega_k(t_{Base})$	Relative weights of SOGR the overall capital expenditures in the reference year t_{Base}
$R_k(t)$	Reserve requirements (as stated in the 2014 ROP budget)
$EJ_l^j(t)$	Employment Jobs of type j (industrial and non-industrial) which exist within the region l.
$\Gamma_{DC}^j(t_{Base}, t)$	Number of units of construction type j (this includes both residential and non-residential constructions)
$\tilde{\Gamma}_{DC}^j(t_{Base}, t)$	Total DC revenues which are collected at time t from all residential and non-residential constructions
$FO_{i,k}^j(t)$	Annual (year t) available funding from property tax and utility rates from account j of program's i operations which are supported by k
$H_l(t)$	Number of households in region l at time t
$C_{DC}^j(t)$	The cost of collected DCs from units of type j at time t. For residential units this represents the unit cost while for non-residential units this represents cost per unit floor area

Within the model, the capital expenditures are given by $FC_{i,k}(t_{Base}+1, t)$ and consist of two categories:

- Capital expenditures to support the existing population ($k = \{Tax, Utility\}$)
- Capital expenditures to support growth ($k = \{DC\}$)

E.3. CAPITAL EXPENDITURES TO SUPPORT EXISTING POPULATIONS

48. The equations below apply to $k = \{Tax, Utility\}$ only

49. Base capital expenditures are determined from council approved budget projections $FC_{i,k}^*(t_{Base}+1, t)$ in the base year t_{Base}

50. The council approved capital budget projections $FC_{i,k}^*(t_{Base}+1, t)$ represent the base capital budget from $t = t_{Base}+1$ (the first year of council approved projections) to $t = t_{Base}+t_\Delta$ where t_Δ represents the projection horizon for council approval.

51. In the current model, t_Δ =10 years

52. The base population $P_{Base}(t)$ represents the population expectations which are consistent with the council approved capital budget

53. In contrast, the population $P(t)$ represents the model generated population (population generated within the model)

54. Beyond, the projection horizon, the capital expenditures are derived using the State of Good Repair (SOGR) estimates as the key driver

55. When model population projections $P(t)$ are not available we assume that $P(t) = P_{Base}(t)$

56. The population adjusted capital expenditures are therefore given by:

$$FC_{i,k}(t_{Base}+1,t) = \begin{cases} \dfrac{P(t)}{P_{Base}(t)} FC_{i,k}^*(t_{Base}+1,t) & \text{if} \quad t \in [t_{Base}+1, t_\Delta] \\[2em] \left(1 - \omega_k(t_{Base})\right) \dfrac{P(t)}{P(t-1)} \left(\dfrac{1}{n} \sum_{j=t-n}^{t-1} FC_{i,k}^*(t_{Base}+1, j) \right) + \omega_k(t_{Base}) S_{i,k}(t_{Base}+1,t) & \text{if} \quad t > t_\Delta \end{cases}$$

57. In the above, $FC_{i,k}(t_{Base}, t)$ is derived as a weighted sum of its last n years average and the State of Good Repair values

58. The value n is set to 10 for all programs with the exception of waste management (for which it is set to n=8)

59. The weighting factor $\omega_k(t_{Base})$ provides the relative weights of SOGR the overall capital expenditures in the reference year t_{Base}

60. Given that the SOGR numbers are provided in nominal terms, they are converted to their $t_{Base}+1$ dollar value as:

$$S_{i,k}(t_{Base}+1,t) = \left(1 + \lambda_I\right)^{-(t-t_{Base}-1)} S_{i,k}(t)$$

61. The capital expenditures can then be converted to their nominal values as:

$$FC_{i,k}(t) = \left(1 + \lambda_I\right)^{(t-t_{Base}-1)} FC_{i,k}(t_{Base}+1,t)$$

E.4. CAPITAL EXPENDITURES TO SUPPORT GROWTH

62. The equations below apply to $k = \{DC\}$ only

63. Base capital expenditures for DC supported programs are determined from council approved budget projections $FC_{i,DC}(t_{Base}+1,t)$ in the base year t_{Base} (given in terms of $t_{Base}+1$ dollars)

64. The council approved capital budget projections $FC_{i,DC}^*(t_{Base}+1,t)$ represent the base capital budget from $t = t_{Base}+1$ (the first year of council approved projections) to $t = t_{Base}+t_\Delta$ where t_Δ represents the projection horizon for council approval.

