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SERVICES AND SOLUTIONS FOR A LIVABLE REGION

METRO VANCOUVER REGIONAL DISTRICT
REGIONAL PLANNING COMMITTEE

REGULAR MEETING

May 7, 2021
9:00 AM
28th Floor Boardroom, 4730 Kingsway, Burnaby, British Columbia

A G E N D A[1]

1. ADOPTION OF THE AGENDA

1.1 May 7, 2021 Regular Meeting Agenda
That the Regional Planning Committee adopt the agenda for its regular meeting scheduled for May 7, 2021, as circulated.

2. ADOPTION OF THE MINUTES

2.1 April 9, 2021 Regular Meeting Minutes
That the Regional Planning Committee adopt the minutes of its regular meeting held April 9, 2021, as circulated.

3. DELEGATIONS

4. INVITED PRESENTATIONS

4.1 Russell Whitehead, Associate Vice President, and Christopher Kuno, Senior Consultant, Colliers Strategy & Consulting
Subject: Industrial Lands Intensification Study

4.2 Adrian Lightstone, National Manager, Advisory Services, WSP
Subject: Metro 2050 Regional Resilience Framework Study

5. REPORTS FROM COMMITTEE OR STAFF

5.1 *Metro Metro* 2050 Draft Policy Language: Goal 4 – Provide Diverse and Affordable Housing Choices and Goal 5 – Support Sustainable Transportation Choices
That the MVRD Board receive for information the report dated April 1, 2021, titled "*Metro 2050* Draft Policy Language: Goal 4 – Provide Diverse and Affordable Housing Choices and Goal 5 – Support Sustainable Transportation Choices".

[1] *Note: Recommendation is shown under each item, where applicable.*

5.2 Metro Vancouver Industrial Lands Intensification Analysis Study

That the MVRD Board receive for information the report dated April 12, 2021, titled "Metro Vancouver Industrial Lands Intensification Analysis Study".

5.3 Metro 2050 Regional Resilience Framework Study

That the MVRD Board receive for information the report dated April 11, 2021, titled "*Metro 2050* Regional Resilience Framework Study".

5.4 Manager's Report

That the Regional Planning Committee receive for information the report dated April 27, 2021, titled "Manager's Report".

6. INFORMATION ITEMS

6.1 Best Management Practices for Invasive Species Hedge Bindweed and American Bullfrog

7. OTHER BUSINESS

8. BUSINESS ARISING FROM DELEGATIONS

9. RESOLUTION TO CLOSE MEETING

Note: The Committee must state by resolution the basis under section 90 of the Community Charter on which the meeting is being closed. If a member wishes to add an item, the basis must be included below.

10. ADJOURNMENT/CONCLUSION

That Regional Planning Committee adjourn/conclude its regular meeting of May 7, 2021.

Membership:

Coté, Jonathan (C) - New Westminster
Froese, Jack (VC) - Langley Township
Copeland, Dan - Delta
Dueck, Judy - Maple Ridge
Gambioli, Nora - West Vancouver
Guerra, Laurie - Surrey
Hurley, Mike - Burnaby
Kirby-Yung, Sarah - Vancouver
McEwen, John - Anmore
Muri, Lisa - North Vancouver District
Steves, Harold - Richmond
Vagramov, Rob - Port Moody
van den Broek, Val - Langley City
West, Brad - Port Coquitlam

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METRO VANCOUVER REGIONAL DISTRICT
REGIONAL PLANNING COMMITTEE

Minutes of the Regular Meeting of the Metro Vancouver Regional District (MVRD) Regional Planning Committee held at 9:00 a.m. on Friday, April 9, 2021 in the 28th Floor Boardroom, 4730 Kingsway, Burnaby, British Columbia.

MEMBERS PRESENT:
Chair, Mayor Jonathan Coté*, New Westminster
Vice Chair, Mayor Jack Froese*, Langley Township
Councillor Dan Copeland*, Delta
Councillor Judy Dueck*, Maple Ridge
Councillor Nora Gambioli*, West Vancouver
Councillor Laurie Guerra*, Surrey
Mayor Mike Hurley*, Burnaby
Councillor Sarah Kirby-Yung*, Vancouver (arrived at 9:01 a.m.)
Mayor John McEwen*, Anmore
Councillor Lisa Muri*, North Vancouver District
Councillor Harold Steves*, Richmond
Mayor Rob Vagramov*, Port Moody (arrived at 9:01 a.m.)
Mayor Val van den Broek*, Langley City
Mayor Brad West*, Port Coquitlam (arrived at 9:07 a.m.)

MEMBERS ABSENT:
None.

STAFF PRESENT:
Heather McNell, General Manager, Regional Planning and Housing Services
Amelia White, Legislative Services Coordinator, Board and Information Services

1. ADOPTION OF THE AGENDA

1.1 April 9, 2021 Regular Meeting Agenda

It was MOVED and SECONDED
That the Regional Planning Committee:
a) amend the agenda for its regular meeting scheduled for April 9, 2021 by adding Item 3.1 Late Delegation – Blaire Chisholm; and
b) adopt the agenda as amended.

CARRIED

9:01 a.m. Mayor Vagramov and Councillor Kirby-Yung arrived at the meeting.

*denotes electronic meeting participation as authorized by Section 3.6.2 of the *Procedure Bylaw*

2. ADOPTION OF THE MINUTES

2.1 March 5, 2021 Regular Meeting Minutes

It was MOVED and SECONDED
That the Regional Planning Committee adopt the minutes of its regular meeting held March 5, 2021, as circulated.

CARRIED

3. DELEGATIONS

3.1 Blaire Chisholm

Blaire Chisholm, Chief Operating Officer, Pooni Group, spoke to members regarding the proposed *Metro 2050* policy – regarding Employment Lands and Mixed Use Adjacent to Rapid Transit Stations, presented in the Manager's Report, Item 5.5, in the agenda, offering comments about the benefits of expanding the radius of the area where residential uses would be permitted on upper floors on lands with a regional Employment land use designation within 400 metres of rapid transit stations.

Presentation material titled "Presentation to the Regional Planning Committee" and on-table executive summary is retained with the April 9, 2021 Regional Planning Committee agenda.

9:07 a.m. Mayor West arrived at the meeting.

4. INVITED PRESENTATIONS

No items presented.

5. REPORTS FROM COMMITTEE OR STAFF

5.1 *Metro 2050* Q1 2021 Status Update

Report dated March 26, 2021, from Erin Rennie, Senior Planner, Regional Planning and Housing Services, providing an update of the technical and engagement work associated with *Metro 2050* between December 2020 and March 2021.

It was MOVED and SECONDED
That the Regional Planning Committee receive for information the report dated March 26, 2021, titled "*Metro 2050* Q1 2021 Status Update".

CARRIED

5.2 *Metro 2050* Draft Policy Language – Goal 3: Protect the Environment and Respond to Climate Change Impacts and the Implementation Section

Report dated March 26, 2021, from Erin Rennie, Senior Planner, Regional Planning and Housing Services, providing the Regional Planning Committee with the

opportunity to review and comment on the draft content of Goal 3 and the Implementation section of *Metro 2050*, the updated regional growth strategy.

Members were provided a presentation on the *Metro 2040* proposed policy changes that would be reflected in *Metro 2050*.

Request of Staff:
Staff were requested to provide a copy of the Conservation and Recreation designation map, located in Strategy 3.1 of the *Metro 2050* draft.

Members discussed the proposed policy changes and noted the following:

- appreciation for the directions on environment and climate policy;
- the loss of the tree canopy and importance of the aspirational targets;
- concern about the inclusion of mobility pricing;
- the interconnectedness between member jurisdictions' Official Community Plans and the Regional Growth Strategy; and
- needing clarity on the difference between the Conservation and Recreation designation and the Sensitive Ecosystem Inventory.

Presentation material titled "*Metro 2050* Draft Goal 3 and Implementation: New Content in the Update to the Regional Growth Strategy" is retained with the April 9, 2021 Regional Planning Committee agenda.

It was MOVED and SECONDED
That the MVRD Board receive for information the report dated March 26, 2021, titled "*Metro 2050* Draft Policy Language – Goal 3: Protect the Environment and Respond to Climate Change Impacts and the Implementation Section".

CARRIED

5.3 *Metro 2050* Projections Update

Report dated March 17, 2021, from Sinisa Vukicevic, Program Manager of Planning Analytics, Regional Planning and Housing Services, providing the Regional Planning Committee with the opportunity to review and comment on the draft Metro Vancouver projections for *Metro 2050*, the updated regional growth strategy.

Members were provided a presentation on draft 2050 projections for population, dwelling units and employment.

Presentation material titled "*Metro 2050*: Draft Projections for Population, Dwelling Units and Employment" is retained with the April 9, 2021 Regional Planning Committee agenda.

It was MOVED and SECONDED
That the MVRD Board receive for information the report dated March 17, 2021, titled "*Metro 2050* Projections Update".

CARRIED

5.4 Metro Vancouver 2020 Regional Industrial Lands Inventory

Report dated March 25, 2021, from Eric Aderneck, Senior Planner, Regional Planning and Housing Services, providing the *2020 Regional Industrial Lands Inventory* to the Regional Planning Committee and MVRD Board for information.

Members were provided a presentation on the 2020 Regional Industrial Lands Inventory, which provided an overview of the amount, type and uses of industrial lands in the region and the change since 2015.

Presentation material titled "2020 Regional Industrial Lands Inventory" is retained with the April 9, 2021 Regional Planning Committee agenda.

It was MOVED and SECONDED
That the MVRD Board:

a) receive for information the report dated March 25, 2021, titled "Metro Vancouver 2020 Regional Industrial Lands Inventory"; and
b) direct staff to distribute the report titled "Metro Vancouver 2020 Regional Industrial Lands Inventory", to member jurisdictions, the Province, the Port of Vancouver, TransLink, the Urban Development Institute, NAIOP, Vancouver Airport Authority, Agricultural Land Commission, and Squamish Lillooet and Fraser Valley Regional Districts to support ongoing efforts to protect the region's essential industrial land base for industrial activities.

CARRIED

5.5 Manager's Report

Report dated March 31, 2021, from Heather McNell, General Manager, Regional Planning and Housing Services, providing an update on the Regional Planning Committee 2021 Work Plan, *Metro 2040* Housing Demand Estimates, *Metro 2040* Targets for Growth to Urban Centres and along Transit Corridors, and *Metro 2050* Policy – Employment Lands and Mixed Use Adjacent to Rapid Transit Stations.

Members were provided a presentation on the rationale for the radius of 200 metres as part of the draft *Metro 2050* policy to allow residential uses on upper floors on lands with regional Employment land use designation within 200 metres of a rapid transit station.

Presentation material titled "Employment Lands and Mixed Use Adjacent to Rapid Transit Stations" is retained with the April 9, 2021 Regional Planning Committee agenda.

Members considered a proposal to investigate the feasibility of expanding the Employment Lands buffer from 200 metres to 400 metres.

It was MOVED and SECONDED
That the Regional Planning Committee receive for information the report dated March 31, 2021, titled "Manager's Report".

CARRIED

6. INFORMATION ITEMS
No items presented.

7. OTHER BUSINESS
No items presented.

8. BUSINESS ARISING FROM DELEGATIONS
No items presented.

9. RESOLUTION TO CLOSE MEETING
No items presented.

10. ADJOURNMENT/CONCLUSION

It was MOVED and SECONDED
That the Regional Planning Committee conclude its regular meeting of April 9, 2021.

CARRIED
(Time: 11:09 a.m.)

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Amelia White,
Legislative Services Coordinator

Jonathan Coté, Chair

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SERVICES AND SOLUTIONS FOR A LIVABLE REGION

To: Regional Planning Committee

From: Erin Rennie, Senior Planner, Regional Planning and Housing Services

Date: April 1, 2021 Meeting Date: May 7, 2021

Subject: ***Metro 2050* Draft Policy Language: Goal 4 – Provide Diverse and Affordable Housing Choices and Goal 5 – Support Sustainable Transportation Choices**

RECOMMENDATION

That the MVRD Board receive for information the report dated April 1, 2021, titled "*Metro 2050* Draft Policy Language: Goal 4 – Provide Diverse and Affordable Housing Choices and Goal 5 – Support Sustainable Transportation Choices".

EXECUTIVE SUMMARY

Staff, in collaboration with the *Metro 2050* Intergovernmental Advisory Committee, have drafted new and amended content for *Metro 2050* Goal 4: Provide Diverse and Affordable Housing Choices and Goal 5: Support Sustainable Transportation Choices (Attachment). The content has been prepared in alignment with the MVRD Board-endorsed policy recommendations from the *Metro 2040* Housing and Transport Policy Reviews respectively, which were completed in collaboration with member jurisdictions, stakeholders and others throughout 2020 and early 2021.

The proposed changes to these two goals focus on:

- increasing the supply of transit-oriented, affordable rental housing;
- confirming Metro Vancouver's role in monitoring housing data;
- calling for expanded measures to address housing speculation and vacant homes;
- new policies added with focus on the specific housing needs of lower income households, people experiencing homelessness and better protecting tenants;
- utilizing the Major Transit Growth Corridors concept to align with Transport 2050;
- improved policies related to transportation issues such as parking, active transportation, new mobility, goods movement, transport-related air quality and noise impact, and integration with regional land use planning; and
- improving resiliency in the housing and transportation policy areas.

A complete draft of *Metro 2050* will be presented to the Regional Planning Committee and MVRD Board in June with a recommendation that it be referred out for formal comment between July and November 2021.

PURPOSE

To provide the Regional Planning Committee and MVRD Board with the opportunity to review and comment on the draft content of Goal 4 and Goal 5 of *Metro 2050*, the updated regional growth strategy.

BACKGROUND

Between September and November of 2020 the Regional Planning Committee and MVRD Board endorsed or received the recommended policy directions of 8 of the 11 themed *Metro 2040* Policy Reviews. The draft strategies contained in Goal 4 (Provide Diverse and Affordable Housing Choices) and Goal 5 (Support Sustainable Transportation Choices) have been prepared based on the directions associated with the Housing and Transport policy reviews (Reference 1). Metro Vancouver staff have been working through the strategies of Goals 4 and 5 with the members of the *Metro 2050* Intergovernmental Advisory Committee, but at the time of writing of this report the comment period had not yet closed. The draft content is being provided to the Regional Planning Committee and MVRD Board for information.

DRAFTING *METRO 2050* – GOAL 4 AND GOAL 5

In the Fall of 2020 and early 2021, the MVRD Board endorsed the policy recommendations for the Housing (Reference 2 and 3) and Transport (Reference 4 and 5) Policy Reviews in November, 2020. The policy recommendations were used to guide the development of new and amended policy language.

Metro 2050 is an update to the regional growth strategy; as such, the existing text of *Metro 2040* is being used as the 'base' for the development of *Metro 2050*. For this reason, a 'marked up' version of *Metro 2040* has been prepared for ease of communicating the proposed policy changes (Attachments 1-7). A column down the right hand side of the drafts explains the rationale for any change, and where applicable the previous policy action reference number from *Metro 2040* is noted, and new policies are highlighted as red text. Where appropriate, staff have proposed minor 'housekeeping' changes to text throughout to provide additional clarity or update terminology as needed.

As with the other Goals of the regional growth strategy, some general changes that are being applied to content include:

- the term "municipality" has been revised to read "member jurisdiction";
- actions that were previously categorized as "requested of other agencies" have now been rewritten as advocacy actions for Metro Vancouver to complete. The exception is actions for TransLink which will be a signatory to *Metro 2050*;
- new strategy rationale sections have been added documenting the intention of each individual strategy; and
- where appropriate, the linkage of any policy action or strategy to climate change mitigation and adaptation has been highlighted.

Housing Challenges to Be Addressed in *Metro 2050*

Among the regional housing challenges that have emerged or increased over the past decade, policies proposed in *Metro 2050* have been designed to address the following key challenges:

- Rising rates of homelessness across the region;
- Increased focus on tenant protections and mitigating impacts to renters in redeveloping Urban Centres and FTDAs;
- Record low rental vacancy rates;
- A shortfall of transit-oriented affordable rental housing;
- Cost of housing surpassing average household incomes; and

- Local government housing monitoring challenges and a need for regional coordination of performance monitoring.

Transportation Challenges to be Addressed in *Metro 2050*

Among the regional transportation challenges that have emerged or increased over the past decade, policies proposed in *Metro 2050* have been designed to address the following key challenges:

- Strong demand for transit service expansion;
- Increasing need to align population and job growth with transit investment;
- Slow progress towards regional GHG reduction targets;
- Slow progress towards regional mode shift targets;
- Greater understanding of the impact of roadway air pollution and noise on adjacent communities;
- Growing congestion on key arterials impacting the economy and costs of goods movement; and
- The emergence of new mobility options and the growing role of e-commerce.

SUMMARY OF PROPOSED CHANGES

Goal 4

Strategy 4.1 Expand the supply and diversity of housing to meet a variety of needs

- Housing Demand Estimates (Appendix Table A.2 of *Metro 2040*) have been removed from the regional growth strategy, as member jurisdiction progress will now be monitored through provincially-required Housing Needs Reports (Reference 6);
- A new policy added highlighting the planning resources and services that Metro Vancouver provides, for example its role in data collection and in supporting regional housing policy and research;
- Calls for the Province to consider new legislation enabling inclusionary zoning powers in BC and to increase funding and expand eligibility for all First Nations to prepare Housing Needs Reports;
- Revised Regional Context Statement (RCS) requirements that focus on the housing policy *outcomes* that should be identified in a RCS; and
- A new expectation that Housing Action Plans be aligned with provincially-required Housing Needs Reports, and that they be reviewed or updated by member jurisdictions every 5-10 years.

Strategy 4.2 Increase rental housing supply and protect tenants

- A new strategy focusing on rental housing and tenant protections;
- Action added for Metro Vancouver to monitor the purpose-built rental housing supply and report on gaps by income level and number of bedrooms;
- A new regional target of 15% affordable housing in new and redeveloped rental units within Urban Centres, Frequent Transit Development Areas, and Major Transit Growth Corridors, and a request that member jurisdictions demonstrate how they will work toward this target within their local context;
- A call to the Province to expand measures to address housing speculation and vacant homes; and

- New policies added with a focus on increasing transit-oriented affordable housing, increasing market and below-market rental housing, protecting existing non-market rental housing, and strengthening protections for renters.

Strategy 4.3 Meet the housing needs of lower income households and homeless populations

- Call to the Federal Government and the Province to provide portfolio-based, long-term funding sources for non-profit housing providers;
- Calls to the Federal Government and the Province for ongoing rent supplements and housing benefits, and an increase to the shelter portion of income assistance;
- New policies added with focus on the specific housing needs of lower income households and people experiencing homelessness; and
- A new expectation that Housing Action Plans should be linked with plans to address homelessness, and identify strategies to increase community acceptance and communicate the benefits of affordable and supportive housing development.

Goal 5

Strategy 5.1 Coordinate land use and transportation to encourage transit, multiple-occupancy vehicles, cycling and walking

- Transit expansion priorities replaced with the Major Transit Growth Corridors concept;
- Active transportation terminology updated with "Regional Cycling Network" (i.e. Metro Vancouver's Regional Greenway Network plus TransLink's Major Bikeway Network);
- Action added for Metro Vancouver to lead the development of a regional parking strategy;
- New Regional Context Statement requirements addressing zero-emission vehicles and transit-oriented affordable housing;
- Support TransLink in considering an increased role in the provision of transit-oriented affordable housing through Land Value Capture mechanisms; and
- Actions to increase the resilience of the transportation system.

Strategy 5.2 Coordinate land use and transportation to support the safe and efficient movement of vehicles for passengers, goods and services

- Updated references to the adopted Regional Goods Movement Strategy;
- Addition of truck routes to the list of protected rights-of-way (along with rail and navigable waterways);
- A call for research into low-carbon last-mile delivery and the impact of e-commerce distribution centres;
- New policy to minimize public exposure to unhealthy levels of noise, vibration and pollution associated with the transportation system; and
- A call for the Federal Government and the Province to consider regional land use objectives, greenhouse gas impacts, transportation demand management alternatives, and other long-term costs before contemplating roadway expansion.

NEXT STEPS

Staff anticipate receiving comments and revisions on the draft content of Goals 4 and 5 from the *Metro 2050* Intergovernmental Advisory Committee (IAC) in the coming weeks. As part of the engagement on the draft of Goals 4 and 5, IAC members have been asked to comment specifically on two questions. For Goal 4, whether Strategies 4.1 and 4.2 should be combined to focus more broadly on rental and affordable housing supply rather than having a separate Strategy 4.2 targeting rental

housing and tenant protections. For Goal 5, IAC members have been asked to identify a preference between listing the Major Transit Growth Corridors or providing a general list of priority areas in policy 5.1.3. In response to feedback on these questions and other comments, the Committee and Board can expect to see further changes to Goals 4 and 5 when they are received as part of the full draft of *Metro 2050*, which will be presented to the Regional Planning Committee and MVRD Board in June 2021 with a recommendation to refer it out to signatory agencies and organizations for a formal review and comment period between July and November 2021.

ALTERNATIVES

This is an information report. No alternatives are presented.

FINANCIAL IMPLICATIONS

There are no financial implications to this report. All work was completed as part of the 2020 and 2021 Board-approved Regional Planning budgets.

CONCLUSION

Metro Vancouver staff, with the support of the *Metro 2050* Intergovernmental Advisory Committee, have been drafting new and amended content for *Metro 2050*, by goal area, based on the MVRD Board endorsed policy review recommendations. The policy content for Goal 4 (Provide Diverse and Affordable Housing Choices) and Goal 5 (Support Sustainable Transportation Choices) has been drafted to address some of the key housing and transportation challenges that have been identified during the past ten years of implementation, and are being presented to the Regional Planning Committee in this report for discussion. The draft strategies of *Metro 2050* build on the successes of *Metro 2040*, using the existing policy content as a 'base' to make improvements and enhancements to further the integration of land use and transportation, protect important lands, and support the effective implementation of the shared regional vision.

In accordance with the approved project schedule, in June 2021 staff will present a complete draft of *Metro 2050* to the Regional Planning Committee and MVRD Board for consideration, with a recommendation that it be referred out for formal comment between July and November 2021.

Attachments *(45159898)*

1. *Metro 2050* Draft Goal 4 Preamble
2. *Metro 2050* Draft Strategies 4.1
3. *Metro 2050* Draft Strategies 4.2
4. *Metro 2050* Draft Strategies 4.3
5. *Metro 2050* Draft Goal 5 Preamble
6. *Metro 2050* Draft Strategies 5.1
7. *Metro 2050* Draft Strategies 5.2
8. Goal 4 Housing Key Terms

References

1. *Metro 2050* Q3/Q4 2020 Status Update, Regional Planning Committee, November 6, 2020
2. *Metro 2040* Housing Policy Review Endorsed Recommendations
3. *Metro 2040* Housing Policy Review Summary
4. *Metro 2040* Transport Policy Review Endorsed Recommendations

5. *Metro 2040* Transport Policy Review Summary
6. Manager's Report, Regional Planning Committee, April 9, 2021

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Goal 4: Provide Diverse and Affordable Housing Choices (Formerly 'Develop Complete Communities')

PREAMBLE (p45)

Proposed Metro 2050 Text	Rationale for Change
A diverse and affordable housing stock is critical to accommodating growth and supporting a vibrant population. Communities across Metro Vancouver are experiencing significant housing pressures paired with accelerating housing costs in the rental and ownership markets. At the same time as demand for rental housing is increasing, existing affordable rental housing stock is aging and in need of ongoing maintenance and renewal. In addition, the creation of new affordable rental units, particularly in proximity to transit, is challenged by high land and construction costs. Lower income households, who make up the majority of renters in the region, are being forced to look further afield for housing that is affordable and meets their needs. Additionally, the most acute housing needs are those faced by populations at risk of homelessness and other vulnerable populations who urgently require access to permanent, affordable, and supportive housing units. In response to these challenges, a diverse mix of housing types and tenures that respond to an aging population, changing family and household characteristics and a range of household incomes and needs across the region is needed. Having housing choices means that all residents can find adequate and suitable housing that is affordable based on their household income, and that meets their unique needs and preferences. Goal 4 of *Metro 2050* encourages diverse and affordable housing choices as a means to provide equal opportunity for residents to live in their desired community or neighbourhood, close to employment, transit, schools, amenities and important social connections. The first strategy identifies actions to promote an adequate supply of housing to meet existing and future housing needs across the housing continuum. Aligning housing policy efforts across the region and supporting the preparation and implementation of Housing Action Plans that work toward achieving the number and type of housing units required to meet the needs identified in local Housing Needs Reports is critical. The second strategy advocates for incentives to stimulate the supply of below-market and market rental housing, particularly in transit-oriented locations, and encourages measures to mitigate or limit the net loss of existing affordable rental and non-market housing stock.	• Remove all references to Metro 2040 Strategy 4.2 – Complete Communities content moved to Metro 2050 Goal 1. • Preface the Strategy descriptions with an overview of the housing landscape in Metro Vancouver. • Introduce the intent and benefit of each new Goal 4 strategy.

The third strategy advocates for capital and operating funding to support the provision of permanent, affordable, and supportive housing, and ongoing housing and income benefits to supplement the high cost of rent in the private market. It recognizes that housing plans and policies must be aligned with plans to address homelessness. All levels of government have a role to play in creating opportunities for diverse housing options and senior government funding is essential to meeting the housing needs of these populations.	
Strategies to achieve this goal are:	
4.1 Expand the Supply and Diversity of Housing to Meet a Variety of Needs	*Metro 2040* Strategy 4.1 title is now the *Metro 2050* Goal 4 title – this is a new Strategy title but much of the *Metro 2040* 4.1 content has been retained in *Metro 2050*
4.2 Increase Rental Housing Supply and Protect Tenants	New Strategy
4.3 Meet the Housing Needs of Lower Income Households and Homeless Populations	New Strategy

#	Proposed *Metro 2050* Text	Rationale for Change
Goal 4 (Formerly 'Develop Complete Communities')		
Strategy 4.1 (Formerly 'Provide Diverse and Affordable Housing Choices')		
4	**Provide Diverse and Affordable Housing Choices**	The new Goal 4 title is the previous title of *Metro 2040* Strategy 4.1 – the benefit is that this title has already been vetted by member jurisdictions and is broad enough to describe the new *Metro 2050* Goal 4 dealing with housing.
4.1	**Expand the Supply and Diversity of Housing to Meet a Variety of Needs**	The new Strategy 4.1 title is aligned with Goal 1 of the *Regional Affordable Housing Strategy* (RAHS) – the benefit is that RAHS concepts are already vetted by member jurisdictions.
	Strategy Rationale: Housing diversity refers to the range of housing types and tenures required to meet the needs of households of all sizes, incomes, ages, and abilities. Expanding the supply and diversity of housing that meets a variety of needs across the housing continuum increases affordability, social equity, and resilience in the region.	Adding a new "strategy rationale" section after each strategy will help explain the intention of the subsequent policies.
	Metro Vancouver will:	
		Action 4.1.1 is deleted as most actions in the *Regional Affordable Housing Strategy (2016)* are complete or underway. Avoids duplication.
4.1.1	Assist member jurisdictions in developing Housing Action Plans by providing analysis on regional demographics, household characteristics, and market conditions, and work with member jurisdictions to review and refine local housing priorities, policies and Housing Needs Reports in the context of this analysis.	• Formerly *Metro 2040* 4.1.2 • Replace "municipalities" with "member jurisdictions" • Remove "in accordance with Metro Vancouver's Affordable Housing Strategy" • Replace "Housing Demand Estimates" with "Housing Needs Reports".
4.1.2	Monitor and report on the progress of member jurisdiction Housing Action Plans in achieving the number and type of housing units required to meet current and anticipated housing needs, as outlined in the member jurisdiction's Housing Needs Report.	• Formerly *Metro 2040* 4.1.3 • Replace "success" with "progress" with regards to Metro Vancouver's role in monitoring and reporting on Housing Action Plans. • Replace "municipal" with "member jurisdiction"

		• Replace "Housing Demand Estimates" with "Housing Needs Reports"
		Metro 2040 4.1.4 moved to *Metro 2050* Strategy 4.3
		Metro 2040 4.1.5 moved to *Metro 2050* Strategy 4.2
4.1.3	Support member jurisdictions to develop and deliver housing policies and actions by compiling, analyzing and communicating data, preparing implementation guidelines and best practices research, and convening discussions on issues of common interest.	**New policy** – This policy highlights Metro Vancouver's regional planning function and the planning resources and services it provides to member jurisdictions, for example its role with regards to data collection and supporting regional housing policy and research.
4.1.4	Accept Regional Context Statements that describe how local plans, strategies, and policies will achieve diverse and affordable housing options, expand the supply and diversity of housing to meet a variety of needs along the housing continuum, and meet or work towards Actions 4.1.7 and 4.1.8	Minor housekeeping edits to clarify Metro Vancouver's RCS expectations vis a vis Strategy 4.1
4.1.5	Advocate to the Province to create new enabling legislation that allows local governments in British Columbia to mandate affordable housing through inclusionary zoning powers.	**New policy** – This policy requests that the province enable the authority for inclusionary zoning powers in local governments in B.C. as has been done in provinces such as Alberta, Manitoba, and Ontario. The benefit of inclusionary zoning powers is that it would enable local governments to require affordable housing units in new residential developments via the zoning bylaw, without having to offer additional density negotiated through the rezoning process.
4.1.6	Advocate to the Province for expanded funding maximums and eligibility that supports Treaty and Non-Treaty First Nations in developing Housing Needs Reports to ensure a complete regional and provincial understanding of housing need, and to help inform local plans, policies, and development decisions.	**New policy** – Previous advocacy by Metro Vancouver resulted in Treaty First Nations (including Tsawwassen First Nation) becoming eligible for provincial funding to prepare a Housing Needs Report (HNR), even though First Nations are not subject to the provincial requirement to complete HNRs. Non-Treaty First Nations within the Metro Vancouver boundary are not eligible for the HNR funding program. To ensure a regional

		understanding of housing need, all First Nations in B.C. should be eligible to access funding from the province to conduct these assessments. This policy advocates for increased funding eligibility and funding maximums (not based on population) for First Nations as their HNR projects are much more costly and will require custom data work, and will contribute to a regional and provincial understanding of housing need.
	Member Jurisdictions will:	
4.1.7	Adopt Regional Context Statements that:	
a)	indicate how they will work towards meeting estimated future housing needs and demand as determined in their Housing Needs Report;	• Replace "municipalities" with "they/their" • Replace "Housing Demand Estimates" with "Housing Needs Reports"
b)	articulate how local plans and policies, including neighbourhood and area plans, will meet the need for diverse (in tenure, size, and type) and affordable housing options;	Minor housekeeping edits to better describe RCS requirements that align with Strategy 4.1
c)	identify policies and actions that contribute to the following outcomes: i) increased supply of suitable, adequate, accessible and affordable housing to meet a variety of needs along the housing continuum; ii) increased diversity of housing tenure options, such as ownership, rental, co-op housing, rent-to-own models, and cohousing; iii) increased density and supply of diverse ground-oriented and infill housing forms in low-density neighbourhoods, such as duplex, four-plex, townhouse, laneway/coach houses, and low-rise apartments, particularly in proximity to transit; iv) increased housing affordability through the integration of land use and transportation planning such that households can reduce combined housing and transportation costs; v) increased social connectedness in multi-unit housing; vi) high quality urban design and overall integration of housing within neighbourhood contexts; and vii) existing and future housing stock that is low carbon and resilient to climate change impacts and natural hazard risks;	• **Revised policy** – This policy has been revised to add clarity to the housing policy *outcomes* that should be identified in a RCS versus the *measures and tools* that can be used to achieve such outcomes. The benefit of identifying broader outcomes is that it is less directive in terms of setting local housing policy and will account for changing best practices and the introduction of new tools over time. • The following outcomes have been added: - Suitable, adequate and affordable housing supply - Diversity of tenure - Gentle density and missing middle housing forms

		- Reduced housing + transportation cost burden - Increased social connectedness - Quality urban design - Low carbon and resilient housing • The concept of "housing affordability" is defined in the *Metro 2050* glossary. More than "affordable housing", it is the consideration of all the costs associated with housing within the context of a household's overall budget and circumstances, for example child care and transportation costs.
		Metro 2040 4.1.7 a) iii) moved to *Metro 2050* Strategy 4.3
4.1.8	Prepare and implement Housing Action Plans that:	
a)	are aligned with Housing Needs Reports, and reviewed or updated every 5-10 years to ensure that Housing Action Plans are based on recent evidence and responsive to current and future housing needs;	**New policy** – The intent of this policy is to ensure that all members develop Housing Action Plans and keep them current as a means of encouraging local housing policy decisions that are based on the most recent housing needs, data and market conditions, and aligned with provincially-required Housing Needs Reports. To date, 15 member jurisdictions have or will soon adopt a housing plan or strategy, though some are now over 10 years old and in need of review or update. • This policy is based on Policy Review Recommendation #4 "Introduce more robust requirements for the adoption of Housing Action Plans".
b)	assess local housing market conditions, by tenure, including assessing housing supply, demand, and affordability;	No change. Formerly *Metro 2040* 4.1.8 a).
c)	identify housing priorities, based on the assessment of local housing market conditions, household incomes, changing population and household demographics, and key categories of local housing	• **Revised policy** – Minor housekeeping changes have been made to align this policy with the information collection

	need, including specific statements about special needs housing and the housing needs of equity-seeking groups;	categories required by the provincial Housing Needs Reports regulation. • This policy responds to Policy Review Recommendation #7 "Apply a Social Equity lens to the housing policy framework by adding explicit references to the unique housing needs of specific equity-seeking groups, and employing inclusive policy language".
d)	identify implementation measures within their jurisdiction and financial capabilities, including actions set out in Action 4.1.7.	• No change. Formerly *Metro 2040* 4.1.8 c) • Replace "municipalities" with "they/their"
		Metro 2040 4.1.8 d) moved to *Metro 2050* Strategy 4.2
		Metro 2040 4.1.8 e) moved to *Metro 2050* Strategy 4.3
		Metro 2040 4.1.8 f) moved to *Metro 2050* Strategy 4.2
		Metro 2040 4.1.9 moved to *Metro 2050* Strategy 4.2
		Metro 2040 4.1.10 moved to *Metro 2050* Strategy 4.3
		Metro 2040 4.1.11 moved to *Metro 2050* Strategy 4.3

#	Proposed *Metro 2050* Text	Rationale for Change
Goal 4		
Strategy 4.2 (New Goal 4 Strategy)		
4.2	**Increase Rental Housing Supply and Protect Tenants**	The new Strategy 4.2 title is aligned with Goal 2 of the *Regional Affordable Housing Strategy* (RAHS) – the benefit is that RAHS concepts are already vetted by member jurisdictions. This strategy places an emphasis on rental housing and tenant protections as per Policy Review engagement feedback.
	Strategy Rationale: Purpose-built rental housing is a critical component of the housing continuum, offering security of tenure to the many residents who cannot or choose not to purchase a home. The secondary rental market also forms a large part of the region's overall rental housing stock, and provides additional rental housing options such as secondary suites, laneway/coach houses, and rented condominiums. Increasing the rental housing supply and renewing aging rental housing while minimizing the impacts of redevelopment and renovation on existing tenants preserves affordability and increases opportunities for everyone in the region to access a home they can afford.	Adding a new "strategy rationale" section after each strategy will help explain the intention of the subsequent policies.
	Metro Vancouver will:	
4.2.1	Monitor the purpose-built rental housing stock, and report on rental housing supply gaps by income level and number of bedrooms.	**New policy** – This policy will enable Metro Vancouver to identify areas where rental housing is being lost or gained, and to identify vulnerabilities or gaps in the purpose-built rental supply by affordability level and unit size. This information will be tracked through the annual reports / the Metro Vancouver Housing Data Book.
4.2.2	Implement the *Metro Vancouver Housing 10-Year Plan (2019)* and seek opportunities for Metro Vancouver Housing to partner with member jurisdictions and others to expand affordable rental housing across the region.	• Formerly *Metro 2040* 4.1.5 • **Revised policy** – Minor housekeeping changes have been made to reference Metro Vancouver Housing's new strategic plan. • Remove "and assist municipalities in the management of units acquired through municipal processes" from *Metro 2050* – this action is now directly referenced in

		the *Metro Vancouver Housing 10-Year Plan*. • This policy responds to Policy Review Recommendation #6 "reference the *Metro Vancouver Housing 10-Year Plan*, particularly the goal of developing partnerships with member jurisdictions as a means to expand affordable rental housing across the region".
4.2.3	Set a regional target of 15% affordable rental units in redeveloped and new housing development within Urban Centres, Frequent Transit Development Areas, and Major Transit Growth Corridors, and monitor progress toward it every 5 years.	**New policy** – This policy commits Metro Vancouver to setting an aspirational regional target to address housing needs in the region. Further study will be undertaken to develop a methodology for measuring, monitoring, and reporting on this target following the adoption of *Metro 2050***.**
4.2.4	Accept Regional Context Statements that describe how local plans, strategies, and policies will increase rental housing supply while protecting tenants, and that meet or work towards Actions 4.2.7 and 4.2.8.	**New policy** – This policy describes Metro Vancouver's RCS expectations vis a vis Strategy 4.2.
4.2.5	Advocate to the federal government and the Province to provide incentives to stimulate private sector investment in rental housing to help achieve the current and anticipated need for rental housing units, as determined by Housing Needs Reports.	• Formerly *Metro 2040* 4.1.9 and rephrasing as an advocacy action. • 'And their agencies' moved to glossary definition of "the province". • Replace "Housing Demand Estimates" with "Housing Needs Reports" • Replace "market" with "rental" to make this policy applicable to market and below-market rental.
4.2.6	Advocate to the Province for expanded measures to address housing speculation and vacant homes as a means of increasing long-term rental options, and bringing unoccupied housing into the secondary rental market.	**New policy** – This policy advocates in part for an amendment to the *Local Government Act* in order for all BC local governments to be able to impose Vacancy Taxes similar to the City of Vancouver's Empty Homes Tax. An amendment was made to the *Vancouver Charter* to enable this power in the City of Vancouver in 2016. Other Metro Vancouver

		member jurisdictions have expressed their desire to implement similar measures.
	Member Jurisdictions will:	
4.2.7	Adopt Regional Context Statements that:	**New policy** – This policy describes RCS requirements that align with the policies of Strategy 4.2.
a)	identify policies and actions that increase the supply of transit-oriented affordable rental housing;	**New policy** – This policy supports increasing the supply of transit-oriented affordable rental housing in the region, given that renter households, especially those with lower incomes, are more likely to use transit.
b)	identify policies and actions that support the redevelopment of aging purpose-built rental housing to increase the supply of market and below-market rental housing, while protecting tenants;	**New policy –** This policy encourages the redevelopment of aging purpose-built rental housing in a way that expands the overall supply of rental housing.
c)	identify policies and actions that encourage the protection and renewal of existing non-market rental housing;	**New policy –** This policy highlights the importance of preserving and replacing existing non-market housing units. It also implements recommendations from the Hey Neighbour Collective Discussion Paper.
d)	identify policies and actions that mitigate impacts on renter households due to renovation or redevelopment, and strengthen protections for tenants;	**New policy –** This policy strengthens *Metro 2050*'s focus on tenant protections based on Policy Review engagement feedback. It also implements recommendations from the Hey Neighbour Collective Discussion Paper.
e)	articulate how local plans and policies, including neighbourhood and area plans, will protect renter households, particularly during redevelopment or densification of Urban Centres, Frequent Transit Development Areas, and Major Transit Growth Corridors;	**New policy –** This policy strengthens expectations for renter protections to be articulated in local plans and policies for Urban Centres and FTDAs, and creates alignment with *Metro 2050* Goal 1. It also implements recommendations from the Hey Neighbour Collective Discussion Paper.
f)	demonstrate how they will, within their local context, work towards the regional target of 15% affordable rental units in redeveloped and new housing development within Urban Centres, Frequent Transit Development Areas, and Major Transit Growth Corridors;	**New policy** – The intent of this policy is to encourage member jurisdictions to set their own transit-oriented affordable housing targets or calibrate their inclusionary housing

		policies to specifically increase the supply of affordable rental housing in transit-oriented locations, working toward a regional minimum of 15% affordable rental housing in new developments that are built in transit-oriented areas regionally. • This policy is based on Policy Review Recommendation #2 "Expand the regional growth strategy's role with regards to housing (i.e. establish region-wide provisions to stimulate housing production)". • This new policy also relates to Action 19 of the "2020 Declaration for Resilience in Metro Vancouver Communities" endorsed by the Metro Vancouver Regional Planning Committee and Board and Goal 4 Action g.) of the RAHS. The definition of "affordable housing" for the purpose of *Metro 2050* refers to housing that is affordable to households earning up to 120% of the regional median household income ($85,000). Adding a definition of "affordable housing" responds to Policy Review Recommendation #3 "Introduce a regionally endorsed, shared definition of housing affordability or affordable housing".

g)	identify policies and actions that contribute to the following outcomes: i) increased purpose-built rental housing supply and healthy rental vacancy rate; ii) replacement or renewal of aging rental housing stock and prevention of net affordable rental and non-market rental unit loss; iii) increased security of tenure for renter households; iv) increased support for tenants affected by major renovation or redevelopment and rising rental costs in areas designated for new growth or transit investment; v) reduced energy use and greenhouse gas emissions from existing rental buildings, while considering impacts on tenants and affordability; and vi) improved resilience of rental housing stock to climate change impacts and natural hazard risks;	**New policy** – This policy outlines the housing policy *outcomes* that should be identified in a RCS versus the *measures and tools* that can be used to achieve such outcomes. The benefit of identifying broader outcomes is that it is less directive in terms of setting local housing policy and will account for changing best practices and the introduction of new tools over time. • In response to these outcomes, RCSs should identify existing member jurisdiction policies such as tenant relocation policies, rental replacement policies, strata conversion policies, inclusionary housing policies, climate policies and targets, etc. • This policy also implements recommendations from the Hey Neighbour Collective Discussion Paper.
4.2.8	Prepare and implement Housing Action Plans that:	**New policy** – This policy describes expectations for Housing Action Plans vis a vis Strategy 4.2.
a)	encourage the supply of new rental housing and mitigate or limit the loss of existing rental housing stock;	• No change. Formerly *Metro 2040* 4.1.8 d) • Remove "where appropriate"
b)	encourage tenant protections and assistance for renter households impacted by renovation or redevelopment of existing purpose-built rental housing;	**New policy –** This policy strengthens *Metro 2050*'s focus on tenant protections based on Policy Review engagement feedback. It also implements recommendations from the Hey Neighbour Collective Discussion Paper.
c)	cooperate with and facilitate the activities of Metro Vancouver Housing under Action 4.2.2.	No change. Formerly *Metro 2040* 4.1.8 f)

Goal 4

Strategy 4.3 (New Strategy)

#	Proposed *Metro 2050* Text	Rationale for Change
4.3	**Meet the Housing Needs of Lower Income Households and Homeless Populations**	The new Strategy 4.3 title is aligned with Goals 3 and 5 of the *Regional Affordable Housing Strategy* (RAHS) – the benefit is that RAHS concepts are already vetted by member jurisdictions. All existing *Metro 2040* actions relating to social/supportive housing have been moved to Strategy 4.3.
	Strategy Rationale: Lower income households and populations facing or at risk of homelessness have the most acute housing needs in our region. Through collaboration with the federal government and the province, efforts to support the provision of non-market housing can ensure equitable access to housing for all. Meeting the housing needs of the most vulnerable in our communities also provides a number of co-benefits including positive health outcomes and improved social cohesion.	Adding a new "strategy rationale" section after each strategy will help explain the intention of the subsequent policies.
	Metro Vancouver will:	
4.3.1	Accept Regional Context Statements that describe how local plans, strategies, and policies will meet the specific housing needs of lower income households, including the existing housing needs of the homeless population, and that meet or work towards Actions 4.3.6 and 4.3.7.	**New policy** – This policy describes Metro Vancouver's RCS expectations vis a vis Strategy 4.3.
4.3.2	Advocate to the Federal Government and the Province for incentives to stimulate non-market rental supply and capital and operating funding to support the construction of permanent, affordable, and supportive housing across the region.	• Formerly *Metro 2040* 4.1.4 and 4.1.11 • Remove reference to transitional housing and replace with an emphasis on permanent housing. • Replace "private" with "non-market" to specify the type of housing for which incentives are being requested
4.3.3	Advocate to the Federal Government and the Province to provide capital and operating funding to meet the current and anticipated housing needs of lower income households and populations facing or at risk of homelessness, as determined by Housing Needs Reports.	• Formerly *Metro 2040* 4.1.10 and rephrasing as an advocacy action. • 'And their agencies' moved to glossary definition of "the province" • Replace "Housing Demand Estimates" with "Housing Needs Reports" • The definition of "lower income households" for the purpose of *Metro 2050* is households earning less than 80%

		of the regional median household income ($60,000).
4.3.4	Advocate to the Federal Government and the Province for portfolio-based, long-term funding sources for non-profit housing providers that shift away from short-term, project-based funding models as a means of ensuring the sustainability of the non-profit housing sector.	**New policy** – This policy advocates for secure funding sources to support the non-profit housing sector in order to protect and maintain the financial viability and sustainability of this critical portion of the affordable housing stock.
4.3.5	Advocate to the Federal Government and the Province to provide ongoing rent supplements and housing benefits, and to increase the shelter portion of income assistance to ensure that lower income households and populations facing or at risk of homelessness can afford suitable and adequate housing.	**New policy –** This policy strengthens *Metro 2050*'s focus on the specific housing needs of lower income households and people experiencing homelessness and responds to Policy Review Recommendation #7 "add equity lens; link housing and homelessness").
	Member Jurisdictions will:	
4.3.6	Adopt Regional Context Statements that:	**New policy** – This policy describes RCS requirements that align with the policies of Strategy 4.3.
a)	indicate how they will collaborate with the federal government, the Province, and other partners, to assist in increasing the supply of permanent, affordable, and supportive housing units;	• Formerly *Metro 2040* 4.1.7 a) iii) • Remove reference to transitional housing and replace with an emphasis on permanent housing. • Remove reference to specific policy tools
b)	identify policies and actions that partner with other levels of government and non-profit organizations to create pathways out of homelessness and contribute to meeting the housing and support needs of the homeless population.	**New policy** – This policy strengthens *Metro 2050*'s focus on the specific housing needs of lower income households and people experiencing homelessness and responds to Policy Review Recommendation #7 "add equity lens; link housing and homelessness"). All references to homelessness in *Metro 2050* are related to the housing-specific needs of the homeless population (i.e. not related to mental health and addictions, preventing homelessness, etc. which is out of the scope of *Metro 2050*)

4.3.7	Prepare and implement Housing Action Plans that:	**New policy** – This policy describes expectations for Housing Action Plans vis a vis *Metro 2050* Strategy 4.3.
a)	identify opportunities to participate in programs with other levels of government to secure additional housing units to meet the housing needs of lower income households;	No change. Formerly *Metro 2040* 4.1.8 e)
b)	identify strategies to increase community acceptance and communicate the benefits of affordable and supportive housing development;	**New policy** – This policy addresses barriers to building new affordable and supportive housing as a result of community opposition.
c)	are aligned with or integrate plans to address homelessness, and identify strategies to reduce the total number of households that are in core housing need.	**New policy** – The intent of this policy is to ensure that Housing Action Plans are linked to local, provincial, and federal plans to address homelessness and households in core housing need, and responds to Policy Review Recommendation #7 “add equity lens; link housing and homelessness”.

Goal 5: Support Sustainable Transportation Choices

PREAMBLE

Proposed Metro 2050 Text	Rationale for Change
Land use influences travel patterns and transportation systems, in turn, affect land use and development. Achieving the goals of *Metro 2050* requires the alignment of land use and transportation strategies. Accessible and sustainable transportation choices are supported by strategies for a compact urban area, with transit-oriented development patterns that focus growth in Urban Centres, Major Transit Growth Corridors and Frequent Transit Development Areas. This transit-oriented pattern of growth helps reduce vehicle use, traffic congestion, energy consumption and air emissions from on-road sources while fostering transit ridership and active transportation. It provides the region's residents with resilient mobility options, a cleaner environment, and opportunities to reduce household transportation costs. The first strategy identifies actions required to increase the proportion of trips by transit, cycling, walking, and other alternatives to single-occupant vehicle travel. Implementation of TransLink's Major Transit Network will be critical in reinforcing the network of transit-oriented Urban Centres, Major Transit Growth Corridors and Frequent Transit Development Areas. *Metro 2050* aligns these growth designations with planned transit connections to provide clearer expectations about future growth and investment. Aligning land use and transportation in this way enables a diversity of transit-oriented affordable housing, shorter trips and greater access to opportunity. The second strategy recognizes the fundamental role that the Major Road Network, Regional Truck Route Network, provincial highways, and federal transportation facilities play in shaping regional growth, moving people and goods among and between the region's communities and economic areas, and connecting the region with intra-provincial, national and international destinations. The strategy advocates for active management of the existing and planned capacity of the road network and the demands put upon it. This minimizes the need for capital-intensive roadway expansion in the future. Further, rail and marine transportation have the potential to play a larger role in the future for goods movement, so protecting rail rights-of- way and access points to waterways today is critical in preserving transportation options in the future. This strategy also anticipates the changing nature of industry and digitalization of commerce. Metro Vancouver works in partnership with member jurisdictions, TransLink, Port of Vancouver, airport authorities, the federal government, and the province to coordinate decision-making in support of the regional growth strategy. TransLink prepares and implements strategic transportation plans for roads,	• Updated terminology: *Metro 2050*, *Transport 2050,* Major Transit Growth Corridors, Regional Truck Route Network • Paragraph two increases emphasis on alignment of land use and transportation, referencing the Major Transit Network and Major Transit Growth Corridors. • Increased overall emphasis on active transportation and goods movement.

transit, active transportation, and goods movement, among other regional transportation programs. TransLink is also responsible for the region's long-term transportation strategy, *Transport 2050. Metro 2050 and Transport 2050* comprise the region's long-term vision for the land use and transportation system. The province prepares provincial highway and transit plans which help to guide the development of regional transportation plans. Both the federal government and the province play significant roles in funding regional transit and goods movement infrastructure. Furthermore, Metro Vancouver advocates for reductions in transportation-related greenhouse gas emissions and common air contaminants.		
Strategies to achieve this goal are:		
5.1	Coordinate land use and transportation to encourage transit, multiple-occupancy vehicles, cycling and walking	
5.2	Coordinate land use and transportation to support the safe and efficient movement of vehicles for passengers, goods and services	

#	Proposed Metro 2050 Text	Rationale for Change
Goal: 5		
Strategy 5.1		
5	**Support Sustainable Transportation Choices**	No change.
5.1	**Coordinate land use and transportation to encourage transit, multiple-occupancy vehicles, cycling and walking**	No change.
n/a	Strategy Rationale: The coordination of land use and transportation supports positive region building by ensuring communities are connected to sustainable transportation networks – transit, walking and cycling – while investing in transportation improvements for existing neighbourhoods. Over time, this creates a regional growth pattern where destinations are closer together and more accessible for all, with less need to drive as multiple convenient travel options are available to meet daily needs. The benefits of this "transit-oriented" growth pattern include: reduced greenhouse gas emissions; formation of complete, compact communities; more physical activity and improved health; lower transportation costs; and a more resilient economy with better access to job opportunities, diverse and affordable housing, and community amenities.	
	Metro Vancouver will:	
5.1.1	Provide input into TransLink's regional transportation system and demand management strategies through the provision of land use, growth management and air quality information and forecasts, and the evaluation of land use and vehicle emissions impacts.	**Revised Policy.** • "Acknowledgements of TransLink's mandate" content moved to *Metro 2050* Section B, "Scope and Linkages to Other Plans."
5.1.2	Work with TransLink to ensure that the following objectives are ensure that the following objectives are embedded in regional transportation planning principles: a) the regional land use framework and strategy, as set out in Strategy 1.2; b) reduced energy consumption and greenhouse gas emissions, as well as the air quality objectives set out in Strategy 3.3, in part through transit ridership growth and mode shift; and c) the safe and efficient movement of vehicles for passengers, goods, and services, as set out in Strategy 5.2. d) the formation of complete, equitable, healthy, and resilient communities.	**Revised Policy.** • *Metro 2040* 5.1.2 is long and overly complex. Separate Objective A and Objective B actions into distinct policies. • Regional Transportation Commissioner is defunct. • Part (d) aligns with *Transport 2050* objectives.

<table>
<tr>
<td>5.1.3</td>
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Two versions of 5.1.3 are provided for Intergovernmental Advisory Committee discussion:

Option A: List of the Major Transit Growth Corridors
Collaborate with TransLink and member jurisdictions, in support Strategy 5.1.2 (a), to encourage the growth of population, jobs, and Major Transit Network services along the following regionally-significant Major Transit Growth Corridors:

<table>
<tr><th>Corridor</th><th>Extent</th></tr>
<tr><td>1. Expo Line</td><td>Expo Line corridor, incl. Surrey Metro Centre to Langley RCC</td></tr>
<tr><td>2. Millennium Line</td><td>Millennium Line corridor, incl. Metro Core to UBC FTDA</td></tr>
<tr><td>3. Canada Line (Cambie St)</td><td>Canada Line corridor, excl. Sea Island</td></tr>
<tr><td>4. Marine Dr / Main St</td><td>Ambleside MTC to Lower Lynn FTDA</td></tr>
<tr><td>5. Hastings St</td><td>Metro Core to Lochdale Urban Village</td></tr>
<tr><td>6. 41st Ave</td><td>Joyce Station to UBC FTDA</td></tr>
<tr><td>7. Willingdon Ave</td><td>Hastings St to Metrotown RCC</td></tr>
<tr><td>8. Scott Rd and 72 Ave</td><td>Scott Rd SkyTrain Station to Newton MTC</td></tr>
<tr><td>9. King George Blvd</td><td>Surrey Metro Centre to Newton MTC</td></tr>
<tr><td>10. 104 Ave</td><td>Surrey Metro Centre to Guildford MTC</td></tr>
<tr><td>11. Lougheed Hwy</td><td>Coquitlam RCC to Maple Ridge RCC</td></tr>
</table>

Option B: General List of Priority Areas
Collaborate with TransLink and member jurisdictions, in support Strategy 5.1.2 (a), to encourage the growth of population, jobs, and Major Transit Network services between Urban Centres, according to the following priorities:

Priority 1: Major Transit Growth Corridors
Priority 2: Major Transit Network
Priority 3: Frequent Transit Network
Priority 4: Local Transit Networks

</td>
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Revised Policy.
• Policy was previously part of 5.1.2.
• In Metro 2040, policy listed 11 priority corridors for rapid transit and frequent transit expansion. Many of these priorities have been completed in the last ten years.
• Rather than specifying transit investment needs, the revised Options focus on coordinated growth of population, jobs and transit along key corridors between Urban Centres.
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<tr>
<td>5.1.4</td>
<td>Collaborate with TransLink, in support of Strategy 5.1.2(b), on the achievement of regional priorities to increase the share of trips made by transit, multiple-occupancy vehicles, cycling, and walking, and reduce energy consumption and air emissions from on-road transportation sources. Metro Vancouver will support the development of strategic transportation plans to achieve this objective, within TransLink's mandate to plan and manage the regional transportation system.</td>
<td>
Revised Policy.
• Previously part of Metro 2040 5.1.2.
• "Acknowledgements" content moved to Metro 2050 Section B, "Scope and Linkages to Other Plans."
</td>
</tr>
<tr>
<td>5.1.5</td>
<td>Collaborate with TransLink, the Province, and member jurisdictions to implement land use and transportation data collection, forecasting, and performance measures and/or targets, as</td>
<td>Revised Policy.</td>
</tr>
</table>

	appropriate, in support of the development of future regional growth management, climate action, air quality management, and transportation strategies and plans.	• Reference added to future climate action plans.
5.1.6	In collaboration with other agencies, implement the *Regional Greenways 2050* plan by developing and managing the Regional Greenway Network, as shown in Map X.	**Revised Policy.** • Update ROW policy to instead reference Regional Greenway Network.
5.1.7	Accept Regional Context Statements that identify policies and actions that coordinate land use and transportation planning to support transit, multiple-occupancy vehicles, zero-emission vehicles, cycling and walking, and that meet or work towards Action 5.1.13.	**Revised Policy.** • Zero-emission vehicles reference is key addition to RCS requirements.
5.1.8	Collaborate with member jurisdictions and TransLink to develop a regional parking strategy to right-size the supply of parking in the region, make more efficient use of the limited land supply, and improve housing and transportation affordability.	**New Policy.** • Reflects endorsed Transport Policy Review recommendation #2.
5.19	Support member jurisdictions and TransLink in developing livability and place-making strategies in response to changing mobility technologies, such as regulating ride-hailing services; managing the impacts of automated, connected, electric and shared vehicles; reallocating road or curb space to support people-first streets; and implementing traffic calming initiatives.	**New Policy.** • Supports efforts by members and TransLink to anticipate and manage changes in transportation technology.
5.1.9	Advocate to the Province, in collaboration with TransLink and member jurisdictions, to evaluate and develop measures to mitigate the potential negative impacts on the region's Industrial, Agricultural, and Conservation and Recreation areas when planning rapid transit alignments, station locations, and other transportation infrastructure.	**Revised Policy.** • References added to mitigation and ecosystems.
5.1.10	Advocate for the Province, TransLink and Metro Vancouver to work together to coordinate transportation planning and infrastructure projects in the Lower Mainland, including adjacent regional districts.	**Revised Policy.** • Policy simplified and reference to Intergovernmental Advisory Committee removed.
5.1.11	Advocate to the Federal Government and the Province to support the implementation of the regional growth strategy by providing increased, reliable and sustainable funding for expanding and operating: a) the regional transit system; and b) the Regional Cycling Network, including both the Major Bikeway Network and Regional Greenway Network.	**Revised Policy.** • Reference to "transportation system" updated to "transit system" to emphasize transit funding gap. • Reference to pilot projects replaced with call for increased funding for RCN.
5.1.12	Advocate to railway companies, when developing their plans and strategies for rail corridors and facilities in the region, that they coordinate and consult with member jurisdictions, TransLink, Port of Vancouver and Metro Vancouver to ensure that they are compatible with and support the regional transportation and land use planning goals of the regional growth strategy.	**Revised Policy.** • Minor revisions for clarity.
	Member jurisdictions will:	
5.1.13	Adopt Regional Context Statements that identify how land use and transportation policies and actions:	**Revised Policy.**

	a) coordinate to encourage a greater share of trips made by transit, multiple-occupancy vehicles, cycling and walking; b) support the development and implementation of municipal and regional transportation system and demand management strategies, such as: parking pricing and supply measures, transit priority measures, ridesharing, mobility pricing, and car-sharing programs; c) manage and enhance municipal infrastructure in support of transit, multiple-occupancy vehicles, cycling and walking; d) support the transition to zero-emission vehicles; e) work collaboratively with TransLink, Metro Vancouver, the Province, and others to implement the *Regional Greenways 2050* plan by developing and managing a Regional Greenway Network, as identified in Map 9; f) enhance walkability through such measures as: sidewalk capital programs, street design and accessibility guidelines, and establishing urban grids in master-planned developments; and g) consider adjacent member jurisdictions and First Nations when making plans, policies, and programs related to new mobility, shared mobility and inter-connectivity.	• Mobility pricing added under (b) to reflect findings of Mobility Pricing Independent Commission. • Zero-emission vehicles added under (d) for consistency with *Climate 2050.* • Part (e) integrates with proposed policy 5.1.6. • Part (f) addresses walkability and urban design specifically. • Part (g) encourages coordination with adjacent jurisdictions and First Nations.
	TransLink will:	
5.1.14	In collaboration with Metro Vancouver: a) prepare and implement strategic transportation plans that support focused growth in Urban Centres and Frequent Transit Development Areas, and in appropriate areas within the Major Transit Growth Corridors, while avoiding those known unmitigated areas at risk to climate change and natural hazard impacts (as shown in Map X); b) provide adequate opportunities to provide input into TransLink's strategic planning and decision-making processes that would affect the achievement of the objectives and priorities as set out in Action 5.1.2; c) establish performance measures and/or targets that support an increased share of trips made by transit, multiple-occupancy vehicles, cycling and walking, and the associated reductions in air emissions from on-road transportation sources, and monitor progress towards achieving these targets; d) prepare and implement regional transportation system and demand management strategies, such as: ridesharing programs, mobility pricing and regulation for ride-hailing services and other emerging mobility technologies; e) support the development of safe and comfortable regional cycling networks serving Urban Centres, Frequent Transit Development Areas, Major Transit Growth Corridors, and other areas of high commuter and/or recreational cycling potential; f) support the development of a regional parking strategy to right-size the supply of parking in the region to make more efficient use of the limited land supply, and improve housing and transportation affordability;	**Revised Policy.** • Part (f) regional parking strategy reference corresponds with 5.1.8. • Part (g) drawn from climate policy input. • Part (h) drawn from TransLink's Land Value Capture study. • Part (i) drawn from Regional Resilience Framework. • Part (j) complements Metro Vancouver and member jurisdiction active transportation actions elsewhere in 5.1. • Part (k) responds to need for improved connectivity for First Nations communities.

	g) evaluate cooperatively with the Province, the Integrated Partnership for Regional Emergency Management, and member jurisdictions, the potential impacts of climate change and known unmitigated natural hazards on rapid transit alignments, station locations, and associated transportation infrastructure; h) consider an increased role in supporting transit-oriented affordable housing through such mechanisms as: strategic land acquisition, disposition, and development; land value capture; or the use of Benefitting Area Taxes; i) continue developing active transportation and transit networks as a means to create redundancy in low-cost, low-emission travel options; j) implement, cooperatively with the Province, member jurisdictions, and others, to implement both the Regional Greenway and Major Bikeway Networks, as identified in Map X; and k) continue to identify viable new opportunities to create and improve transit linkages to and within reserve First Nations communities.	

#	Proposed Metro 2050 Text	Rationale for Change
Goal: 5		
Strategy 5.2		
5	**Support Sustainable Transportation Choices**	No change.
5.2	**Coordinate land use and transportation to support the safe and efficient movement of vehicles for passengers, goods and services**	No change.
n/a	**Strategy Rationale** Major roads, truck routes, provincial and federal highways, port terminals, railyards, airports, and transit play a vital role in supporting our regional economy, shaping regional growth, and connecting us to other regions. Making the most of the goods movement system requires protecting industrial lands and transportation rights-of-way, minimizing community impacts, reducing greenhouse gas emissions, and seeking demand-management alternatives to infrastructure expansion, particularly for passenger transportation.	
	Metro Vancouver will:	
5.2.1	Support implementation of the Regional Goods Movement Strategy prepared by TransLink and continue to participate in the Greater Vancouver Urban Freight Council.	**Revised Policy.** • Refers specifically to implementing the now-completed Regional Goods Movement Strategy. • New reference to participating in GVUFC.
5.2.2	Accept Regional Context Statements that identify coordinated land use and transportation policies and actions in support of the safe and efficient movement of vehicles for passengers, goods and services and that meet or work towards Action 5.2.7.	No change.
5.2.3	Collaborate with the Province, TransLink, and other regional districts to ensure that the following elements are considered when contemplating future expansion of private vehicle capacity on major roads, highways, and crossings: a) transportation demand management and active transportation strategies as alternatives to, or as integral with, such capacity expansion; b) the negative impacts on the achievement of regional greenhouse gas emission reduction targets and air quality objectives; c) the negative impacts on the implementation of the regional land use framework and strategy as set out in Strategy 1.2; d) the long-term effects of induced demand, ongoing maintenance requirements, life-cycle costs and opportunity costs; and e) the ability of the transportation system to withstand known unmitigated climate change impacts and natural hazards.	**Revised Policy.** • "Bridges" changed to the more general "crossings." • Active transportation added to part (a) as a TDM/integration approach. • Parts (c) through (e) added to reference Strategy 1.2, true costs, and resilience considerations.

5.2.4	Advocate to the Federal Government and the Province, in collaboration with member jurisdictions, the Fraser Valley Regional District and the Squamish-Lillooet Regional District, to minimize impacts from vehicle movement on the environment and public health within the Lower Fraser Valley Airshed.	**Revised Policy.** • Extraneous qualifiers deleted for readability. • Reference added to federal government and adjacent regional districts.
5.2.5	Advocate to the Federal Government and the Province to support the safe, reliable and efficient movement of vehicles for passengers, goods and services through shared funding, policies and regulations for: a) protection of rail rights-of-way, truck routes, and access points to navigable waterways; b) protective and mitigation measures on air quality, habitat, and communities; c) applied research into transportation system and demand management-related technologies, policies, and regulations to optimize the movement of vehicles for passengers, goods, and services, in particular to and from airports, ports, intermodal goods handling facilities, low-carbon last mile delivery, and distribution centres for e-commerce; and d) survey instruments to obtain timely and comprehensive data on the travel patterns of residents, workers, and goods and service vehicles travelling inter- and intra-regionally.	**Revised Policy.** • Part (a) adds truck routes to list of corridors to protect. • Part (c) anticipates the research gaps associated with e-commerce.
5.2.6	Advocate to the Federal Government, the Province and the Port of Vancouver to reduce truck traffic on local roads by more effectively utilizing the existing multi-modal transportation network on a 24-hour basis, expanding short-sea shipping, moving more containers by rail directly from marine container terminals to inland transload facilities, and enhancing co-location of import and export transload facilities.	**New Policy.** • Adapted from Regional Goods Movement Strategy 2.9.4.
	~~Advocate that the province and partner agencies, as appropriate, support the protection of rail rights-of-way and access points to navigable waterways in order to reserve the potential for goods movement, in consideration of the potential impacts on air quality, habitat and communities.~~	**Deleted Policy.** • *Metro 2040* policy 5.2.5 deleted. Policy is redundant with *Metro 2050* policy 5.2.5(a).
	Member jurisdictions will:	
5.2.7	Adopt Regional Context Statements that: a) identify routes on a map for the safe and efficient movement of goods and service vehicles to, from, and within Urban Centres, Frequent Transit Development Areas, Major Transit Growth Corridors, Industrial, Employment and Agricultural areas, ports, airports, and international border crossings; b) identify land use and related policies and actions that support the optimization and safety of goods movement to and from Industrial lands via roads, highways, railways, airports, and access points to navigable waterways, including short sea shipping; c) support the development of local and regional transportation system management strategies, such as the provision of information to operators of goods and service vehicles for efficient travel decisions, management of traffic flow using transit priority measures, coordinated traffic signalization, and lane management;	**Revised Policy.** • Part (b) and (f) updated per Regional Industrial Lands Strategy. • Part (e) corresponds with *Metro 2050* 1.2.20, which would provide guidance to assist with developing this RCS content.

	d) identify policies and actions which support the protection of rail rights-of-way, truck routes, and access points to navigable waterways in order to reserve the potential for goods movement; e) identify policies and actions to minimize public exposure to unhealthy levels of noise, vibration, and air pollution associated with the Major Road Network, Major Transit Network, railways, truck routes, and Federal / Provincial Highways; and f) identify policies and actions that anticipate the land requirements for goods movement and drayage, such as truck parking and e-commerce distribution centres, and mitigate the negative impacts of these uses on neighbourhoods.	
	TransLink will:	
5.2.8	Support the safe and efficient movement of vehicles for passengers, goods and services by: a) managing and maintaining the Major Road Network and Regional Truck Route Network (as shown in Map X) in collaboration with member jurisdictions; b) implementing the Regional Goods Movement Strategy; c) preparing and implementing regional transportation system and demand management strategies, in consideration of the goals and strategies of the regional growth strategy for Urban Centres, Frequent Transit Development Areas, and Major Transit Growth Corridors; and d) continuing to identify viable new opportunities to create and improve transit linkages between the region's industrial and employment areas and local labour force.	**Revised Policy.** • Co-management of MRN and TRN with member jurisdictions added for clarity. • Reference to Regional Truck Route Network added. • Part (c) now includes Major Transit Growth Corridors. • Part (d) is a key Regional Industrial Lands Strategy recommendation.
5.2.9	Support the protection of rail rights-of-way, truck routes, and access points to navigable waterways to reserve the potential for goods movement, in consideration of the potential impacts on air quality, habitat and communities.	**Revised Policy.** • Truck routes added to list of corridors to protect (to complement Metro Vancouver and member jurisdiction policies).
5.2.10	Seek to minimize negative impacts from within-and-through passenger, goods, and service vehicle movement on the environment and public health affecting the region and areas within the Lower Fraser Valley Airshed.	**Revised Policy.** • "Negative" impacts added for clarity.

Key Terms – Metro 2050 Goal 4

Provide Diverse and Affordable Housing Choices

1. Goal 4 Glossary Terms https://orbit.gvrd.bc.ca/orbit/llisapi.dll/link/42494726

- **Affordable Housing:** For the purpose of *Metro 2050*, "affordable housing" is housing that is affordable to households earning up to 120% of the regional median household income ($85,000 per year based on 2016 Census Median Household Income of $72,600).
- **Housing Affordability:** In Canada, housing is considered affordable when a household (ownership or rental) is spending no more than 30% of its gross (before-tax) income on total housing costs, including utilities. Housing Affordability is a concept that considers all of the costs associated with housing within the context of a household's overall budget and circumstances, for example child care and transportation costs.
- **Lower Income Households:** For the purpose of *Metro 2050*, "lower income households" are those earning less than 80% of the regional median household income ($60,000 per year based on 2016 Census Median Household Income of $72,600).

Income Table (not included in Metro 2050)

Income Group Definition	Income Thresholds (based on 2016 Census Median Household Income of $72,600)
Less than 50% of regional median household income	< $35,000
50% to 80% of regional median household income	$35,000 - $60,000
80% to 120% of regional median household income	$60,000 - $85,000
120% to 150% of regional median household income	$85,000 - $115,000
More than 150% of regional median household income	$115,000 +

2. Other Key Terms (not included in Metro 2050 Glossary)

- **Special needs housing:** a term used in BC provincial legislation to describe individuals with diverse housing needs. The term "special needs housing" is broadly defined because a variety of housing types are required to address the needs of these diverse populations. Persons with special housing related needs may include:
  - Individuals with mental or physical disabilities
  - Individuals with substance misuse issues
  - Individuals living with HIV/AIDS
  - Individuals with mental illness
  - Women and children fleeing violence
  - Children in government care
  - Individuals who are homeless or at risk of homelessness

- Seniors
- Youth

- **Market rental housing:** rental housing with rents that are generally similar to the rent of other units in the private (non-subsidized) rental housing market.
- **Below-market rental housing:** rental housing with rents equal to, or lower than, average rates in private-market rental housing.
- **Non-market housing:** housing that is subsidized by government as well as non-profit housing that is below market and protected from market forces.
- **Supportive housing:** a type of housing that provides on-site supports and services to residents who cannot live independently
- **Housing continuum:** the range of housing options available in our communities, from temporary options such as emergency shelters for people who are homeless, to more permanent housing such as rental and homeownership.

To: Regional Planning Committee

From: Eric Aderneck, Senior Planner, Regional Planning and Housing Services

Date: April 12, 2021 Meeting Date: May 7, 2021

Subject: **Metro Vancouver Industrial Lands Intensification Analysis Study**

RECOMMENDATION

That the MVRD Board receive for information the report dated April 12, 2021, titled "Metro Vancouver Industrial Lands Intensification Analysis Study".

EXECUTIVE SUMMARY

Given the limited supply of industrial lands in the Metro Vancouver region, one of the key components to meet increasing demand is industrial intensification. Metro Vancouver commissioned a study to explore the challenges and opportunities of industrial intensification in this region. The Industrial Lands Intensification Analysis Study builds on past research undertaken by Metro Vancouver, and outlines examples and recommendations for developing higher density industrial forms, while protecting the industrial use and intent for the lands.

The Study's recommendations include collaborating with member jurisdictions to implement the Regional Industrial Lands Strategy through:

- Updating municipal zoning bylaws to permit the intended industrial activities, including new and emerging forms of industry and supportive accessory uses;
- Zoning bylaw provisions that encourage density build out and/or creative design solutions;
- Reviewing parking requirements for industrial developments;
- Encouraging lot consolidation to create larger development sites; and
- Advancing 'Bring-to-Market' strategies to encourage reinvestment and more intensive development of industrial lands.

PURPOSE

To provide for information to the Regional Planning Committee and MVRD Board the completed Industrial Lands Intensification Analysis Study.

BACKGROUND

The Metro Vancouver Regional Industrial Lands Strategy (RILS), approved by the MVRD Board in July of 2020, identified that constrained industrial land supply is one of the main challenges facing the Metro Vancouver region, stating:

> *With a limited supply of vacant industrial land remaining, there are fewer opportunities to accommodate both new industrial businesses and those businesses that are seeking to expand their operations….* (References 1 and 2).

The RILS identified 34 recommendations and 10 priority actions to respond to the challenges facing the region's industrial lands, one of which was to "facilitate the intensification / densification of industrial forms where possible". Encouraging the better utilization and intensification of industrial lands is also an existing policy in the regional growth strategy (*Metro 2040*) under Strategy 2.2, and is intended to be brought forward into *Metro 2050* (Reference 3).

In late 2020, Metro Vancouver commissioned Colliers Consulting to prepare a study to further explore industrial lands intensification opportunities in the region. The Industrial Lands Intensification Analysis Study (the Study) has been completed (Attachment 1) and is ready for Committee and Board consideration.

INDUSTRIAL LANDS INTENSIFICATION ANALYSIS STUDY

The Study builds on previous research undertaken and commissioned by Metro Vancouver, including that associated with the preparation of the RILS. The Study explores current examples from both within the Metro Vancouver region and other jurisdictions in North America, and references how industrial intensification opportunities are informed by market trends, construction costs, and land supply and demand. This includes profiling the key drivers of industrial intensification, and various development formats and types of uses most suitable to multi-level industrial development, together with a consideration of different building designs, geographic locations, and associated financial analyses.

The Study summarizes the findings from past research associated with industrial land development, including: stratification, financial viability of multi-level industrial buildings, industrial edge planning, and agri-industrial activities. Relative to those findings and based on the identified challenges, the Study presents recommendations pertaining to:

- Permitted Uses / Zoning
- Density and Site Constraints
- Height Restrictions
- Parking / Loading
- Building Design
- Municipal Fees and Approvals
- Site Size Requirements
- Geotechnical Considerations
- Proximity to Transportation and Employees
- Market Pressures
- Land Values
- Land Banking
- Ineffective Uses

Key Findings

Key findings noted in the Study are:

- The need for intensification is driven by several factors including limited land supply and strong demand, population growth and density, international trade, ecommerce, external economies of scale, municipal regulations, automation, land values, and speculation.
- The interplay between industrial land values, construction costs, lease / strata rates, among other related variables influence the market feasibility of multi-storey industrial development.

- Important considerations regarding the feasibility of intensified industrial development include geotechnical conditions, development format, lot size, population density, accessibility and amenities.
- Metro Vancouver has experienced a recent wave of higher-density projects being built in the region resulting from market pressure and demand drivers.
- The design and development of intensified, multi-storey industrial projects, include numerous considerations such as site coverage, floor area ratios, lot size requirements, tenant space requirements, loading / access / parking, integration / scale of accessory uses, and physical site features.
- The demand for industrial floorspace within Metro Vancouver is increasingly driven by service-oriented industrial uses that are generally less land-intensive than traditional heavy industries.
- Emerging flex-industrial companies are increasingly demanding integrated, multi-purpose facilities that accommodate design, manufacturing, distribution, and showrooms / retail activities. These companies generally prefer the benefit of being closer to the consumer within desirable neighbourhoods compared to the challenges and costs associated with the smaller / more constrained inner urban sites.
- Modestly sized multi-level projects are the most common form of multi-storey industrial development in Metro Vancouver, primarily consisting of small-to-medium bay flex industrial and mezzanine space with multiple floors of office space above.
- While second floor flex industrial space is costly to develop and less desirable to tenants, the office space above tends to help make the projects viable while introducing more ground floor industrial supply to the market. This is particularly evident in dense urban locations that are highly accessible by vehicle and public transit.

Recommendations

Recognizing that the various sizes / contexts of sites and types of industrial uses have very different built form potential, the Study's recommendations to support intensification opportunities include:

- Explore municipal fees and approval process impacts, noting that land and construction costs and design complexity are generally much higher for multi-storey industrial building projects;
- Update and modernize industrial use definitions in zoning bylaws to reflect current and emerging industrial activities;
- Revise zoning bylaw provisions that limit industrial development densities, including height and coverage; and
- Review industrial parking requirements, especially for locations close to transit service.

It is noted that Metro Vancouver has previously studied the potential for industrial intensification, finding that a major common challenge to building multi-storey industrial buildings is financial viability. While that challenge still exists, it is changing. This can be seen in the recent examples of projects made viable, in part, through increasing lease rates / sales prices for industrial space in the

region, which is being driven by the limited land supply and strong demand for space. Aligning regional and municipal industrial policies and regulations with industrial market drivers would encourage more efficient industrial land usage.

NEXT STEPS

Regional Planning staff will continue to work closely with member jurisdictions and other stakeholders to advance the recommendations of the Regional Industrial Lands Strategy. This includes broadly sharing the results of the Industrial Lands Intensification Analysis Study and exploring the recommendations with member jurisdictions, industrial developers, and other agencies and stakeholders, to encourage higher density industrial forms, where appropriate, while protecting the industrial use intent of the limited land supply. The Study's results will be used to inform the amended and new policy language in *Metro 2050*, the update to the regional growth strategy, and the future Regional Land Use Assessment project that is currently being scoped.

ALTERNATIVES

This is an information report. No alternatives are presented.

FINANCIAL IMPLICATIONS

This consultant's study was undertaken within the Board approved Regional Planning budget.

CONCLUSION

To advance the actions of the Regional Industrial Lands Strategy, Metro Vancouver commissioned an Industrial Lands Intensification Analysis Study to further explore the opportunity and challenges around industrial intensification / densification in the region. The Study builds on past research undertaken by Metro Vancouver exploring industrial lands intensification, and summarizes the key drivers of industrial intensification, provides examples and recommendations for developing higher density industrial forms, and offers recommendations to support intensification.

Metro Vancouver will continue to work with member jurisdictions, agencies, and stakeholders to advance the recommendations of the Regional Industrial Lands Strategy, including the effective utilization of the region's limited industrial lands. Successfully achieving the vision of the RILS will require the continued close collaboration and partnership with stakeholders, and a long-term shared commitment by Metro Vancouver and its member jurisdictions.

Attachment *(44278398)*

Metro Vancouver Industrial Lands Intensification Analysis Study, Colliers International, March 2021

References

1. Metro Vancouver Regional Industrial Lands Strategy – Full Report
2. Metro Vancouver Regional Industrial Lands Strategy – Executive Summary
3. *Metro 2050* Policy Review Summary – Industrial and Mixed Employment

44140741

Metro Vancouver

Industrial Intensification Analysis

FINAL REPORT | March 10, 2021

Prepared for: Metro Vancouver
Prepared by: Colliers Strategy and Consulting Group
Authors: Russell Whitehead, Project Manager
Christopher Kuno, Planning Consultant
Amin Wu, Financial Analyst

Table of Contents

Executive Summary

The intensification of industrial development can be measured in a variety of ways related to the optimized utilization of industrial land appropriate for each subsector. Generally, this can be broken down to intensity (amount of activity) and density (amount of building area). This report seeks to provide a better understanding of the most up-to-date market viability of mixed-use, multi-storey, and intensified industrial development within Metro Vancouver.

Summary of Challenges and Recommendations

1. Challenge: The relatively static nature of zoning bylaws mean that new industrial uses may not be able to be accommodated without a lengthy amendment process.

   Recommendations:

   - Recognize the importance of flexibility in allowing new industrial uses in industrial zones, keeping in mind the intent of higher-level policies and objectives.
   - Limiting non-industrial and accessory uses in industrial zones may prevent other users from occupying industrial space and ensure the greatest supply of industrial space.
   - Recognize that some accessory uses in industrial projects may support industrial activities and encourage the infill and intensification of industrial development by improving overall financial and operational viability.
   - In addition, expanding the scope of allowable industrial or industrial supportive uses in an intensified industrial development can create land efficiencies, increase overall employment levels per square foot of land, and support increased transit ridership.

2. Challenge: Prescribed limitations in land use plans and zoning bylaws may prevent the intensification of industrial land that a proponent would otherwise wish to develop.

   Recommendations:

   - Consider the intent of existing industrial and economic policy and remain flexible in site design allowing industrial developments to meet higher level objectives.
   - When adjacent industrial sites are compatible uses, reduce the required building setbacks to encourage the maximum industrial square footage achievable.
   - If building setbacks, parking, loading, and other requirements can be fully satisfied while providing the maximum building site coverage of a specific lot, then there should not be an artificial cap on the amount of permissible building site coverage nor densities of industrial usage.

3. Challenge: Regulating the maximum building heights achievable have an impact on the likelihood of industrial intensification in stacked formats along with high ceiling clear facilities.

   Recommendations:

   - Where appropriate, particularly in areas without conflicting adjacent uses or view concerns, increase or remove maximum height limitations from zoning bylaws to allow flexibility and encourage proponents to maximize the industrial productivity of each site.
   - Consider building minimum height requirements for strategic industrial areas to encourage intensification of industrial sites.

4. Challenge: Minimum parking requirements may be oversupplying parking, particularly on industrial sites accessible by transit or where usage requirements demand less on-site presence and employment.

   Recommendations:

   - Reducing minimum parking requirements will allow greater lot utility and disincentivize private vehicle use for commuting.
   - Consider allowing for structured parking to be excluded from FAR and site coverage calculations.
   - Allow for flexibility in parking requirements. Explore parking that is calculated by user demand and user requirements.
   - Allow and support the parking of light employee vehicles on the roof of an industrial development to encourage greater site utilization.
   - Allow and support surface storage on the roof of an industrial development to encourage greater site utilization.
   - Parking regulations should be reviewed by municipalities, particularly in transit-oriented industrial/mixed employment areas, to ensure that they are not too excessive based on current and expected industrial trends.
   - Minimize surface parking and encourage the design of parking areas that are adaptable for future uses and users.
   - Consider that certain parking areas could be used to accommodate employees during the day and fleet vehicles overnight.
   - Consider that certain portions of the lot can be used for parking and storage at certain times of the day and can also be used for loading at other times.

5. Challenge: Zoning bylaws and design guidelines may prohibit the necessary design features required for an intensified industrial project.

   Recommendation:

   - Municipalities should comprehensively review the requirements and intent of design guidelines in order to remove potentially limiting elements that discourage the development of intensified industrial

buildings. These may include a review of elements such as vehicle ramps, exterior walkways, outdoor elevators, excessive landscaping, screening, and other potentially outdated building design requirements.

- Consider reduced engineering requirements, particularly in the public right-of-way. For example, by allowing truck turning and other measures in the right-of-way, there could be more flexibility for the built form to accommodate a more intensified development.

6. Challenge: Municipal fees and lengthy approval timelines can represent a significant portion of the cost to develop an industrial development.

   Recommendations:

   - Consider reducing municipal fees for new intensified industrial developments which meet higher level policy objectives regarding economic growth and job creation.
   - Consider calculating the payment of municipal fees such as development cost charges on economic production space as opposed to gross square footage of an intensified industrial development.
   - Municipalities should undertake a review of the municipal approvals timeline in order to identify efficiencies that can be adopted. This may include elements such as concurrent development permit and rezoning processes, a more streamlined review process, or a certified builder process.
   - Municipalities should consider expediting the approval process for intensified industrial projects that meet a number of municipal goals and objectives similar to the process and policies frequently adopted for the approval of affordable rental housing.
   - Consider waiving Development Cost Charges (DCCs) for industrial floor area on additional storeys to financially incentivize development.
   - Consider waiving Community Amenity Contributions (CACs) in the approvals process when rezoning to higher intensity industrial zones.
   - Consider a transition to the Development Permit tool in industrial areas. This tool could control use and density by way of design, which would allow for the use and density to be more permissive in the zoning bylaw, which would reduce overall timelines and create a more flexible system.

7. Challenge: Small industrial lots are less conducive to intensified industrial developments than larger industrial parcels.

   Recommendations:

   - Where possible, prevent and discourage the subdivision of large industrial parcels and consider requiring minimum site sizes for certain industrially zoned properties in key strategic areas.
   - In greenfield industrial areas, encourage the development and retention of larger industrial parcels.
   - Encourage infill industrial projects, particularly on older properties that are not utilizing significant portions of the site.

- Encourage the redevelopment and consolidation of small industrial land parcels.
- Consider the impact of industrial stratification on the parceling of small industrial sites which may result in complications when consolidating larger parcels in the future.
- Smaller industrial parcels, particularly in more valuable urban areas, may be conducive to mixed-use industrial projects in formats that mix accessory office space above with industrial at grade.

8. Challenge: Some soils are not conducive to intensified industrial projects.

   Recommendations:

   - Encourage high lot coverage on sites with poor soil conditions and stacked industrial projects on sites with suitable soil.
   - Support multi-storey industrial projects where the site's topography results in the ability to provide direct truck access to upper floors without a costly ramp.

9. Challenge: Intensified industrial projects are most suitable in areas that are highly accessible to alternative and single occupant transportation modes.

   Recommendations:

   - Encourage industrial intensification in areas accessible to large residential populations and in areas well serviced by alternative transportation modes.
   - Support and encourage intensification of well-located industrial sites through rezoning and policy.
   - Explore the creation of intensified industrial, and in particular light / mixed-use industrial, in areas close to residential land uses and transit.

10. Challenge: Allowing too many non-industrial uses in industrial zones may place pressure on industrial sites from higher value uses.

    Recommendation:

    - Consider some select limited higher value accessory uses in some industrial zones or at select sites such as local workforce serving small scale retail, food services, and health facilities that can have functional or economic links to industrial uses, industrial users, and employees. Municipalities should review the intent of industrial plans and recognize the potential value for complementary uses while recognizing that high value uses may also drive away essential uses of lower value.

11. Challenge: Land values are a key determinant in the feasibility of an intensified industrial development.

    Recommendations:

    - Municipalities should be proactive and have supportive policies in place for when land values reach the required levels for more intensified industrial projects.

- Up zoning sites and increasing the allowable uses permitted on industrial sites will increase land values. Municipalities should review their goals and objectives to ensure that the resulting increase in land value does not prohibit other industrial users or encourage land banking.
- Explore the impact of industrial strata units being sold to foreign investors for investment holding purposes.
- Explore measures to ensure industrial units are being utilized for industrial uses as opposed to remaining vacant as a long-term investment hold.

12. Challenge: Lengthy holding periods of industrial land parcels may artificially limit the supply of developable industrial land.