65. In the current model, t_Δ =10 years

66. Beyond, the projection horizon, the DC supported capital expenditures are derived as:

$$FC_{i,\text{DC}}(t_{Base}+1,\text{t}) = \begin{cases} \dfrac{P(t)}{P_{Base}(t)} FC_{i,\text{DC}}(t_{Base}+1,\text{t}) & \text{if} \quad t \in [t_{Base}+1, 2041] \\[3mm] \dfrac{P(t)}{P(t-1)} FC_{i,\text{DC}}(t_{Base}+1,\text{t}-1) & \text{if} \quad t > 2041 \end{cases}$$

67. The capital expenditures can then be converted to their nominal values as:

$$FC_{i,\text{DC}}(t) = (1+\lambda_I)^{(t-t_{Base}-1)} FC_{i,\text{DC}}(t_{Base}+1,t)$$

- Given $l = \{\text{Brampton, Cadedon, Mississagua}\}$, we define the totals as:

$$A(t) = \sum_l A_l(t)$$

With $A = \{E, E_{Base}, H, H_{Base}\}$ and:

$$A(t) = \sum_{l,a} A_{l,a}(t)$$

With $A = \{P, P_{Base}\}$ and age groups a

- Annual DCs are collected from eligible residential and non-residential construction projects at a specific point in time (usually at the point of building permit issuance)

68. The projected number of new units $\Gamma^j_{DC,\text{Base}}(t_{Base},t)$ of type j which are eligible for DC, at time t are obtained from the 2012 DC study

69. These are provided as input for $t \le 2031$:

   - $j = $ Small Apartment Residential
   - $j = $ Large Apartment Residential
   - $j = $ Other Residential

For:

   - $j = $ Industrial, Non-Residential
   - $j = $ Non-Industrial, Non-Residential

These are computed as (for all times t) for j = Industrial:

$$\Gamma^j_{DC,\text{Base}}(t_{Base},t) = \begin{cases} 90 \cdot \left[\sum_l EJ^j_l(t) - \sum_l EJ^j_l(t-1) \right] & \text{if} \quad \sum_l EJ^j_l(t) > \sum_l EJ^j_l(t-1) \\[3mm] 0 & \text{if} \quad \sum_l EJ^j_l(t) \le \sum_l EJ^j_l(t-1) \end{cases}$$

And for for j = Non-Industrial:

$$\Gamma_{DC,\text{Base}}^{j}(t_{Base},t) = \begin{cases} 27 \cdot \left[\sum_{l} EJ_{l}^{j}(t) - \sum_{l} EJ_{l}^{j}(t-1) \right] & \text{if} \quad \sum_{l} EJ_{l}^{j}(t) > \sum_{l} EJ_{l}^{j}(t-1) \\ 0 & \text{if} \quad \sum_{l} EJ_{l}^{j}(t) \leq \sum_{l} EJ_{l}^{j}(t-1) \end{cases}$$

70. An adjustment function $f(t_{Base},t)$ is introduced to give:

$$\Gamma_{DC,Adj}^{j}(t_{Base},t) = \begin{cases} \Gamma_{DC,Base}^{j}(t_{Base},t) f(t_{Base},t) & \text{if} \quad t \leq 2031 \\ \Gamma_{DC,Adj}^{j}(t_{Base},t-1) \dfrac{P_{Base}(t)}{P_{Base}(t-1)} & \text{if} \quad t > 2031 \end{cases}$$

For:

- $j =$ Small Apartment Residential
- $j =$ Large Apartment Residential
- $j =$ Other Residential

And:

$$\Gamma_{DC,Adj}^{j}(t_{Base},t) = \begin{cases} \Gamma_{DC,Base}^{j}(t_{Base},t) f(t_{Base},t) & \text{if} \quad t \leq 2031 \\ \Gamma_{DC,Base}^{j}(t_{Base},t) & \text{if} \quad t > 2031 \end{cases}$$

For:

- $j =$ Industrial, Non-Residential
- $j =$ Non-Industrial, Non-Residential

71. In the above, $\Gamma_{DC,\text{Base}}^{j}(t_{Base},t)$ represents the projected DC units from the 2012 DC study while the $\Gamma_{DC,Adj}^{j}(t_{Base},t)$ represent the projected DC units which were adjusted by the ROP DC team using the adjustment function $f(t_{Base},t)$