Recommendations:

- Presently, municipalities do not have the right to force landowners to develop their property. Municipalities should focus on "Bring-to-Market-Strategies" to encourage reinvestment, utilization, and more intensive use.
- Reduce barriers associated with development to encourage more immediate action on industrials sites.

13. Challenge: Higher value uses may be pushing out industrial users from suitable industrial sites.

Recommendations:

- Municipalities should review the permitted use of new self-storage facilities, particularly on industrial sites well suited for intensification or in key employment areas.
- Consider the creative adaptive reuse and infill of underutilized parking facilities, particularly in urban areas for industrial uses. New uses may include innovative approaches to using underutilized space including infill self-storage, ghost kitchens, and maker spaces.

Table 16 Factors Affecting Industrial Intensification in Metro Vancouver

Intensification Factor	Relative Degree of Importance		
	High	Medium	Low
Permitted Uses	■		
Density and Site Constraints		■	
Height Restrictions		■	
Parking/Loading	■		
Building Design			■
Municipal Fees and Approvals	■		
Site Size Requirements[1]		■	
Geotechnical Considerations	■		
Proximity to Transportation and Employees	■		
Market Pressure	■		
Land Values	■		

[1] Intensified industrial developments, specifically Format A, require site sizes that facilitate functional, financially feasible design.

Market Trends

Growing demand, decreasing vacancy rates, and a scarcity of vacant land have pushed the region to a point where there is a critical need for more industrial supply. The shortage of supply has resulted in rapidly increasing land values which are now higher than many other cities in North America. The interplay between industrial land values, construction costs, lease/strata rates, among other related variables influence the market feasibility of multi-storey industrial development. Without a consistent influx of new supply, Metro Vancouver may risk losing a significant amount of potential employment from businesses that may instead choose another market with more availability. As a result of a limited and decreasing amount of vacant and appropriate supply to meet the demands of a wide range of industrial users, average lease rates and industrial land values have grown significantly throughout Metro Vancouver over the past decade.

Construction Costs

Through discussions with numerous developers, brokers, architects, and other stakeholders in the region, it is understood that the cost of intensified, multi-storey industrial development is significantly higher than traditional development. Factors such as ramping and loading requirements, additional services/utilities, freight elevators, geotechnical conditions, parking requirements, lengthy approvals, and higher lending costs can push total construction costs up to 2.5 times higher than traditional single floor development. For the most challenging multi-level projects, these costs could potentially exceed $250 per square foot. Aside from site specific factors such as geotechnical conditions or uncommon municipal development standards, construction costs do not vary much by region. As such, they do not have a huge impact on the intensification potential between industrial areas unless they are increased by factors such as outdated/surplus minimum parking requirements for particular user types.

Industrial Land Inventory and Capacity

Metro Vancouver has a finite amount of remaining suitable vacant industrial land to accommodate medium-term demand. This supply is further constrained by geographic limitations such as accessibility, lot size, slopes, and soil quality. Additionally, the existing restrictions of the ALR, along with occasional rezonings of industrial land to other land uses such as residential have further limited the availability of existing supply. Colliers has estimated the current inventory of vacant industrial land based on an absorption of 235 acres per year between 2018-2020. Based on this absorption level since 2018, the current inventory of vacant industrial land is estimated at 4,030 acres. The most recent employment-based industrial demand forecasts estimate the potential need for between 200 and 275 acres of land per year between 2020 and 2050. This would result in the full absorption of vacant land between approximately 2037 and 2045. More likely, before this land is completely absorbed the remaining vacant supply would be small, scattered parcels unsuitable for most industrial users. Therefore, the complete absorption of the most suitable supply could occur in the early 2030s.

As a result, without additional land supply or the intensification of existing land, future economic growth could be hindered.

Key Drivers of Industrial Intensification

While intensified industrial development is not entirely new to Metro Vancouver, there has been a recent wave of higher-density projects being built in the region resulting from market pressure and demand drivers. Developers consider these factors along with the economics of intensified/multi-storey development which is ultimately related to whether the increased land and construction costs of building up can be compensated by high enough industrial lease / strata rates and additional revenue generating accessory space. The need for industrial intensification is driven by several factors including limited land supply and strong demand, population growth and density, international trade, the growth of ecommerce, agglomeration economics, municipal regulations, automation, land values, and speculation.

Multi-Level Development Formats

There are a few general forms of multi-level industrial developments that have recently started to become more popular throughout North America, each of which have specific land/lot requirements, suitable tenant types, and scales of accessory uses. These include large scale stacked industrial (Format A), flex industrial with office above (Format B) and flex industrial with office/residential above (Format C).

Large stacked industrial formats are suitable for users who need large, contiguous space such as e-commerce, food production, heavy manufacturing, distribution, and last-mile fulfillment. Conversely, these formats would be less suitable for businesses with significant outdoor storage and trailer parking requirements or light industrial users with smaller floorplate requirements. The most well-known multi-storey industrial development of this format is Prologis Georgetown Crossroads in Seattle which includes two stacked levels of large-format industrial space with truck access and loading provided to the second floor through a ramp wrapping around the building. This is the most expensive type of multi-level industrial development due to significant costs and efficiency issues resulting from a ramp large enough to accommodate North American sized trucks.

Modestly sized multi-level projects (Format B) are the most common form of multistorey industrial development in Metro Vancouver, primarily consisting of small-to-medium bay flex industrial and mezzanine space with multiple floors of office space above. These developments are particularly attractive to tenants such as light manufacturing, engineering, hub-and-spoke distribution centres, breweries, and creative economy firms such as digital content creators and software designers. The viability of such development is driven by premium lease and strata rates achievable in areas of Metro Vancouver that are in high demand from such users, along with the higher values associated with office floorspace. While second floor flex industrial space is costly to develop and less desirable to tenants, the office space above helps make the projects viable while introducing

more industrial supply to the market. This is particularly evident in dense urban locations that are highly accessible by vehicle and public transit.

Format C is similar to Format B, with the addition of residential floorspace on top of both industrial and office uses. Wall Financial's Strathcona Village is one of the first of such developments in North America, including 280 condos, 70 social housing units, 14,000 sf of office space, and 46,000 sf of flex industrial space. These projects would be well suited for the same industrial tenants as Format B.

Industrial Subsectors Suitable for Intensified Developments

The demand for industrial floorspace within Metro Vancouver is driven more and more by service-oriented industrial uses that are generally less land-intensive than traditional heavy industries. Many of these are emerging industry subsectors which may have modern business models that do not directly fit under current municipal definitions of light or heavy industrial. Growing industrial sectors include logistics / last-mile distribution, niche manufacturing (food, coffee roasting, breweries, etc.), ecommerce/technology, creative industries, artisanal craftsmanship, film production, research and development, storage, equipment maintenance, and building supplies. Many of these businesses desire well-located, accessible urban locations and would be suitable for intensified/densified industrial developments. This demonstrates the importance of a clear municipal understanding regarding which uses to permit within specific industrial or mixed-employment areas.

Emerging flex-industrial companies are increasingly demanding integrated, multi-purpose facilities that accommodate design, manufacturing, distribution, and showrooms/retail activities. These companies generally prefer the benefit of being closer to the consumer within desirable neighbourhoods compared to the challenges and costs associated with small/constrained inner urban sites. There is also a growing demand from both employers and employees for locations within complete communities, resulting in the additional demand for accessory uses on top of what could be defined as industrial. This could include nearby amenities and services such as restaurants, coffee shops, gyms, medical services, and personal services.

Geographical and Locational Considerations

The locational characteristics impacting both the viability of multi-level industrial development and potential tenant demand include a variety of factors. Some industries and development formats are suitable for a wide range of locations, whereas others have more specific requirements. Important considerations regarding the feasibility of intensified industrial development include geotechnical conditions, development format and lot size, population density and growth, and accessibility and amenities. Ground conditions vary throughout Metro Vancouver and many industrially zoned sites are located on soil that makes multi-level development cost prohibitive. The likelihood of multi-storey development is also directly related to the availability of suitably sized lots. Large-scale multi-storey developments like Oxford Riverbend or Prologis Georgetown (both Format A),

require lot sizes large enough to accommodate the construction of a ramp to provide second floor truck access while also including enough leasable space to make the projects work financially. In addition to finding a suitably skilled workforce, the tenant types most likely to occupy multi-storey industrial developments are generally focused on serving the local/regional population, ranging from the distribution of goods from large fulfillment centres to the provision of services or manufactured goods to a localized population. Finally, accessibility and amenities are key factors that potential employees consider when deciding where to work and that potential consumers consider when deciding where to spend their money.

Design and Development Considerations

The design and development of intensified industrial projects, particularly multi-storey, include numerous considerations such as site coverage and floor area ratios, lot size requirements, tenant space requirements, loading/access/parking, integration/scale of accessory uses, and physical site features. These considerations vary based on scale and format of development and target tenant types, and in some cases may hinder or facilitate the development of multi-storey projects.

If building setbacks, parking, loading, and other requirements can be fully satisfied while providing the maximum building site coverage of a specific lot, then there should not be an artificial cap on the amount of permissible building site coverage nor densities of industrial usage. For larger developments, the requirement of a ramp that wraps around usable building space results in a less efficient design than a single storey building that could utilize more of the site area. Building height requirements are also important to consider. Industrial ceiling height requirements are constantly growing due to technological advancements, reaching over 40 feet in some of the newest, most advanced warehouses. As such, when these types of facilities are stacked on top of one another, the height of the total development can be significant. When municipalities have building height regulations based on older industrial formats with lower ceiling heights, the viability of multi-storey developments can be hindered.

The design of industrial buildings must meet the requirements of target tenant types while providing flexibility to adapt as user needs change. Office and retail uses can be supportive of industrial tenancies to a limit before established industrial areas can potentially become destabilized due to land speculation, taxes, and land use conflicts. The redevelopment of some sites to include an additional floor of light industrial space may not be feasible without the allowance for the inclusion of office space above which is of higher value in the market. It is also important to ensure that the design and interface between different uses within mixed-use projects minimize any potential conflicts. Municipal bylaws could be written to best reflect this balance, providing reasonable flexibility for accessory uses while requiring the inclusion of industrial uses.

Finally, the physical features of the site itself are important considerations. While industry has traditionally sought the flattest land in the region given the nature of most forms of production, storage, and distribution activity, the cost of providing ramping/truck access to second floor units has shifted more awareness to the

potential benefits of sloped sites. This is evident in the Ironworks development, which utilized a sloped site to provide direct truck access to its first and second floors without the need of a costly ramp.

Planning and Policy Review

Regional policies as well as those of six municipalities (City of Vancouver, City of Burnaby, City of North Vancouver, City of Richmond, City of Surrey, and the Township of Langley) were examined to identify efforts currently being undertaken to support intensified industrial development. These municipalities have significant industrial land areas and are key markets where demand and high land values for industrial floor area will instigate further densification and intensification where allowable. These municipalities were compared to identify policy items of concern that may limit or prohibit future industrial intensification. In addition, interviews were conducted with municipal planning staff to identify key action items for future implementation and areas of concern regarding industrial intensification.

While all municipalities reviewed have policies and statements in place noting the importance of the industrial sector, a number of policies and Official Community Plans require updating from an intensified industrial perspective to meet current market conditions. Most municipalities could include more prescriptive language as to how intensified development can occur. Additionally, in a number of municipalities, while there are goals and policies in place, zonings bylaw do not fully align with the objectives outlined in higher level policy documents.

Case Studies

Colliers reviewed examples of multi-storey developments with industrial components that are either recently constructed, currently under construction, or proposed. The analysis primarily focused on nine projects within Metro Vancouver to identify development trends, successes, challenges, and lessons learned. An additional five case studies within the United States were also reviewed to provide an understanding of industrial development trends occurring throughout North America.

Generally, the case studies indicate that the most common form of multi-level, mixed-use industrial development within Metro Vancouver is light industrial at grade with office space above. While there are a few examples with above ground light industrial floorspace, they are currently under development and have not attracted as much interest as ground floor units. Large-format, multi-level developments are only just becoming viable, however only within areas of Metro Vancouver north of the Fraser River on land that was purchased more than a few years ago due to the rapid recent increase of industrial land values. Within the Fraser Valley, it appears that the market is not there yet when it comes to multi-level development.

Financial Analysis

In order to understand how the market dynamics examined in this report impact the feasibility of multi-storey industrial development, Colliers assessed the preliminary feasibility of the following six hypothetical scenarios. The details of the key assumptions used in the financial analysis and a written commentary of the conclusions and implications can be found in Chapter 6.

- Baseline Scenario: Single-floor industrial development with surface parking (10-acre site)
- Scenario 1a: Single-floor industrial development with rooftop parking (10-acre site)
- Scenario 1b: Two-floor industrial development with ramp access (10-acre site)
- Scenario 1c: Three-floor industrial development with ramp access/freight elevator (10-acre site)
- Scenario 2a: Vertical development at 3 FAR, including 2 FAR industrial, 1 FAR office (0.7-acre site)
- Scenario 2b: Vertical development at 6 FAR, including 2 FAR industrial, 4 FAR office (0.7-acre site)

Financial Analysis Results Summary

Key Parameters	Baseline	Scenario 1a	Scenario 1b FORMAT A	Scenario 1c FORMAT A	Scenario 2a FORMAT B	Scenario 2b FORMAT B
Total GFA	217,800 sf	261,360 sf	435,600 sf	653,400 sf	91,480 sf	182,950 sf
Total project cost	35,371,312	59,423,805	127,336,725	208,088,213	37,050,042	75,450,445
Est. revenue after commission	95,239,094	114,286,913	178,626,118	260,153,993	53,841,295	114,430,574
Developer profit	10,956,710	13,148,052	20,549,907	29,929,220	7,022,778	14,925,727
Total residual land value	48,911,071	41,715,056	30,739,485	22,136,560	9,768,475	24,054,402
Residual price per acre	4,891,107	4,171,506	3,073,949	2,213,656	N/A	N/A
Comparables: Land value/ac	6,161,115	6,161,115	6,161,115	6,161,115	N/A	N/A
Residual price per buildable sf	N/A	N/A	N/A	N/A	107	131
Comparables: Value/buildable sf	N/A	N/A	N/A	N/A	170	170
Financial Viability	Almost viable, if the land is purchased 3-4 years ago	Almost viable, if the land is purchased 3-4 years ago	Almost viable, if the land is purchased 3-4 years ago	Not viable, unless the third floor can be converted into office space and the subject location is close to transit and urban amenities	Not Viable, unless the site was purchased a few years ago or the developer waits a number of years until the threshold strata/lease rates can be met.	Not Viable, unless the site was purchased a few years ago or the developer waits a number of years until the threshold strata/lease rates can be met.

1. Introduction

1.1 Scope of Work and Methodology

Colliers Strategy and Consulting Group (Colliers) was engaged by Metro Vancouver in late 2020 to conduct a study reviewing the issues and opportunities regarding industrial densification along with the potential for mixed-use developments featuring industrial and commercial components. The purpose of this study is to assist Metro Vancouver with its objective to increase the capacity and utility of its limited industrial land base, and to identify specific recommendations that could help inform municipal planning processes. Colliers completed the following scope items to produce this report:

- Literature review and information analysis
- Stakeholder interviews
- Industrial market analysis
- Industrial intensification overview
- Case studies of multi-storey industrial developments
- Financial analysis of hypothetical multi-storey development formats
- Assessment of key constraints and potential solutions to incentivize intensified development
- Key recommendations consistent with regional and municipal planning objectives

1.2 Limitations

This report was prepared by Colliers exclusively for Metro Vancouver. The information contained within has been obtained from sources deemed reliable. While every effort has been made to ensure its accuracy, Colliers cannot guarantee it. Colliers assumes no responsibility for any inaccuracies in this information. All findings related to potential future market conditions are made based on currently available information, and actual future market conditions may be materially different than projected, particularly due to the uncertainties arising from COVID-19. This document is only intended for Metro Vancouver.

1.3 List of Documents Reviewed

Intensified industrial development within Metro Vancouver is not a new topic with numerous related studies being conducted over the past 10 years. To provide a foundational understanding of industrial intensification while informing the analyses conducted within this report, Colliers reviewed the following reports, presentations, and articles. While additional websites, articles, and planning documents were also examined, the list below represents the key content that was reviewed.

- Regional Growth Strategy: Metro Vancouver 2040 Shaping Our Future (Metro Vancouver, 2011)
- Industrial Lands Intensification Analysis (Eric Vance & Associates, 2011)
- Best Practices for the Intensive Use of Industrial Land (Metro Vancouver, 2012)
- Higher Density Multi-Level Industrial Building Feasibility Study (Wozny, 2013)
- Metro Vancouver Industrial Land Redevelopment and Intensification (Stantec, 2013)
- Opportunities for the Intensive Use of Industrial Land (Metro Vancouver, 2013)
- Industrial Intensification Implementation Guidelines (Metro Vancouver, 2014)
- Industrial Lands Inventory (Metro Vancouver, 2015)
- Stratification of Industrial Land in Metro Vancouver (Aderneck, 2018)
- Agri-Industrial Activities in Metro Vancouver (EcoPlan International, 2018)
- Defining Industrial for the Regional Industrial Lands Strategy (Metro Vancouver, 2018)
- Industrial Edges – Compatibility and Interface Issues in Metro Vancouver (Bokeh Urban Design, 2018)
- Changing Nature of Industry and Industrial Land Demand in Metro Vancouver (Wollenberg, 2019)
- Study on Industrial Intensification Feasibility in Metro Vancouver (NAIOP, 2019)
- Is it Time to Go Vertical in Vancouver (Colliers, 2019)
- Multi-Storey Future – What We Know and Where We Are Going (Nelson, 2019)
- From Horizontal to Vertical – Building the Future of Industry (Aderneck, 2020)
- From Horizonal to Vertical: Industrial Intensification Grows Up (Aderneck, 2020)
- Industrial Lands Webinar (Aderneck and Beth Berry, 2020)
- Planning Considerations for Multi-Level Industrial Development in Vancouver (Aderneck, 2020)
- Regional Industrial Lands Strategy (Metro Vancouver, 2020)

1.4 List of Interviewees

To build upon the information gathered during the literature review, Colliers conducted informative interviews with a range of professionals including developers, architects, brokers, and planners. The list of individuals outlined below provided critical feedback towards the understanding of constraints, solutions, and recommendations regarding multi-storey industrial development. Additional information was also gathered through webinars and informal discussions with industry peers. We thank all who participated in these informational interviews for their critical contribution to the project in informing the next steps for intensified industrial development in Metro Vancouver.

- Chris Morrison (Executive Vice President, Colliers International)
- Matt Smith (Vice President, Colliers International)
- Roy Pat (Vice President, Colliers International)
- Pat Phillips (Vice President, Colliers International)
- Sean Bagan (Vice President, Colliers International)
- Dan Cupa (Director of Development, PC Urban)
- Beth Berry (VP Industrial Development, Beedie)
- Blake Asselstine (Leasing Director, Beedie)
- Jeff Miller (Head of Industrial, Oxford Properties)
- Drew Gilbertson (Director of Vancouver Industrial Leasing, Oxford Properties)
- Ben Taddei (COO, Conwest)
- Michael Hungerford (Partner, Hungerford)
- Joshua Gaglardi (Principal, Orion Construction)
- Craig Taylor (President, TKA+D Architecture)
- Alan Boniface (Principal, Alan Boniface Architecture)
- Chris Gowing (Partner, Mallen Gowing Berzens Architects)
- Matthew Bourke (Planner III, City of Vancouver)
- Jason Chu (Manager of Long-Range Planning, Township of Langley)
- Patrick Klassen (Community Planning Manager, City of Surrey)
- John Hopkins (Senior Planner, City of Richmond)

1.5 Definition, Measures, and Benefits of Industrial Intensification

The intensification of industrial development can be measured in a variety of ways related to the optimized utilization of industrial land appropriate for each subsector. Generally, this can be broken down to intensity (amount of activity) and density (amount of building area), as outlined below.

Industrial Intensity/Intensification (amount of activity)

- Labour intensity – employment per acre or building floor area
- Value generated – business revenue/profit per unit
- Production and volume of throughput – per building area, land area, or total employment
- Vehicular movement – per hour (trucks, loading, cranes, etc.)
- Quality and pay of jobs – education and pay levels
- Multiplier job impacts of different business types
- Value of lands and improvements

Industrial Density/Densification (amount of building)

- Building floor area ratio – building floorspace / lot area
- Building site coverage – building floorplate / lot area)
- Number of floors – upper floors potentially used for other uses
- Building height – volume/cubic area of building

These measures range based on subsector, however underutilized lots typically include surplus outdoor storage, loading, parking, sheds, and other similar low-value improvements. Underutilized buildings generally include underused or empty areas resulting from inefficient design, a trend particularly evident in older structures. Numerous studies indicate that industrial productivity is correlated to factors associated with proximity to suppliers, customers, competitors, and workers, which allows for increased value output per unit. Industrial intensification can lead to higher business output per both worker and area of land, generating positive benefits for both industry and the community, as outlined below. This report seeks to provide a better understanding of the most up-to-date market viability of mixed-use, multi-storey industrial development within Metro Vancouver.

Key Benefits

- More efficient use of land with increased industrial space and capacity for businesses to grow
- Accommodate employment growth, economic growth, and a higher tax base
- Reduced pressure to rezone other lands such as the Agricultural Land Reserve (ALR)
- Increased efficiencies through co-located operations, collaboration, and shared resources
- Reduced environmental impact

2. Metro Vancouver Industrial Market

2.1 Overview

Industrial lands play an important role in Metro Vancouver's economy, consisting of only 4% of the region's land base yet 27% of total jobs while offering wages that are approximately 10% higher than the average job. As of 2016, activities on industrial lands generated $27 billion in direct Gross Domestic Product (GDP), representing 30% of Metro Vancouver's total GDP. Industrial activity on these lands also provided an additional $30 billion in indirect and induced GDP, $16 billion of which was retained within the region. The necessity for and feasibility of intensified industrial development is driven by the economic importance of industrial lands along with a wide variety of market factors as outlined below.

Growing demand, decreasing vacancy rates, and a scarcity of vacant land have pushed the region to a point where there is a critical need for more industrial supply. The shortage of supply has resulted in rapidly increasing land values which are now higher than many other cities in North America. The interplay between industrial land values, construction costs, lease/strata rates, among other related variables influence the market feasibility of multi-storey industrial development. Without a consistent influx of new supply, Metro Vancouver may risk losing a significant amount of potential employment and economic activity from businesses that may instead choose another market with more availability. The following section of this report seeks to provide a clear understanding of the key market dynamics impacting the feasibility of multi-storey industrial development.

2.2 Market Outlook and Impact of COVID-19

The Metro Vancouver industrial market has been relatively resilient to the economic downturn caused by COVID-19. Vacancy rates have continually decreased quarter over quarter and are near record lows. At the end of 2020, the vacancy rate was 1.2%. The only increase in total vacant inventory within the past year have been in mid-bay (5,000-10,000 square feet) industrial units, experiencing only a modest total increase of 42,148 square feet. Demand is strongest for bulk/logistics space exceeding 100,000 square feet yet there are currently no vacancies in this size segment. Although some smaller bay industrial businesses such as those related to automotive, retail, or textiles have been facing some difficulties due to COVID-19, overall demand has remained strong due to the acceleration of e-commerce, diversified manufacturing operations, and certain industries looking to solidify their presence close to areas of high population density.

Moving forward, industrial real estate is expected to continue flourishing within Metro Vancouver resulting from consistently growing urban populations, diversifying employment opportunities, e-commerce, supply chain logistics, international trade, and emerging light industrial subsectors. The key challenge facing the region is the confluence of expected continual demand for industrial space with limited supply, some of which is further constrained by locational, physical, geographical, and regulatory measures. In recent years, Metro Vancouver

has absorbed approximately 250 acres of new industrial land per year with minimal redevelopment of older industrial buildings, a trend that is not expected to slow down anytime soon. The needs, desires, and types of industrial tenant types, particularly those suitable for multi-storey projects, are expected to continue evolving and contributing to the regional economy.

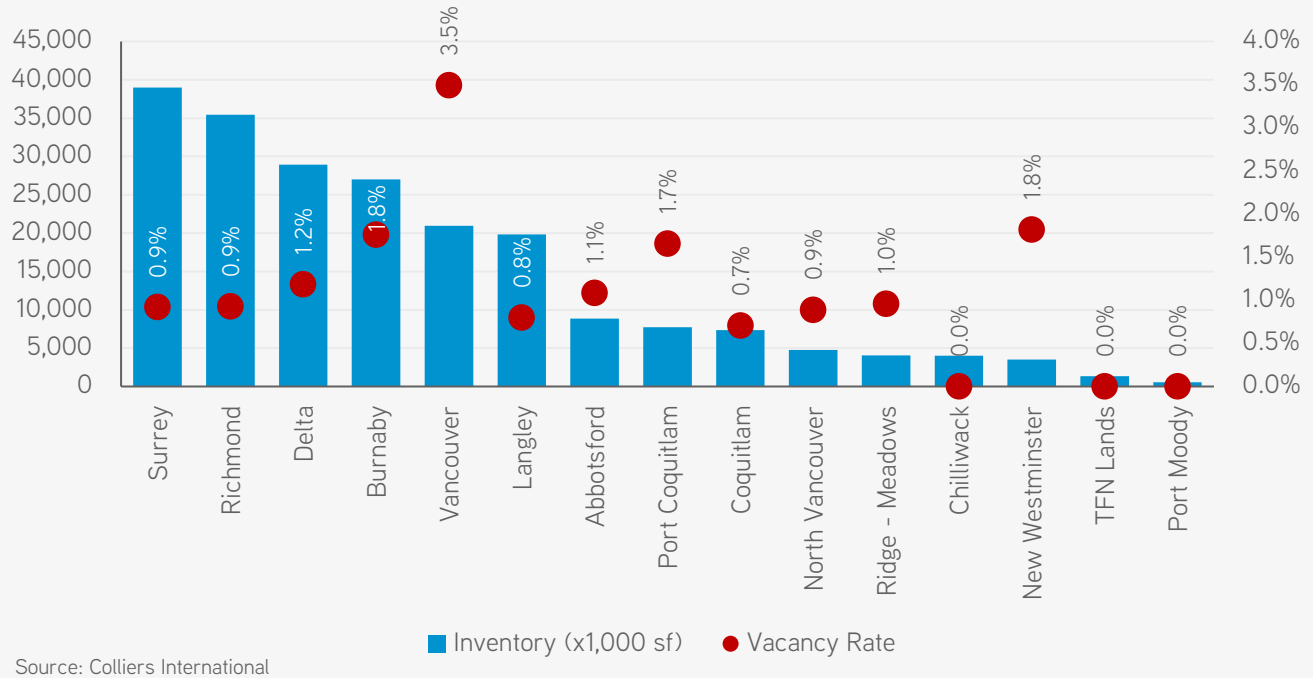
2.3 Market Statistics

Metro Vancouver Industrial Inventory by Municipality (Q3 2020)

Figure 1 displays Metro Vancouver's Q3 2020 industrial floorspace inventory, broken down by municipality (excluding Abbotsford). The total inventory has grown by an annual average of only 1.3% between 2010 and Q3 2020. This is just over half the rate of growth experienced during the previous ten years (2.3%). The slowing growth in total floorspace is due to a variety of factors deterring development including the lack of available land. Conversely, this does not indicate a reduction of demand for industrial floorspace, which is evident by consistently decreasing vacancy rates and increasing lease rates throughout the region. As of Q3 2020, the regional average vacancy rate was 1.3%, shrinking to 1.2% in Q4 2020.

The City of Surrey currently has the largest inventory of industrial floorspace (39 million square feet), followed by the Cities of Richmond (35 million square feet), Delta (29 million square feet), Burnaby (27 million square feet), and Vancouver (21 million square feet). Over the past 10 years, annual average growth in total supply has been largest in Maple Ridge – Pitt Meadows (8.3%), Surrey (3.9%), and Delta (3.5%). Conversely, annual

Figure 1 Metro Vancouver Industrial Inventory by Municipality (Q3 2020)



Source: Colliers International

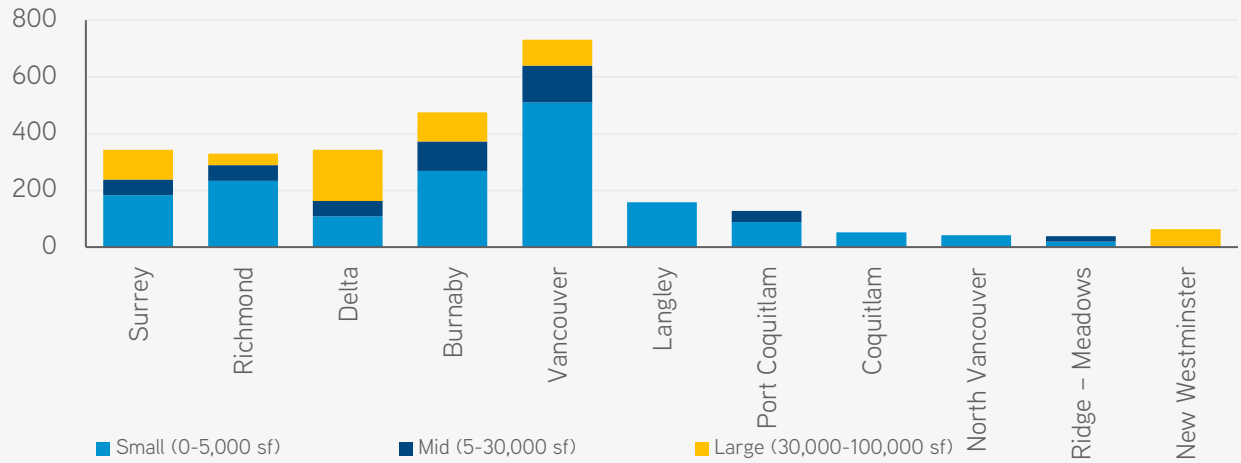
floorspace growth has been much slower in denser submarkets such as Vancouver (0.1%), North Vancouver (0.2%), and Burnaby (0.3%). This is not a result of a lack of demand in these markets, but rather a lack of available land suitable for industrial development along with constrained redevelopment opportunities.

Table 1 Metro Vancouver Industrial Inventory by Municipality (square feet)					
Submarket	2010	Q3 2020	Annual Change	Annual Growth	Vacancy Rate
Surrey	26,543,676	39,005,767	1,246,209	3.9%	0.9%
Richmond	32,946,884	35,451,031	250,415	0.7%	0.9%
Delta	20,563,857	28,928,443	836,459	3.5%	1.2%
Burnaby	26,342,885	27,033,900	69,102	0.3%	1.8%
Vancouver	20,798,246	20,953,116	15,487	0.1%	3.5%
Langley	17,146,379	19,846,604	270,023	1.5%	0.8%
Port Coquitlam	7,482,408	7,730,544	24,814	0.3%	1.7%
Coquitlam	7,592,575	7,342,770	-24,981	-0.3%	0.7%
North Vancouver	4,636,146	4,747,391	11,125	0.2%	0.9%
Ridge–Meadows	1,810,984	4,035,798	222,481	8.3%	1.0%
New West	2,989,400	3,499,038	50,964	1.6%	1.8%
Total	169,750,740	213,339,382	4,358,864	2.3%	1.3%

Source: Colliers International

As outlined in Figure 2, Colliers has examined the total inventory of vacant industrial space by unit size. In total, there is a disproportionate amount of vacant space among smaller unit sizes (0-5,000 sf), representing 62% of total vacancies. Vancouver and Burnaby have the largest number of vacancies in this size group. Only 22% of current vacancies are larger properties (30,000-100,000 sf), and there are currently no vacancies for larger bulk/logistics facilities exceeding 100,000 square feet. This is one of the key challenges within Metro Vancouver. Based on discussions with key stakeholders, there is a notable amount of demand for larger units, resulting in some companies locating in other regions that can better accommodate their needs.

Figure 2 Metro Vancouver Industrial Vacancies by Unit Size (square feet, 000s)

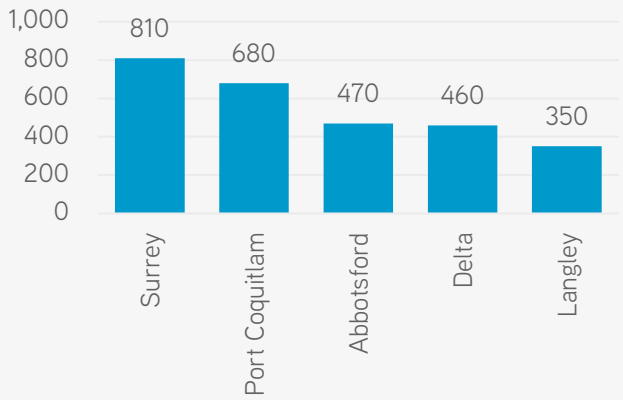


Source: Colliers International

Historical Completions, Absorption, and Vacancy Rates (Q1 2010 – Q3 2020)

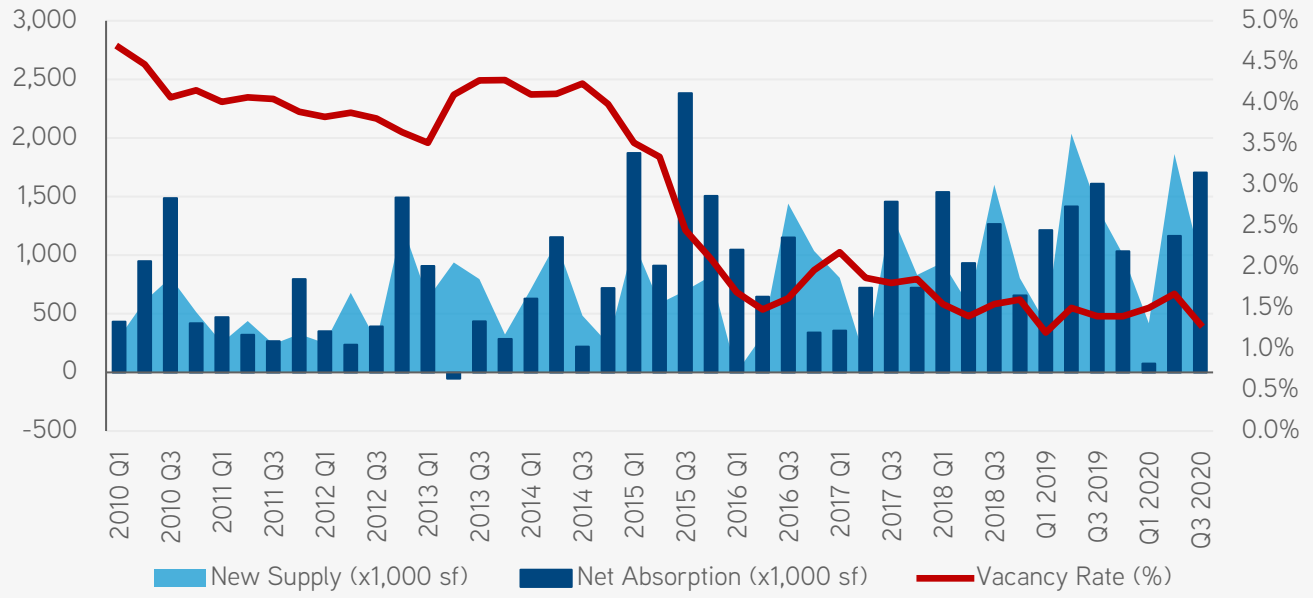
As outlined in Figure 4, the average Metro Vancouver industrial vacancy rate consistently declined from over 4.5% in 2010 down to 1.3% as of Q3 2020. The 10-year average annual absorption rate during this period was approximately 3.5 million square feet growing to 4.1 million square feet over the last 5 years. Since 2015, an annual average of 3.6 million square feet of floorspace was added to the region, indicating that demand has been outpacing supply by an average of approximately 500,000 square feet per year. This has resulted in decreasing available supply throughout an already constrained region.

Figure 3 SF Under Construction (Top 5 Markets, 000s)



There is currently a regional record of 3.5 million square feet of industrial floorspace under construction in Metro Vancouver, approximately 66% of which is in Surrey, Port Coquitlam, Delta, and Langley. Although this is a significant influx of supply, it is still lower than the annual absorption experienced in recent years indicating continued ongoing pressure on the regional market. The recent trends of decreasing vacancy rates, increasing lease rates, increasing land values, and strong absorption levels are expected to continue for years to come, particularly in denser parts of the region.

Figure 4 Metro Vancouver Industrial Completions, Absorption, and Vacancy (Q1 2010 - Q3 2020)



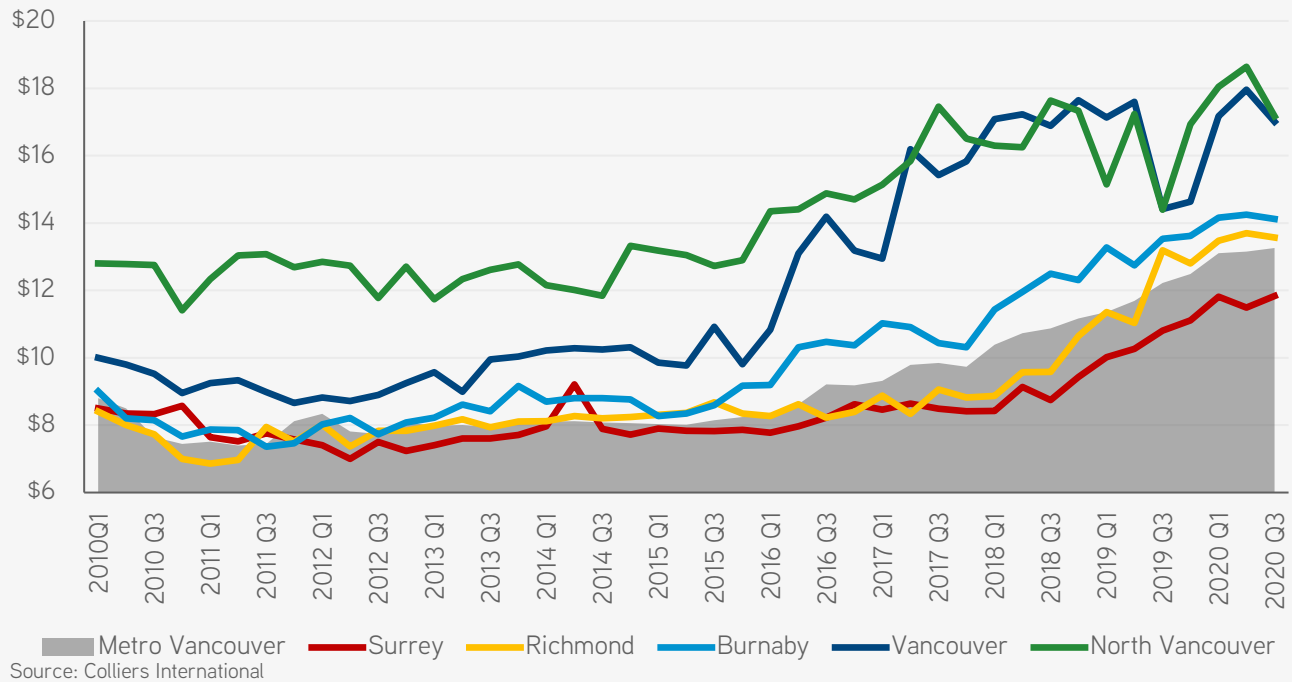
Source: Colliers International

Historical Average Industrial Lease Rates (Q1 2008 – Q3 2020)

As a result of a limited and decreasing amount of vacant and appropriate supply to meet the demands of a wide range of industrial users, average lease rates have grown significantly throughout Metro Vancouver. This trend has become even more evident since the beginning of Q1 2015. Over the past 5 years, lease rates have grown at an annual average of 12.3% which is more than double the 10-year average of 5.9% and even higher than the 10-year average inflation rate of 1.8%. It can be expected that rates will continue to grow at a similar or potentially higher level moving forward without a consistent and significant influx of new supply.

The annual average lease rate growth for new leases over the past 5 years has been highest in Port Coquitlam (16.1%), Richmond (14.2%), Vancouver (13.7%), Coquitlam (13.4%), and Burnaby (13.1%). The highest average lease rates can be found in North Vancouver ($17.17/sf), Vancouver ($17.01/sf), and Burnaby ($14.12/sf). The lowest rates are currently found in Delta ($11.74/sf) and Langley ($11.95/sf). Lease rates are generally higher in the most desirable inner-city locations such as Mount Pleasant, sometimes exceeding $20/sf, yet there is still a discount in terms of what tenants would be willing to pay for an above ground unit. As explored in more detail within the following sections of this report, the viability of intensified industrial development is impacted by how close these rates (or strata rates) are to a certain threshold, land values, construction costs, municipal regulations and fees, and other associated aspects of the development process.

Figure 5 Metro Vancouver Avg. Industrial Lease Rates (Q1 2010 - Q3 2020)



Source: Colliers International

Table 2 Metro Vancouver Industrial Lease Rates by Submarket (2000-2020)								
Submarket	2010	2012	2014	2016	2018	2020	Average Annual Growth	
							5-Year Avg.	10-Year Avg.
Surrey	$8.57	$7.23	$7.72	$8.62	$9.43	$11.83	6.7%	3.3%
Richmond	$7.00	$7.83	$8.24	$8.39	$10.65	$13.57	14.2%	6.8%
Delta	$6.52	$7.52	$7.71	$8.14	$10.22	$11.74	12.5%	6.1%
Burnaby	$7.66	$8.08	$8.76	$10.37	$12.31	$14.12	13.1%	6.3%
Vancouver	$8.95	$9.25	$10.31	$9.18	$17.65	$17.01	13.7%	6.6%
Langley	$7.13	$7.39	$8.20	$9.25	$11.39	$11.95	10.9%	5.3%
Port Coquitlam	$6.43	$6.51	$7.24	$8.38	$12.66	$13.54	16.1%	7.7%
Coquitlam	$7.45	$7.26	$8.16	$9.88	$13.37	$13.98	13.4%	6.5%
North Van	$11.41	$12.71	$13.32	$14.70	$17.33	$17.17	8.5%	4.2%
Ridge-Meadows	$8.51	$6.93	$7.00	$7.83	$9.26	$12.51	8.0%	3.9%
Regional Average	$7.44	$8.08	$8.06	$9.18	$11.17	$13.26	12.3%	5.9%

Source: Colliers International

2.4 Land Values

Although many factors influence the price of industrial land such as zoning, lot size, servicing, access, and soil quality, Colliers provides a range of market achievable prices based on recent sales activity. These are high level estimates and should therefore only be used for comparative purposes. Of the municipalities listed below, the average price of serviced and developable land ranges from as low as $2.5 million/acre in Surrey up to $9.5 million/acre in Vancouver. Prices have grown at a rapid rate, accelerating in recent years. Between 2005 and 2010, average price per acre within Metro Vancouver grew by approximately 12.8% per year. Comparatively, over the last five years the average price has grown by approximately 29.6% per year. Skyrocketing land values are one of the major considerations regarding intensified redevelopment of key sites, as construction of traditional single-storey industrial on expensive sites may no longer be financially viable.

Table 3 Metro Vancouver Industrial Land Values by Submarket (per acre)								
Submarket	2010			2020			Annual Growth	
	Min	Mid	Max	Min	Mid	Max	2005-10	2015-20
Surrey	$650,000	$875,000	$1,100,000	$2,500,000	$2,750,000	$3,000,000	6.9%	21.4%
Richmond	$950,000	$1,175,000	$1,400,000	$4,500,000	$4,750,000	$5,000,000	14.8%	30.4%
Delta	$800,000	$900,000	$1,000,000	$2,750,000	$3,250,000	$3,500,000	13.5%	26.1%
Burnaby	$1,100,000	$1,250,000	$1,400,000	$4,250,000	$5,750,000	$7,500,000	15.7%	36.0%
Vancouver	$900,000	$2,100,000	$3,300,000	$8,000,000	$8,750,000	$9,500,000	1.0%	31.7%
Port Coquitlam	$850,000	$975,000	$1,100,000	$3,500,000	$4,000,000	$4,500,000	21.1%	31.0%
Coquitlam	$900,000	$1,050,000	$1,200,000	$3,750,000	$4,250,000	$4,750,000	16.5%	30.5%

Source: Colliers International

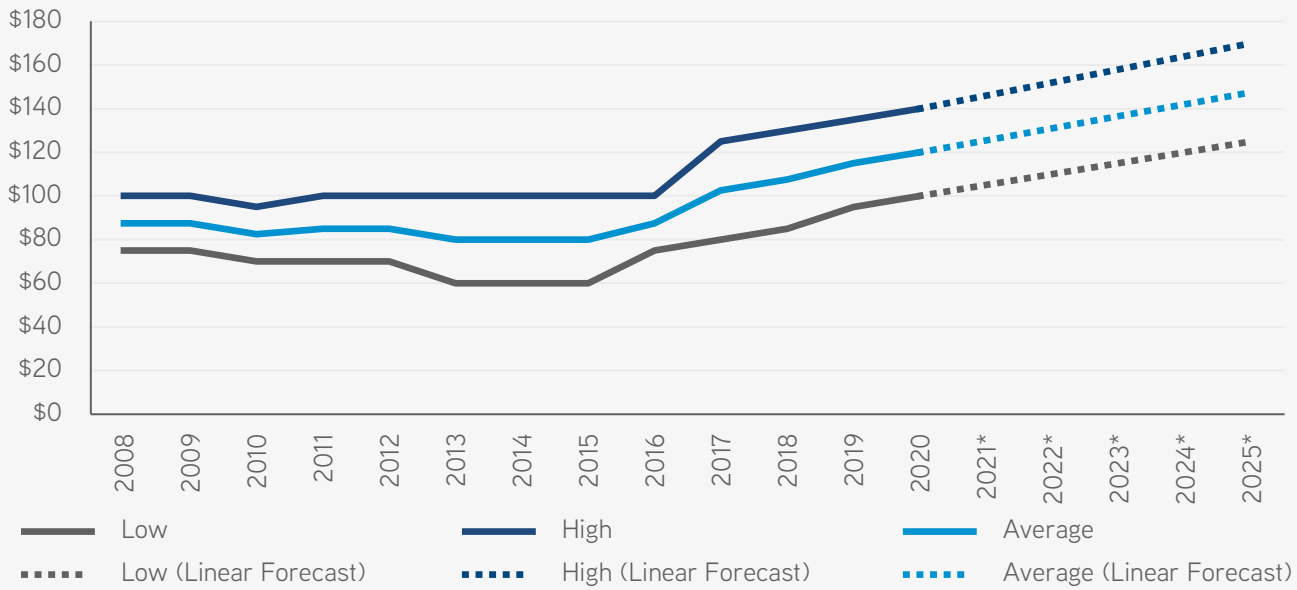
2.5 Construction Costs

Construction costs range based on design and use, most of which have been increasing in recent years among both industrial and non-industrial development formats. Based on the Altus Group Canadian Development Cost Guide, the average construction cost for a typical warehouse in Metro Vancouver with 10%-20% office space currently ranges from $100 to $140 per square foot. This is approximately 50% higher than five years ago. Based on a similar rate of growth moving forward, Colliers estimates that these costs could potentially rise to approximately $125 to $170 per square foot by 2025.

Through discussions with numerous developers, brokers, architects, and other stakeholders in the region, it is understood that the cost of intensified, multi-storey industrial development is significantly higher than traditional development. Factors such as ramping and loading requirements, additional services/utilities, freight elevators, geotechnical conditions, parking requirements, lengthy approvals, and higher lending costs can push total costs up to 2.5 times higher than traditional single floor development. For the most challenging multi-level projects, these costs could potentially exceed $250 per square foot.

Aside from site specific factors such as geotechnical conditions or uncommon municipal development standards, construction costs do not vary much within the region. As such, they do not have a huge impact on the intensification potential between industrial areas unless they are increased by factors such as surplus minimum parking requirements for particular user types. The key determining factors behind businesses' locational decisions along with the impact of construction costs on the viability of multi-storey industrial developments are examined in more detail within the following sections of this report.

Figure 6 Warehouse/Light Industrial Construction Cost Estimates ($/sf)



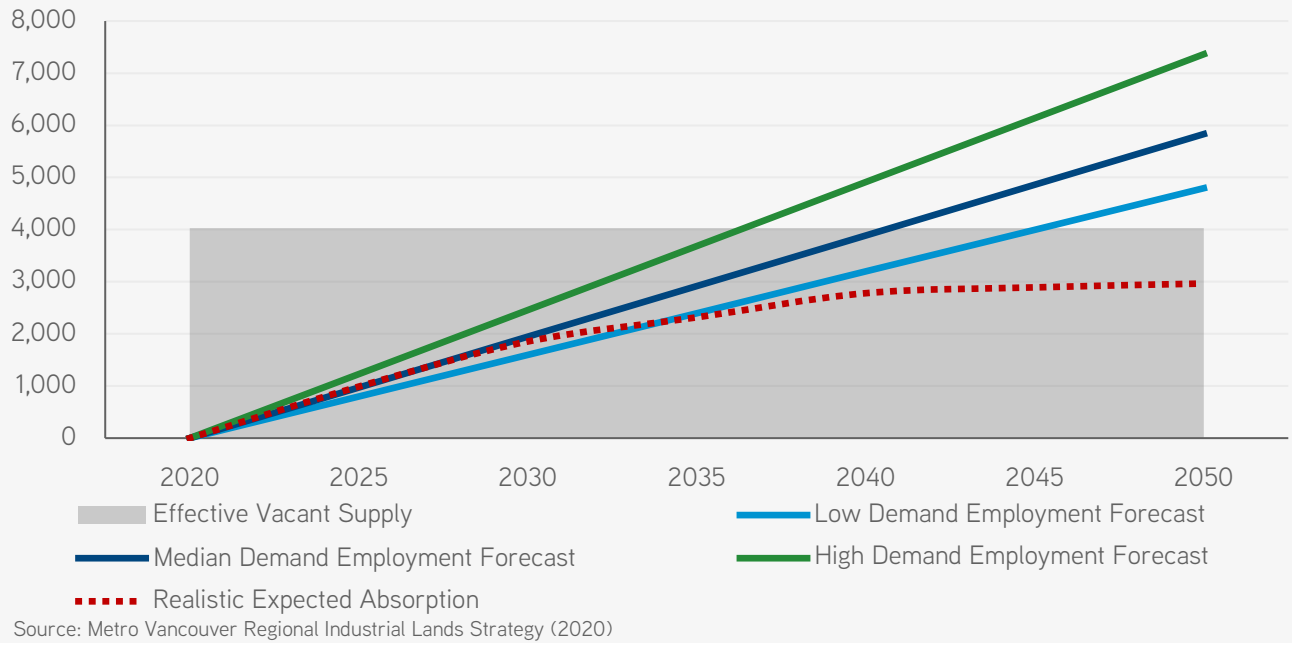
Source: Altus Group, Canadian Construction Cost Guide (2008-2020)

2.6 Industrial Land Inventory and Capacity

The 2015 Metro Vancouver Industrial Lands Inventory calculated a regional total of 28,000 acres of industrial land at the time, 20% of which was vacant while some of the occupied land was used for non-industrial uses. The development potential of this vacant land was further reduced by factors such as lot size, slope, location, accessibility, and soil conditions. Specifically, there was a very limited inventory of vacant sites large enough for trade enabling logistics uses, with only 20% of vacant land on sites larger than 50 acres. It is estimated that the region's inventory of vacant industrial supply shrank to 4,500 acres as of 2018. This is the most currently available data at the time of this study; however, it should be noted that the 2020 Metro Vancouver Industrial Lands Inventory will be completed later in 2021. In the interim, Colliers has estimated the current inventory of vacant industrial land based on an assumed absorption of 235 acres per year between 2018-2020. Based on this assumption, the current inventory of vacant industrial land is estimated at 4,030 acres.

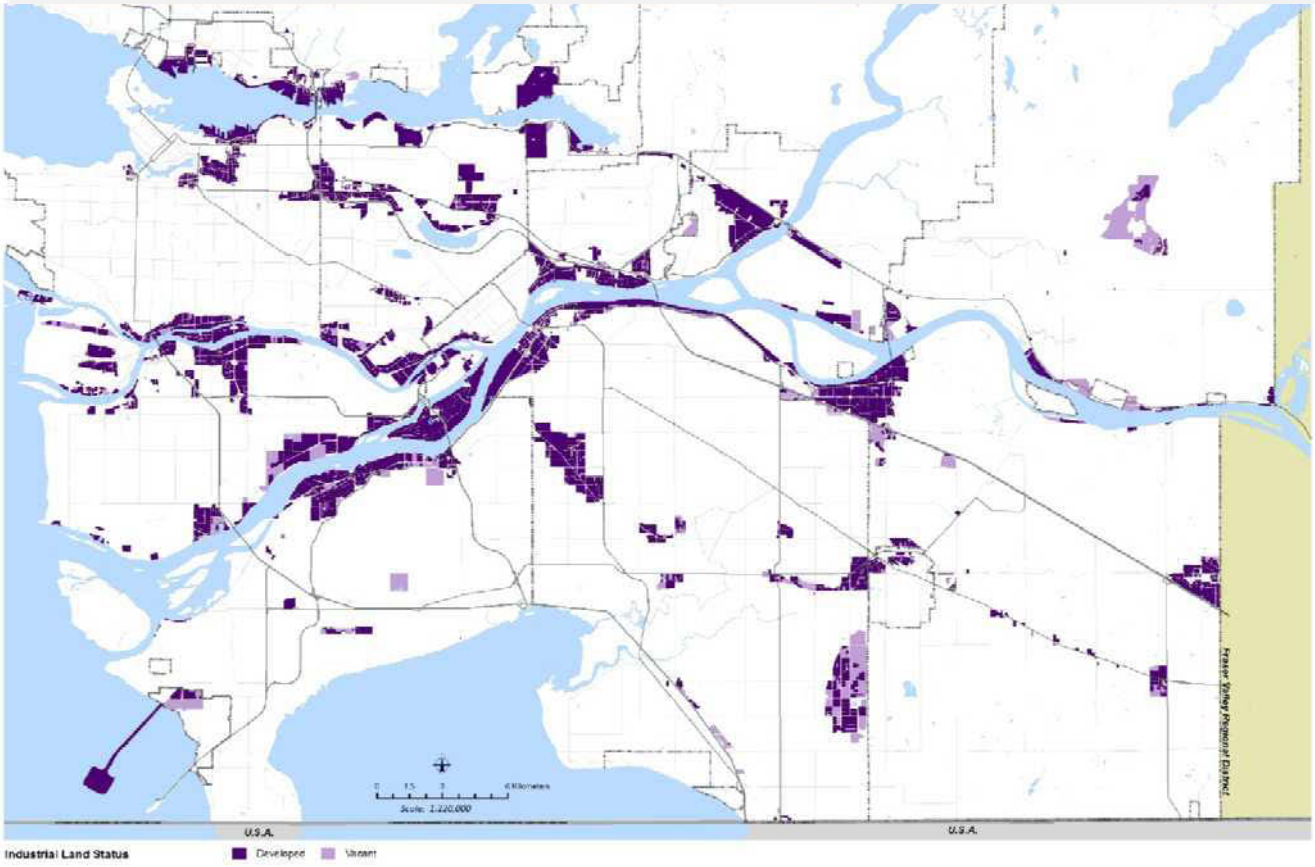
The most recent employment-based industrial demand forecasts estimate the potential need for between 200 and 275 acres of land per year between 2020 and 2050. This would result in the full absorption of vacant land between approximately 2037 and 2045. More likely, before this land is completely absorbed the remaining vacant supply would be small, scattered parcels unsuitable for most industrial users. Therefore, the complete absorption of the most suitable supply could occur in the early 2030s. As a result, without additional land supply or the intensification of existing land, future economic growth could be hindered. This is indicated by the dotted red line on the graph below, which represents potential businesses (and jobs) choosing to locate in other markets with more readily available industrial land. Theoretically, the gap between the employment related demand forecasts and the constrained reality would represent lost employment/industrial output potential.

Figure 7 Metro Vancouver Industrial Land Capacity, Acres (2020-2050)



Source: Metro Vancouver Regional Industrial Lands Strategy (2020)

Figure 8 Inventory of Developed and Vacant Industrial Lands (2020)



Source: Metro Vancouver Industrial Lands Inventory (2020)

3. Industrial Intensification Considerations

3.1 Key Drivers of Industrial Intensification

While intensified industrial development is not entirely new to Metro Vancouver, there has been a recent wave of higher-density projects being built in the region resulting from market pressure and demand drivers, as outlined below. Developers consider these factors along with the economics of intensified/multi-storey development which is ultimately related to whether the increased land and construction costs of building up can be compensated by high enough industrial lease / strata rates and additional revenue generating accessory space within functional buildings.

The need for industrial intensification is driven by several factors, including:

- Limited land supply and strong demand
- Population growth and density
- International trade
- Growth of ecommerce
- Agglomeration economics
- Municipal regulations
- Automation
- Land values and speculation

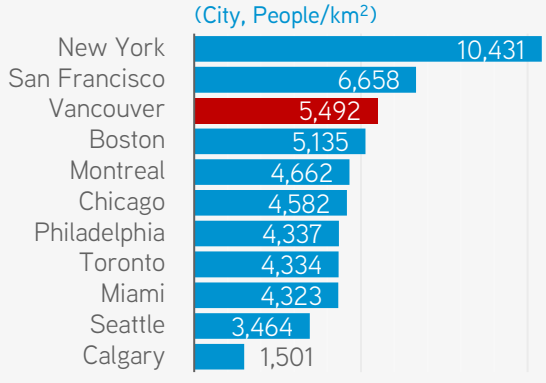
Limited Land Supply and Strong Demand

Metro Vancouver has a finite amount of remaining suitable vacant industrial land to accommodate medium-term demand. This supply is further constrained by geographic limitations such as accessibility, lot size, slopes, and soil quality. Additionally, the existing restrictions of the ALR, along with occasional rezonings of industrial land to other land uses such as residential have further limited the availability of existing supply. For example, between 2010 and 2015 approximately 330 acres of industrial land was removed from the total Metro Vancouver inventory. The remaining suitable vacant industrial lands are expected to be absorbed by the early 2030s or potentially even sooner if market demand trends experienced since 2016 continue. This is one of the key factors contributing to the necessity for more intensified forms of industrial development.

Population Growth and Density

There is a strong relationship between population growth, density, and the economic viability of multi-storey industrial developments. Many of the tenant types likely to pay the higher lease rates associated with inner city locations justify the decision based on the benefits of reduced transportation times to a larger pool of potential consumers in a smaller geographic area. The denser the population, the greater the tenant demand for central locations as to have quicker access to customers and a larger labour pool.

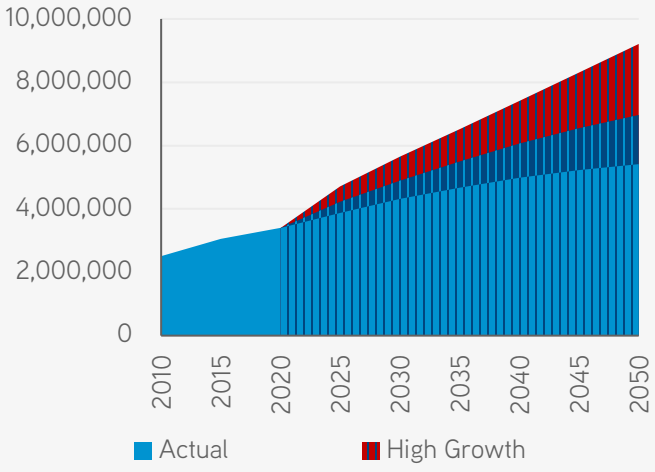
Figure 9 Population Density



Source: Colliers International

The population of Metro Vancouver is projected to grow by approximately 14% over the next 10 years. With its constrained land base, this is likely to result in the continued densification of municipalities throughout the region. The first North American city to have a multi-storey distribution warehouse with ramps to the second floor was Seattle, with an estimated density of 3,244 people/km^2. The City of Vancouver has a density of 5,493 people/km^2, suggesting a greater trade area potential when compared to Seattle. However, the entire region of Metro Vancouver (including non-developable land) has a population density of 2,090 people/km^2 which is notably lower than the City of Vancouver and likely below the threshold to support intensified development in certain peripheral locations. Municipal-specific density levels and population projections are some of the key factors influencing the viability of multi-level industrial development in specific areas of Metro Vancouver, examined in more detail within *Section 3.4 Geographical and Locational Considerations.*

Fig. 10 Vancouver Port TEU Projections



Source: Port of Vancouver Container Traffic Forecast (2016)

International Trade

The Port of Vancouver continues to experience record total cargo volumes, a trend that is occurring despite COVID-19 and expected to continue, as displayed in Figure 10. By 2030, the Port is expected to handle between 4.32 million and 5.65 million TEUs[1] annually, an annual increase of between 2.7% and 6.6%. Vancouver's port has one of the most diversified ranges of cargo in terms of both imports and exports of goods in North America and the forecasted growth of port activity will continually contribute to the demand for industrial space required to store goods being transported through the port.

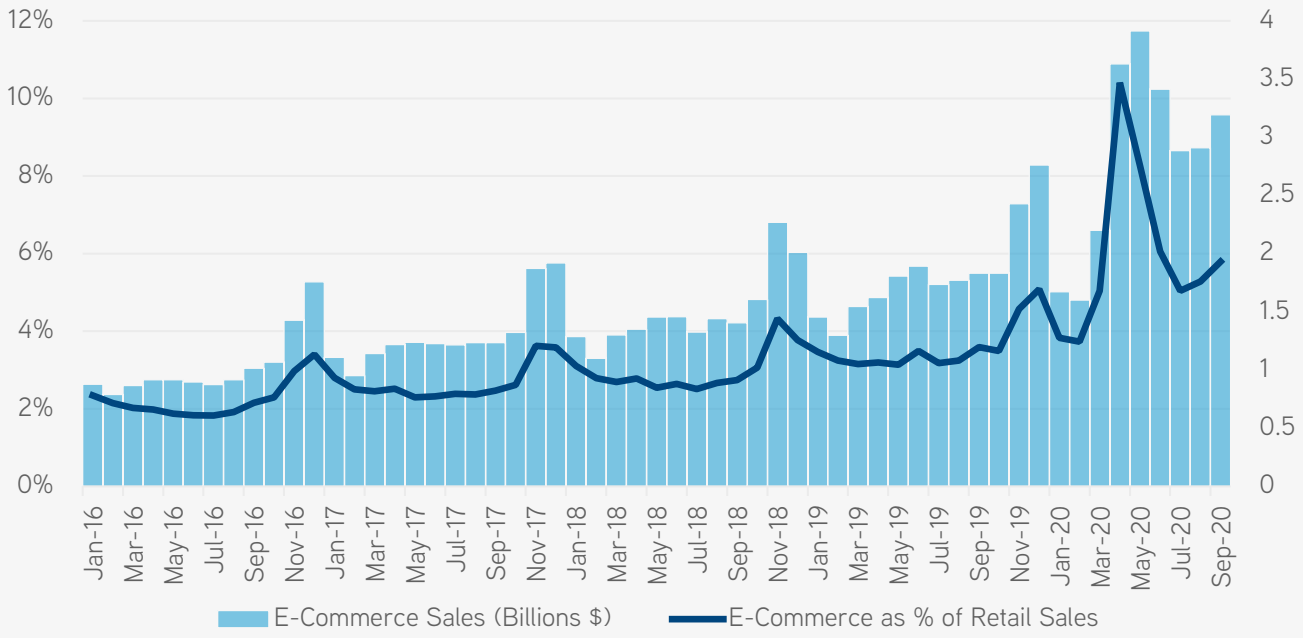
Growth of E-Commerce

Studies have shown that every additional billion dollars of e-commerce sales requires an additional 1.25 million square feet of supportive industrial floorspace[2]. As displayed on the following page in Figure 11, Statistics Canada reports that e-commerce is continuing to capture a larger share of Canada's total retail market and is expected to rise by up to 40% over the next 10 years. This trend increased dramatically during the initial months of the pandemic as retailers were forced to close, reaching a record of $4 billion in April 2020 accounting for 10.3% of total retail sales. In more recent months, online sales have shifted back towards the gradual increase experienced over the past few years. These figures, as tracked by Statistics Canada, only include sales from Canadian e-commerce companies and do not account for items bought from international markets such as the US, representing approximately 20% in additional online sales.

[1] TEUs refer to twenty-foot equivalent units, which is a cargo capacity metric often used to describe the capacity of container terminals.

[2] Source: CBRE US Market Flash (2018), Warehouse Demand to Grow with Rising E-Commerce Sales

Figure 11 Canadian E-Commerce as a % of Total Retail Sales (2016-2020)



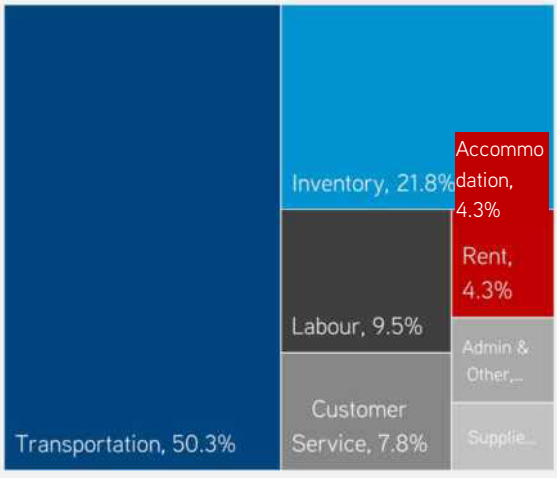
Source: Statistics Canada

As a result of e-commerce, demand has been growing for logistics and 'last mile' fulfillment centres required to meet customer expectations regarding delivery times. An indicator of such demand in Metro Vancouver is the Amazon lease in Q2 2018 for 450,000 square feet of distribution space in phase 1 of the Delta iPort development. Following this trend, numerous 3rd party logistics companies are now occupying large blocks of space in Metro Vancouver which has further reduced the industrial supply of vacant floorspace and land.

Supply Chain Costs and the Desire for Urban Locations

Accommodation costs (which include triple net costs – base rent, plus property taxes, and building operating costs) generally account for less than 5% of total supply chain costs. Transportation costs are significantly higher, in many cases exceeding 50% of total costs. This further accentuates the tenant desire for consumer proximity, with many businesses choosing to pay higher rates in buildings closer to major centres of population. The benefits of faster delivery times to a larger population at lower costs in many cases outweigh the premium price for an inner-city location.

Figure 12 Supply Chain Cost Breakdown



Every business has its own unique mix of suppliers, target markets, transportation needs, and labour force

requirements that influence location decisions. The businesses that are highly reliant on population proximity will likely desire an inner-city location, whereas businesses that are less labour intensive and more cost sensitive may move out to more affordable suburban properties. Relocation costs are also important to consider, with most businesses preferring locations with surplus space for future growth to minimize the future need for relocation. Emerging industrial tenant types most suitable for multi-storey developments are examined further in *Section 3.3 Industrial Subsectors Suitable for Intensified Developments.*

Locational Economies

Another benefit of densified industrial development is the clustering of similar companies together within a relatively small geographic area, allowing for a high degree of competition, innovation, and specialization. This can create spillover of technological innovations resulting from the competition between firms within the same industry, greater return of scale for intermediate inputs resulting in lower costs, and a larger potential pool of skilled labour. This clustering can also benefit both the consumer and business through the creation of destinational nodes with a variety of similar products and/or services, such as the breweries of Mount Pleasant.

Municipal Regulations

The definition of an industrial land use is broad, constantly evolving, and includes hundreds of different businesses, many of which may not have been well-known at the time when the latest planning regulations were developed. It is essential that planning frameworks applied to industrial land are frequently examined and refined to consider emerging industries expected to seek industrial space in different parts of Metro Vancouver. Regulations such as maximum density levels or heights can also have a strong impact on the likelihood of industrial densification. Zoning amendments that permit either higher total densities or a higher proportion of accessory uses such as office or residential can spur a wave of development due to the demand and value of higher density mixed-use formats. More specific examples of the constraints and best practices regarding the impact of planning policy on industrial development are examined in *Chapter 4. Planning Policy Review.*

Automation

The automation of industrial businesses continues to impact numerous manufacturing and logistics operations as technological innovations expand capabilities at declining costs. The need for automation is ultimately driven by labour availability/costs, size of business, and the rapid growth of operations such as e-commerce companies which can be up to 3x more labour intensive than traditional logistics operators. Smaller businesses more likely to occupy small multi-level urban industrial units are less likely to automate than larger operators.

Mobile automation innovations such as robotic forklifts are reducing the labour requirements of certain industries.

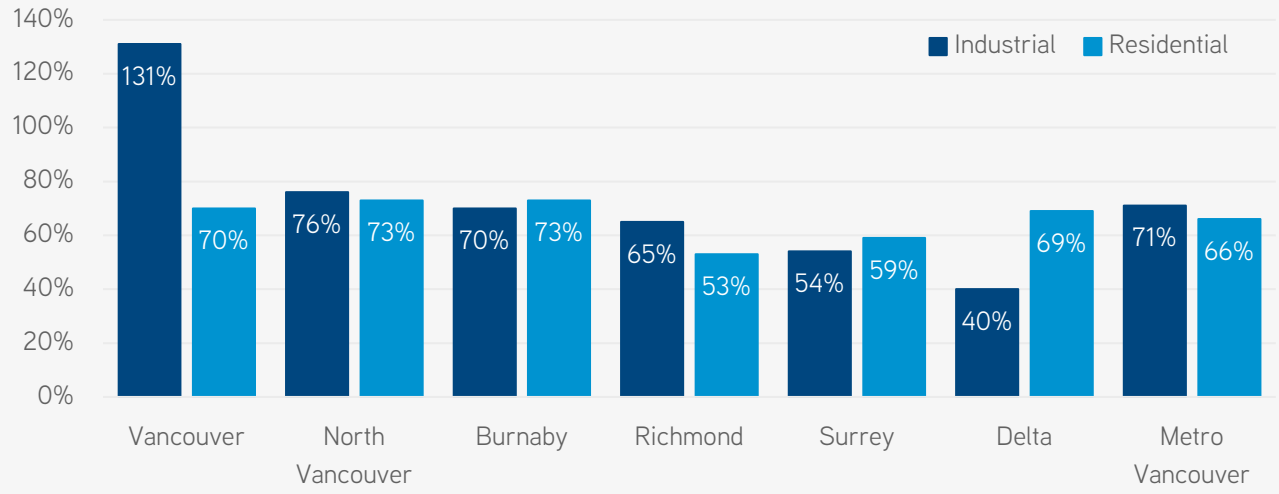
The concept of fully automated 'micro-factories' supported by local supply chains has been growing in popularity.

The key differentiator between automation technologies and other types of equipment is autonomy from human control. This can be grouped into two categories: fixed automation and mobile automation. Fixed automation refers to expansive installations such as conveyor belts and sorters which have been used for years. Mobile automation refers to robotics solutions that work in diverse environments and offer a large amount of flexibility for scaling up/down as needed. This includes automated guided vehicles such as forklifts and robots. Automation innovations will continue rapidly advancing and impacting labour requirements. Approximately 40% of the Canadian labour force could be at high risk of being impacted by automation in the next 10-20 years. However, the demand for industrial space itself is less likely to decrease anytime soon, as large sites will always be required for the production and warehousing of goods.

Land Speculation and Property Taxes

The rising industrial land values within Metro Vancouver have, in some instances, resulted in landlords/owners seeking rents that may be higher than those supported by potential tenants. Additionally, if land has redevelopment potential, long-term leases may not be offered or there may be demolition clauses. In this scenario, landlords/owners may be less likely to invest in building upkeep, further detracting from potential tenant interest. Additionally, as land values rise due to market demand and a broader mix of densities and uses, assessed values can rapidly increase based on the highest and best use of the land. This results in higher property taxes that, in most cases, are passed on to the tenants through the agreed upon lease terms.

Figure 13 Assessment Value Increase by Municipality (2012-2017)



Source: Metro Vancouver RILS (2020)

3.2 Multi-Level Development Formats

There are a few general forms of multi-level industrial developments that have recently started to become more popular throughout North America, each of which have specific land/lot requirements, suitable tenant types, and scales of accessory uses.

There are three broad formats of multi-level industrial development occurring throughout North America:

A. Large scale stacked industrial
B. Flex industrial with office above
C. Flex industrial with office/residential above

Format A – Large Scale Stacked Industrial

Prologis Georgetown Crossroads in Seattle was the first multi-storey industrial development of its kind in North America.

One of the most well-known multi-storey industrial developments is Prologis Georgetown Crossroads in Seattle, the first of its kind in North America. This project includes two stacked levels of large-format industrial space with truck access and loading provided to the second floor through a ramp wrapping around the building. There is an additional third floor accessible by freight elevator catered towards light manufacturing, office, and research & development uses. Key tenants include Amazon (~500,000 sf) and Home Depot (~100,000 sf). This is the most expensive type of multi-level industrial development due to the significant costs and site efficiency issues resulting from a ramp large enough to accommodate American sized trucks (~53 feet). These development formats

3030 Beta Avenue in Burnaby benefited from a sloped site to provide two levels of truck access without building a ramp.

are suitable for users who need large, contiguous space such as e-commerce, food production, heavy manufacturing, distribution, and last-mile fulfillment. Conversely, these formats would be less suitable for businesses with significant outdoor storage and trailer parking requirements or light industrial users with smaller floorplate requirements.

Within Metro Vancouver, while this format of development is not technically new, it has not been attempted at a large scale since the development of 3030 Beta Avenue in Burnaby in the 1970s. This project benefited from a sloped site which provides truck access to both floors without the requirement of a costly ramp. Currently, Oxford Properties is constructing a similar project within its Riverbend Business Park in South Burnaby. As examined in more detail within *Section 5 Industrial Intensification Case Studies*, this project is on a flat site with challenging soil conditions and requires a ramp wrapping around the building to provide second floor truck access.

Another less costly, moderately intensive format of large-scale industrial developments include one level of occupied space with rooftop stalls for light vehicle / employment parking. This has already occurred throughout Metro Vancouver on sites such as 6440 Beresford Street (Burnaby) and is being planned within upcoming developments such as 3733 192 Street (Surrey). While these developments do not offer a second floor of leasable space, they are able to provide site coverage ratios higher than the typical 40-50% of traditional single-storey developments. This is a simpler form of intensified development, and the rationale of building such a format in comparison to two or more floors depends on factors such as land values and achievable lease rates.

The upcoming industrial development at 3733 Street in Surrey will provide employee rooftop parking resulting in the ability to construct on a larger proportion of the total site area than a typical single-storey development with surface parking.

Format B – Flex Industrial with Office Space Above

Modestly sized multi-level projects are the most common form of multistorey industrial development in Metro Vancouver, primarily consisting of small-to-medium bay flex industrial and mezzanine space with multiple floors of office space above. Most of these developments only have one storey of industrial floorspace (with mezzanine), while others such as PC Urban's IntraUrban Evolution has two levels of industrial floorspace with 2nd floor loading available by freight elevator. This is primarily occurring within the City of Vancouver's Mount Pleasant and Railtown neighbourhoods, facilitated by the proximity to a large population and recent zoning changes allowing densities of up to 6 FSR in some areas and a broad range of permitted uses. Upcoming examples of this type of development include Conwest's Houss (displayed below), Mondivan Group's The Workshop, and Westbank's Main Alley, to name a few.

These developments are particularly attractive to tenants such as light manufacturing, engineering, hub-and-spoke distribution centres, breweries, and creative economy firms such as digital content creators and software designers. The viability of such development is driven by premium lease and strata rates achievable in areas of Metro Vancouver that are in high demand from such users, along with the higher values associated with office floorspace. While second floor flex industrial space is costly to develop and less desirable to tenants, the office space above helps make the projects financially viable while introducing more industrial supply to the market. This is particularly evident in dense urban locations that are highly accessible by vehicle and public transit.

Conwest's Houss at 67 West 6th Avenue in Mount Pleasant, Vancouver is a 52,000 square foot mixed-use development featuring first level industrial space (with mezzanine above), a restaurant, and 3 floors of office space above.

Format C – Flex Industrial with Office Space and Residential Above

Strathcona Village at 983 East Hastings Street in Vancouver was the first project in Metro Vancouver to include industrial, retail, office, and residential floorspace in one development.

Format C is similar to Format B, with the addition of residential floorspace on top of both industrial and office uses. Wall Financial's Strathcona Village is one of the first of such developments in North America, including 280 condos, 70 social housing units, 14,000 sf of office space, and 46,000 sf of flex industrial space. As detailed within the case studies in the latter sections of this report, Hungerford Properties and QuadReal Group are in the early stages of Archetype at 220 East 1st Avenue, a mixed-use project that will feature 150,000 sf (3.5 FSR) of rental residential, 83,000 sf (2.0 FSR) of office space, and 40,000 sf (1.0 FSR) of industrial space combining for a total density of 6.5 FSR. These projects would be well suited for the same industrial tenants as Model B.

Higher Densities Abroad

Multi-level industrial development has been more commonly occurring in other parts of the world for years, justified by high urban densities and smaller truck sizes in countries such as China and Japan. For example, total truck lengths are generally 39 feet long in Japan compared to 53 feet long in North America. The shorter required turning radii of such trucks results in the ability to create spiraled ramps which occupy a significantly smaller total site area and can more efficiently accommodate more than two floors.

Multi-storey truck access is more viable in counties such as Japan that have much smaller truck sizes, demonstrated by projects such as Prologis Park in Osaka.

Table 4 Multi-Level Industrial Development Formats					
Format	Lot Size	Tenant Size	Uses	Access	Upper Floor Tenants
Format A – Large Scale Stacked Industrial	10+ ac	100,000+ sf	Industrial Light Industrial	Ramp to upper floors	Distribution, Food Production, Last Mile Fulfillment, Manufacturing
Format B – Flex Industrial with Office Space Above	0.5+ ac	2,000+ sf	Light Industrial Office	Freight elevator to upper floors	Smaller last mile fulfillment, niche manufacturing, creative economy, film industry, accessory uses
Format C – Flex Industrial with Office and Residential Above	0.5+ ac	2,000+ sf	Light Industrial Office Residential	Freight elevator to upper floors. Separated access to residential.	Smaller last mile fulfillment, niche manufacturing, creative economy, film industry, accessory uses

Warehouse Innovation

As a result of persistent demand for faster delivery times, constrained supply, rising occupancy and labour costs, and technological innovations, warehouses themselves are continually evolving due to the growing need for spaces less than 100,000 square feet close to major population centres. While this has encouraged the aforementioned multi-storey development formats, it is also resulting in the innovation of warehouses themselves. This can include micro-distribution centres, darkstore distribution centres, and nano-distribution nodes, as outlined below.

The rise of e-commerce and its impact on bricks-and-mortar retail has resulted in growing retail vacancies. This provides the opportunity for the repurposing of such units for distribution/fulfillment purposes. For example, Walmart is exploring the use of portions of retail stores for warehousing and distribution and has even filed a patent for an automated system that could store inventory above drop ceilings in their superstores with a fleet of robotic vehicles that transport inventory to and from this attic space. Further, Simon Property Group is considering turning vacant anchor department stores into major distribution hubs with a small experiential retail store in front of an automated fulfillment centre. Meanwhile, the Millennium Parking Garage in Chicago was recently transformed into an urban fulfillment centre.

Vacant anchor tenants are beginning to be repurposed by companies such as Amazon for fulfillment centres.

Dark Stores / Nano Distribution Nodes

There has also been a rise in "dark stores" and "ghost kitchens". Ghost kitchens, for example, are suitable for industrial lands and enable restaurants to outsource all aspects of food delivery to large, centralized locations used by numerous restaurants brands to create economies of scale. Dark stores are an opportunity for persistently vacant retail units, which could become storerooms and delivery depots for businesses that have moved online. This is already occurring, with New York City-based startup Bond expanding its network of their street front facilities that are typically between 600 and 1,000 square feet and easily accessible by local delivery crews.

Vacant storefront retailers ranging from 600 – 1,000 sf are beginning to be repurposed as nano fulfillment centres.

3.3 Industrial Subsectors Suitable for Intensified Developments

The demand for industrial floorspace within Metro Vancouver is driven more and more by service-oriented industrial uses that are generally less land-intensive than traditional heavy industries. Many of these are emerging industries subsectors which may have modern business models that do not directly fit under current municipal definitions of light or heavy industrial.

The following tenant types are driving demand and most likely to occupy intensified mixed-use industrial buildings:

- Logistics/Last-Mile Distribution
- Manufacturing
- Ecommerce/Technology
- Creative Economy
- Film Industry
- Cold Food Storage/Agri-Industrial
- Accessory Uses (office, retail, recreation)

Intensified industrial developments are generally located in urban locations, with small units, upper floors, freight elevator access, high ratios of mezzanine space, limited surface parking, and limited space for tracks. As such, and outlined in more detail below, growing industrial sectors suitable for such space include logistics / last-mile distribution, niche manufacturing (food, coffee roasting, breweries, etc.), ecommerce/technology, creative industries, artisanal craftsmanship, film production, research and development, storage, equipment maintenance, and building supplies. Many of these businesses desire well-located, accessible urban locations. This demonstrates the importance of a clear municipal understanding regarding which uses to permit within specific industrial or mixed-employment areas. These businesses generally occupy units ranging from 5,000 to 20,000 square feet and have a notable impact on the provincial economy through the employment of 1.1 million people and the generation of 35% of provincial GDP.

Emerging flex-industrial companies are increasingly demanding integrated, multi-purpose facilities that accommodate design, manufacturing, distribution, and showrooms/retail activities. These companies generally prefer the benefit of being closer to the consumer within desirable neighbourhoods compared to the challenges and costs associated with small/constrained inner urban sites. There is also a growing demand from both employers and employees for locations within complete communities, resulting in the additional demand for accessory uses on top of what could be defined as industrial. This could include nearby amenities and services such as restaurants, coffee shops, gyms, medical services, and personal services.

Logistics

Logistics operators are one of the largest industrial sectors within Metro Vancouver, facilitating the import and distribution of goods throughout the region along with the export of Canadian made products. Distribution fulfillment centres are commonly large-format warehouses up to 500,000 square feet in size with ample loading access and 36 ceilings.

Large-scale fulfillment centres can reach up to 500,000 square feet with ample loading and 36-foot-high ceilings.

These users typically require large sites exceeding 15 acres and utilize technology such as automated vehicles, conveyer systems, robotics, and other advancements to optimize efficiency. Businesses that provide last-mile distribution of goods purchased online prefer to be located close to major centres of population due the transportation costs associated with deliveries and increasingly lofty consumer expectations regarding delivery times. The constrained industrial land base within Metro Vancouver, particularly for lots of suitable size to accommodate such uses, is driving the need for large-scale, multi-level developments similar to Prologis Georgetown Crossroads (Seattle) or Oxford Properties Riverbend (Burnaby). Tenant types most likely to occupy such developments include Amazon, Home Depot, Best Buy, Walmart, couriers (FedEx, UPS, DHL), and similar companies.

Amazon utilizes its fleet of delivery vehicles and mini urban fulfillment centres to provide same-day delivery.

Last Mile / Smaller Urban Facilities

Evolving market conditions, consumer demand, and increased competition have also resulted in some businesses moving towards a hub and spoke model with several smaller distribution centres even closer to the consumer. For example, while Amazon is still in the market for large format fulfillment centres on the fringes of metro regions, as evidenced by their recent leasing of 450,000 sf of space at Delta iPort, they are also planning to open over 1,000 smaller delivery hubs

in cities and suburbs across North America. These are referred to as "delivery stations" or "micro fulfillment centres", where a local delivery fleet can pick up and transport packages to the customer as fast as possible. With this strategy, Amazon is targeting consumers who need products now but would prefer to avoid going to a retail store for a variety of reasons. Tenants utilizing this sort of strategy could occupy the smaller industrial floorplates more commonly found in densified developments (Format B or C). One of the key challenges associated with this strategy, particularly for constrained inner-city developments, is the parking requirements for the overnight storage of sprinter vans in-between delivery periods.

Manufacturing

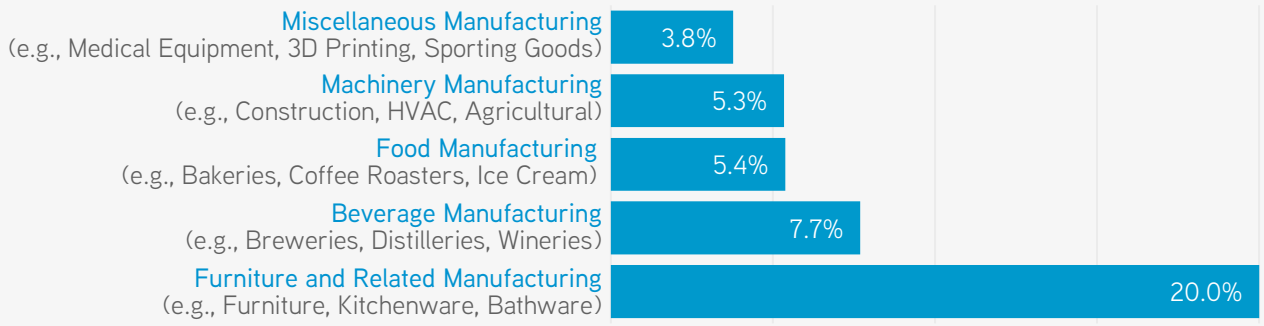
Brassneck Brewery is one of many popular breweries located within Mount Pleasant, Vancouver.

Although manufacturing has been experiencing a reduction in employment on an overall basis within British Columbia (-2% annual growth since 2010), this has primarily been caused by automation innovations that increase employment productivity and reduce labour requirements. However, smaller manufacturing industries, many of which still have relatively high labour requirements, are some of the fasted growing employment sectors within the province. This is demonstrated on the following page in Figure 14. Manufacturing is a broad term that includes several subcategories ranging from lighter industrial businesses such as food manufacturing (bakeries, coffee roasters, etc.), beverage manufacturing (breweries, distilleries, etc.), and clothing manufacturing to heavier industries such as wood product, paper, and machinery manufacturing.

Many of the lighter industries benefit from proximity to a large consumer source and are suited for Formats B and C of industrial densification. For example, food and beverage manufacturers have large population-serving components, and as the regional population grows, so does the demand for such goods from the consumer. This is becoming even more evident due to the rising desire to shop-local among younger demographic cohorts aging into their prime consumption years (35 – 54), contributing to the popularity of tenant types such as breweries, coffee roasters, and distilleries. These types of tenants provide jobs and goods for the local economy and many of the amenities that potential tenants may desire nearby when deciding where to locate.

Creative manufacturing uses such as clothing design, furniture design, medical technologies, and software manufacturing are also rapidly growing industries within Metro Vancouver, many of which prefer the format of flex-industrial units compared to typical office space. The classification of these tenant types is challenging and has frequently resulted in issues regarding whether they should be defined as office or light industrial. Ultimately, these tenants provide both jobs and goods to the local economy, and their inclusion within constrained areas of Metro Vancouver suited for intensified forms of development should be strongly encouraged at the municipal level.