72. Using the population per unit coefficients γ_j we compute the population growth:

$$\Delta P_{DC}(t) = \sum_{j} \Gamma_{DC,Adj}^{j}(t_{Base},t)\gamma_j$$

For $j = \{\text{Small Appartment, Large Appartement, Other Residential}\}$

- The base population growth is given by:

$$\Delta P_{Base}(t) = P_{Base}(t) - P_{Base}(t-1)$$

73. The population ratio is computed as:

$$\rho_P = \frac{\Delta P_{Base}(t)}{\Delta P_{DC}(t)}$$

74. Using the employment per unit coefficients γ_j we compute the employment growth:

$$\Delta E_{DC}(t) = \sum_j \Gamma^j_{DC,Adj}(t_{Base},t)\gamma_j$$

For $j = \{\text{Non Industrial, Industrial}\}$

⚜ The base employment growth is given by:

$$\Delta E_{Base}(t) = E_{Base}(t) - E_{Base}(t-1)$$

75. The population ratio is computed as:

$$\rho_E = \frac{\Delta E_{Base}(t)}{\Delta E_{DC}(t)}$$

76. We compute DC collection proportions for residential units:

$$\zeta^j{}_P(t) = \frac{\Gamma^j_{DC,Adj}(t_{Base},t)}{\sum_l \Gamma^l_{DC,Adj}(t_{Base},t)}$$

For $j = \{\text{Small Appartment, Large Appartement, Other Residential}\}$ and:

$$\zeta^j{}_E(t) = \frac{\Gamma^j_{DC,Adj}(t_{Base},t)}{\sum_l \Gamma^l_{DC,Adj}(t_{Base},t)}$$

For $j = \{\text{Non Industrial, Industrial}\}$

77. The value of the collected DC revenue in year t is therefore given for each construction type j:

$$\tilde{\Gamma}_{DC}(t_{Base},t) = C^j_{DC}(t) \cdot \Gamma^j_{DC}(t_{Base},t)$$

78. We identify the ROP/PaR rescaling function $\vartheta^j(t)$ which is used to reconcile the Par and ROP $\Gamma^j_{DC}(t_{Base},t)$ results

79. The results are rescaled as:

$$\tilde{\Gamma}^j_{DC,New}(t_{Base},t) = \vartheta^j(t)\tilde{\Gamma}^j_{DC}(t_{Base},t)$$

80. The value of the collected DC revenue in year t is therefore given by the sum across all construction types j:

$$\tilde{\Gamma}_{DC}(t) = \sum_j \tilde{\Gamma}^j_{DC,New}(t_{Base},t)$$

81. The new capital (DC eligible) expenditures are given by $FC_{i,DC}(t)$ while the collected Development Charges are given by $\tilde{\Gamma}_{DC}(t)$.

E.5. DEBT

Table 10   Debt Model Definitions

Variable	Description
$FC_{i,\mathrm{DC}}(t_{Base}+1,t)$	Expected Capital expenditures during the year for program i which are supported by DC charges, based on council approved capital budget in $t_{Base}+1$
$\Delta_k(t)$	The reserve contribution from source k
t_{Base}	Base year, with respect to which the future budget computations are performed.
$T(t)$	The number of time periods over which the debt is issued as a function of t
t_{Issue}	The time at which debt is issued
$FC_{i,k,a}(t)$	Expected Capital expenditures during the year for program i which are supported by reserves of type in nominal terms
$\Omega_k(t)$	The available cash in capital reserve $k = \{\mathrm{Tax, Utility, DC}\}$
$\Theta_{\mathrm{DC}}(t)$	Gross Debt at time t
$D_{DC}(t)$	Net Debt at time t
$\Sigma_{DC}(t)$	The amount of new debt issuance used to support the DC reserves
$\Pi_{DC}(t_{Issue},t)$	The amount of debt repayment at time t for debt which was issued at time t_{Issue} and which goes to the principal
$O_{DC}(t_{Issue},t)$	The amount of debt repayment at time t for debt which was issued at time t_{Issue} and which goes to interest
$\Pi_{DC}(t_{History},t)$	The combined amount of debt repayment at time t for debt which was issued at all times $t_{History} \leq t_{Base}$ and which goes to the principal
$O_{DC}(t_{History},t)$	The combined amount of debt repayment at time t for debt which was issued at all times $t_{History} \leq t_{Base}$ and which goes to interest
$\Pi_{DC}(t)$	The total amount of debt repayment which goes to the principal
$O_{DC}(t)$	The total amount of debt repayment which goes to interest
$\theta(t)$	Annual funding deficit for DC eligible programs
$\Upsilon_{DC}(t_{Issue},t)$	Contribution to the sinking fund due to principal payment on a debt issued at t_{Issue}
$\Upsilon_{DC}(t)$	Total amount of the sinking fund for all issues prior to or at time t
$\delta\Upsilon_{DC}(t_{History},t)$	Earned return on sinking fund contribution made on debt issued prior to or at t_{Base}
$\delta\Upsilon_{DC}(t_{Issue},t)$	Earned return on sinking fund contribution made on debt issued after t_{Base}
$i_{DC}(t)$	Interest rate on debt which is issued at time t