Figure 14 Annual Job Growth among Key Manufacturing Subsectors (BC, 2010-19)



Source: BC Statistics

Emerging Technology

The research and development of technology such as virtual and augmented reality is suitable for light-industrial zones.

There has also been consistent employment and production growth driven by emerging technology companies such as biotech, virtual reality, augmented reality, video gaming, 3D printing, and data storage. These business types often require high ceilings, complex labs, storage, and power, accommodating research and development, packaging, and distribution on one site. These types of industries benefit from the clustering or colocation of related operations in densified industrial areas, which can foster collaboration and innovation through shared resources (peer-to-peer lending) and the usage of each other's by-products (material loops), increasing overall efficiencies. Industrial units that were previously used for more traditional industrial uses are consistently being examined and repurposed for these tenant types, many of which have less loading requirements than traditional industries and are suitable for second floor units with access through a freight elevator. These are modern, adaptive uses of industrial spaces; however, they are currently restricted in some industrial zones.

Architectural firms often desire the unit formats provided within newer flex-industrial developments.

Creative Economy

The creative economy refers to a broad range of industries that are related to the use of human creativity to generate knowledge, information, and products. While some of these industries are manufacturers or emerging technologies, as outlined above, others include artisan businesses such as custom craftsmanship, art galleries, graphic designers, architects, marketing firms, and similar uses.

The expanding range and intensity of such uses are consistently adding interest, energy, and jobs to areas of Metro Vancouver where they choose to locate. The space needs of these businesses vary and can generally be accommodated within the unit formats and contexts typical of multi-storey developments through the provision of production space, office space, logistics facilities, and freight elevators close to local consumers/customers. Despite the suitability of these tenant types for industrial developments, many of them are still classified by municipalities as office rather than industrial, leading to challenges regarding the tenanting of the second-floor units of multi-level, flex industrial developments.

Film and Television Industry

Another rapidly growing sector within Metro Vancouver is the film and television industry, led by the region's continued establishment as "Hollywood North" due to the relatively close proximity to Los Angeles, competitive tax incentives and government support, and a community that natures creativity. Within BC, employment related to the motion picture industries has grown at an annual average of approximately 10%, one of the fastest growing employers in the region.

Animatrik Film Design located in Burnaby operates the largest independent motion capture stage in North America.

The film and television sector is typically not considered an industrial real estate user, however it occupies a significant portion of industrial space within Metro Vancouver. In recent years, the industry has been looking for warehouse sites to convert into large production studios exceeding 15,000 sf such as Animatrik Film Design in Burnaby. There has also been a significant amount of leasing activity related to the production of animation and other creative services related to the industry. Such users are typically suitable for industrial areas, and production and post-production studios should therefore be permitted within certain zones as they have motion capture spaces and viewing/sound rooms to record in.

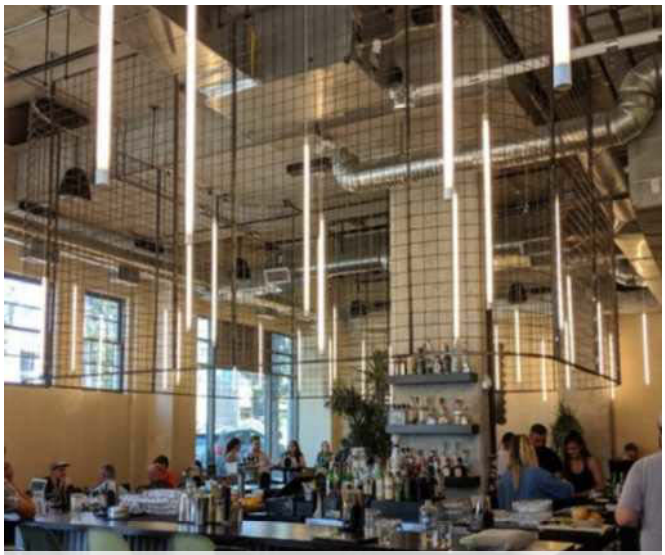
Food Production / Cold Food Storage / Delivery Services

Consumers are increasingly making informed decisions about their daily eating habits which, along with the rise of grocery delivery services, is encouraging innovation across the food supply chain. This is leading to the growth of businesses related to urban and indoor farming, precision agriculture, alternative proteins, and cold food storage, in many cases relatively close to urban populations. For example, SPUD.ca, one of British Columbia's first sustainable grocery delivery services, recently launched its Food-X urban delivery system. Food X provides other grocery retailers access to SPUD's industry leading technology, warehousing, home delivery, and food preparation platform, with the goal of enhancing grocery delivery to more residents throughout the region. Walmart was the first retailer within Metro Vancouver to partner with Food-X, which is housed within a 74,000 square foot facility in Burnaby.

Supportive Accessory Uses

Fitness studios are growing in demand within Metro Vancouver and suitable for industrial unit formats.

Industrial districts of Metro Vancouver that are consistently densifying are resulting in growing daytime populations that generally create demand for supportive accessory uses such as office, healthcare, personal services, restaurants, coffee shops, and fitness studios. For example, medical and dental uses are important to permit in specific areas, especially those such as Mount Pleasant which have a diversity of uses and strong population base. Additionally, fitness studios are traditionally non-conforming uses in industrial zones but are in high demand and could serve as much desired amenities to nearby workers.

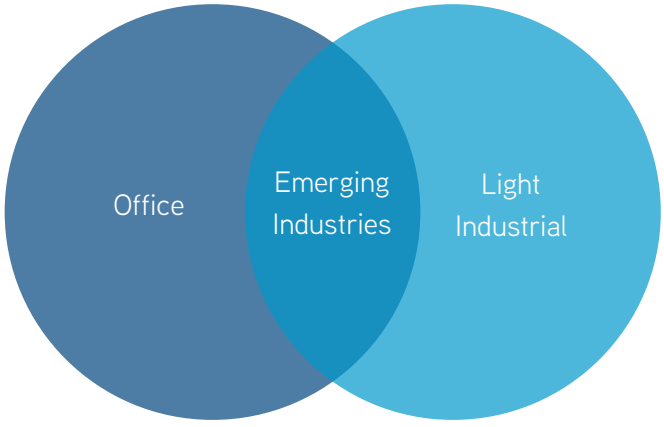


Tacofino in Mount Pleasant added a much-needed influx of food & beverage floorspace serving nearby employees.

The financial viability of many multi-storey industrial developments is also driven by the higher values for office floorspace in the upper levels of the development when compared to the industrial rates of the lower levels. In addition to medical services, other office-type tenants suitable to such projects include developers, engineers, consultants, and other professional services firms. However, the allowance of too much additional office space could have the unintended consequence of pushing up land values, property taxes, and lease rates passed on to industrial users, destabilizing the area for industrial users. This also applies to recreational uses. The appropriate scale of such uses is important to understand and is examined in further sections of this report.

Summary

There are a wide range of rapidly growing business types in Metro Vancouver that may not have been around when zoning bylaws were being written in certain municipalities. Additionally, many of the users outlined above fall in between the traditional definitions of "office" or "industrial". As such, it is essential that municipalities focus on examining the lists of permitted uses within industrial or mixed-employment lands to ensure they are not being too restrictive.



3.4 Geographical and Locational Considerations

The locational characteristics impacting both the viability of multi-level industrial development and potential tenant demand include a variety of factors, as outlined below. Some industries and development formats are suitable for a wide range of locations, whereas others have more specific requirements.

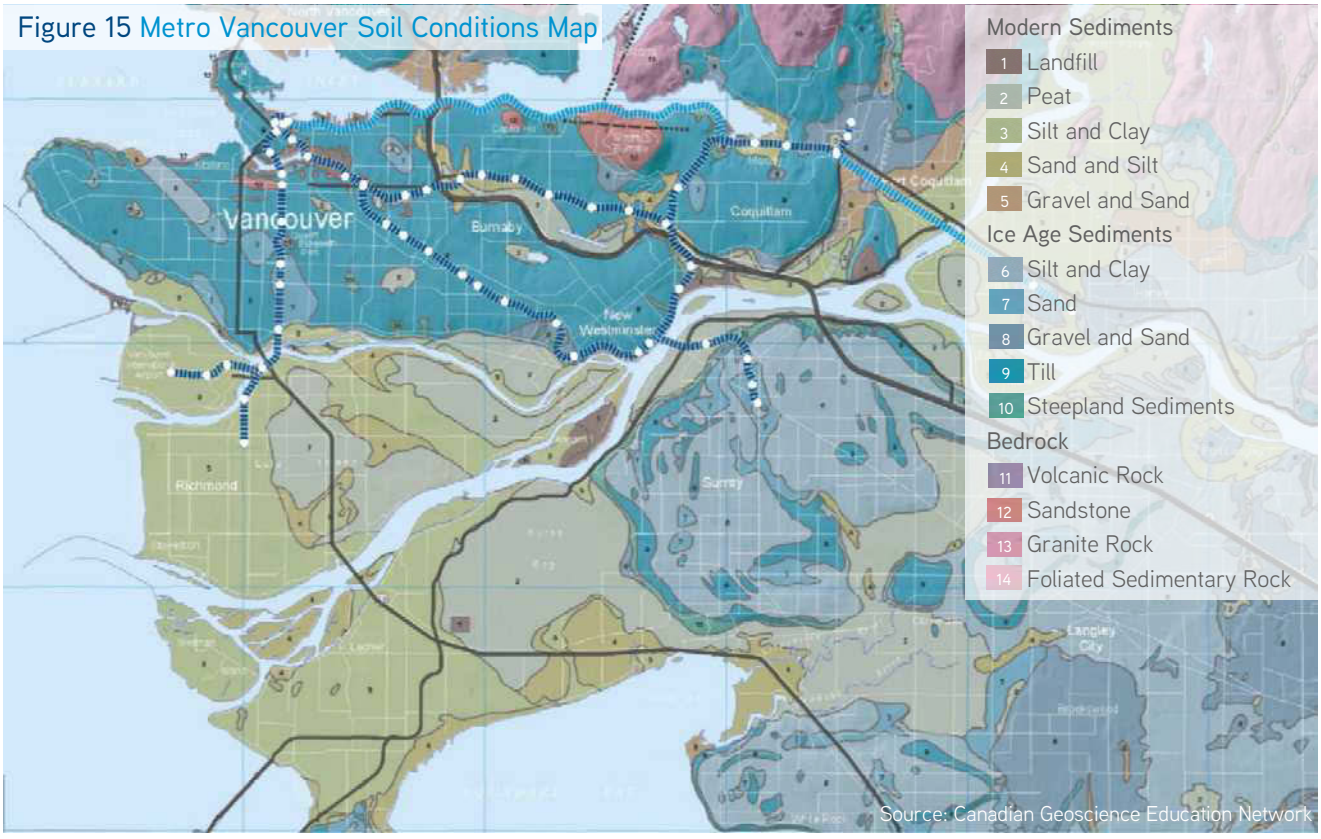
Considerations regarding where intensified development is most feasible include:

- Geotechnical conditions
- Development format and lot size
- Population density and growth
- Accessibility and amenities

Geotechnical Conditions

Ground conditions vary throughout Metro Vancouver and many industrial zoned sites are located on soil that makes multi-level development more expensive, and in many cases cost prohibitive. When examining the locational suitability for such development throughout Metro Vancouver, it is therefore important to consider soil conditions of industrial lands.

Figure 15 Metro Vancouver Soil Conditions Map



Challenging soil conditions are generally loose, water-saturated sediments less than 10,000 years old such as the Fraser River floodplain, including clay, peat, silt, and landfill. Clay is tricky due to its tendency to shift around

as it dries or moistens, requiring deep foundation depths to increase stability. Peat consists of decaying organic matter. It holds a large amount of water and therefore has a low bearing capacity and a tendency to shift around.

Similar to peat, silt is problematic due to its ability to retain water. Poorly designed and compacted landfills are also poor foundations and more likely to liquify during a strong earthquake. The soil quality of Richmond, Delta, and smaller areas of land throughout Metro Vancouver are therefore less likely to be suitable for multi-storey industrial development.

The peat (2) and sand/silt (4) of Still Creek, Burnaby may result in higher costs associated with earthquake stabilization.

Ice Age sediments provide much more suitable foundations when compared to modern sediments, underlying the rolling uplands (15 to 250 metres in elevation) of the Fraser Valley dating back to the last glaciation of the area (11,000 to 25,000 years ago). Till is one of the best soil types for construction due to its combination of silt, sand, clay, and stones. It combines the best of all their qualities into the ideal balancing support for a foundation. It generally does not shift, expand, or shrink and handles the presence of water well. Mixtures of compacted sand and gravel are also suitable, allowing soil to drain water quickly which reducing the risk of the building shifting around. Rock and bedrock such as sandstone and limestone are also excellent options due to their high bearing capacity.

The peat (2) and silt/clay (3) of Big Bend result in significant costs associated with the creation of a solid foundation.

The majority of industrial land within Vancouver and Burnaby has soil well suited for multi-storey development, aside from the Still Creek and Big Bend industrial lands. Burnaby's new multi-storey development was only feasible because Oxford purchased the land years ago at less than half its current market value. Some areas of Surrey also have soil well suited for development, including the Newton and Campbell Heights industrial lands. Still Creek lands (near Highway 1 and the SkyTrain) are built on a mixture of sand and silt. While these lands have moderate to high bearing capacity and generally are decent foundation materials, they are slightly more prone to damage during earthquakes and may result in higher construction costs. The Big Bend industrial lands are a mixture of peat, silt, and clay which make multi-storey development less feasible. For example, Oxford Properties' Riverbend project is currently being constructed on a site consisting of modern sediments (peat, silt, and clay). This added significant costs (over 2.5x traditional construction costs) associated with densifying the soil and providing stone columns for additional support.

Development Format and Lot Size Requirement

The likelihood of multi-storey development is also directly related to the availability of suitably sized lots. Large-scale multi-storey developments like Riverbend or Prologis Georgetown (Format A), require lot sizes large enough to accommodate the construction of a ramp to provide second floor truck access while also including enough leasable space to make the projects work financially. These projects typically require sites larger than 10 acres with suitable soil quality, which are scarcely available in the region.

On the other hand, smaller multi-level development typologies with freight elevators (Formats B and C) can be built on much smaller sites, as demonstrated by the amount of development activity occurring in denser industrial areas of Metro Vancouver such as Mount Pleasant on sites smaller than 1 acre. Although unique and hard to find, sites with a grade can be advantageous for two-level industrial buildings, providing loading from two sides/levels while removing the need for a ramp.

Population Density and Growth Projections

The tenant types most likely to occupy multi-storey industrial developments are generally focused on serving the local/regional population, ranging from the distribution of goods from large fulfillment centres to the

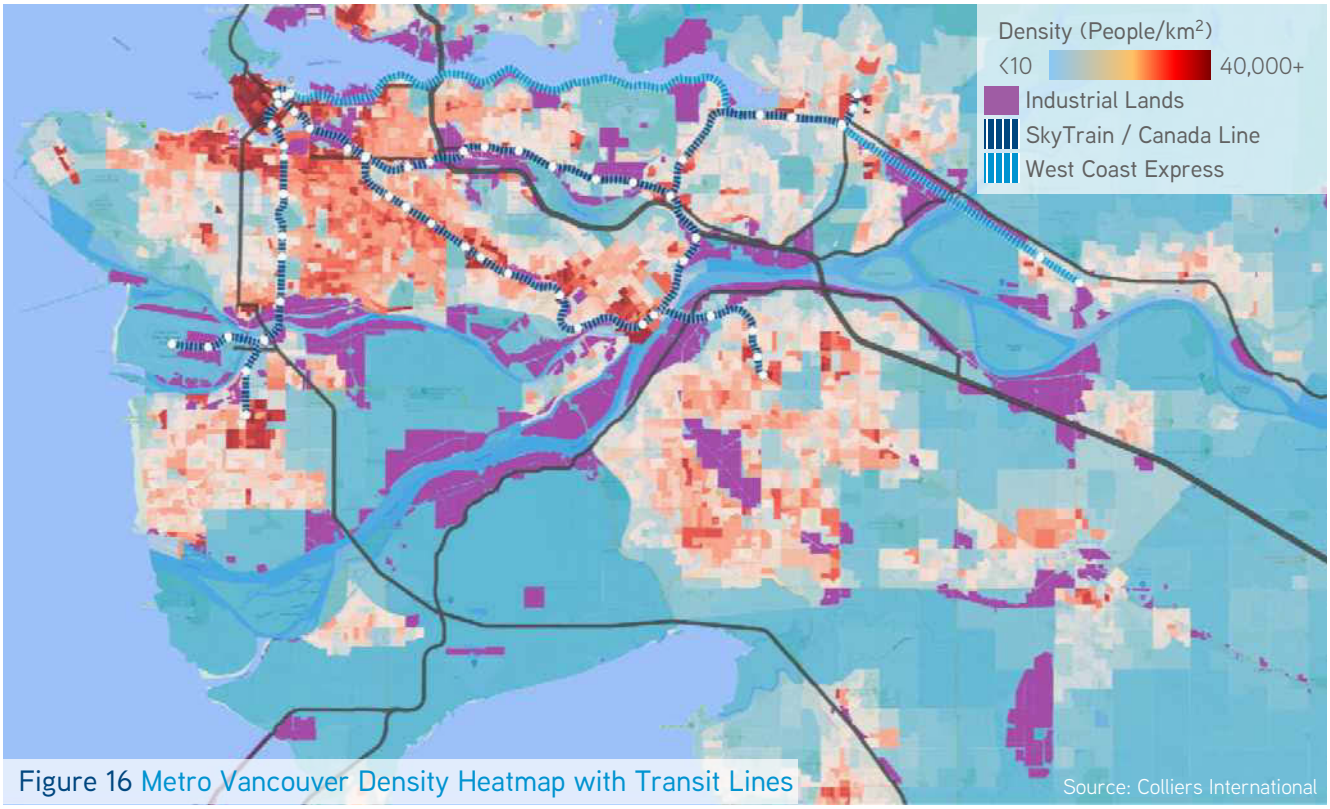


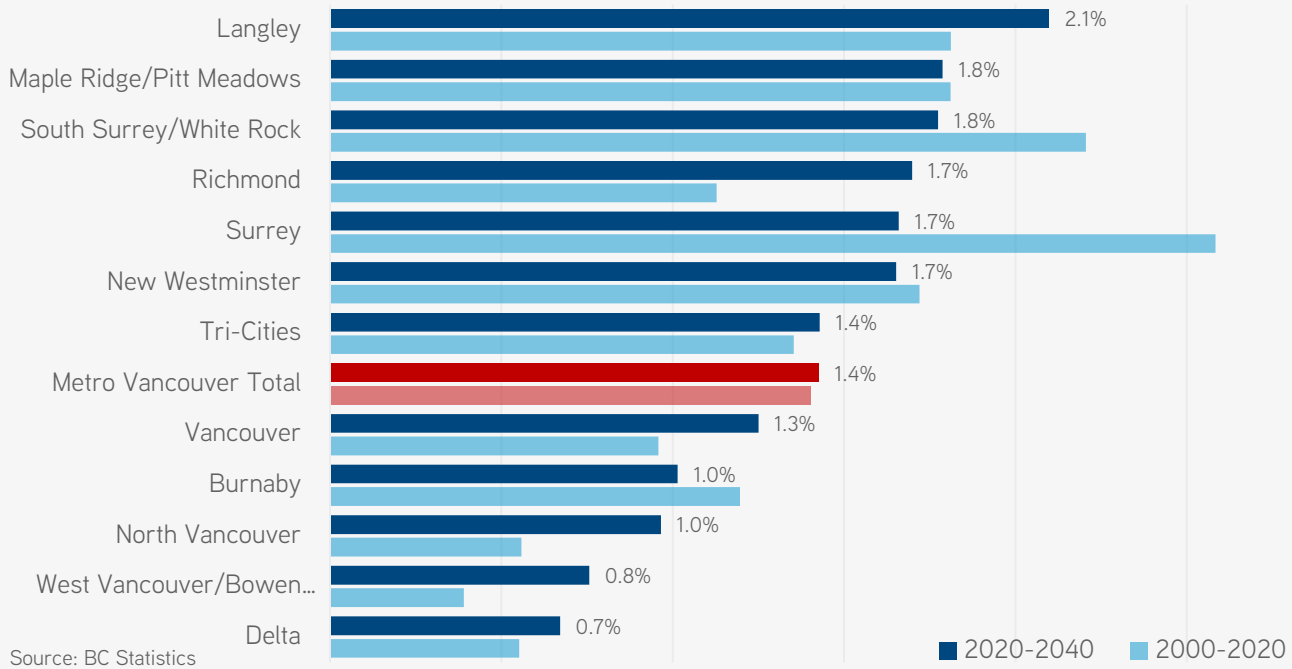
Figure 16 Metro Vancouver Density Heatmap with Transit Lines

Source: Colliers International

provision of services or manufactured goods to a localized population. As such, the majority of these industries utilize a business model similar to a retailer, which considers trade area size and the expenditure potential

generated from the population within. Additionally, one of the biggest challenges facing many industrial employers is finding suitable employees. In many cases, highly educated and skilled employees may have choices regarding where they work, and as such, could decide to work in a location that is conveniently accessible or more desirable based on factors such as available amenities. As such, population density, growth projections, accessibility, and accessory amenities are important to consider.

Figure 17 Metro Vancouver Population Projections (Annual Growth, 2020 - 2040)



Source: BC Statistics

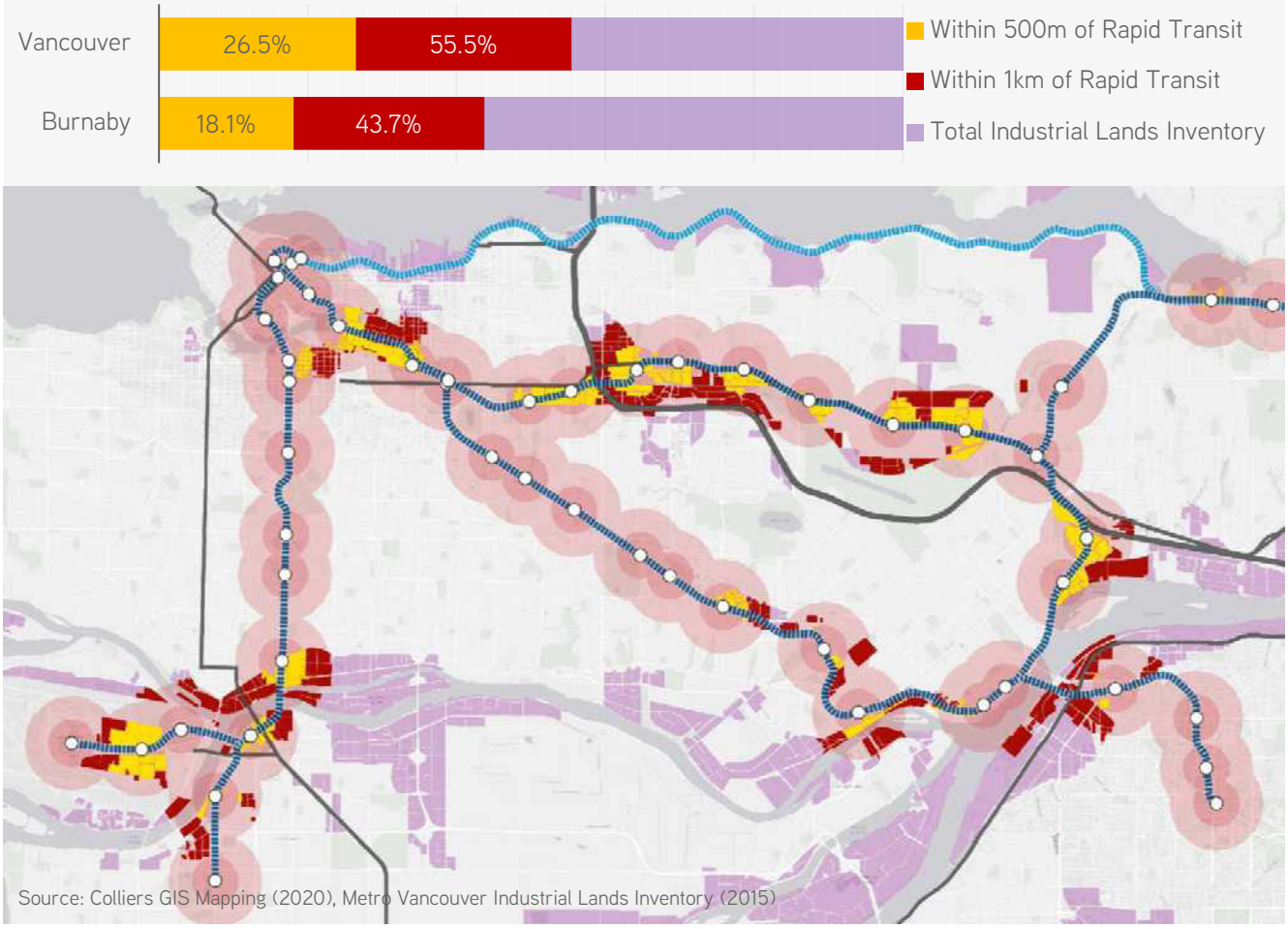
As outlined in Figure 16, density levels are highest the closer Downtown Vancouver, decreasing towards the Fraser Valley. Density generally provides a strong source of consumers, labour, and amenities, leading to the strong industrial activity in inner-city regions such as Mount Pleasant and Railtown. Mount Pleasant in particular has proven to be highly sought after based on the proximity to a dense population along with desirability as a place to work from employees which favour the accessibility and nearby amenities of the neighbourhood over suburban industrial developments.

Population growth projections are also important to examine. For example, while Surrey and Langley are currently less dense than Vancouver and Burnaby, their populations are projected to increase at higher annual rates over the next 20 years. This will bring large amounts of additional consumers and potential employees, increasing the potential of the area for intensified development in the long term. As such, industrial lands that are still relatively close to Vancouver and Burnaby yet centrally located to serve this growing population, such as Big Bend in Burnaby or River Road in Delta, could also be suitable locations for multi-storey development in the future.

Accessibility and Amenities

As mentioned above, accessibility and amenities are key factors that potential employees consider when deciding where to work and that potential consumers consider when deciding where to spend their money. This is also a consideration for logistics companies that increasingly require strong vehicular accessibility to consumers to ship their goods at fast times. Therefore, the smaller, more labour intensive and consumer facing tenant types suitable for multi-storey industrial developments are optimally located in areas that can be accessed easily by rapid transit, highway, local arterial streets, and, in some cases, by foot. Transit proximity also can reduce the parking requirements of on-site employees, which in turn results in potentially lower construction costs and more feasible development.

Figure 18 Metro Vancouver Transit Oriented Industrial Lands Inventory



Source: Colliers GIS Mapping (2020), Metro Vancouver Industrial Lands Inventory (2015)

These smaller formats developments often have tenants and customers that also desire nearby amenities such as restaurants and personal services. As such, areas of Metro Vancouver that fill these characteristics are highlighted in Figure 18. For example, approximately 27% of industrial/mixed-employment lands within Vancouver and 18% within Burnaby are within 500 metres of a transit station. Aside from the potential soil

issues mentioned above, Still Creek is an example of a strong location due to its proximity to numerous SkyTrain stations, Highway 1, and rail. Larger occupiers are less focused on proximity and accessibility by labour and consumers, and more focused on the efficient distribution of goods to consumers. As such, these types of businesses are less reliant on public transit and the availability of amenities and more so on the availability of a strong road network relatively close to consumers.

Summary

Industrial businesses are generally more profitable if their market potential is greater. With the expansion of the industrial subsectors identified in *Section 3.3 Industrial Subsectors Suitable for Intensified Developments,* demand for industrial/light-industrial/flex space in proximity to dense, growing populations with nearby amenities will continue to be in high demand moving forward. Inner city locations are in many cases worth the premium in terms of tenancy costs, particularly as these costs are generally much lower than other factors such as transportation costs. The value-add sectors tend to prefer high profile, inner urban locations and have the most potential in urban, transit-oriented locations like Vancouver and Burnaby. Smaller scale, light-industrial developments with offices above are the most suitable for these areas.

The larger-format model of Riverbend or Prologis is more suitable for highway-oriented and/or port-serving locations. Rail access is also desirable, but not as important as vehicle access. These types of developments still require relatively close proximity to the population, specifically where delivery times are essential. These development formats are also more impacted by the additional costs associated with strengthening the foundation on sites with poor soil quality. As such, the most suitable areas of Metro Vancouver for such development are somewhat limited until the population of the Fraser Valley densifies, as well as due to the lack of available vacant land.

3.5 Design and Development Considerations

The design and development of intensified industrial projects, particularly multi-storey, include numerous considerations as outlined below. These considerations vary based on scale and format of development and target tenant types, and in some cases may hinder or facilitate the development of multi-storey projects.

Key design and development considerations regrading multi-storey projects include:

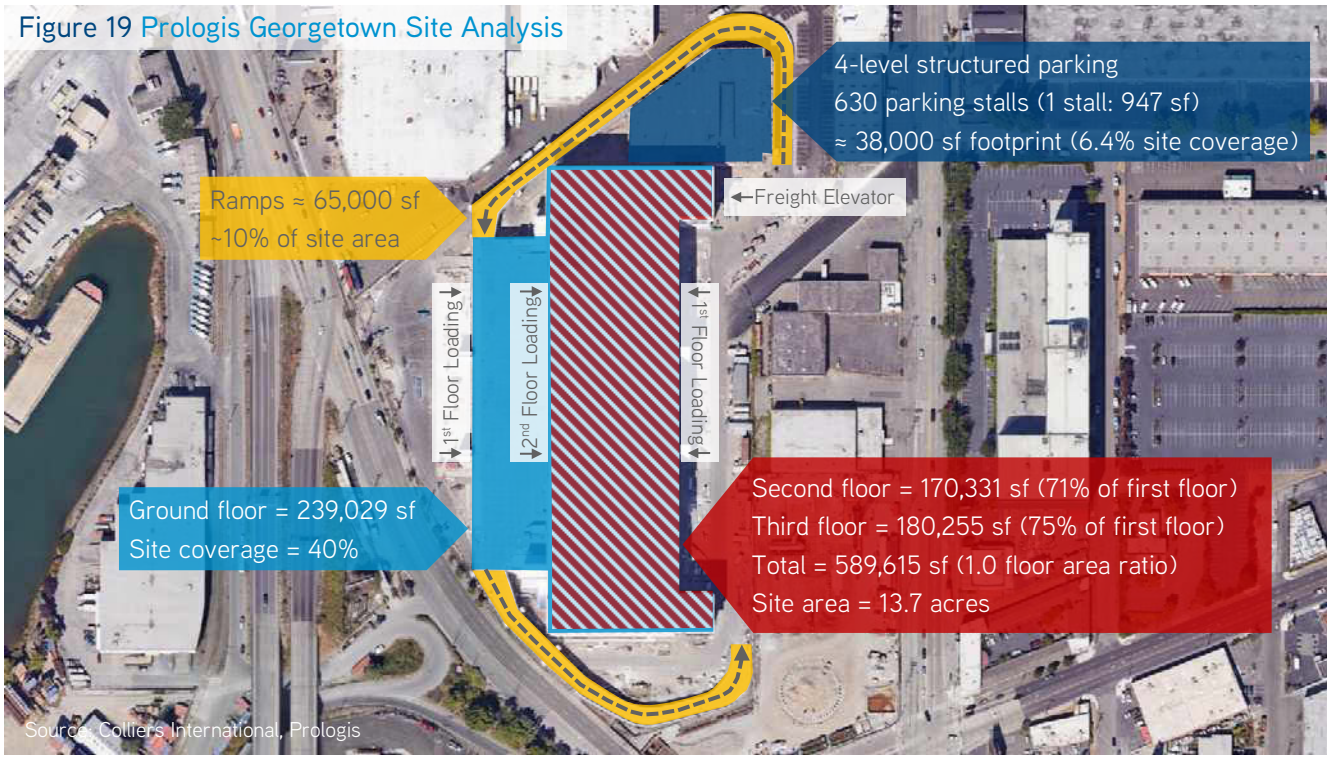
- Site coverage and floor area ratios
- Lot size requirements
- Tenant space requirements
- Loading/access/parking
- Integration/scale of accessory uses
- Physical site features

Site Coverage and Floor Area Ratios

Building site coverages and floor area ratios vary depending on development format. Large-scale, multi-storey developments (Format A) such as Prologis Georgetown typically require a ramp to provide loading access to second floor tenants. This development provides a good example of maxed out site dimensions of this format. Based on the turning radius required by the US truck sizes that will be utilizing the ramp, it takes up approximately 10% of total site area with an additional 6% of total site area taken up by a 4-level structured parkade providing 630 parking stalls (1 stall per 947 square feet).

Due to additional circulation/access/egress requirements and an irregularly shaped lot, the development was able to achieve 40% site coverage. This is lower than the typical site coverage for this development format which can reach over 50% as demonstrated in projects such as Riverbend. Due to the space required for 2nd floor truck loading, the second and third floors are just over 70% the size of the ground floor, resulting in a floor

Figure 19 Prologis Georgetown Site Analysis

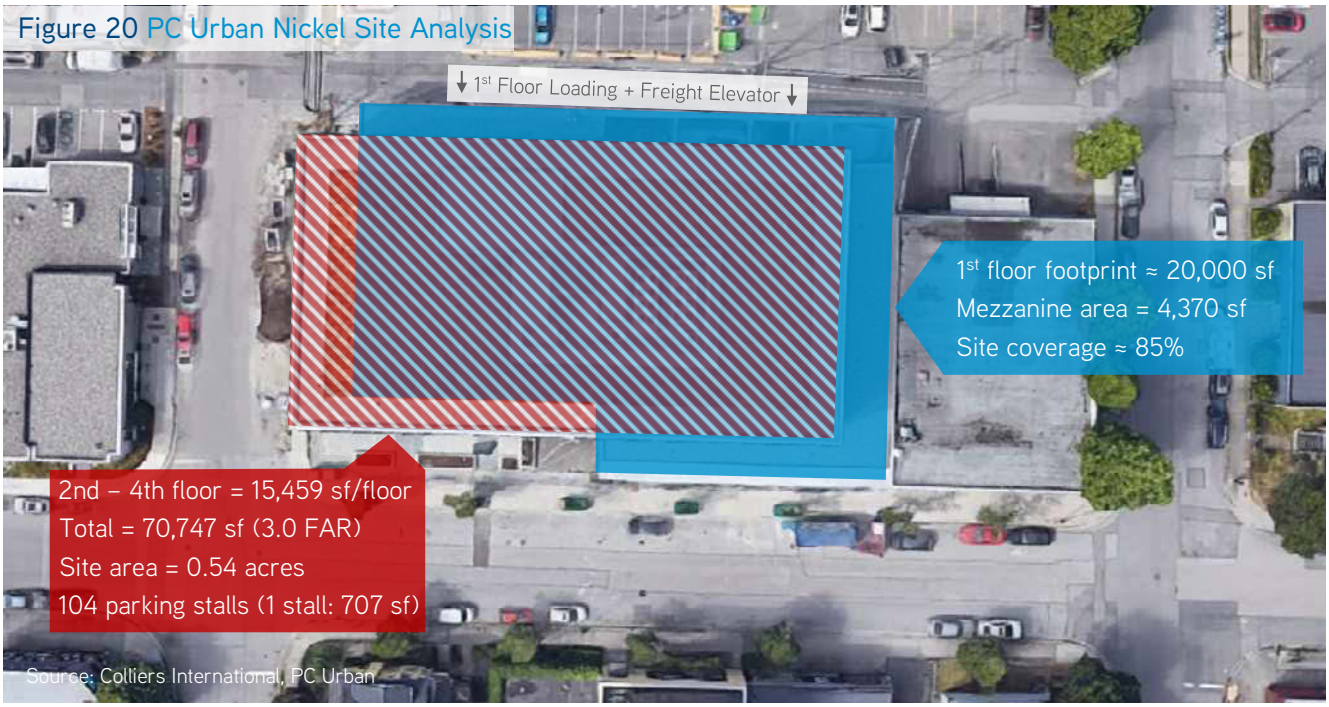


Source: Colliers International, Prologis

area ratio of 1.0 on the 13.7-acre site. This is typically the density range viable on such a development with three floors. Two storey developments of the same format would typically have a maximum floor area ratio of approximately 0.70-0.80.

On the other end of the spectrum, smaller scale light industrial mixed-use developments with ground floor and mezzanine industrial space, underground parking, and three floors of office space above (Format B) have the ability to occupy a much larger proportion of total site area. This is particularly evident within lands with minimal building setback and site coverage restrictions, as demonstrated by PC Urban's Nickel project at 285 West 5th Street. This development has a ground floor footprint of approximately 20,000 square feet, representing approximately 85% of the 0.54-acre parcel. This is possible as the development does not require ramp access to the upper floors, which also allows the 2nd – 4th floors, which are presently used by a software company for office space, to have a significantly larger footprint relative to the first floor when compared to Format A. As such, this project was able to achieve the maximum permitted density of 3.0. Despite higher achievable densities, these developments proportionally have a larger amount of common space when compared to larger format industrial developments.

Figure 20 PC Urban Nickel Site Analysis



Source: Colliers International, PC Urban

If building setbacks, parking, loading, and other requirements can be fully satisfied while providing the maximum building site coverage of a specific lot, then there should not be an artificial cap on the amount of permissible building site coverage nor densities of industrial usage. Generally, FAR maximums are a factor of consideration at the municipal level, however the land economics of developing industrial floorspace on lots less than 1 acre often rely on the ability to also include a significant component of office space in multi-storey projects. For example, up until recently, the density limited in Mount Pleasant I-1 was 3.0 (1 FAR light industrial + 2 FAR office/service/retail). This zoning resulted in numerous developments with only one floor of light industrial with

additional mezzanine industrial floorspace, and 3 floors of office above. More recently, the Mount Pleasant I-1 zone was amended to allow up to 6.0 FAR (2.0 FAR light industrial + 4 FAR office/service/retail). Due to the size of most parcels within this area, the only way to achieve a 2.0 minimum light industrial FAR is to build a second floor of industrial floorspace which is expected to bring more total supply to the market when compared to the older density cap of 3.0.

Table 5 Multi-Level Industrial Development Statistics

Development	Lot	Floors	Total SF	FAR	Floor Heights	Loading
Prologis Georgetown 	13.7 ac	Level 1 – Fulfillment Level 2 - Fulfillment Level 3 – Flex/office *("Makers Space")*	589,615 *40% Site Coverage*	1.0 (2.5 max)	Level 1 – 28' Level 2 – 24' Level 3 – 16'	Ramps to second floor and freight elevators to third floor
Oxford Riverbend 5 	20.0 ac	Level 1 – Industrial Level 2 - Industrial	707,056 *50% Site Coverage*	0.8	Level 1 – 32' Level 2 – 28'	Truck access provided by ramp to second floor
Conwest Ironworks 	2.4 ac	Level 1 – Industrial Level 2 – Flex/Office Level 3 – Office	191,387	1.9 (3.0 max)	22' for industrial users down to 11' for office	Sloped site provides loading access without a ramp
Chard 34 W7 	0.4 ac	Level 1 – Light Ind. Level 2 – Office Level 3 – Office Level 4 – Office	48,000	2.8 (3.0 max)	Level 1 – 17' Level 2 – 11' Level 3 – 11' Level 4 – 11'	3 ground level docks with freight elevator to upper levels
IntraUrban Evolution 	0.8 ac	Level 1 – Light Ind. Level 2 – Light Ind. Level 3 – Ind./Office Level 4 – Office	102,600	2.9 (3.0 max)	25' for industrial down to 13'6" for office	4 freight elevators and 3 oversized dock doors at ground level
PC Urban Nickel 	0.5 ac	Level 1 – Light Ind. Level 2 – Office Level 3 – Office Level 4 – Office	70,747 *85% Site Coverage*	3.0 (3.0 max)	19'7" for industrial down to 9'7" for office	1 freight elevator with 3 oversized dock doors at ground level

Lot Size and Building Heights

As demonstrated in Table 4 and Figures 19/20, the required lot size for multi-storey industrial development varies significantly based on development format. For larger developments, the requirement of a ramp that wraps around usable building space results in a less efficient design than a single storey building that could utilize more of the site area. In addition to the requirement for higher-than-average lease/strata rates, the size of sites for such development need to be large enough to create financially viable developments regardless of the less efficient use of land per storey. The larger developments (Format A) typically require sites exceeding 10 acres in size, which are hard to find in Metro Vancouver.

On the other hand, smaller format developments with light industrial at grade, or on the first two floors, office above, with freight elevator loading rather than ramp loading can be developed on much smaller sites less than 1 acre. Once again, the ability for these developments to make sense financially in some cases depend on the permitted density of office uses on top the industrial floor(s) due to the growing construction costs and land values of inner-city locations suitable for such development.

Ceiling heights requirements are consistently increasing due to technological advancements, reaching over 40 feet in some of the newest advanced warehouses. This enhances efficiency and productivity.

Building height requirements are also important to consider. Industrial ceiling height requirements are constantly growing due to technological advancements, reaching over 40 feet in some of the newest, most advanced warehouses. As such, when these types of facilities are stacked on top of one another, the height of the total development can be significant. When municipalities have building height regulations based on older industrial formats with lower ceiling heights, the viability of multi-storey developments can be hindered.

For example, large-scale multi-level developments (Format A), especially on sites with soil conditions require exceedingly expensive foundations. However, the incremental expense of strengthening the foundation for a third floor would be less than the first two floors. Theoretically, the development of additional floors may make the development feasible where a two-storey development may not be financially feasible. As mentioned, each floor of these developments is quite high, and the addition of a third floor could easily result in a total height exceeding 100 feet. In this situation, if the municipality had a height cap it could unintentionally be restricting this format of multi-storey development. In most cases, there is no need for maximum heights on sites suitable for large scale developments as they are generally located away from areas where views, aesthetics, or shading may be of concern.

Parking Requirements

Minimum parking requirements are also important to examine, as costs of over $30,000 per structured parking stall add significant additional expense to multi-level developments. Parking regulations vary among municipality, and there is rarely much consideration regarding the location and the impact of factors such as transit proximity. Parking is therefore sometimes overbuilt, particularly for lighter industrial developments close to transit. For example, Chard Development's The Yukon (6th and Yukon) is approximately 90% sold out, yet there is still a full floor of leftover parking that was not desired by any of the tenants for themselves or their visitors. This additional parking therefore added significant additional expenses to the development that may have not been required based on its locational context. On the other hand, developments positioned to target tenants that utilize sprinter vans and other delivery vehicles may demand more parking to store these vehicles overnight although vehicle storage can sometimes be accommodated with on-street parking.

Parking regulations should be reviewed by municipalities, particularly in transit served industrial/mixed-employment areas, to ensure that they are not too excessive based on current and expected industrial market trends. In addition to transit, the automation of certain industries and efforts to encourage carpools and car share programs may reduce the necessary amount of on-site parking compared to when the zoning bylaws were written. Additionally, creative solutions may be possible, for example by using employee parking spaces to store sprinter vans overnight when they are not in use, although such vans may require higher clear heights.

Loading and Access

Many of the industrial tenant types that could be interested in multi-level developments, particularly above ground units, are concerned with the efficiency of loading and truck access. For example, although there is the desire for direct truck access on second floor units among larger-scale tenants, the perception of lack of efficiency using a freight elevator system instead could potentially dissuade potential tenants from choosing a site. There is often also a requirement for curb space / access for drop off and pick up of deliveries such as couriers.

Above ground loading via freight elevators is often perceived as undesirable even though it can be quite efficient.

While the perceived operational nuisance associated with multi-level buildings and freight elevators can be significant for businesses focused on efficiencies, in reality they can still be fairly effective. However, another hybrid option could be the provision of upper-level loading access only to smaller sprinter vans, with loading for larger trucks remaining on the ground floor. This would require much smaller and more affordable ramping systems when compared to those in Prologis' Georgetown Crossroads or Oxford Properties' Riverbend.

Tenant Space Requirements

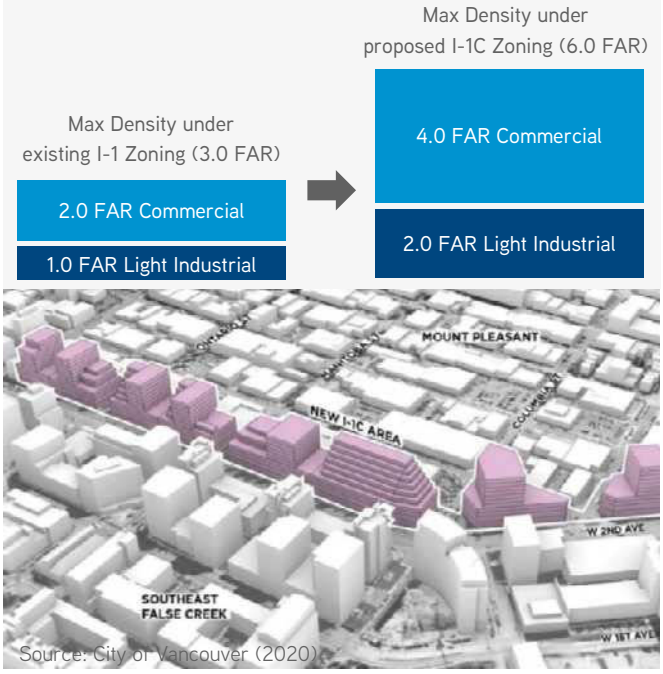
The design of industrial buildings must meet the requirements of target tenant types while providing flexibility to adapt as user needs change. For the smaller tenant types more suitable for inner city, mixed-employment lands, unit size requirements are generally less than 10,000 square feet. Typically, these are light industrial units with a loading bay and mezzanine space for office and/or retail/wholesale components. These types of units are suitable for multi-level developments with additional building features such as freight elevators, wide corridors, high ceilings, adequate column spacing, and floors with load-bearing capacity.

Larger occupiers such as fulfillment centres generally require spaces exceeding 100,000 square feet with direct truck loading access, 300-500 pounds/sf loading capacity, and open efficient layouts ideally with efficient column spacing. These developments occupy larger floorplates such as Prologis Georgetown Crossroads, which has a main floor footprint of 240,000 square feet divisible down to 75,000 square feet units. It is therefore essential to provide developments with flexibility, particularly in terms of potential partitioning or consolidating of internal units, so potential tenants can either occupy the entire floor or a smaller section of the same floor.

Integration and Scale of Accessory Uses

Limited office and retail uses can support of industrial activities, however, can also potentially cause destabilizing due to land speculation, taxes, and land use conflicts. However, the redevelopment of some sites to include an additional floor of light industrial space may not be feasible without the allowance for the inclusion of office space above which is of higher value in the market. For example, to encourage the development of more job supporting floorspace within Mount Pleasant, the City is proposing a zoning amendment which will allow up to 4.0 FAR of office space if a minimum of 2.0 FAR of industrial is constructed. This is expected to increase the overall density of light industrial space within multi-level developments in the area, which recently has hovered around 1.0 FAR.

Figure 21 Mount Pleasant I-1C Zoning Amendment



Source: City of Vancouver (2020)

Limited retail uses are also required to service the daily needs of the local workforce; however, this demand is very limited, namely to coffee and lunch restaurants. Any retail uses should not be designed to attract significant customer traffic from beyond the immediate industrial area in order to minimize conflicts with industrial users. For example, a general rule of thumb, is that 5,000 full time employees generate demand for approximately 10,000-15,000 square feet of food and convenience-oriented retail floorspace and an additional 5,000 square feet of service commercial. Allowing other retail uses which are not directly associated with the industrial operations may introduce other issues which could detract from the industrial potential of the area, such as increased traffic, higher expectations about area amenities and transit service, while driving up land prices.

It is also important to ensure that the use, design, and interface between different uses within mixed-use projects minimize any potential conflicts. Some types of industrial tenants can be more readily mixed/integrated with other forms of development such as office space. The provision of a separate elevator for office tenants could be beneficial, while the location of retail floorspace (if any) should also be considered. While many light industrial zones could support the inclusion of supportive retailers such as a restaurant with a patio, it is important to position such a retail unit away from the nosier truck access routes of the site in order to facilitate a more inviting dining experience. Municipal bylaws could be written to best reflect this balance, providing reasonable flexibility for accessory uses while requiring the inclusion of industrial uses.

Physical Site Features

The physical features of the site itself are important considerations. While industry has traditionally sought the flattest land in the region given the nature of most forms of production, storage, and distribution activity, the cost of providing ramping/truck access to second floor units has shifted more awareness to the potential benefits of sloped sites. This is demonstrated by Conwest's Ironworks located in East Vancouver, as displayed below. This project benefited from a sloped site that resulted in the ability to provide truck access to two levels of the development without a costly ramp and utilized an entire city block (and closed middle lane), which benefits design options. The site's topography was highlighted by Conwest staff as being critical in the feasibility of the design decision. Following the development of this project, the City changed how they calculate FAR, in terms of including exterior building corridors which were previously excluded.

Figure 22 Conwest Ironworks Site Analysis

Ironworks takes advantage of its sloped site to provide multi-floor truck access without the construction of a costly ramp.

4 Planning Policy Review

The planning policy review compares and analyzes the various policies in place at the regional and municipal scale that encourage the intensification of industrial lands. The review begins with an analysis of regional policies as they are the guiding framework for municipal policy and decision making. The following section reviews the current policies of six municipalities in the region (City of Vancouver, City of Burnaby, City of North Vancouver, City of Richmond, City of Surrey, and the Township of Langley). These municipalities have significant industrial land areas and are key markets where demand and high land values for industrial floor area will instigate further densification and intensification where allowable.

While all municipalities reviewed have policies and statements in place noting the importance of the industrial sector, a number of policies and Official Community Plans require updating from an intensified industrial perspective to meet current market conditions. Notably, the City of Burnaby's Official Community Plan and Economic Development Strategy require updates to align with the modern industrial climate. Further, most municipalities could include more prescriptive language as to how intensified development can occur. Finally, in a number of municipalities, while there are goals and policies in place, the zoning bylaw does not fully align with the objectives outlined in higher level policy documents.

Some municipal zoning bylaws allow for a wide range of uses within their 'industrial' zones, in some cases, to recognize the various uses that did not fit the old definition of industrial uses that were already in place. In the case of the City of Vancouver, some industrial zones allow office and in I-4 'creative products manufacturing', encourage the redevelopment of older industrial buildings to higher densities developments with greater and higher level uses. This has led to the change, or loss, of traditional industrial activities in certain areas as redevelopment and higher values take hold. It is crucial that in addressing the regional shortage in industrial land, that steps be taken to intensify suitable sites to create more industrial floor area.

4.1 Metro Vancouver Regional Growth Strategy

The Metro Vancouver Regional Growth Strategy was adopted in 2011 and is one plan among a set of interconnected plans developed around Metro Vancouver's Sustainability Framework to focus on land use policies and guide the future development of the region and support the efficient provision of transportation, regional infrastructure, and community services. As a response to the six key challenges the region faces, five goals were arranged to achieve desired outcomes.

Supporting Policies for Intensifying Industrial Development

- Goal Number 2: Support a Sustainable Economy

- This goal recognizes that the "land base and transportation systems required to nurture a healthy business sector are protected and supported. This includes supporting regional employment and economic growth. Industrial and agricultural land is protected and commerce flourishes in Urban Centres throughout the region".

〉 Strategy 2.2: Protect the supply of Industrial Land

- Metro Vancouver's role is to:
  - 2.2.2 Work with the province, municipalities, and other agencies to investigate industrial taxation rates and policies that support industrial activities.
  - 2.2.3 Accept Regional Context Statements that project and support the ongoing economic viability of industrial activities that meet or work towards Action 2.2.4
  - 2.2.4 The role of municipalities is to adopt Regional Context Statements, which:
    - bi) Support and protect industrial uses;
    - bii) Support appropriate accessory uses, including commercial space and caretaker units;
    - biii) Exclude uses which are inconsistent with the intent of industrial areas, such as medium and large format retail, residential uses (other than industrial caretaker units where necessary), and stand-alone office uses that are not supportive of industrial activities;
    - biv) Encourage better utilization and intensification of industrial areas for industrial activities;
    - di) Support a mix of industrial, commercial, office, and other related employment uses, while maintaining support for established industrial areas, including potential intensification policies for industrial activities, where appropriate;
    - diii) Support the regional objective of concentrating commercial and other major trip-generating uses in Urban Centres and Frequent Transit Development Areas;
    - dv) Allow low density infill / expansion based on currently accepted local plans and policies in Mixed Employment areas and support increases in density only where the Mixed Employment area has transit service or where an expansion of transit service has been identified in TransLink's strategic transportation plans for the planned densities;

4.2 Metro Vancouver Regional Industrial Lands Strategy

Supporting Policies for Intensification

The Metro Vancouver Regional Industrial Lands Strategy was a coordinated effort by Metro Vancouver to establish a vision for the future of industrial lands across the Metro Vancouver region to the year 2050 and outlines the challenges the region faces. In response to these challenges, 34 recommendations are proposed along with 10 priority actions which inform the four big moves established to protect and ensure the economic viability and longevity of industrial land. This study, examining the intensification of industrial land in the Metro Vancouver region, was established as a result of "Big Move #2 – Intensify and Optimize Industrial Lands".

While not a "one size fits all" approach to long term industrial strategies for every municipality in the Metro Vancouver region, the policies and recommendations made in the Regional Industrial Lands Strategy should be undertaken by municipalities to balance regional objectives with municipal goals and ensure a sufficient supply of industrial land can remain consistent with demand and catalyze future economic growth and stability.

Big Moves

1. Protect Remaining Industrial Lands
2. Intensify and Optimize Industrial Lands
3. Bring the Existing Land Supply to Market & Address Site Issues
4. Ensure a coordinated approach

Priority Actions

1. Define Trade Oriented Lands
2. Undertake a Regional Land Use Assessment
3. Strength Regional Policy
4. Seek Greater Consistency in Local Government Zoning Definitions and Permitted Uses
5. Facilitate the Intensification / Densification of Industrial Forms Where Possible
6. Prepare Bring-to-Market Strategies for Vacant or Underdeveloped Industrial Lands
7. Ensure Transportation Connectivity
8. Coordinate Strategies for Economic Growth and Investment
9. Improve Data and Monitoring
10. Develop a Framework for Coordination

Of the 34 recommendations made, the following pertain to the intensification of industrial lands.

› **Recommendation 7: That municipalities facilitate the intensification/densification of industrial forms where possible through actions including:**

- Remove any unnecessary restrictions to densify or limit height, where contextually appropriate; planning the space to accommodate new, smaller industrial uses when older, centrally located industrial areas densify; allowing mixing of industrial with other employment uses so long as the industrial component is secured as a condition of redevelopment; and exploring opportunities to encourage intensification in target areas (i.e. proper geotechnical conditions, access to infrastructure and transit) via incentives. These could include pre-zoning, density bonuses, financial incentives, and/or others.

〉 Recommendation 8: That Metro Vancouver conduct a study of the financial factors and other issues that prevent the development of multi-storey industrial spaces in various regional market areas.

- The study should identify the gap between development costs and market rents or sales prices in different municipalities to assess if there are ways that Metro Vancouver and member jurisdictions could improve the feasibility of delivering higher-density industrial spaces.

〉 Recommendation 9: That the Province review the current approach to property tax assessment and tax rates based on the highest and best use of a property with regard to its impact on industrial businesses.

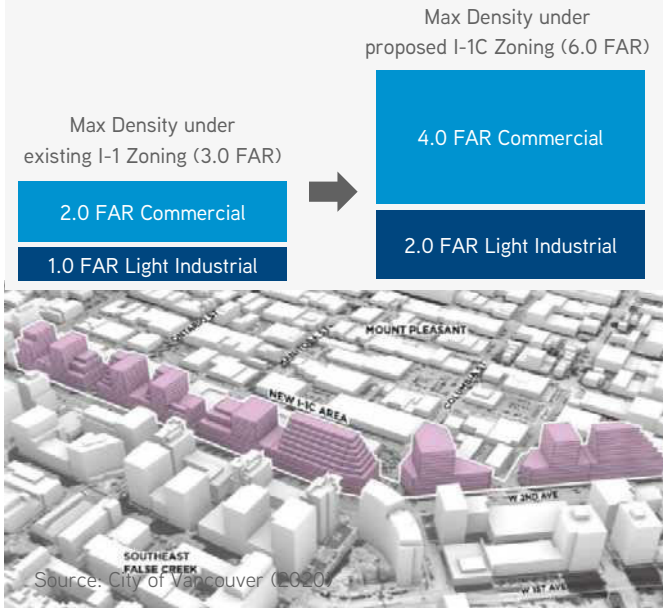
- The value of industrial lands and the associated rise in property taxes is placing increasing pressure on industrial businesses, particularly in high growth and high value areas where other land uses may be considered "highest and best use". The review should identify if there are reasonable approaches to mitigate the destabilizing effect of rapidly rising assessments and taxes on industrial businesses.

4.3 City of Vancouver

Policy Reviewed

1. City of Vancouver Employment Lands and Economic Review (ELER) Part 2: Emerging Directions for Consideration Through Vancouver Plan (October 2020)
2. Interview with City of Vancouver Planning Staff
3. City of Vancouver Zoning Bylaw

Figure 23 Mount Pleasant I-1C Zoning Amendment



Source: City of Vancouver (2020)

Summary

Regarding industrial intensification in the City of Vancouver, Staff note that the goal of policy is to allow for market drivers to align with development requirements and to ensure the intent of policy is clear. As a direction from the Employment Lands and Economy Review, Staff are recommending the doubling of permitted density from the existing 3.0 FSR permitted under I-1 zoning to 6.0 FSR under a proposed I-1C zoning designation. The proposal increases the minimum industrial density required and allows accessory uses above to supplement the additional costs associated with developing upper floor industrial spaces. This is a concentrated attempt to make overall projects more economically feasible recognizing that upper floors of industrial generally command less rent per square foot and that upper floors of office are able to receive higher per square foot rents than lower floors of industrial space.

In addition, the City of Vancouver recently amended the I-1 District Schedule to add an additional high value use and created a new I-1C District Schedule as a result of the Emerging Directions for Consideration Through Vancouver Plan (ELER Phase 2). The new District Schedule introduces new bylaw, policies, and guidelines for the south side of 2nd Avenue, between Yukon and Quebec Streets, to support employment-intensive stacked light industrial and limited retail uses on lower levels with compatible office and service uses above. The intent is to increase the City's land use capacity for industrial space and introduce new employment space in the form of modernized stacked light industrial with intensified office space above. Notably, the new I-1C District allows twice the density permitted in I-1 (from 3.0 FSR to 6.0 FSR) and maintains the area's industrial land use designation by maintaining that a minimum of 33% of the overall floor area of each site is secured for industrial uses.

These policy directions represent attempts for the City of Vancouver to be proactive in supplying vital industrial space while understanding the economic drivers behind development decision making. City of Vancouver Staff recognize that there are greater costs and higher levels of uncertainty related to upper floors of industrial space and hope that over time, the market will adapt to and recognize the utility of these floors. Staff also note that they are cautious in updating additional uses as to not displace lower value uses that are still essential for a diverse economy yet less critical in servicing the local population. The aim is to deflect and discourage speculation while landowners wait for higher and more valuable uses on industrial sites.

4.4 City of Burnaby

Policy Reviewed

1. City of Burnaby Official Community Plan (1998)
2. Burnaby Economic Development Strategy 2020 (2007)
3. City of Burnaby Zoning Bylaw

Summary

Both the City of Burnaby's Official Community Plan and Economic Development Strategy are in need of updates in alignment with current industrial market conditions and demand. While policy directions in the Official Community Plan support industrial intensification, notably "Amend the Burnaby Zoning Bylaw to encourage intensification of the use of industrial lands, meet contemporary needs and promote higher employment levels", language and policy should be implemented to explicitly support intensified development. Although Burnaby has recently approved a multi-storey industrial development, it is understood that regulatory restrictions and contradictory planning policy created conflict with the approval of the intensified project. In interviews with Oxford Properties, the applicant wished to develop an additional floor of industrial floor area, however, Staff were concerned about the additional height and built form that would result despite the fact that a further intensified project aligns with numerous municipal and regional policies and objectives.

It is important to note that no maximum floor area ratio limit in Burnaby's Industrial Zoning Bylaw (outside of the M8 District), allows for a degree of flexibility in what is developable on industrial sites. However, both the relatively low allowable lot coverage and heights achievable on most industrially zoned sites inhibit the ability to develop more intensified projects.

4.5 City of North Vancouver

Policy Reviewed

1. City of North Vancouver Official Community Plan (2014)
2. City of North Vancouver Economic Development Strategy (2008)
3. City of North Vancouver Zoning Bylaw

Summary

The City of North Vancouver recently amended the M4 Industrial Zoning bylaw to permit provincially licensed lounges accessory to industrial brewing and distilling uses without the need for site-by-site rezoning. In recognizing the M4 lands primarily between the 200-300 blocks of East Esplanade and East 1st Avenue as important employment areas, the City aspires to create a more favorable environment for industrial uses focused on small-scale and customer focused production. This flexibility in allowing additional uses without required regulatory approvals and associated time and cost, seeks to improve the utility and increases the value of these industrial lands. It should be noted that this flexibility in allowing additional uses is likely to increase land values and demand for M4 zoned industrial sites and may put pressure on lower value industrial uses to displace in favor of more valuable uses. While it is important to maximize the value of industrial land, it is also important to recognize the utility and value of uses that are generally considered lesser in economic value.

The City of North Vancouver's Official Community Plan encourages the continued support for industrial spaces recognizing that industrial lands are vital for continued economic growth and employment. Notably Policy 7.2.8, which encourages the intensification of employment floor area, will be a guide in encouraging future industrial intensification in key areas, particularly areas accessible to workers. It should be noted that Council's Strategic Plan 2018-2022 makes no reference to economic development in the industrial sector of the city.

4.6 City of Richmond

Policy Reviewed

1. City of Richmond Official Community Plan (2012)
2. City of Richmond Resilient Economy Strategy Action Plan (2014)
3. Industrial Lands Intensification Initiative (ILLI)– Summary of Findings and Proposed Amendments to Richmond Official Community Plan (2021)
4. Interview with City of Richmond Planning Staff
5. City of Richmond Zoning Bylaw

Summary

The City of Richmond's Resilient Economy Strategic Action Plan builds on the economic policies of the Official Community Plan and reiterates the importance of industrial land on the local and regional economy in supporting economic development and employment. Notably policy 5.1.2.4 explores the possibility of higher site coverage on industrial land to better utilize valuable industrial lands. The policy places emphasis on flexibility to allow users to achieve higher density forms of industrial development if it is suitable for operational goals instead of limiting use from the onset of a development project. In general, the City of Richmond is being proactive in supporting additional industrial floor area through intensification and redevelopment. In particular, policy 6.1c recognizes the financial constraints associated with multi-storey industrial floor area and seeks to encourage industrial intensification through lower fees on square footage above. Further, Policy 6.11 – the periodic review of allowable uses and bylaw regulations will ensure that Richmond's industrial zoning bylaw is current with industrial demand.

Despite the proactive approach to encouraging more intensified industrial projects through high site coverage, the City of Richmond's industrial zoning bylaw could be less restrictive in allowing for more dense industrial forms through an increase in allowable heights and densities achievable. High site coverages allow for high lot utilization, however, there are often still substantial loading and parking requirements for industrial uses and height restrictions may prohibit more creative developments.

The updates to the City of Richmond Official Community Plan and Zoning Bylaw through the Industrial Lands Intensification Initiative (ILLI) will encourage more efficient and intensive industrial development in the City of

Richmond. Notable recommendations include increasing the maximum building height to accommodate taller industrial buildings driven by technological advances, increasing density achievable on large industrial sites, expanding the list of allowable industrial uses, and reducing parking requirements to support shifts in industrial user types.

While the City has traditionally experienced more standard format industrial development, high density projects, particularly ones on large parcels that support multiple levels of policy, will be supported even if zoning bylaws currently do not permit them through the creation of comprehensive development district. Staff note that the ILLI is the first step in a multidepartment strategy addressing economic development and industrial intensification in the City of Richmond. Future work will be conducted to understand the impact of new and emerging industrial sectors, evaluate the appropriateness of some non-industrial uses in industrial zones and analyze the impact of industrial stratification on the overall industrial market.

4.7 City of Surrey

Policy Reviewed

1. City of Surrey Official Community Plan (2013)
2. Building the Next Metropolitan Centre: Realizing Surrey's Economic Opportunities – The City of Surrey Economic Strategy 2017 to 2027 (2017)
3. Interview with City of Surrey Planning Staff
4. City of Surrey Zoning Bylaw

Summary

A number of policies and objectives in the City of Surrey reaffirm the importance of industrial land and recognize the importance of these lands for future economic development and growth. While the Official Community Plan was adopted in 2014, the City of Surrey recognized the importance of being flexible with regulations such as parking standards and zoning restrictions to allow for more optimized use of industrial lands. Policies in place supporting industrial intensification include, Policy E1.5 encouraging full and efficient utilization of industrial lands to create the most amount of economic activity per hectare, Policy E1.6 supporting the infill and redevelopment of underutilized properties, and Policy E1.7 recognizing the importance of flexibility.

Discussion with City of Surrey Staff suggest that market feasibility has been the predominately limiting factor for intensified industrial projects in Surrey. While industrial projects have intensified through higher ceiling clears and taller overall buildings, proponents have indicated that high lot coverage, multi-storey and high FAR industrial buildings are not yet financially feasible. Staff suggested that while a review of Zoning Bylaw was to be undertaken in the short-medium term future to accommodate more intense industrial projects, if a proponent made an application for an intensified project that did not conform to an industrial zone, the City could

accommodate a proposal with a comprehensive development zone assuming the project is contextually appropriate and meets policy objectives. The City of Surrey noted that ideal locations for intensified industrial sites would likely be in Newton or Bridgeview due to the proximity to urban markets and alternative transportation modes, and while land use plans are not yet updated for intensified industrial uses, flexibility can be provided when required. While this may encourage interim intensified industrial development, necessitating a Comprehensive Development zone or Development Variance Permit results in additional processing time, cost, and risk.

4.8 Township of Langley

Policy Reviewed

1. Township of Langley Official Community Plan (2013)
2. Economic Development Strategy (2012)
3. Interview with Township of Langley Planning Staff
4. Township of Langley Zoning Bylaw

Summary

The Township of Langley has a significant number of policies pertaining to industrial development both within the Official Community Plan and the Economic Development Strategy. Notably in 2012, the Township of Langley identified that the densification of developable lands relieves pressure on agricultural lands and allows for a greater mix of uses. A notable policy in the Official Community Plan is Policy 2.4.12 which directly encourages the efficient utilization of industrial lands and intensification of industrial development. Echoed and recognized by most actors in the public and private sector, land values were identified by municipal staff as a key determinant in the feasibility of stacked industrial projects being developed in the Township of Langley. While there has been a trend to intensify industrial buildings through increased building heights and gradually increasing floor area ratios to accommodate modern warehousing technologies, the market has not yet required industrial developments to have high floor area ratios and high lot coverages.

Similar to the City of Burnaby, not having a limited maximum floor area ratio in the industrial zoning bylaw on industrial zones lends itself to allowing higher and more stacked forms of industrial development. However, the limiting factor on intensifying these sites is heavily tied to the heights achievable on most industrially zoned land. While it is positive that the Township of Langley desires a high ratio of employment on industrial sites and a long-term supply of these lands, more can be done to explicitly encourage more advanced forms of industrial development. Work should be undertaken within the industrial zoning bylaw to further encourage intensified industrial development such as modifying the permitted maximum heights to allow users to dictate space as per their operation requirements and market conditions.

4.9 Fraser Valley Regional Growth Strategy – Fraser Valley Future 2050 Draft

Policy Reviewed

1. Fraser Valley Regional Growth Strategy – Fraser Valley Future 2050 Draft

Summary

The Fraser Valley region has a similar set of goals and objectives as the Metro Vancouver region in terms of its commitment to economic development and resiliency. The Fraser Valley region, similar to Metro Vancouver, recognizes the importance of industrial land on the local and regional economy and protects industrial land through a number of policies to ensure an adequate supply is maintained. A key differentiation of industrial land in this region is the significantly lower land values experienced in the market. Relatively lower land values place less pressure on industrial land conversion to other uses and although construction costs are similar to municipalities in Metro Vancouver, the per square foot rent/sale rates achievable are not at the point where significant industrial intensification is occurring.

4.10 Zoning Comparison

A review of the industrial zoning bylaws of major municipalities in the Metro Vancouver region was conducted to identify gaps in the zoning districts that limit the ability to intensify industrial development. Most notably, the City of Vancouver has been the most proactive in modifying the zoning districts to allow for higher density buildings and larger built forms. The City of Vancouver also recognizes that regulating lot coverage is less important in these more urban industrial developments and allows developers to build based on context and end use as opposed to more conforming site restrictions (outside of required adjacencies, setbacks, etc.). Further, the City of Vancouver is taking an approach more based on land economics and development feasibility recognizing that intensified uses are vital to continued city growth, but also in understanding the additional costs and risks associated with such developments.

A number of municipalities, despite commitments to protect and intensify industrial lands, have not yet fully adopted zoning bylaws which encourage and promote more intensified uses regardless of economic climate. Notably, the City of North Vancouver's relatively low maximum height achievable limit the ability for intensified stacked industrial uses despite there not being maximum site coverages and densities achievable. A similar trend is observed in the City of Burnaby where, despite there being no prescribed maximum densities, built form and industrial floor area achievable is highly limited by height and lot coverage. Flexibility in built form, where contextually sensitive, can allow industrial developers, when market conditions are right, to maximize the creation of industrial floor area.

Table 6 Zoning Comparison Analysis			
City of Vancouver			
Zone	Maximum Achievable FAR	Height (m)	Lot Coverage
I-1	3.0	18.3	-
I-1A	3.0	33.5	-
I-1B	3.0	38.0	-
I-2	3.0	30.5	-
I-3	3.0	30.5	-
I-4	5.0	30.5	-
IC-1	3.0	18.3	-
IC-2	3.0	18.3	-
IC-3	4.0	18.3	-
M-1	5.0	30.5	-
M-1A	5.0	18.3	-
M-1B	2.0	12.2	-
M-2	5.0	30.5	-
MC-1	2.5	13.8	-
MC-2	2.5	13.8	-
City of Burnaby			
Zone	Maximum Achievable FAR	Height (m)	Lot Coverage
M1	-	12.0	50%
M2	-	4 storeys	60%
M3	-	4 storeys	-
M4	-	10.5	50%
M5	-	12.0	50%
M6	-	12.0	25%
M7	-	12.0	25%
M8	1.2	18.0	40%
City of North Vancouver			
Zone	Maximum Achievable FAR	Height (m)	Lot Coverage
M-1	-	12.192	-
M-2	-	12.192	-
M-2A	-	12.192	-
M-3	-	12.192	-
M-4	-	12.192	-
M-5	-	9.144	50%
City of Richmond			
Zone	Maximum Achievable FAR	Height (m)	Lot Coverage
I	1.1	12.0	60%
IL	1.2	25.0	60%
IB1	1.0	12.0	60%
IB2	1.2	36.0	90%
IR1	1.0	12.0	60%

IR2	1.2	35.0	90%
IS	1.0	12.0	50%
IS1	0.1	12.0	8%
City of Surrey			
Zone	Maximum Achievable FAR	Height (m)	Lot Coverage
IB	1.0	12.0	60%
IB1	1.0	14.0	60%
IB2	1.0	14.0	60%
IB3	1.0	14.0	60%
IL	1.0	18.0	60%
IL-1	1.0	18.0	60%
IH	1.0	18.0	60%
IA	1.0	12.0	60%
Township of Langley			
Zone	Maximum Achievable FAR	Height (m)	Lot Coverage
M1A	-	12.0	60%
M1B	-	12.0	60%
M2	-	12.0	60%
M2A	-	-	60%
M2B	-	-	60%
M3	-	-	-
M4	-	-	-
M5	-	12.0	35%
M5A	-	12.0	35%
M6	-	12.0	60%
M7	-	12.0	-
M8	-	12.0	40%
M10	-	12.0	-
M11	-	12.0	75%
M12	-	12.0	60%

4.11 Permitted and Allowable Uses

Many industrial zones in Metro Vancouver were created prior to the emerging popularity of many industrial uses and tenant types as outlined in previous sections of this report. For example, recent economic trends have created strong demand for last mile distribution along with more advanced forms of industrial uses that have not existed in the past such as stacked urban aquaponics[1]. It is important to reassess permitted uses to incentivize multi-storey industrial developments as to not prohibit potential users who may occupy these industrial developments, particularly users that can maximize the utility of upper floors.

[1] Aquaponics refers to a food production system that couples aquaculture with hydroponics.

In analyzing the complexity of allowable uses in various municipalities' zoning district schedules, repetition of uses, very specific uses, outdated uses and uses that are not yet available in the current Metro Vancouver market were found. The limitation and specificity of allowable uses may limit the ability for industrial tenants to use physically and economically suitable space. The Township of Langley's multiple industrial zones have over 70 unique uses, which further restricts the space users can utilize. Flexibility in use in various industrial zoning bylaws, when contextually sensitive, will allow greater opportunity for industrial users to utilize already spaces in a market where vacancy is at an unprecedented low. It is recognized that many municipalities are cognizant of introducing too much flexibility in allowable uses with justifiable fears of displacing industrial users that are essential for a diverse economy, while recognizing that some uses may not be as economically profitable as higher value uses.

4.12 NAIOP Cost of Business Survey – 2019 Industrial Case Study

The NAIOP Cost of Business Survey (COBS) is published annually and quantifies the costs and processing times associated with a typical development project within Metro Vancouver. In 2019, the most recent industrial study was conducted which highlighted that the City of Vancouver was the most improved municipality in terms of receiving building permits and also noted that the City of Surrey and City of Burnaby were making significant strides in reducing and simplifying permit processing for industrial projects. The premise of the 2019 industrial study compared the cost of developing a 100,000 square foot concrete distribution warehouse with a 15,000 square foot office component. It is assumed that every hypothetical project would require DCC and DCL payment along with a rezoning and development permit.

It should be noted that municipal fees to develop a "standard" industrial building across almost every Metro Vancouver municipality increased since the previous study was completed in 2017 with decreases in fees being reported in the City of New Westminster, City of Delta, and the Township of Langley. In regard to regional fees for sewer & drainage, fees have remained consistent between 2017 and 2019. Consistency in municipal fees is beneficial to the development community, not only in the overall bottom line of a development's finances, but also in projecting a development pro-forma for future development projects. The greater the consistency in costs for a development project, the less risky a project.

Further, when examining the timeline for an industrial project to be approved, the majority of municipalities in Metro Vancouver took the same amount of time or longer than previously reported in 2017 with the City of Maple Ridge, the City of Delta, and the City of North Vancouver being exceptions to this. Significant increases in approval timelines were observed in the City of Port Coquitlam, City of Burnaby, and City of Surrey where timelines increased by 100%, 100%, 133% and 203% respectively. Long approval timelines are unfavorable to development projects as it lengthens the amount of time before a project can come to market. Further, long timelines increase the carrying cost associated with holding the land. In general, mitigating and minimizing approval process time, costs, and risks is favorable for development, particularly higher risk developments such as multi-storey industrial projects.

Table 7 NAIOP COBS Municipal Fees (2019)

2017 Rank	2019 Rank	Municipality	Rezoning & Subdivision Application Fees	Development Permit & Building Permit Fees	Administration, Processing & Sprinkler Inspection Fees	DCC/DCL Fee	Sewer & Water Connection Fees	Regional Sewer & Drainage Fees	Taxes	2019 Total	2017-2019 % Change
2	1	Burnaby	$28,596	$206,772	$2,047	n/a	$47,123	$267,000	$154,844	$237,415	6.6%
7	2	New West	$11,607	$149,294	$31,987	$125,461	N/A	$307,050	$245,973	$318,349	-15.0%
3	3	Port Moody	$29,274	$159,909	$32,281	$117,000	N/A	$307,050	$203,253	$338,464	14.7%
1	5	Maple Ridge	$8,012	$97,280	$30,861	$212,091	$31,000	$267,000	$134,051	$348,243	110.9%
9	6	Delta	$4,777	$112,297	$31,644	$228,003	$82,000	$267,000	$178,191	$376,721	-25%
8	8	Langley	$9,528	$1 7,629	$35,011	$303,330	$31,000	$267,000	$104,562	$347,869	-27.5%
11	10	Port Coquitlam	$14,077	$123,535	$29,537	$359,598	$28,000	$267,000	$154,844	$526,747	0.4%
15	11	North Van	$5,700	$125,506	$47,336	$359,523	$50,000	$120,000	$130,947	$538,065	0.5%
14	12	Langley Township	$20,668	$82,505	$35,227	$445,423	N/A	$267,000	$118,731	$583,823	0.8%
16	13	City of Surrey	$9,531	$140,816	$39,052	$459,035	$21,309	$267,000	$69,417	$648,434	-7.0%
12	14	City of Coquitlam	$9,886	$144,585	$33,246	$516,098	N/A	$307,050	$120,579	$703,814	31.9%
17	15	City of Vancouver	$91,378	$117,306	$3,334	$825,000	$72,385	$93,000	$64,067	$1,037,018	33.0%
13	16	District of NV	$10,425	$187,997	$35,513	$964,155	$66,577	$120,000	$106,413	$1,198,089	78.1%
18	17	City of Richmond	$3,243	$139,489	$30,000	$1,158,000	$26,500	$105,000	$75,453	$1,330,732	28.6%

*Note the exclusion of municipalities in the Fraser Valley

Table 8 NAIOP Municipal Timing Review (2019)

2019 Rank	Municipality	Pre-Application Design Review	Rezoning Process (days)	Development Permit Process (days)	Subdivision Approval (Days)	Building Permit (Days)	2019 Approval Timing (Days)	2017 Approval Timing (Days)	Percentage Change
1	Richmond	43895	60-120	Concurrent	Concurrent	Concurrent	120	120	0%
2	Langley Township	30	60-120	Concurrent	Concurrent	Concurrent	120	120	0%
4	City of Langley	N/A	60-123	Concurrent	Concurrent	<60	180	180	0%
5	Maple Ridge	N/A	60-124	Concurrent	Concurrent	Concurrent	120	180	0%
6	New Westminster	<42	120-180	Concurrent	Concurrent	Concurrent	180	180	0%
7	Delta	Request	120-180	Concurrent	Concurrent	<60	240	360	-33%
8	North Vancouver	14-21	180-240	Concurrent	Concurrent	<60	300	360	-17%
10	Port Coquitlam	N/A	120-180	Concurrent	Concurrent	120-180	360	180	100%
11	City of Coquitlam	56-84	180-240	Concurrent	Concurrent	60-120	360	425	-15%
12	District of NV	150	120-180	Concurrent	Concurrent	120-180	360	360	0%
14	City of Vancouver	Varies	240-365	Concurrent	Concurrent	Concurrent	365	365	0%
15	City of Burnaby	N/A	120-1280	Concurrent	Concurrent	180-240	420	180	133%
16	Port Moody	60-90	240-365	Concurrent	Concurrent	60-120	485	365	33%
17	City of Surrey	0	240-365	Concurrent	Concurrent	120-180	545	180	203%

5. Case Studies

5.1 Overview

As outlined on the following pages, Colliers has reviewed examples of multi-storey developments with industrial components that are either recently constructed, currently under construction, or proposed. This analysis primarily focuses on projects within Metro Vancouver to identify development trends, successes, challenges, and lessons learned. An additional five case studies within the United States were also reviewed to provide an understanding of industrial development trends occurring throughout North America. The following projects were examined as part of this analysis:

1.	Riverbend 5, Oxford Properties | Big Bend, City of Burnaby *(under construction)*	FORMAT A
2.	3733 192 Street, Eagle Builders | City of Surrey *(proposed)*	FORMAT A
3.	Riverworks, Conwest | Marine Drive, City of Vancouver *(proposed)*	FORMAT B
4.	IntraUrban Evolution, PC Urban | Clarke, City of Vancouver *(under construction)*	FORMAT B
5.	Archetype, Hungerford Properties | Mount Pleasant, City of Vancouver *(proposed)*	FORMAT C
6.	The Yukon, Chard Developments | Mount Pleasant, City of Vancouver *(under construction)*	FORMAT B
7.	The Manitoba, Wesbild | Marine Drive, City of Vancouver *(proposed)*	FORMAT B
8.	The Gateway, PortLiving | Powell Street, City of Vancouver *(under construction)*	FORMAT B
9.	Alliance on Vanguard, Alliance Partners | Cambie, City of Richmond *(pre-construction)*	FORMAT B
10.	Georgetown, Prologis | Crossroads, City of Seattle *(completed)*	FORMAT A
11.	Track Six, Avenue 55 | SODO Business Park, City of Seattle *(proposed)*	FORMAT B
12.	2505 Bruckner Boulevard, Innovo Property Group | The Bronx, New York City *(proposed)*	FORMAT A
13.	Terminal Logistics Centre, Triangle Equities | Queens, New York City *(proposed)*	FORMAT A
14.	Sunset Industrial Park, Dov Hertz | Brooklyn, New York City *(proposed)*	FORMAT A

Generally, the case studies indicate that the most common form of multi-level, mixed-use industrial development within Metro Vancouver is light industrial at grade with office space above. While there are a few examples with above ground light industrial floorspace, they are currently under development and have not attracted as much interest as ground floor units. Large-format, multi-level developments are just becoming viable, however only within areas of Metro Vancouver north of the Fraser River on land that was purchased more than a few years ago due to the rapid recent increase of industrial land values or in areas that allow for high value accessory uses such as Mount Pleasant. The challenge with this form of development is the costs associated with building ramp access to the second floor, along with the lack of suitably sized lots in locations that would support such development. Within the Fraser Valley, it appears that the market is not there yet when it comes to multi-level industrial development, however larger sites with favourable geotechnical conditions such as Campbell Heights are beginning to experience modest intensification in the form of rooftop parking. These market dynamics are examined further in *Section 6. Financial Analysis.*

5.2 Riverbend 5, Oxford Properties | Big Bend, City of Burnaby

Oxford Properties' Riverbend 5 is the first large-format, multi-level industrial development to be built in Canada that includes ramp access to second floor units suitable for full-sized trucks.

Summary

Riverbend 5 is the first multi-storey industrial development within Metro Vancouver designed to suit large-scale tenants that desire a dense trade area such as last-mile fulfillment centres. The project is currently under construction, featuring a 437,239 sf ground floor and 269,817 sf second floor accessible to full size trucks via a heated ramp. Each floor can be further demised to accommodate multiple tenants as small as 70,000 sf.

Building Statistics	
Tenure	Lease
Address	8225 Wiggins Street
Completion Date	2022
User Types	Large-format industrial
Total SF	707,056 sf
Floor Breakdown	1st Floor: 437,239 sf 2nd Floor: 269,817 sf (62%)
Site Size	~20 ac
Site Coverage	~50%
Clear Height	1st Floor: 32 ft 2nd Floor: 28 ft
Total Height	60 ft
Loading	Heated ramp to 2nd floor
Onsite Parking	739 stalls
Zoning	CD – M2 & M5
Max FAR/Height	40 ft / 60% coverage
Achieved FAR	0.8

Lessons Learned

The development planning of this project included numerous challenges, beginning with the poor soil quality of the site. This resulted in significantly higher construction costs to create a stable foundation. In conjunction with additional costs regarding the required structural features to support the loading requirements of the second floor, it was estimated that total construction costs exceeded 2.5x on a per square foot basis than that of a traditional single-storey industrial development on a site with suitable soil quality. Additional challenges were related to the municipal regulations of this development format. The developer initially proposed the

inclusion of a third floor, which would have required a rezoning, however the City of Burnaby did not support the additional height and design of the ramp. As a result, the third floor was not included, resulting in less leasable floor area than desired. Due to the size of the ramp required to accommodate large-format trucks, along with the 2nd floor parking and loading requirements, the total footprint of the second floor is approximately 62% of the first floor. The forecasted financial return from this development is expected to only barely exceed the costs associated with its construction. This is largely because the land was purchased years ago at approximately 40% of its current market value, and the market demand, lack of supply, and population density north of the Fraser River justify expected achievable lease rates exceeding $20/sf.

The riverside trails adjacent to Riverbend 5 are being marketed as some of the health and wellness amenities of the site.

5.3 3733 192 Street, Eagle Builders | Campbell Heights, City of Surrey

Eagle Builders' upcoming development at 3733 192 Street will be the first large-format project in Campbell Heights to include rooftop parking as an effort to create more leasable floor area than a traditional development.

Summary

3733 192 Street is an upcoming development located within Campbell Heights in the City of Surrey, featuring a 60% site coverage facilitated by the inclusion of 193 rooftop parking stalls for light employee vehicles (not truck access). This is a single-storey, 403,409 sf development, with the inclusion of rooftop parking being the first of its kind within Surrey.

Building Statistics	
Tenure	Lease
Address	3733 192 Street, Surrey
Completion Date	n/a
User Types	Large-scale industrial
Total SF	403,409 sf
Floor Breakdown	Single floor with rooftop parking
Site Size	15.3 ac
Site Coverage	60% (60% max)
Loading	59 grade level doors
Onsite Parking	369 stalls including 193 on the rooftop for personal vehicles
Zoning	CD
Max FAR/Height	1.0 / 45 ft
Achieved FAR	0.6

Lessons Learned

While the costs of constructing developments such as this with rooftop parking are slightly higher than traditional developments with surface parking, they are less costly to build than projects with a full second floor of floorspace with ramp access. As such, the upcoming development of this project likely indicates that the industrial market metrics such as achievable lease rates and large-format tenant demand can support a modest amount of intensification, however that Campbell Heights is not there yet in regards to the support for a second floor of such development. This is likely due to the relatively lower density levels in the surrounding region and distance to the City of Vancouver in comparison to Oxford Properties' Riverbend 5.

5.4 Riverworks, Conwest | Marine Drive, City of Vancouver

Riverworks is one of a handful of new multi-storey, mixed-use light industrial developments occurring in the Marine Drive industrial area of South Vancouver, indicating the market viability for this development format in this region of the City.

Summary

Conwest Developments recently submitted a development application for a mixed-use light industrial project on a vacant site east of TransLink's bus depot in South Vancouver (Marine Drive). This 80,000 sf project is proposed to include two buildings. The first building will be three-storeys, with double-height ground floor light industrial space and two floors of above ground office. The second building will include two-storeys of light industrial space. Ground floor truck access will be provided via a central mews, and above ground access will be provided via freight elevators.