$i_R(t)$	Re-investment rate at which the sinking fund is invested
$R_k(t)$	Cash requirements for reserve of type k
$\tilde{\Gamma}_{DC}^j(t)$	Number of units of construction type j (this includes both residential and non-residential constructions)
$\Delta_k(t_{Base})$	The base contribution to type k reserve
$\Delta_{New}(t)$	Total additional contribution which is required from residential tax and utility rate in order to support the DC debt
$\beta_{i,k}^j(t)$	Funding contribution matrix such that $\sum_{i,j,k} \beta_{i,k}^j(t) = 1$
$FO_{i,k}^j(t)$	Annual (year t) available funding from property tax and utility rates from account j of program's i operations which are supported by k
$\varepsilon_k(t)$	Reserve distribution parameter
$\alpha_k(t)$	Minimum Reserve parameter

82. DC eligible programs are supported by the collected DC revenue $\tilde{\Gamma}_{DC}^j(t)$

83. However since the DC revenue usually lags behind the actual collection of development charges (certain infrastructure, such as water and wastewater pipes, must be laid prior to the construction of a sub-division and collection of the development charges, which occur at the time of issuance of the permit)

84. The interim financing of growth is therefore dependant on the issuance of new debt $\Sigma_{DC}(t)$, at time t

85. The collected DC revenue $\tilde{\Gamma}_{DC}^j(t)$ is used to make the interest $O_{DC}(t)$ and principle $\Pi_{DC}(t)$ payments

86. In the model, the interest and principal payment consists of two components:

    1. Payments on historical issues $\Pi_{DC}(t_{History},t)$ and $O_{DC}(t_{History},t)$, with $t_{History} \le t_{Base}$ (These represent payment on historical debt issues, supported by data)

    2. Payments on future issues $\Pi_{DC}(t_{Issue},t)$ and $O_{DC}(t_{Issue},t)$, with $t_{Issue} > t_{Base}$ (These include payment on debt issued after the start of the simulation)

87. The last year for which historical data is available is given by t_{Base}

88. The principal and interest payments on debt, which are to be made at time t due to debt issues at $t_{History} \le t_{Base}$ time are given by $\Pi_{DC}(t_{History},t)$ and $O_{DC}(t_{History},t)$ respectively

89. The principal and interest payments on debt, which are to be made at time t due to debt issues at $t_{Issue} > t_{Base}$ time are given by $\Pi_{DC}(t_{History},t)$ and $O_{DC}(t_{History},t)$ respectively

90. The Debt periods $T(t)$ represent an array of period for every future debt issue time $t = t_{Issue}$. These are provided as $T(t = t_{Issue}) = T_{Issue}$ and are provided as input

91. Define $\Pi_{DC}(t_{History}, t)$ as the principal payment schedule (which is to be made) for each year t associated with a debt issued in year t_{Issue}. $\Pi_{DC}(t_{History}, t)$ is an array with $t \in \{t_{Issue}, t_{Issue} + 1, ..., t_{Issue} + T\}$

92. Define $O_{DC}(t_{History}, t)$ as the interest payment schedule (which is to be made) for each year t associated with a debt issued in year t_{Issue}. $O_{DC}(t_{History}, t)$ is an array with $t \in \{t_{Issue}, t_{Issue} + 1, ..., t_{Issue} + T\}$

93. The payment schedules $\Pi_{DC}(t_{History}, t)$ and $O_{DC}(t_{History}, t)$ are both obtained from the $t = t_{Base}$ FIR

94. We define the interest and principal payments which are made at time t as:

$$O_{DC}(t) = O_{DC}(t_{History}, t) + \sum_{t_{Issue} = t_{Base} + 1}^{t-1} O_{DC}(t_{Issue}, t)$$

and:

$$\Pi_{DC}(t) = \Pi_{DC}(t_{History}, t) + \sum_{t_{Issue} = t_{Base} + 1}^{t-1} \Pi_{DC}(t_{Issue}, t)$$

95. The amount which can be used to finance the debt payment is given by the fund available in the DC reserve $\Omega_{DC}(t-1)$ (at the end of period t-1 or beginning of period t) as well as the development charges which are available at during the period t, given by $\sum_j \tilde{\Gamma}_{DC}^j(t)$

96. We define the annual funding deficit as:

$$\theta(t) = \left[\sum_j \tilde{\Gamma}_{DC}^j(t) + \Omega_{DC}(t-1) \right] - \left[\sum_i FC_{i,DC}(t) + \left(\Pi_{DC}(t) + O_{DC}(t) \right) + \iota(t) \right]$$

97. In the above, $\theta(t)$ represents the amount of new debt which needs to be issued, in order to support the new capital expenditures

98. The DC reserves are financed by the issuance of new debt $\Sigma_{DC}(t)$ which is paid through the collection of DC rates from new developments:

$$\Sigma_{DC}(t) = \begin{cases} \lceil \theta \rceil_{10m} & \text{if } \theta > 0 \\ 0 & \text{if } \theta \leq 0 \end{cases}$$

99. The function $\lceil \ \rceil_{10m}$ represents the ceiling function which rounds up to the nearest \$10 million

100.   We identify the time at which the debt is issued as the issue time $t_{Issue} = t$

101.   We identify the function:

$$\phi(t, t_{Issue}) = \begin{cases} (t - t_{Issue}) & \text{if } t - t_{Issue} \leq T_{Max} \\ T_{Max} & \text{if } t - t_{Issue} > T_{Max} \end{cases}$$

Presently we set the maximum debt term to $T_{Max} = 10$

102.   Identify the term length $T(t_{Issue})$ for an issue as:

$$T(t_{Issue}) = \begin{cases} \phi(2031, t_{Issue}) & \text{if } t_{Issue} < 2031 \\ \phi(2041, t_{Issue}) & \text{if } t_{Issue} \in (2031, 2041] \\ T_{Max} & \text{if } t_{Issue} > 2041 \end{cases}$$

103.   Given the interest rate $i_{DC}(t)$, the interest issue schedule on the debt issue $t = t_{Issue} \neq 2031 \neq 2041$ is given by:

$$O_{DC}(t_{Issue}, t) = \begin{cases} i_{DC}(t_{Issue}) \cdot \Sigma_{DC}(t_{Issue}) & \text{if } t \in [t_{Issue} + 1, t_{Issue} + T(t_{Issue})] \\ 0 & \text{Otherwise} \end{cases}$$

When $t_{Issue} = 2031$ or $t_{Issue} = 2041$ the interest is given by:

$$\Pi_{DC}(t_{Issue}, t) = \begin{cases} i_{DC}(t_{Issue}) \cdot \Sigma_{DC}(t_{Issue}) & \text{if } t \in t_{Issue} + 1 \\ 0 & \text{Otherwise} \end{cases}$$

104.   Given the reinvestment rate $i_R(t)$, the principal issue schedule on the debt issue $t = t_{Issue} \neq 2031 \neq 2041$ is given by:

$$\Pi_{DC}(t_{Issue}, t) = \begin{cases} \dfrac{i_R(t_{Issue}) \cdot \Sigma_{DC}(t_{Issue})}{(1 + i_R(t_{Issue}))^{T(t_{Issue})} - 1} & \text{if } t \in [t_{Issue} + 1, t_{Issue} + T(t_{Issue})] \\ 0 & \text{Otherwise} \end{cases}$$

When $t_{Issue} = 2031$ or $t_{Issue} = 2041$ the interest is given by:

$$\Pi_{DC}(t_{Issue}, t) = \begin{cases} \Sigma_{DC}(t_{Issue}) & \text{if} & t = t_{Issue} + 1 \\ 0 & & \text{Otherwise} \end{cases}$$