Building Statistics	
Tenure	Strata
Address	1550 West 75th Avenue
Completion Date	n/a
User Types	Light Industrial / Office
Total SF	80,000 sf
Floor Breakdown	Building 1: 3 Floors Building 2: 2 Floors
Site Size	2.8 ac
Loading	Central mews for ground floor access with freight elevator to upper floors
Onsite Parking	Underground
Zoning	M-2
Max FAR/Height	1.0 / 100 ft
Achieved FAR	0.65

Lessons Learned

Multi-storey developments catering to light-industrial users are becoming more popular in industrial regions within Vancouver with strong vehicular and rapid transit access. The Marine Drive industrial area in Southern Vancouver has been demonstrated as one of the next regions of the City likely to experience an influx of vertical supply. Smaller scale projects such as this on sites smaller than 5 acres generally are only able to accommodate freight elevator loading as the lot size requirement for providing ramp access is closer to 10 acres.

5.5 IntraUrban Evolution, PC Urban | Clarke, City of Vancouver

IntraUrban Evolution is one of the first multi-storey industrial developments to include a 2nd floor of light industrial floorspace with loading access provided by freight elevators.

Summary

IntraUrban Evolution is one of the first multi-storey, light industrial projects within the City of Vancouver to include 2 floors of industrial floorspace in comparison to the single floor seen in most of these buildings. This 102,600 sf project will include 12-18 ft ceilings, extensive glazing providing a variety of views, and common rooftop patio amenities. Ground floor access will be provided via 3 oversized dock doors, with second floor access provided via 2 freight elevators.

Lessons Learned

While this project has attracted significant tenant interest due to its convenient location close to transit and Downtown Vancouver, the biggest challenge has been the demand for second floor industrial space without direct loading access. Due to a single shared loading area, there has been a common perception that the 2nd floor units would result in inefficiencies. This perception has been hard to change as there

Building Statistics	
Tenure	Strata
Address	1055 Vernon Drive
Completion Date	2021
User Types	Light industrial and office
Tenants	No. 1 Collision Centre
Total SF	102,600 sf
Floor Breakdown	1st Floor: Light Industrial 2nd Floor: Light Industrial 3rd Floor: Flex/Office 4th Floor: Office
Site Size	0.8 ac
Site Coverage	85%
Clear Height	18 ft ground floor down to 12 ft for 4th floor office space
Total Height	42 ft 6 in
Loading	2 freight elevators and 3 ground level oversized dock doors
Onsite Parking	60 stalls
Zoning	I-2
Max FAR/Height	3.0 / 100 ft
Achieved FAR	2.9

currently are not any comparable 2nd floor units in the City to serve as case studies demonstrating that 2nd floor access via freight elevator can be as efficient as direct ground floor access. The asking strata rates for the 2nd floor units are only a slight discount from ground floor units, and potential tenants have expressed no concern with price, but rather the inefficiencies of second floor access. Additionally, based on the lack of demand for the 2nd floor units, and the requirement of their inclusion due to the I-2 zoning, the ratio of required presales (40-50%) to get the project off the ground in the first place was challenging. Developers have indicated that the inclusion of more office space, for example with the upcoming amendment permitting 6.0. FSR in Mount Pleasant, is an effective way to bypass this initial hurdle.

While the ground floor of IntraUrban Evolution generated significant interest and was quickly purchased by No. 1 Collision Centre, the 2nd floor light industrial units have generated less demand due to the perceived inefficiencies of freight elevator loading.

5.6 Archetype, Hungerford Properties | Mount Pleasant, City of Vancouver

Archetype is the first mixed-use project in Vancouver to include strata commercial/industrial space with rental residential.

Summary

Archetype is an upcoming mixed-use development that will include rental residential units in addition to ground floor flex industrial floorspace, ground floor retail, and above ground office space. This is the first project in Vancouver to combine strata commercial, strata industrial, and rental residential.

Building Statistics	
Tenure	Strata / Rental Residential
Address	220 East 1st Avenue
Completion Date	2022
User Types	Industrial / Office / Residential
Tenants	Targeted for creative designers and manufacturers
Total SF	274,300 sf
Floor Breakdown	32,000 sf strata flex industrial 67,000 sf strata office space 200 units rental residential Ground floor retail
Site Size	1.0 acre
Loading	Ground level dock access
Zoning	FC-2
Max FAR/Height	7.0 / 75 feet
Achieved FAR	6.5 (1.0 Ind / 2.0 Off / 3.5 Res)

Lessons Learned

This success of the development program was based on the size of the site and the commercial components that subsidized the development of rental residential. Due to the strong transit-oriented location, this development was attracting interest for office strata rates exceeding $1,000/sf prior to COVID-19. The goal of the development is to fulfill two major needs within the City of Vancouver, the creation of more light industrial supply along with new rental residential supply. To avoid interface issues between the industrial/office and residential uses, two buildings are being constructed. The first building will have retail at grade with residential above, and the second building will have light industrial at grade with office space above.

5.7 The Yukon, Chard Developments | Mount Pleasant, City of Vancouver

The Yukon represents the most common format of mixed-use industrial/office development occurring within Mount Pleasant, yet demonstrates the challenges associated with minimum parking requirements in transit-oriented locations.

Summary

The Yukon is a 45,000 square foot, 4-floor strata light industrial and office development currently being constructed in Mount Pleasant. This development includes a single floor of light industrial and three floors of office above, the most common format occurring in this part of Vancouver.

Building Statistics	
Tenure	Strata
Address	2238 Yukon Street
Completion Date	2021
User Types	Light Industrial / Office
Tenants	n/a
Total SF	45,124 sf
Floor Breakdown	1st Floor: Light Industrial 2nd – 4th Floors: Office
Site Size	0.4 ac
Clear Height	1st Floor: 17 ft 2nd–4th Floors: 11 ft
Loading	1 freight elevator and 3 ground floor dock doors
Onsite Parking	83
Zoning	I-1
Max FAR/Height	3.0 / 110 ft
Achieved FAR	3.0

Lessons Learned

This project further demonstrates the strong demand for strata office and light industrial units within the City of Vancouver as it is over 90% sold out. However, its transit-oriented location resulted in less parking demand than anticipated/required by current zoning bylaws. Brokers active in the area have indicated that although the development is nearly sold out, there is still a full floor of parking that tenants do not need for either employees or visitors. This indicates the importance of reviewing parking standards within close proximity to rapid transit, as the inclusion of surplus parking adds significant additional construction costs.

5.8 The Manitoba, Wesbild | Marine Drive, City of Vancouver

Manitoba will follow in the footsteps of PC Urban's IntraUrban Evolution by introducing multiple floors of above ground light industrial floorspace with loading access provided by numerous freight elevators.

Summary

The Manitoba will be one of few multi-storey developments in Vancouver to include above ground industrial floorspace with loading provided by numerous freight elevators. This 340,000 sf project will include 230,000 sf of light industrial floorspace within its first 4 floors, and office space on the 5th and 6th floors. Ground floor access will be provided through a central loading spine.

Building Statistics	
Tenure	Strata
Address	8188 Manitoba Street
Completion Date	n/a
User Types	1st – 4th Floors: Light Industrial 5th–6th Floors: Office
Total SF	340,000 sf
Floor Breakdown	230,000 sf light ind. (1st – 4 floors) 110,000 sf office (5th – 6th floors)
Site Size	2.5 acres
Loading	Loading spine providing ground floor dock access with freight elevators for upper loading.
Onsite Parking	439 (359 underground)
Zoning	I-2
Max FAR/Height	3.0 / 100 ft
Achieved FAR	3.0

Lessons Learned

This project is aiming to attract tenant interest for the above ground light industrial units based on the momentum generated by similar projects that will be completed and tenanted earlier, along with its location close to rapid transit and provision of numerous amenities including a running track on the roof, dog daycare, end of trip facilities, and covered patio space. The completion of projects such as this with multiple levels of light industrial floorspace will serve as effective case studies regarding the tenant types most likely to occupy above ground units, along with the efficiencies of freight elevator loading in comparison to direct truck loading.

5.9 The Gateway, PortLiving | Powell Street, City of Vancouver

The Gateway will be a unique development due to the inclusion of 3 floors of self storage units that will be retained and operated by PortLiving, along with a top floor of production space rather than office space.

Summary

The Gateway is a 110,000 sf mixed-use project currently under construction. It will include ground floor strata light industrial floorspace with direct truck loading access, and its top level is being marketed as production space. Its 2nd – 5th floors will be retained and operated by PortLiving as self-storage units.

Building Statistics	
Tenure	Strata
Address	3333 Bridgeway Street
Completion Date	2021
User Types	Industrial / Office / Production
Tenants	Self-storage, creative industry
Total SF	110,000 sf
Floor Breakdown	1st Floor: Light Industrial 2nd–5th Floor: Self Storage 6th Floor: Production Space
Site Size	0.8 ac
Clear Height	10 ft to 13 ft ceiling heights
Loading	Ground floor dock loading with freight elevators
Onsite Parking	49 parking stalls
Zoning	I-2
Max FAR/Height	3.0 / 100 ft
Achieved FAR	3.0

Lessons Learned

The expected programming of this development is relatively unique when it comes to multi-storey, mixed-use light industrial developments within Metro Vancouver. Rather than selling off the entire building, PortLiving is retaining the 2nd – 5th floors for self-storage units, indicating the continued demand for such uses relatively close to major centres of population. While the detailed design of the storage facilities is unavailable, it is reasonable to assume they could potentially be converted for other uses in the future. Additionally, the 6th floor units are being marketed as production space, targeting the film industry, artists, and other creative industries. Amenities such as end-of-trip facilities and rooftop patio space with scenic views are expected to appeal to the target tenant types.

5.10 Alliance on Vanguard, Alliance Partners | Cambie, City of Richmond

Alliance on Vanguard will become the first multi-level light industrial development within the City of Richmond.

Summary

Alliance on Vanguard is the first multi-storey, light industrial development to occur within the City of Richmond, conveniently located adjacent to Highway 99. This 2-storey development will feature units ranging from 1,966 sf to 6,045 sf, with 22 ft ceiling heights. Ground floor access will be provided via a central loading mews, and above ground access will be provided by 6 freight elevators.

Building Statistics	
Tenure	Strata
Address	4899 Vanguard Road
Completion Date	2022
User Types	Light Industrial
Total SF	200,000 sf
Floor Breakdown	2-floors of light industrial units ranging from 1,966 to 6,045 sf
Site Size	4.8 ac
Clear Height	22 ft ceiling heights
Total Height	56 ft
Loading	Ground floor dock access with 6 freight elevators
Onsite Parking	240 parking stalls
Zoning	IR1
Max FAR/Height	1.0 / 40 ft / 60% coverage
Achieved FAR	1.0

Lessons Learned

This development has drawn a notable amount of initial market interest as it is already over 60% sold out, although 75% of purchasers have been international investors. The tenant demand for such as development format within Richmond, particularly for the 2nd floor units, will therefore become clearer once the building is completed and occupied. The City of Richmond's flexibility regarding permitted uses and municipal constraints regarding intensified industrial development were some of the factors leading to the feasibility of this project.

5.11 Georgetown, Prologis | Crossroads, City of Seattle

Prologis' Georgetown development in the City of Seattle was North America's first modern multi-storey industrial development.

Summary

Prologis' Georgetown development in the City of Seattle was North America's first modern multi-storey industrial development. The building features truck ramps which lead to loading docks on the second level, significantly increasing the warehousing capacity of the project as goods can be directly loaded into trucks on multiple floors. Tenants are Amazon and Home Depot, who occupy the entire facility and take advantage of the close proximity to the Seattle market.

Building Statistics	
Tenure	Lease
Address	6050 East Marginal Way
Completion Date	Q4 2018
User Types	Level 1 and 2: Fulfillment, Level 3: Maker's Space
Tenants	Amazon, Home Depot
Total SF	590,000 sf
Floor Breakdown	Level 1: 239,029 sf
Site Size	596,772 sf
Site Coverage	40%
Clear Height	28', 24', 16'
Total Height	68' total clear
Loading	Level 1: 66 dock high doors and 4 drive in doors, Level 2: 38 dock doors and 2 drive in doors
Onsite Parking	635 Stalls
Zoning	IG2/U85
Max FAR	2.5 FAR
Achieved FAR	1.0 FAR

Lessons Learned

From a construction logistics and cost perspective, building a multi-storey warehouse is more difficult than a single-storey traditional warehouse. High land values in the urban Seattle market justified the higher construction costs associated with this development. Only sites that are well located in regions that can demand sufficient rents or strata rates to justify elevated construction costs can accommodate additional floors. These costly projects are still only achievable in a limited number of North American markets.

Employee parking is provided via a 4-floor structured parkade. The entire site includes a total of 635 parking stalls.

The construction of a ramp suited to accommodate large North American sized trucks added significant costs to the development.

5.12 Track Six, Avenue 55 | Sodo Business Park, City of Seattle

Avenue 55 resembles a similar multi-level light industrial development format that is currently trending in Metro Vancouver.

Summary

Track Six will be a 4-storey light industrial building located in the middle of Seattle's SODO neighbourhood. The multi-storey facility will accommodate light industrial users targeting industrial flex companies with warehousing or distribution needs. Floors 2-4 will be serviced by forklift rated freight elevators with dock loading at grade.

Lessons Learned

While the project is for industrial users, the limited ceiling heights on the second to fourth floors may limit the type of tenants interested in the space. Larger scale distribution and logistics users may find the urban location suitable, however, space constraints and lack of loading ability from upper floors will be restrictive. The well-lit modern facility is anticipated to be attractive to creative industries.

Building Statistics	
Tenure	Lease
Address	3847 1st Ave S
Completion Date	Q4 2022
User Types	Light industrial and office.
Tenants	N/A
Total SF	212,516
Floor Breakdown	Floor 1: 51,975 sf, Floor 2: 54,601 sf, Floor 3: 54,601 sf, Floor 4: 54,000 sf
Site Size	104,401 sf
Site Coverage	49.78%
Clear Height	Floor 1: 24', Floor 2 and 3: 16', Floor 4: 14'
Total Height	4-storey (83 feet)
Loading	5 surface loading berths.
Onsite Parking	109 stalls.
Zoning	IG1-U/85
Max FAR	2.5 FAR
Achieved FAR	2.06 FAR

5.13 2505 Bruckner Blvd, Innovo Property Group | The Bronx, New York

2505 Bruckner Boulevard will feature 2 levels of large-format industrial space with direct 2nd floor truck access through a ramp.

Summary

2505 Bruckner Boulevard will be a multi-storey urban logistics facility that will give tenants access to over 9.4 million people in a 15-mile radius. The facility has high ceilings that can accommodate modern vertical racking systems up to 32 feet in height. From a location perspective, the development is at the apex of 3 major highways linking the site to customers in the tri-state area. It is speculated that Amazon is seeking to acquire the entirety of the project for a large last-mile logistics facility. Sufficient parking is provided to accommodate employees along with fleet parking and electric vehicle charging.

Lessons Learned

The high land values and proximity to end consumers justify the high construction costs associated with the large and modern multi-storey development. A large logistics tenant will capitalize on the advantageous location and proximity to consumers.

Building Statistics	
Tenure	Lease
Address	2505 Bruckner Boulevard
Completion Date	Q1 2022
User Types	Logistics and Distribution
Tenants	Amazon speculated
Total SF	968,000 SF (including parking and vehicle storage)
Floor Breakdown	Level 1: 238,000 SF, Level 2: 285,000 SF
Site Size	871,200 SF
Site Coverage	Approx. 34%
Clear Height	Level 1: 32', Level 2: 28'
Total Height	60'
Loading	Level 1: 74 dock doors and 2 drive-in doors. Level 2: 37 dock doors and 2 drive-in doors.
Onsite Parking	133 stalls for trailers and trucks and 664 vehicle stalls.
Zoning	C8-1
Max FAR	1.0 FAR
Achieved FAR	0.95 including parking structure

The site is strategically located within an extremely dense trade area providing a population of 9.4 million within 15 miles.

Truck loading on the second floor ensures the efficiencies associated with ground level access.

5.14 Terminal Logistics Centre, Triangle Equities | Queens, New York

The Terminal Logistics Centre adds office space on top of 2 large-format industrial floors with direct ramp access.

Summary

The Terminal Logistics Centre will become the first vertical Air Cargo development on the Eastern Seaboard and will provide tenants with Class-A industrial space. The primary tenant(s) will be the air cargo industry from the JFK Airport market. The building is designed to allow tractor trailer access to both the first and second floors through an external ramp system. The site's proximity to the JFK Airport along with key markets in Queens, Brooklyn and Greater New York City mean this project will be a key multi-modal centre for logistics, distribution, and air support operations.

Building Statistics	
Tenure	Lease
Address	130-02 S Conduit Ave
Completion Date	Q1 2022
User Types	Logistics
Tenants	To be determined.
Total SF	Approx. 242,000
Floor Breakdown	Lower Level: 50,000 SF Level 1: 57,000 SF, Level 2: 75,000 SF, Level 3: 60,000 SF
Site Size	130,680 SF
Site Coverage	Approx. 43%
Clear Height	Level 1, 2 and 3: 26'
Total Height	Approx. 78'
Loading	Level 1: 13 docks, Level 2: 13 docks, Level 3: 2 docks
Onsite Parking	100 vehicle stalls
Zoning	M1-2
Max FAR	2.0 FAR
Achieved FAR	Approx. 1.85 FAR

Lessons Learned

Similar to other multi-storey developments in North America, high land values and proximity to key transportation infrastructure and consumers justify the higher cost associated with building additional storeys of industrial floor area. High ceilings allow for modern racking storage systems, generally seen as a requirement in modern logistics facilities.

5.15 Sunset Industrial Park, Dov Hertz | Brooklyn, New York

The four-floor Sunset Industrial Park will be the largest multi-storey, large-format industrial development in North America.

Summary

The Sunset Industrial Park will be the largest multi-storey industrial development in North America. Built on an 18-acre site which was acquired for $225 million, its proximity to end users and a large workforce justify the high costs associated with the project. An intricate ramp system will allow each of the floors to be cross-docked and directly serviceable by full size tractor trailers. In addition, high ceiling heights can accommodate tall racking systems.

Building Statistics	
Tenure	Lease
Address	50 W 21st Street
Completion Date	TBD, demolition in Q2 2020
User Types	Distribution
Tenants	To be announced
Total SF	1,300,000 SF
Floor Breakdown	N/A
Site Size	784,040 SF
Site Coverage	Approx. 25%
Clear Height	Level 1-2: 32', Level 3-4: 28'
Total Height	120'
Loading	Ramps to each floor for full size tractor trailers.
Onsite Parking	TBD
Zoning	M3-1
Max FAR	Max 2.0 FAR
Achieved FAR	Approx. 1.66 FAR

Lessons Learned

Bridge Development Partners and DH Property Holdings identified high earning millennials and the continued desire for last-mile/just-in-time deliveries as the target market for the Sunset Industrial Park which will focus primarily on logistics. Potential clients identified have been typical large e-commerce companies such as Amazon along with logistics companies. Floors can be demised into 30 to 40,000 square foot spaces which can handle smaller users if required. Upon completion, Bridge Development Partners anticipate rents to be in the mid-$30s per square foot.

6. Financial Analysis

6.1 Introduction

In order to understand how the market dynamics examined in this report impact the feasibility of multi-storey industrial development, Colliers assessed the preliminary feasibility of the hypothetical scenarios outlined below:

- Baseline Scenario: Single-floor industrial development with surface parking (10-acre site)
- Scenario 1a: Single-floor industrial development with rooftop parking (10-acre site)
- Scenario 1b: Two-floor industrial development with ramp access (10-acre site)
- Scenario 1c: Three-floor industrial development with ramp access/freight elevator (10-acre site)
- Scenario 2a: Vertical development at 3 FAR, including 2 FAR industrial, 1 FAR office (0.7-acre site)
- Scenario 2b: Vertical development at 6 FAR, including 2 FAR industrial, 4 FAR office (0.7-acre site)

6.2 Hypothetical Building Location and Form

Table 9 Hypothetical Building Location and Form

	Baseline Scenario	Scenario 1a	Scenario 1b FORMAT A	Scenario 1c FORMAT A	Scenario 2a FORMAT B	Scenario 2b FORMAT B
Location	South Vancouver/ South Burnaby	South Vancouver/ South Burnaby	South Vancouver/ South Burnaby	South Vancouver/ South Burnaby	South Vancouver (not Mount Pleasant) /South Burnaby	South Vancouver (not Mount Pleasant) /South Burnaby
Building Form	Single floor with surface parking	Single floor with rooftop parking	2 floors, with ramp access/freight elevator to second floor	3 floors, with ramp access/freight elevator to second and third floor	Vertical industrial development with 3 FAR (2 FAR industrial, 1 FAR office)	Vertical industrial development with 6 FAR (2 FAR industrial, 4 FAR office)
Land Area	10-Acre	10-Acre	10-Acre	10-Acre	0.7-Acre	0.7-Acre
Coverage Ratio	50%	60%	50%	50%	95%	95%
FAR	0.50	0.60	1.00	1.50	3.00	6.00
Total GFA	217,801 sf	261,361 sf	435,602 sf	653,403 sf	91,476 sf	182,953 sf
Industrial Area	217,801 sf	261,361 sf	435,602 sf	653,403 sf	60,984 sf	60,984 sf
Office Area	0 sf	0 sf	0 sf	0 sf	30,492 sf	121,968 sf

Key Locational Considerations

The locational characteristics outlined in the previous sections of this report impact the viability of multi-level industrial development. For the purposes of this analysis, it is assumed that the hypothetical sites for the proposed development scenarios are close to dense populations and accessible by multiple forms of transit.

Based on market research and discussions with developers and other stakeholders in the area, it is commonly believed that such development would be viable in cities such as Vancouver and Burnaby, but that the market is still a number of years away from supporting these development formats further out in municipalities such as Surrey and Langley.

Lot Size and Site Coverage Ratio

The assumptions listed below regarding lot size and site coverage ratios are based on hypothetical sites that are assumed to be regular shaped with no other physical encumbrances or issues (i.e., environmental, soil quality, terrain, slopes, etc.):

- Baseline Scenario / 1a / 1b/ 1c: The lot size is assumed to be 10 acres, which is the typical minimum threshold required for this format of intensive development.
- Scenario 1a: The site coverage is assumed to be 60%, as it minimizes the space required for surface parking through the introduction of rooftop, light vehicle employee parking.
- Baseline Scenario / 1b / 1c: The site coverage ratio is assumed to be 50%.
- Scenario 2a / 2b: These vertical projects are assumed to be built on 0.7-acre sites in areas of relatively high population density. The site coverage ratio for these scenarios is assumed to be 95% as they would not require the development of an exterior ramping system.

6.3 Key Assumptions

Strata Price

According to interviews with developers and brokers and an assessment of the market context in South Vancouver and South Burnaby, it is reasonable to assume the following strata prices:

Table 10 Industrial and Office Strata Price Assumptions

	Baseline Scenario	Scenario 1a	Scenario 1b	Scenario 1c	Scenario 2a	Scenario 2b
Industrial	1st Floor: $460/sf	1st Floor: $460/sf	1st Floor: $460/sf 2nd Floor: $430/sf	1st Floor: $460/sf 2nd Floor: $430/sf 3rd Floor: $420/sf	Ground Floor: $580/sf Second Floor: $560/sf	Ground Floor: $580/sf Second Floor: $560/sf
Office	n/a	n/a	n/a	n/a	Blended: $750/sf	Blended: $750/sf

While the development scenarios assume that the units will be sold as strata, if they were leasehold, the property value could be roughly determined by dividing the estimated achievable lease rates by the market cap rate. This should result in similar revenue creation when compared to strata sales.

Industrial Land Market Values

For any development site, one of the most important figures to understand is the land market value. The land market value is a fair benchmark for land pricing. If the residual land value, as explained below, is lower than the market benchmark, it is reasonable to say the proposed development scenario is not financially viable or other development levers may be required (partnerships, lower development profit, etc.).

The residual land value (RLV) is calculated by assessing the total created value, after total project costs and development profits, while excluding land values. This measure is widely used for comparisons with benchmark land values, which is based on the price per acre for medium to low-density large parcel development (referring to Scenarios 1a/1b/1c in this study) or price per buildable square foot for high-density small parcel development (referring to Scenarios 2a/2b in this study). It is also a fair financial parameter to assess how much a developer would likely pay for a site.

Based on recent transactions of industrial land in South Vancouver and South Burnaby, it is estimated that the market value for medium to low-density large industrial land is approximately $6.17 million per acre, while the market value of high-density small industrial land is approximately $170 per buildable square foot. The following sections of this Chapter compare the land residual value per acre and the benchmark land value per acre for Scenarios 1a/1b/1c and discuss the land residual value and benchmark land value for Scenarios 2a/2b on a price per buildable square foot basis.

Parking Requirements

For the purposes of this research, it is assumed 1 parking stall per 1,000 sf gross floor area for industrial and 1 parking stall per 495 SF GFA for office, per the City of Burnaby parking bylaw. Table 10 displays the parking stalls required, and the parking stalls provided in each scenario.

Table 11 Parking Stall Required and Parking Stall Provided in Each Scenario

	Baseline Scenario	Scenario 1a	Scenario 1b	Scenario 1c	Scenario 2a	Scenario 2b
Building Form	Single floor with surface parking	Single floor with rooftop parking	2 floors, with ramp access/freight elevator to second floor	3 floors, with ramp access/freight elevator to second and third floor	Vertical industrial development with 3 FAR (2 FAR industrial, 1 FAR office)	Vertical industrial development with 6 FAR (2 FAR industrial, 4 FAR office)
Required Stalls	218	261	435	653	123	307
Provided Stalls	218	261	435	622 (max achievable on site)	123	174 (max achievable on-site)

For the vertical industrial development scenarios (2a/2b), it is assumed that the building provides up to 2 level of underground parking, considering the significant additional expense to develop multiple levels of underground parking. It is assumed that the proposed parking area of each scenario could provide adequate surface parking for truck loading and maneuvering. Building setback requirements and restrictions are also considered.

Parking Stall Revenue

For Scenarios 1a/1b/1c, parking stalls are treated as limited property in the strata. The strata purchasers have parking stalls assigned but do not own them or pay for their use. Therefore, there is no revenue generated from the parking stalls. For Scenarios 2a/2b, it is assumed that 50% of parking stalls are assigned to strata purchasers and the other half are selling at $50,000 per stall. This is based on observed patterns within new developments occurring recently.

Hard and Soft Costs

Informed from interviews with developers, it is reasonable to assume hard and soft costs for the proposed hypothetical development scenarios to be as follows. The blended hard costs include the costs associated with parking, while the soft costs are represented as a percentage of hard costs.

Table 12 Assumed Hard and Soft Costs

	Baseline Scenario	Scenario 1a	Scenario 1b	Scenario 1c	Scenario 2a	Scenario 2b
Hard Costs	$125/sf	$175/sf	$225/sf	$240/sf	$300/sf	$305/sf
Architect & Consultants	4%	4%	4%	5%	5%	5%
Development Management	4%	4%	4%	5%	5%	5%
Permits and DCCs	5%	5%	5%	5%	5%	5%
Property Taxes	1.5%	1.5%	1.5%	1.5%	2%	2%
Financing Costs	4.5%	4.5%	4.5%	4.5%	5.5%	5.5%

Contingency Costs, Commission Rate, Developers Profit Rate, and Building Efficiency Rate

It is reasonable to assume that contingency costs will be approximately 6.5% of total hard and soft costs, while the commission rate is estimated to be 3% based on interviews with Colliers' brokerage team. The developers' profit rate for Scenarios 1a/1b/1c is expected to be 13% of total investment, rising to 15% for Scenarios 2a/2b due to the complexities and risk involved.

Table 13 Assumed Building Efficiency Rate

	Baseline Scenario	Scenario 1a	Scenario 1b	Scenario 1c	Scenario 2a	Scenario 2b
Building Efficiency Rate (Salable Area/Gross Floor Area)	98%	98%	95%	94%	91%	90%

6.4 Baseline Scenario | 10-acre site, single floor with surface parking

The detailed proforma used to assess the viability of the baseline development format is included in Appendix II, with the key findings and conclusions summarized below.

Summary

- The total project cost of the proposed hypothetical development is approximately $35.37 million.
- The estimated revenue after commission from a strata sale is approximately $95.24 million.
- The developer profit of this scenario is approximately $10.96 million.
- The total residual land value of the whole development is approximately $4.89 million per acre, which is lower than the market benchmark ($6.16 million per acre).
- The sensitivity study shows that when the industrial strata price increases from $460/sf to $530/sf, the residual land value of this scenario would meet the market benchmark.

Conclusion

Based on the financial analysis, the residual land value of the hypothetical baseline development scenario would be lower than the market benchmark. This is not surprising given the rapid rise in industrial land values in South Vancouver and South Burnaby, along with constrained supply. The developers of currently active construction projects of this format may have already acquired the land years ago at a lower price, making this development format feasible. For example, this proposed scenario would result in a residual land value notably higher than the market land price 3 or 4 years ago.

6.5 Scenario 1a | 10-acre site, single floor with rooftop parking

The detailed proforma used to assess the viability of Scenario 1a is included in Appendix III, with the key findings and conclusions summarized below.

Summary

- The total project cost of the proposed hypothetical development is approximately $59.42 million.
- The estimated revenue after commission from a strata sale is approximately $114.29 million.
- The developer profit of this scenario is approximately $13.15 million.
- The total residual land value of the whole development is approximately $4.17 million per acre, which is lower than the market benchmark ($6.16 million per acre).

- The sensitivity study shows that when the industrial strata price increases from $460/sf to $551/sf, the residual land value of this scenario would meet the market benchmark.

Conclusion

Based on the financial analysis, the residual land value of Scenario 1a would also be lower than the market benchmark. This follows similar logic to the findings of the baseline scenario. Due to the industrial land values within South Vancouver and South Burnaby, it is unlikely that a developer will choose to build this format, unless they have held the land for numerous years. Conversely, the comparatively lower land values in areas such as Surrey and Langley may make this form more viable, as demonstrated by the proposed developed of 3733 192 Street in Campbell Heights outlined in the case studies within this report.

6.6 Scenario 1b | 10-acre site, two-floors with ramp access

The detailed proforma used to assess the viability of Scenario 1b is included in Appendix IV, with the key findings and conclusions summarized below.

Summary

- The total project cost of the proposed hypothetical development is approximately $127.34 million.
- The estimated revenue after commission from a strata sale is approximately $178.63 million.
- The developer profit of this scenario is approximately $20.55 million.
- The total residual land value of the whole development is approximately $3.07 million per acre, which is lower than the market benchmark ($6.16 million per acre).
- The sensitivity study shows that when the blended industrial strata price reaches $532/sf, the residual land value of Scenario 1b would meet the market benchmark.

Conclusion

This analysis shows that the residual land value of Scenario 1b would be lower than the market benchmark, which is an interesting finding based on the fact that this format is currently being constructed by Oxford Properties with their Riverbend project. This is not surprising, however. Interviews with developers have indicated that this format is currently only achievable if the land was purchased approximately 3 or more years ago at a price of approximately 50% the current value. It follows that the market is almost there when it comes to this format of development, and it is likely to eventually occur again once strata/lease rates increase a little more. This is only a matter of time based on the market dynamics outlined in this report, however the biggest challenge will be finding suitable sites for such development that are relatively close to urban nodes.

6.7 Scenario 1c | 10-acre site, three floors with ramp access and freight elevators

The detailed proforma used to assess the viability of Scenario 1c is included in Appendix V, with the key findings and conclusions summarized below. For this scenario, the number of provided surface parking stalls is less than the requirement, based on the site coverage ratio of 50% and an average required space per stall of approximately 350 square feet. This scenario would require a parking variance of 31 stalls.

Summary

- The total project cost of the proposed hypothetical development is approximately $208.09 million.
- The estimated revenue after commission from a strata sale is approximately $260.15 million.
- The developer profit of this scenario is approximately $29.93 million.
- The total residual land value of the whole development is approximately $2.21 million per acre, which is the lowest value compared to Scenario 1a and 1b, representing 36% of the market benchmark price.
- The sensitivity study shows that when the blended industrial strata price reaches $512/sf, the residual land value of Scenario 1c would meet the market benchmark. Another sensitivity study was conducted to test the potential for converting the 3rd level of industrial space to office space. When the office strata price reaches $540/sf and the office space is 100% sold out, the project would be financially viable.

Conclusion

While this development format resulted in the lowest land residual when compared to Scenarios 1a and 1b, it also has the lowest threshold strata price to make it viable. As such, this format could be the most viable when comparing scenarios 1a, 1b, and 1c. If the third floor were to be used for office space rather than industrial, this format would be even more achievable, however it may be difficult to garner significant office demand on large sites suitable for such development unless they are close to transit and the amenities of urban living. One of the challenges associated with this format, if the third floor were used for industrial, is the heights associated with such a building. For example, the City of Burnaby did not support Oxford's Riverbend proposal to add a third floor due to concerns regarding the total building height.

6.8 Scenario 2a | 0.7-acre site, 2 FAR industrial and 1 FAR office

The detailed proforma used to assess the viability of Scenario 2a is included in Appendix VI, with the key findings and conclusions summarized below.

Summary

- The total project cost of the proposed hypothetical development is approximately $37.05 million.

- The estimated revenue after commission from a strata sale is approximately $53.84 million.
- The developer profit of this scenario is approximately $7.02 million.
- The total residual land value of the whole development is approximately $107 per buildable sf, which is lower than the market benchmark ($170 per buildable sf).
- The sensitivity study shows that when the blended industrial strata price and office strata price reach $646/sf and 846/sf respectively, the residual land value of Scenario 2a will meet the market benchmark.

Conclusion

While this development format is currently occurring throughout Vancouver, the financial analysis indicates a residual land value lower than the market benchmark. This could be due to factors such as the rapid growth of industrial land values, the significant costs associated with underground parking, and the fact that many developers of recent/current projects would have purchased the land a few years ago at a lower price. This pattern is likely to repeat itself. For example, if a developer were to purchase an inner urban industrial site today, they might wait a few years until the threshold strata/lease rates could be met, or even sell the land again once its value increases even more. Current rents are unable to support the proposed development scenario. When the blended industrial strata price and office strata price reach $646/sf and $846/sf respectively, the residual land value of Scenario 2a will meet the market benchmark.

6.9 Scenario 2b | 0.7-acre site, 2 FAR industrial and 4 FAR office

The detailed proforma used to assess the viability of Scenario 2b is included in Appendix VII, with the key findings and conclusions summarized below.

Summary

- The total project cost of the proposed hypothetical development is approximately $75.45 million.
- The estimated revenue after commission from a strata sale is approximately $114.43 million.
- The developer profit of this scenario is approximately $14.93 million.
- The total residual land value of the whole development is approximately $131 per buildable sf, which is lower than the market benchmark ($170 per buildable sf).
- The sensitivity study shows that when the blended industrial strata price and office strata price reach $608/sf and 808/sf respectively, the residual land value of Scenario 2b will meet the market benchmark.

Conclusion

The analysis shows that this development format would be closest to matching the market benchmark, indicating that the allowance of more office floorspace (4 FAR instead of 1 FAR) could make the introduction of more

industrial supply (2 FAR instead of 1 FAR) much more viable. It will be interesting to see the result of the recent rezoning in Mount Pleasant allowing for such a development format, which is likely to result in an influx of additional supply being built in this area over the next decade. However, one challenge associated with the allowance of more office space is the potential resulting increase of land values. For example, if land values rise too much, the split between the theoretical achievable residual land value and the market benchmark may be too high to make development viable. This is a tricky balance; however, it is expected that the allowance of up to 4 FAR of office in inner urban areas may be a suitable amount to balance the needs to the market.

Parking requirements are also important to reassess. In this hypothetical scenario, the amount of underground parking provided (174) is less than the zoning requirement (307). Any additional parking stalls would require a third level of underground parking, adding significant additional expenses to the project (~$175/sf), plus associated maintenance costs. In transit-oriented locations, current parking regulations may lead to overbuilt parking supply in densified developments such as this, and these requirements should therefore be reviewed by municipalities on a locational-specific basis with a focus on transit-oriented, mixed-employment areas.

Table 14 Financial Analysis Results Summary

Key Parameters	Baseline Scenario	Scenario 1a	Scenario 1b	Scenario 1c	Scenario 2a	Scenario 2b
Total project cost	35,371,312	59,423,805	127,336,725	208,088,213	37,050,042	75,450,445
Est. revenue after commission	95,239,094	114,286,913	178,626,118	260,153,993	53,841,295	114,430,574
Developer profit	10,956,710	13,148,052	20,549,907	29,929,220	7,022,778	14,925,727
Total residual land value	48,911,071	41,715,056	30,739,485	22,136,560	9,768,475	24,054,402
Residual price per acre	4,891,107	4,171,506	3,073,949	2,213,656	N/A	N/A
Comparables: Land value/ac	6,161,115	6,161,115	6,161,115	6,161,115	N/A	N/A
Residual price per buildable sf	N/A	N/A	N/A	N/A	107	131
Comparables: Value/buildable sf	N/A	N/A	N/A	N/A	170	170
Financial Viability	Almost viable, if the land is purchased 3-4 years ago	Almost viable, if the land is purchased 3-4 years ago	Almost viable, if the land is purchased 3-4 years ago	Not viable, unless the third floor can be converted into office space and the subject location is close to transit and urban amenities	Not Viable, unless the site was purchased many years ago or the developer waits a number of years until the threshold strata/lease rates can be met.	Not Viable, unless the site was purchased many years ago or the developer waits a number of years until the threshold strata/lease rates can be met.

7. Summary of Challenges and Recommendations

The need for industrial intensification is driven by several factors, including limited industrial land supply and strong demand, population growth and density, international trade, the growth of ecommerce, agglomeration economics, municipal regulations, automation, land values, and speculation. Intensifying industrial development can be a means of addressing the industrial land shortage in the Metro Vancouver region. This may take the form of more intensified new developments or through infill projects on existing industrial sites. Nonetheless, more efficient use of the constrained industrial land supply will continue to support a diversified Metro Vancouver economy and support continued economic growth moving forward. It is critical that municipal policies and goals align with market drivers in response to the needs of the industrial sector to encourage more efficient industrial land usage when market drivers align. The following challenges and recommendations have been summarized following extensive research of best practices, both locally and abroad, and outline supporting policies, goals, and objectives that will ensure industrial development continues to meet regional demand.

7.1 Permitted Uses

Challenge

Municipal zoning bylaws outline and stipulate the specific industrial (and other) uses that are permitted to occur in each industrially zoned parcel of land. The relatively static nature of zoning bylaws mean that emerging industrial and light industrial uses may not be able to be accommodated without a rezoning process. Ultimately, these tenants provide both jobs and goods to the local economy, and their inclusion within constrained areas of Metro Vancouver suited for intensified forms of development should be strongly encouraged at the municipal level. However, the allowance of too much additional non-industrial space, for example, could have the unintended consequence of pushing up land values, property taxes, and lease rates passed on to industrial users, reducing the amount of available space for industrial users, and destabilizing the area for industrial users.

Recommendations

- Recognize the importance of flexibility in allowing new industrial uses in industrial zones, keeping in mind the intent of higher-level policies and objectives.
- Limiting non-industrial and accessory uses in industrial zones may prevent other users from occupying industrial space and ensure the greatest supply of industrial space.
- Recognize that some accessory uses in industrial projects may support industrial activities and encourage the infill and intensification of industrial development by improving overall financial and operational viability. In addition, expanding the scope of allowable industrial or industrial supportive uses in an intensified industrial development can create land efficiencies, increase overall employment levels per square foot of

land, and support increased transit ridership. For example, the I-2 industrial zoning along 2nd Ave in Vancouver supports office development above minimum industrial floor area requirements to supplement the costs of building intensified industrial projects. Further, the newly enacted I-1C zoning allows twice the density permitted in normal I-1 zoning (from 3.0 FSR to 6.0 FSR) as long as a full 2.0 FSR is dedicated to light industrial uses and generally maintains the same use provisions as the I-1 industrial zone.

Table 15 Potential Industrial Uses to Consider Based on the City of Vancouver's New Industrial Zone Bylaw

Outright	Conditional
Manufacturing 〉 Bakery Products Manufacturing 〉 Batteries Manufacturing 〉 Clothing Manufacturing 〉 Dairy Products Manufacturing 〉 Electrical Products or Appliances Manufacturing 〉 Food or Beverage Products Manufacturing (Class B) 〉 Furniture or Fixtures Manufacturing 〉 Ice Manufacturing 〉 Information Communication Technology Manufacturing 〉 Jewellery Manufacturing 〉 Leather Products Manufacturing 〉 Miscellaneous Products Manufacturing (Class B) 〉 Paper Products Manufacturing 〉 Plastic Products Manufacturing 〉 Printing or Publishing 〉 Rubber Products Manufacturing 〉 Shoes or Boots Manufacturing 〉 Wood Products Manufacturing (Class B)	Manufacturing 〉 Brewing or Distilling. 〉 Food or Beverage Products Manufacturing (Class A) 〉 Linoleum or Coated Fabrics Manufacturing 〉 Machinery or Equipment Manufacturing 〉 Metal Products Manufacturing 〉 Miscellaneous Products Manufacturing (Class A) 〉 Motor Vehicle Parts Manufacturing 〉 Nonmetallic Mineral Products Manufacturing 〉 Rubber Manufacturing 〉 Textiles or Knit Goods Manufacturing 〉 Transportation Equipment Manufacturing 〉 Vegetable Oil Manufacturing
Transportation and Storage 〉 Cold Storage Plant 〉 Packaging Plant 〉 Storage Warehouse	Transportation and Storage 〉 Aircraft Landing Place 〉 Bulk Data Storage 〉 Taxicab or Limousine Station 〉 Truck Terminal or Courier Depot
Utility and Communication 〉 Radiocommunication Station	Utility and Communication 〉 Public utility 〉 Recycling depot
Wholesale 〉 Lumber and Building Materials Establishment. 〉 Wholesaling - Class A 〉 Wholesaling - Class B, provided that floor area does not exceed 1,000 m^2	Wholesale 〉 Wholesaling - Class B, floor areas exceeding 1,000 m^2

7.2 Density and Site Constraints

Challenge

Maximum densities prescribed in land use plans and zoning bylaws may prevent the intensification of industrial land. Maximum lot coverage guidelines may reduce achievable buildable area, and large setback requirements can further reduce the development potential of specific sites.

Recommendations

- Consider the intent of existing industrial and economic policy and remain flexible in site design allowing industrial developments to meet higher level objectives. For example, City of Surrey Staff indicated that if a proposal had an intensified development format beyond the stipulations of zoning bylaw, Staff would support the creation of a comprehensive development district to support it (assuming other policies and objectives are met).
- When adjacent industrial sites are compatible uses, reduce the required building setbacks to encourage the maximum industrial square footage achievable.
- If building setbacks, parking, loading, and other requirements can be fully satisfied while providing the maximum building site coverage of a specific lot, then there should not be an artificial cap on the amount of permissible building site coverage nor densities of industrial usage.

7.3 Height Restrictions

Challenge

Regulations such as maximum building heights have an impact on the likelihood of industrial densification, particularly for stacked industrial formats. Industrial ceiling height requirements are constantly growing due to technological advancements, reaching over 40 feet in some of the newest, most advanced warehouses. Building height regulations in industrial zones may be based on older format industrial users with lower ceiling heights, hindering the viability of a multi-storey industrial development or an intensified development with tall, advanced racking systems. In order to achieve higher ceiling clear heights in an industrial project, the overall height allowable for an industrial development must be increased as this is the factor controlled by industrial zoning bylaw.