105.   The sinking fund Balance associated with debt issue at time $t = t_{Issue}$ is given by:

$$\Upsilon_{DC}(t_{Issue}, t) = \begin{cases} -\Upsilon_{DC}(t_{Issue}, t-1)\left(1+i_R(t_{Issue})\right) - \Pi_{DC}(t_{Issue}, t) & \text{if} & t \in [t_{Issue}+1, t_{Issue} + T(t_{Issue})] \\ 0 \end{cases}$$

With the initial condition:

$$\Upsilon_{DC}(t_{Issue}, t) = 0 \quad \forall t \le t_{Issue}$$

106.   The total Sinking Fund at time t is computed as:

$$\Upsilon_{DC}(t) = \sum_{i=2010}^{t} \Upsilon_{DC}(i, t)$$

107.   The value of the reserve contribution for DC supported capital expenditures are given by:

$$\Omega_{DC}(t) = \theta(t) + \Sigma_{DC}(t)$$

108.   We define the as the cumulative debt issuance (Gross Debt) as:

$$\Theta_{DC}(t) = \Theta_{DC}(t-1) + \Sigma_{DC}(t)$$

   ⚑ We define the as the remaining debt (Net Debt) as:

$$D_{DC}(t) = \Theta_{DC}(t) + \Upsilon_{DC}(t)$$

E.6. RESERVES

Table 11 Reserves Model Definitions

Variable	Description
t_{Issue}	The time at which debt is issued
$\Omega_k(t)$	The available cash in capital reserve $k = \{\text{Tax, Utility,DC}\}$
$D_{DC}(t)$	Net Debt at time t
$R_k(t)$	Cash requirements for reserve of type k
$\tilde{\Gamma}_{DC}^j(t)$	Number of units of construction type j (this includes both residential and non-residential constructions)
$\Delta_k(t_{Base})$	The base contribution to type k reserve
$\Delta_{New}(t)$	Total additional contribution which is required from residential tax and utility rate in order to support the DC debt
$\beta_{i,k}^j(t)$	Funding contribution matrix such that $\sum_{i,j,k} \beta_{i,k}^j(t) = 1$
$FO_{i,k}^j(t)$	Annual (year t) available funding from property tax and utility rates from account j of program's i operations which are supported by k
$\varepsilon_k(t)$	Reserve distribution parameter
$\alpha_k(t)$	Minimum Reserve parameter

109. Reserves are divided into two main categories:

- Reserves supported by tax and utility rates, given by $\Omega_{Tax}(t)$ and $\Omega_{Utility}(t)$
- Reserves supported by development charges $\Omega_{DC}(t)$

110. Each reserve must support their respective capital expenditures $\sum_i FC_{i,k}(t)$

111. The net contribution to the reserve funds from the resident funding (revenue from resident and local business tax and utility rate) $FO_{i,k}^j(t)$ at time $t = t_{Base}$ is given by

$$\Delta_k(t_{Base})$$

112. We assume that this will remain the base contribution for $t > t_{Base}$

113. We identify the reserve parameter:

$$\alpha_k(t) = \gamma_k(\dot{D}_{DC}(t))$$

where $\dot{D}_{DC}(t)$ represents the rate of change of net debt

114. This represents the minimum level of funding at the next time period t+1 is given by a proportion of the expected net debt at that time:

$$R_k(t+1) = R_k(t) + \alpha_k(t)D_{DC}(t)$$

115. We define the parameter:

$$\varepsilon_k(t) = \frac{\Omega_k(t-1)}{\sum_k \Omega_k(t-1)}$$

116. The actual level of funding in the reserves at time $t > t_{Base}$ is:

$$\Omega_k(t) = \Omega_k(t-1) - \sum_{i,a} FC_{i,k,a}(t) + \Delta(t_{Base}) + \varepsilon_k(t)O_{DC}(t)$$

117. The new reserve fund contribution is given by:

$$\Delta_{New}(t) = \begin{cases} R_k(t) - \Omega_k(t) & \text{if } R_k(t) > \Omega_k(t) \\ 0 & \text{Otherwise} \end{cases}$$

118. The resident funding is the changed to:

$$FO^j_{i,k}(t) \rightarrow FO^j_{i,k}(t) + \beta^j_{i,k}\Delta_{New}(t)$$