Recommendations

- Where appropriate, particularly in areas without conflicting adjacent uses or view concerns, increase or remove maximum height limitations from zoning bylaws to allow flexibility and encourage proponents to maximize the industrial productivity of each site.
- Allowing higher building heights will allow new industrial developments to utilize technological advancements (For example, automated racking systems).
- Consider minimum height requirements for strategic industrial areas to encourage intensification of industrial sites.

7.4 Parking/Loading

Challenge

The construction costs associated with the development of an intensified industrial project, particularly for a stacked industrial building are higher than that of a traditional industrial development. Parking, particularly underground or in structured parkades, is very costly and providing parking stalls beyond what is required by industrial users unnecessarily increases overall project costs. In many municipalities, parking on industrial sites, as a result of parking requirements outlined in zoning bylaws, occupy a significant portion of the usable site area. Minimum on-site parking requirements may be oversupplying parking, particularly on industrial sites accessible by transit or where usage requirements demand less on-site presence and employment.

Recommendations

- Reducing minimum parking requirements will allow greater lot utility and disincentivize private vehicle use for commuting.
- Consider allowing for structure parking to be excluded from FAR and site coverage calculations.
- Allow for flexibility in parking requirements. Explore parking that is calculated by user demand and user requirements.
- Allow and support the parking of light employee vehicles on the roof of an industrial development to encourage greater site utilization.
- Allow and support surface storage on the roof of an industrial development to encourage greater site utilization.
- Staff at the Township of Langley note that Amazon provides shuttling services for employees to the site from transit. This is reducing the parking required, even at a large Amazon distribution centre with high levels of employment. Consider the impact shuttling services have on parking requirements.
- Consider flexibility for site drive aisles and access requirements when a proponent can demonstrate utility through other means.

- Parking regulations should be reviewed by municipalities, particularly in transit-oriented industrial/mixed employment areas, to ensure that they are not too excessive based on current and expected industrial trends.
- Minimize surface parking and encourage the design of parking areas that are adaptable for future uses and users.
- Consider that certain parking areas could be used to accommodate employees during the day and fleet vehicles overnight.
- Consider that certain portions of the lot can be used for parking and storage at certain times of the day and can also be used for loading at other times.

7.5 Building Design

Challenge

Current zoning bylaws and design guidelines may prohibit the necessary design features, such as exterior ramps and outdoor elevators, required for an intensified industrial development.

Recommendation

- Municipalities should comprehensively review the requirements and intent of design guidelines in order to remove potentially limiting elements that discourage the development of intensified industrial buildings. These may include a review of elements such as vehicle ramps, exterior walkways, outdoor elevators, excessive landscaping, screening, and other potentially outdated building design requirements.
- Consider reduced engineering requirements, particularly in the public right-of-way. For example, by allowing truck turning and other measures in the right-of-way, there could be more flexibility for the built form to accommodate a more intensified development.

7.6 Municipal Fees and Approvals

Challenge

Municipal fees and lengthy approval timelines can represent a significant portion of the cost to develop an industrial development, including the holding costs associated with complex industrial projects which add a higher level of risk for the proponent. In addition, lengthy timelines limit the supply of industrial land that is available to come to the market in any given year.

Recommendations

- Consider reducing municipal fees for new intensified industrial developments which meet higher level policy objectives regarding economic growth and job creation.
- Consider calculating the payment of municipal fees such as development cost charges on economic production space as opposed to gross square footage of an intensified industrial development.
- Municipalities should undertake a review of the municipal approvals timeline in order to identify efficiencies that can be adopted. This may include elements such as concurrent development permit and rezoning processes, a more streamlined review process, or a certified builder process.
- Municipalities consider expediting the approval process for intensified industrial projects that meet a number of municipal goals and objectives similar to the process and policies frequently adopted for the approval of affordable rental housing.
- Consider waiving Development Cost Charges (DCCs) for industrial floor area on additional storeys to financially incentivize development.
- Consider waiving Community Amenity Contributions (CACs) in the approvals process when rezoning to higher intensity industrial zones.
- Consider a transition to the Development Permit tool in industrial areas. This tool could control use and density by way of design, which would allow for the use and density to be more permissive in the zoning bylaw, which would reduce overall timelines and create a more flexible system.

7.7 Site Size Requirements

Challenge

Several private and public sector stakeholders, including developers and municipal staff, recognize that small industrial lots are not conducive to intensified industrial developments due to ramp requirements or freight elevator access, both of which have their respective issues. Multi-storey stacked formats are particularly challenging and expensive to construct where external ramps would be required to reach upper floors.

Recommendations

- Where possible, prevent and discourage the subdivision of large industrial parcels and consider requiring minimum site sizes for certain industrially zoned properties in key strategic areas.
- In greenfield industrial areas, encourage the development and retention of larger industrial parcels.
- Encourage infill industrial projects, particularly on older properties that are not utilizing significant portions of the site.

- Encourage the redevelopment and consolidation of small industrial land parcels.
- Consider the impact of industrial stratification on the parceling of small industrial sites which may result in complications when consolidating larger parcels in the future.
- Smaller industrial parcels, particularly in more valuable urban areas, may be conducive to mixed-use industrial projects in formats that mix accessory office space above with industrial at grade.

7.8 Geotechnical Considerations

Challenge

Due to the engineering requirements of intensified industrial projects, particularly those that are multi-storey, some soil is not conducive to intensified industrial projects due to costly preloading and site preparation requirements. In particular, soil conditions are particularly an issue for lands in close proximity to the Fraser River.

Recommendations

- Encourage high lot coverage on sites with poor soil conditions and stacked industrial projects on sites with suitable soil.
- Support multi-storey industrial projects where the site's topography results in the ability to provide direct truck access to upper floors without a costly ramp.

7.9 Proximity to Transportation and Employees

Challenge

Intensified industrial sites, particularly those with higher levels of employment, are most suitable in areas accessible by alternative and single occupant driving modes of transportation. Traditional industrial developments have been located away from urban areas as to not have conflicts arise from industrial uses. With modern manufacturing technology and different uses allowable on industrial sites, there is the potential for some types of industrial development to be significantly less likely to create land use conflicts and detrimental to the health and wellbeing of nearby residents.

Recommendations

- Encourage industrial intensification in areas accessible to large residential populations and in areas well serviced by alternative transportation modes.
- Support and encourage intensification of well-located industrial sites through rezoning and policy.

- Explore the creation of intensified industrial, and in particular light / mixed-use industrial, in areas close to residential land uses and transit.

7.10 Market Pressure

Challenge

Flexibility in allowing a broad range of industrial and non-industrial uses in industrial zones may place pressure on industrial sites from higher value uses. Notable non-industrial uses which outcompete traditional industrial users include office, retail, fitness facilities, martial arts studios, and recreation facilities such as badminton and go-kart tracks.

Recommendation

- Consider some select limited higher value accessory uses in some industrial zones or at select sites such as local workforce serving small scale retail, food services, and healthcare facilities that can have functional or economic links to industrial uses, industrial users, and employees. Municipalities should review the intent of industrial plans and recognize the potential value for complementary uses while recognizing that high value uses may also drive away essential uses of lower value.

7.11 Land Values

Challenge

As mentioned by both the private and public sector stakeholders, land values are a key determinant in the feasibility of an intensified industrial development, particularly for stacked multi-level formats.

Recommendations

- Municipalities should be proactive and have supportive policies in place for when land values reach the required levels for more intensified industrial projects.
- Up zoning sites and increasing the allowable uses permitted on industrial sites will increase land values. Municipalities should review their goals and objectives to ensure that the resulting increase in land value does not prohibit other industrial users or encourage land banking.
- Explore the impact of industrial strata units being sold to foreign investors for investment holding purposes. This has been identified as a matter of potential concern by a number of municipalities as the provincial foreign-buyers tax does not apply to industrial sites.

- Explore measures to ensure industrial units are being utilized for industrial uses as opposed to remaining vacant as a long-term investment hold.

7.12 Land Banking

Challenge

Several municipal staff identified large industrial land holdings by private landowners as a factor that is artificially limiting industrial development in Metro Vancouver. In some instances, holding industrial land parcels, particularly in areas of high demand, and transacting them may be more profitable than improving land with industrial developments.

Recommendations

- Presently, municipalities do not have the right to force landowners to develop their property. Municipalities should focus on "Bring-to-Market-Strategies" to encourage reinvestment, utilization, and more intensive use.
- Reduce barriers associated with development to encourage more immediate action on industrials sites.

7.13 Inefficient Uses

Challenge

Several municipal staff identified self-storage facilities as challenging to the region's industrial lands strategy. While permitted uses in many industrial zones, self-storage facilities employ few people per square foot and often occupy valuable industrial land close to transit and urban areas. Staff at the Township of Langley identified that higher value per square foot uses such as fitness facilities may be utilizing industrial land in areas well suited for industrial intensification. While these uses are permitted in the zoning bylaws of many municipalities, these high rent tenants may be preventing intensification and redevelopment of industrial sites, particularly in business parks. Staff at the City of Vancouver note that many industrial spaces, particularly ones in valuable urban areas, are utilized by high value users such as medical or advanced manufacturing tenants. The City recognizes however, that lower value industrial uses are also essential to the function of a healthy and diverse economy. Some private sector stakeholders identified restrictions in allowable uses in the zoning bylaw that prevent future industrial intensification by limiting the higher value users that are able to occupy industrial space such as the film industry or other creative light industrial tenants that blur the line between office and industrial.

Recommendations

- Municipalities should review the permitted use of new self-storage facilities, particularly on industrial sites well suited for intensification, to ensure there is a balance between suitable square footage of a valuable and required service and productive employment land close to residential areas.
- Consider the creative adaptive reuse and infill of underutilized parking facilities, particularly in urban areas for industrial uses. New uses may include innovative approaches to using underutilized space including infill self-storage, ghost kitchens, and maker spaces.
- Municipalities should review and keep up to date the allowable uses in the industrial zoning bylaws to ensure they reflect industrial trends and demand.

7.14 Summary

The table below summarizes the factors discussed in this chapter based on a low, medium, and high rating in terms of the relative degree of importance to industrial land intensification in Metro Vancouver.

Table 16 Factors Affecting Industrial Intensification in Metro Vancouver

Intensification Factor	Relative Degree of Importance		
	High	Medium	Low
Permitted Uses			
Density and Site Constraints			
Height Restrictions			
Parking/Loading			
Building Design			
Municipal Fees and Approvals			
Site Size Requirements[1]			
Geotechnical Considerations			
Proximity to Transportation and Employees			
Market Pressure			
Land Values			

[1] Intensified industrial developments, specifically Format A, require site sizes that facilitate functional, financially feasible design.

Appendices

Appendix I | Policy Review

1. City of Vancouver Industrial Intensification Policy

City of Vancouver Employment Lands and Economic Review (ELER) Part 2: Emerging Directions for Consideration Through Vancouver Plan (October 2020)

The Employment Lands and Economy Review is a major research and stakeholder engagement initiative conducted by Staff at the City of Vancouver to inform the economic foundations of the Vancouver Plan planning process. Employment land is critical to the continued economic longevity of the City of Vancouver recognizing that industrial jobs are generally higher paying and support vital sectors of a diversified and healthy economy. The following outlines the report's immediate actionable recommendations for Council pertaining to industrial space.

- ELER Priority Action #4: Intensify job space along the south side of 2nd Avenue between Yukon and Quebec Street

    - Findings demonstrate the need for municipalities like Vancouver to consider ways to encourage multi-storey industrial spaces in key locations to meet needs.
    - Stakeholder and public engagement for both the Employment Lands and Economy Review and the Broadway Plan identified Mount Pleasant as a key location for intensification of industrial and employment uses.
    - Staff is recommending that additional industrial and office capacity be enabled for a small portion of the Mount Pleasant area along the south side of 2nd Avenue between Yukon and Quebec Streets to encourage multi-storey industrial space and additional office employment.
    - A new I-1C District Schedule and an associated Mount Pleasant Employment Intensive Light Industrial Rezoning Policy and Guidelines (I-1C) will be created and brought to Council for referral to Public Hearing. This will provide the policy upon which Council may consider developer-initiated rezonings to I-1C (not a site-specific CD-1).

City of Vancouver Employment Lands and Economic Review Part 2 (ELER) Industrial Areas

Emerging ELER Directions (Section 3) for Vancouver Plan for Industrial Areas, of which Metro Vancouver is supportive of, include the following:

〉 3.1. Protect Industrial Lands for Employment Use

- City of Vancouver response: The City of Vancouver should take action to protect the remaining industrial land base and ensure the ongoing viability of industrial operations in the City for the next 30 years.
    - 3.1.1 Endorse the Metro Vancouver Regional Industrial Lands Strategy.
    - 3.1.5 Citywide, no overall net loss of industrial space.
    - 3.1.6 Support industrial goods movement and viability of logistical lands and infrastructure.

〉 3.2. Enable balanced industrial intensification.

- City of Vancouver response: The City should support actions that balance the intensification of industrial lands while considering the impact on surrounding communities and the displacement of existing businesses. The directions identified in the ELER encourage the development of multi-storey, employment intensive industrial forms that provide additional space for valuable and essential uses.
    - 3.2.1 Modernize zoning to encourage multi-storey industrial.
    - 3.2.4 Consider Broadway Plan short-term recovery action including a new I-1C district schedule and rezoning policy.
    - 3.2.5 Support employment intensification in key areas.
    - 3.2.6 Consider increasing industrial intensification in the Eastern Core

〉 3.3 Facilitate the right users in the right spaces.

- City of Vancouver response: In tandem with balanced intensification, a thoughtful approach to broadening allowable uses and modernizing zoning regulations is needed to link industrial users to the right spaces.
    - 3.3.1 Consider flexibility in industrial uses.
    - 3.3.2 Review Mount Pleasant and Burrard Slopes industrial zones.
    - 3.3.5 Review I-4 Zones.
    - 3.3.7 Seek to balance the need for self-storage with maintaining industrial spaces for other city-serving uses and employment.
    - 3.3.8 Continue to encourage Production Distribution and Repair spaces at-grade.

〉 3.4 Monitor, report and coordinate industrial change.

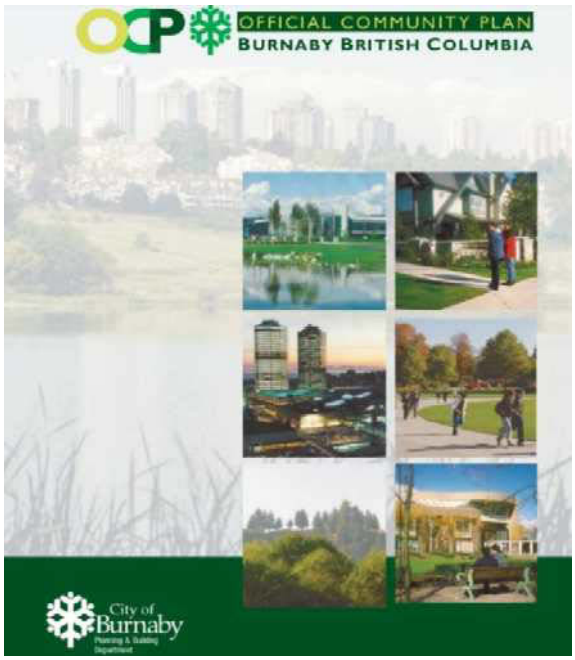
- City of Vancouver response: Staff should expand and improve coordination across departments and stakeholders to monitor the supply of industrial space in Vancouver.
    - 3.4.1 Monitor supply and market effects of increased flexibility.
    - 3.4.2 Seek to bring unused industrial spaces to market.

2. City of Burnaby Industrial Intensification Policy

The City of Burnaby's Official Community Plan was adopted by Council in 1998 and was updated and revised in 2014. The purpose of the OCP is about defining directions that guide Burnaby's development to meet its anticipated needs over the coming decades. It should be noted that Burnaby's Official Community Plan is substantially older than the OCP of most other major Metro Vancouver municipalities.

OCP Section 6: Industrial

〉 Industrial Goal: To provide for and facilitate a diverse range of development opportunities within designated industrial areas, adopting approaches that collectively:



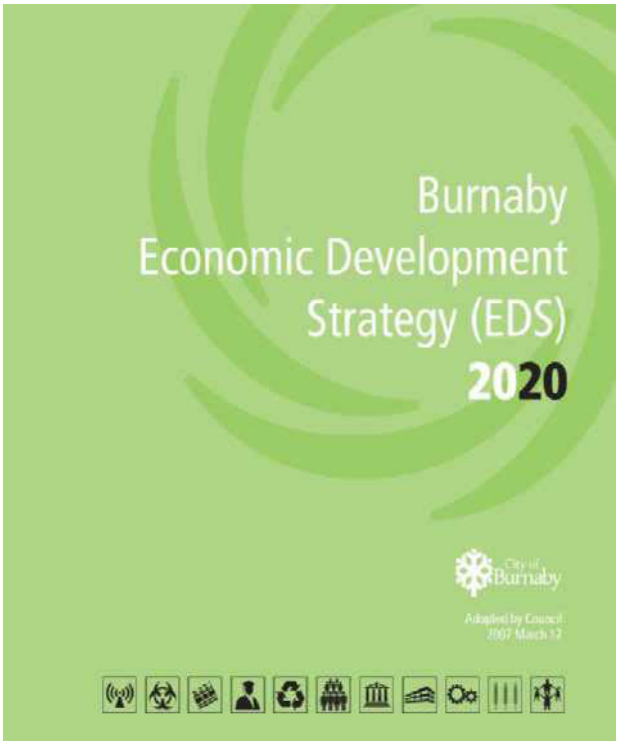
- "Meet changing needs that are responsive to Burnaby's strategic advantages within the region, ensure an adequate supply of industrial land is available to meet anticipated needs over the next two decades, make effective and efficient use of available industrial lands, seeking to attract and accommodate high quality employment intensive industries and overall increases in floor space densities, contribute to the overall growth of the tax base and employment in the City, appropriately integrate industrial development with the surrounding, encourage the continued operation and enhancement of existing industries that are viable and in locations that are to remain designated for industrial use, encourage and guide the transition of identified industrial sites that are no longer conducive to continued industrial use and that offer compelling community benefits through their more intensive redevelopment for other purposes."

〉 Policy Directions pertaining to industrial developments

- Ensure an adequate supply of land.
- Make effective and efficient use of available lands.
- Integrate with surrounding environment.
- Encourage the continued operation and enhancement of existing industries.
- Guide transition of identified industrial sites.
- In industrial areas, encourage industrial uses that achieve relatively high employment densities. and tax base benefits through intensification of use in developing and redeveloping areas.
- Add to the inventory of land available for business centres that incorporates a mix of research, light manufacturing and business office uses.
- Amend the Burnaby Zoning Bylaw to encourage intensification of the use of industrial lands, meet contemporary needs and promote higher employment levels.

Burnaby Economic Development Strategy (EDS 2020)

The City of Burnaby's Economic Development Strategy was adopted by Council in 2007 with the goal of providing a clear strategy for improving the local economy. In 2007, it was already recognized that the City of Burnaby's supply of vacant land for commercial and industrial development was rapidly dwindling. The report emphasizes the potential for redevelopment of lower intensity land uses as a requirement to maintaining industrial users in the City. As a result, the Official Community Plan was updated to encourage more efficient use of industrial land through the following actions:



- Look for opportunities to refine policies and regulations to encourage infill and redevelopment at higher minimum densities, particularly in industrial parks, business parks and other industrial sites.
- In addition, the Economic Development Strategy seeks to examine regulations related to site coverage, setbacks, parking requirements and maximum density to ensure that efficient employment density can be achieved.
- Further, it is suggested that Burnaby continue removing any allowable uses that have unacceptably low density of employment.

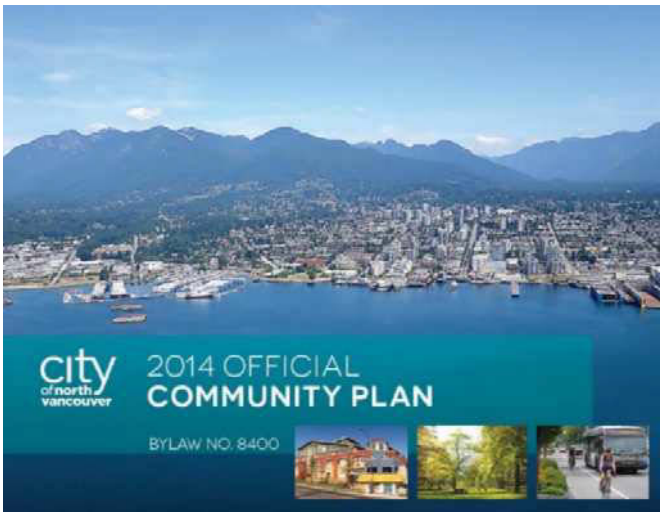
3. City of North Vancouver Industrial Intensification Policy

The City of North Vancouver adopted a new Official Community Plan in 2014. The community's long-term vision is by 2031, the City of North Vancouver will be a vibrant, diverse and highly livable community that is resilient to climate or other changes, and sustainable in its ability to prosper without sacrifice to future generations.

OCP Density, Height and Development in the City of North Vancouver's Land Use Designations

〉 Mixed Employment

- To allow for light industrial and automotive uses characterized by research and development activities, business parks, storage, assembly of semi-finished products from previously prepared materials, automotive uses, automobile sales or other light industrial and service commercial uses with limited smoke, noise, soot, dirt, vibration or odor. A limited amount of complementary commercial use could be supported—commercial uses with high trip-generating uses should be directed to mixed-use and commercial areas.



〉 Industrial

- To allow for light and heavy industrial uses characterized by port activities, goods production, manufacturing, distribution, storage or fabrication and a range of marine-related uses including boat repair, ship chandlery, and boat building.

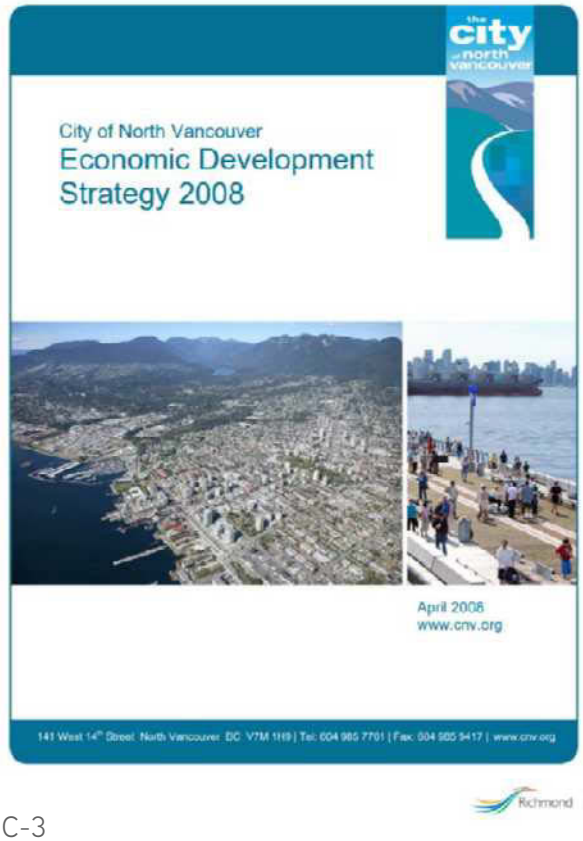
Chapter 7 of the Official Community Plan: Economic Development Goals and Objectives

〉 7.1.2: Seek a strong balance of employment to resident labour force as generating more jobs close to home makes for shorter average commutes.

〉 7.2.3: Support an increase in the intensity of use in the City's business parks through the Zoning Bylaw, supporting these areas as innovation zones.

〉 7.2.7: Maintain the City's mixed employment areas which provide light industrial and service commercial uses in the City.

- 7.2.8: Encourage an increase in the floor area devoted to employment generating uses to meet demand.
- 7.2.9: Provide a high level of public services and infrastructure for commercial and industrial lands.
- 7.1.12: Ensure that permitted use on designated industrial lands are most appropriate for an industrial location (as opposed to being better suited to a commercial location), allow for intensification of industrial lands and prohibit residential as a principal use.



City of North Vancouver Economic Development Strategy (2008)

While there are a number of higher-level economic development policies in the 2014 Official Community Plan, in the 2008 Economic Development Strategy, Goal C-3 recognized the importance of industrial development as being critical to the city's economy both in terms of economic diversification and also through linkages to other local business sectors. In addition, Strategy 30 of this goal recommended not only maintaining the existing supply of industrial land, but also supported more intensive uses of the land. This commitment informed current OCP policies recognizing the importance of the industrial land base and encouraged higher permitted densities to allow for significant intensification.

4. City of Richmond Industrial Intensification Policy

The City of Richmond Official Community Plan (OCP) is the City's statement for the long-term future of community planning in which the city wishes to evolve. The plan adopted by Council in 2012 guides growth and development till 2041.

OCP Objective 2: Mitigate noise from the Canada Line in nearby residential uses, and between industrial and commercial uses on nearby residential uses and vice versa.

- For new Commercial, Industrial and Mixed Uses (rezonings and development permits) within 30m of any residential use:

- To mitigate unwanted noise on residential properties, all new developments shall demonstrate that the building envelope is designed to avoid noise generated by the internal use and that noise generated from rooftop HVAC units with comply with current Noise Bylaw.

City of Richmond Employment Lands Strategy in the Official Community Plan

〉 The 2041 Employment Land Strategy determines the City of Richmond's employment land use needs for the next 30 years. The study concluded that Richmond has enough employment lands to meet demand in all sectors to 2041, including any employment lands currently planned for redevelopment to other uses.

Multiple-Objective Employment Land Policies

〉 The objective of this policy is to support the development of community-wide employment lands to achieve a resilient economy.

- 6.1c) Review DCC rates and programs, to encourage employment land development (ex. Light industrial DCCs based on level of use and lower DCCs on upper storeys to encourage employment land densification).
- 6.1i) Periodically review the Zoning Bylaw to simplify the list of permitted uses on employment lands and re-examine FARs, lot coverage and building heights to enable densification and multi-use.
- 6.1j) Enable multi-use, rather than singular use, of employment lands.
- 6.1l) Increase density (greater FAR, higher lot coverage, increased building heights) for employment uses.
- 6.1n) Explore the potential for shared parking between sites of different uses where parking demand occurs at different times of day.

Objective Specific Employment Lands Policies | Asia-Pacific Gateway.

〉 Encourage higher density industrial employment uses and maintain adequate flexibility in industrial land designations within the urban footprint to meet future land use needs.

- 6.2a) Protect the Industrial Land Base.
  - Integrate YVR and PMV long-term economic development plans with Richmond's long-term plans to recognize the potential unavailability of traditional manufacturing uses.
  - Monitor the availability of industrial lands in Richmond.

- Wherever possible, aim to accommodate traditional manufacturing displaced by higher-priced development within the City.

- 6.2h) Investigate the feasibility of establishing minimum floor area ratios in industrial zones.
- 6.2i) Consider increasing the maximum building height in industrial zones or removing it altogether.
- 6.2j) Consider increasing maximum lot coverage in industrial zones, provided that parking and loading requirements are met.
- 6.2l) Consider reducing surface parking requirements in areas of low employment-to-build area ratios.
- 6.2p) Consider area specific DCC reductions or eliminations in areas of redevelopment with already established infrastructure.
- 6.2q) Consider creating a DCC incentive of lower DCCs on upper storeys in multi-storey industrial developments.

City of Richmond Resilient Economy Strategy Action Plan (2014)

The City of Richmond adopted the municipality's first Economic Development Strategy (EDS) in 2002 which was intended as a comprehensive framework for economic development and growth. The latest update of the EDS evaluates outstanding action items and develops new ones based on current economic prospects and priorities for the City of Richmond. The Resilient Economy Strategy follows the adoption of the 2012 City of Richmond OCP guiding growth and development to 2041. The goal of this strategy is to retain the economic sectors that are fundamental to Richmond's economic wellbeing and character, in order to grow the sectors which Richmond is best suited to tap opportunities taking into account local and regional natural, social, and economic assets and to make the local economy more resilient.

The action plan, intended to contain actionable items achievable in 3-5 years includes strategies to increase Richmond's capacity to accommodate light industrial business, strengthen Richmond's role as a gateway for goods import and export, and to support economic diversity, small business opportunity, and localization. The four economic goals for Richmond's Resilient Economy Strategy are:

1. Maintain and increase Richmond's attractiveness for, and ability to accommodate, businesses across a wide range of sectors. Rather than focus on picking winners, the strategy aims to make sure Richmond has a broad ability to maintain a diverse and growing industrial and commercial base.
2. Reinforce the sectors that are extremely important to Richmond's local economy and that have substantial potential for growth in employment and tax base.
3. In quantitative terms, aim to at least maintain Richmond's share of total regional employment, which has been about 10% over the last twenty years.

4. Aim to continue having a larger share of regional employment than regional population, as this enables Richmond to maintain a reasonable allocation of property tax burden and to provide a full range of services to residents.

In achieving these goals, of the 9 main strategies adopted, two pertain to industrial development and intensification in the City of Richmond.

〉 5.1 Increase Richmond's Capacity to Accommodate Industrial Business.

- In recognizing that the City of Richmond has a small inventory of vacant, available, serviced, zoned, developable land to accommodate new light industrial uses, the Employment Lands Study, completed as part of the 2041 OCP update, indicates that a large proportion of industrial land is not readily available for industrial users. In addressing this, the City of Richmond has a number of high priority action items.
- 5.1.2.1 Develop a much more comprehensive understanding of industrial land and supply in Richmond.
- 5.1.2.2 Work with owners of large tracts of vacant industrial land to see where it is possible to create subdivided, serviced industrial lands available in the short term.
- 5.1.2.3 Convene a team of City planning and economic development staff to examine lands that are not in the ALR, currently zoned agricultural and designated industrial in the OCP.
- 5.1.2.4 Examine the potential to achieve higher site coverage on industrial land.
    - Current zoning regulations allow 60% site coverage. This forces lower intensity land use because most industrial users must be on the ground floor. Users should be given the flexibility to achieve higher intensity use if it works for them.
- 5.1.2.5 Evaluate older industrial areas that are un-intensively developed to see if there are realistic opportunities for densification using zoning, infill, re-subdivision or other development tools.
- 5.1.2.6 Review regulatory processes to look for ways to make permitting and licensing for industrial and commercial businesses and developments more cost effective, efficient and supportive while complying with City policies, bylaws and regulations.
- 5.1.2.7 Explore creative ways to allow or encourage a wider range of uses in the large inventory of vacant office space in low density business park projects. Much of this space was built in anticipation of growth in technology firms that did not materialize.
- 5.1.2.8 Continue to maintain an on-line inventory of lands/buildings available for sale.
- 5.1.2.9 Continue to maintain DCC rates for industry competitiveness to major Metro municipalities.

〉 5.4 Retain and Support Businesses Already in Richmond.

- 5.4.2.1 Continue the outreach to businesses located in parts of the City Centre designated for high density redevelopment.
- 5.4.2.2 Continue to monitor commercial and industrial property tax rates to ensure they are reasonable relative to competing municipalities and continue to identify ways to ease property taxes on employers in redevelopment areas.

Industrial Lands Intensification Initiative – Summary of Findings and Proposed Amendments to Richmond Official Community Plan (2021)

The 2014 Resilient Economy Strategy identified using industrial land more intensively as a key opportunity to increase the City of Richmond's capacity for industrial activity. The Industrial Lands Intensification Initiative was endorsed by Council in 2017 and presents a number of policy directions that could be implements in order to further protect and encourage the intensification of industrial lands through amendments to the Official Community Plan and Zoning Bylaws. In a Council meeting held on January 11th, 2021, the motion was carried.

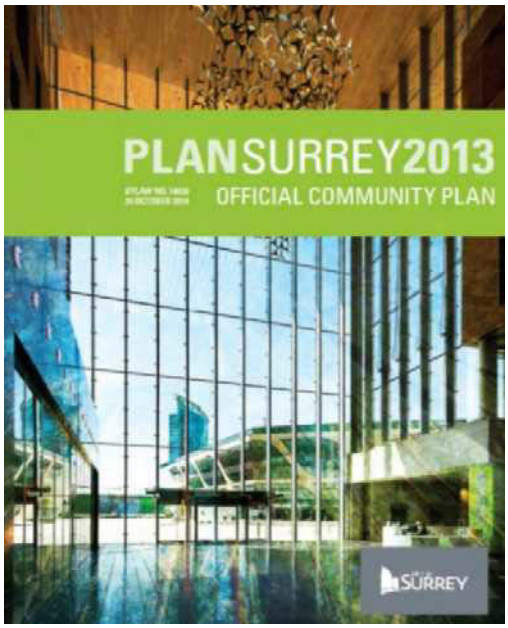
〉 Summary of Proposed Changes

- Zoning Bylaw: Recognize/regulate ancillary office space for defined industrial uses.
  - Rationale: Industrial users require some office space to support their primary facilities and operations. This provides clarity for business users and City staff.
- OCP and Zoning Bylaw: Do not encourage retail sales in the I and IL zones, but allow limited retail uses in the IB and IR zones as an accessory use for manufacturing businesses only, including microbreweries.
  - Rationale: Evolving business models require integrated space where design, manufacturing, distribution, and showroom/retail activities can occur within a single building.
- Zoning Bylaw: Introduce new industrial uses to reflect emerging industries such as e-commerce logistics and retail showrooms.
  - Rationale: To recognize and help track emerging industrial uses and reduce parking requirements for specific uses that have demonstrated reduced parking demand.
- Zoning Bylaw: Reduce parking regulations for selected defined industrial uses. Include a further reduction for selected defined industrials uses in the City Centre.
  - Rationale: Flexible parking standards will help support the shifts in the type of industrial users that may occupy an industrial property and optimize the use of rapid transit infrastructure.

- Zoning Bylaw: Increase the building site coverage from 60% to 75% for sites outside the City Centre.
    - Rationale: To remove barriers to more intense forms of industrial development when other site requirements can be achieved.
- Zoning Bylaw: Increase the maximum building height from 12m to 16m for sites outside of the City Centre, but maintain the 12m maximum building height for industrial sites within 50m of a residentially zoned lot.
    - Rationale: The need for taller industrial buildings is driven by new forms of storage racking systems that allow vertical warehousing and increased warehouse efficiency.
- OCP: Allow consideration of increasing the maximum density from 1.0 floor area ratio to 1.5 FAR outside of the City Centre, subject to a rezoning process, provided the site is a minimum 2.5 ha in area, is close to major transportation infrastructure, is not adjacent to residential uses, and has satisfied transportation and servicing issues.
    - Rationale: To remove barriers to more intense forms of industrial development, for example multi-level warehouses, in appropriate locations.
- OCP: Introduce Development Permit guidelines for industrial buildings that are multi-storey and have an external access.
    - Rationale: To address visual, scale and massing issues associated with large, multi-storey industrial developments.

5 City of Surrey Industrial Intensification Policy

The PlanSurrey 2013 Official Community Plan was adopted by Council in October 2014 and is comprised of objectives and policies that set out the City of Surrey's long-term plan for community development.



Theme E: The Economy – Support a Diversified, Vibrant, High-Quality Economy. Section E1: Employment Lands.

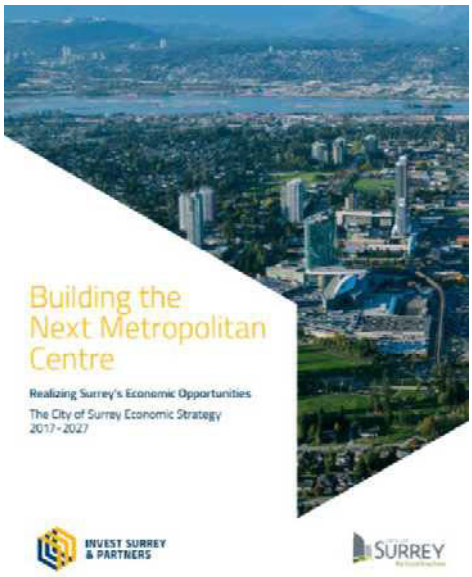
The goal of this policy is to ensure sufficient supply and efficient use of employment lands. "Due to a limited industrial land base within the region, Surrey faces an ever-increasing demand for its employment lands. It is imperative that the City uses its employment reserves strategically and efficiently. In addition to newly developed employment areas, redevelopment and

intensification of existing industrial sites will become necessary in order to meet the growing demand for new employment lands in the future."

- E1.1: Ensure a sufficient supply of employment lands in Surrey, including designated industrial lands, to meet the current and future needs of the local and regional economy.
- E1.2: Monitor the utilization and availability of industrial lands in conjunction with Metro Vancouver.
- E1.3: Identify lands that may be suitable for future employment uses and that are located in areas that provide suitable access to major transportation corridors. Consider employment land needs in the preparation of all secondary plans.
- E1.4: Locate, site and design employment areas to be accessible, compatible, have access to high quality, frequent public transportation, and be well integrated into surrounding communities and neighbourhoods. Design employment districts to provide services to workers employed in those areas.
- E1.5: Encourage the full utilization and efficient use of industrial and other employment lands in order to maximize jobs and economic activity per hectare.
- E1.6: Support the infill and redevelopment of underutilized properties within Commercial, Mixed Employment and Industrial land designations and remove regulatory or other barriers to achieving the full development capacity in these locations.
- E1.7: Develop flexible zoning regulations and bylaws to support more intensive uses of existing employment lands.
- E1.10: Ensure sufficient, convenient, and appropriate access to employment lands including supply and goods movement routes and access to employment opportunities for Surrey's workforce.
- E1.11: Protect industrially designated land specifically for industrial purposes, particularly industrial land accessible by water and railways.
- E1.12: Support proposals that use industrially designated land for commercial purposes only where: Commercial and retail uses are accessory uses supporting the principal industrial use and retail uses are limited to serving the needs of industrial employees and commercial and retail uses do not pose short- or long-term conflicts or threaten the conversion of industrial lands to commercial uses.
- E1.13: Prohibit the conversion of industrial, business park or mixed-employment lands to residential or other non-employment uses.
- E1.32: Review parking standards to identify ways in which parking can be provided more efficiently and sustainability within Industrial and Mixed Employment development areas.

Building the Next Metropolitan Centre: Realizing Surrey's Economic Opportunities – The City of Surrey Economic Strategy 2017 to 2027

The City of Surrey highlights that building an economy that will transform Surrey into Metro Vancouver's next metropolitan centre requires investment attraction, the creation of an innovation economy, distinct and competitive business communities, and job creation & workforce development. With this goal in mind, Surrey has maintained a competitive industrial tax policy to support business growth, making is the second lowest in the region for the past 10 years. It is noted that while the region has a strained industrial land base, Surrey remains a municipality that still has a sizable inventory allowing for industrial growth and expansion. Of Surrey's industrial land base, 38% of land has been categorized as underdeveloped or vacant which poses as a significant opportunity for growth.



6 Township of Langley Industrial Intensification Policy

OCP Overview

The Township of Langley is described as a "community of communities" with a rural and urban mix. The Township of Langley's Official Community Plan was adopted in 2013 and guides development and growth in the Township for the next 30 years till 2043. Given many physical constraints (water, topography, Agricultural Land Reserve, and the Canada-USA border), much of the Township of Langley is difficult for urban development. The Township of Langley's Official Community Plan outlines a number of goals pertaining to economic development of the industrial sector.

〉 OCP Goal 2. Promote Agriculture and Enhance Farm Viability

- Non-farm uses of agricultural land may be supported for sound reasons leading to improved overall sustainability of the community in a manner that minimizes impacts to agriculture, subject to the approval of the Agricultural Land Commission.

〉 OCP Goal 4. Maintain a balance between local job opportunities and labour force growth.

- The Township of Langley has been able to meet its longstanding objective to provide one job for every resident in the labour force. There is sufficient employment land in the community to continue to create good jobs close to home.

Further, the Township of Langley has a number of policies in place that encourage employment generating industrial development.

〉 2.1.1: Locate urban development, including industrial uses, within the urban development area.

〉 2.1.2: Discourage urban development outside the urban development area to preserve agricultural land, the rural landscape, and the environment.

〉 2.1.5: Recognize the impact of major transportation corridors on the community and give consideration to appropriate development options on major east-west transportation corridors, including along the Fraser Highway.

- 2.2.5: Consider development agro-industrial areas in appropriate locations to accommodate industrial uses directly related to agriculture. Existing industrial uses are identified on "Map 1". Direct new agro-industrial uses to industrial areas within the urban development area.
- 2.3.12: Support existing industrial activities and new Urban areas in the Regional Centre and Frequent Transit Development Areas by minimizing impacts on existing industrial areas through appropriate buffering, landscaping, and building design.
- 2.3.13: Encourage transit improvements in all centres and Frequent Transit Development Areas. As transit service improves in these areas, consider reducing parking requirements for residential and commercial uses based on a review of parking needs.
- 2.4.11: Areas designated as Industrial are intended for manufacturing and warehousing activities, and in some cases office use, subject to policies in community plans. Retail activities directly related and accessory to industrial uses, and limited commercial activities supporting industrial activities, may be considered subject to policies in community plans. Residential uses are limited to one dwelling unit per lot for use by an owner, manager, or caretaker. Other commercial or residential uses are not permitted.
- 2.4.12: Encourage efficient utilization of industrial lands and intensification of industrial development.
- 2.4.13: Areas designated as Mixed Employment are intended primarily for industrial uses. Efficient utilization of land and intensification of industrial development is encouraged.
- 2.4.16: Encourage industrial and business park development in the Willowbrook area in conformity with the Willowbrook Community Plan
- 2.4.17: Complete and or update detailed plans for the Gloucester and Northwest Langley areas to ensure that they continue to provide employment lands for the Township.
- 3.7.2: Ensure a long-term supply of employment lands is maintained, with a match between available land and the requirements of future market demand.
- 3.7.4: Encourage industrial development that has a high employment ratio.
- 3.7.5: Preserve industrial designated lands for industrial uses and uses accessory to industry.
- 3.7.6: Consider designation of new employment lands where appropriate.
- 3.7.7: Encourage buffering between employment and non-employment land.

Economic Development Strategy (2012)

The Township of Langley's Economic Development Strategy was initially endorsed by Council in 2002 and has been most recently updated in 2012. The strategy guides an articulate mission statement, a realizable set of objectives, and devises a supporting action plan to meet these objectives. The mission of the Township of Langley is for the Township to be the "premier place to live, work, and invest. Diverse communities should thrive in a harmonious urban-rural setting, where balanced land use recognizes heritage while meeting the needs of a growing employment base. The Township of Langley economy generates more jobs than required

by our working residents by leveraging our traditional industries and diversifying into emerging sectors. Increased development densities have created a major town centre, fostered by quality transit and transportation infrastructure, high quality community amenities, and exceptional recreation features".

〉 Initiative 10: Promoting the Densification of Developable Lands.

- Densification of developable lands allows for a greater mix of uses. This densification should also relieve pressure on agricultural lands.

7 Fraser Valley Regional Growth Strategy – Fraser Valley Future 2050 Draft

Chapter 2: Economic Strength and Resiliency

〉 Goal: To realize the region's economic potential by providing opportunities in employment and education that will grow the economy by building on the region's strengths.

- Building complete communities that provide residents with jobs and services close to where they live can improve employment opportunities and contribute to local self-sufficiency.
- Ensuring a strong economy also requires anticipating future demand.
- Manufacturing will continue to grow in the region and with population growth, there will be increased opportunities for employment in such areas as technology, health care, sales and services, business services and others.

〉 Section 2.1 Create Opportunities for employment and education.

- Promote the development of a strong employment base and favorable investment climate by recognizing economic drivers and being flexible enough to take advantage of changing markets and new opportunities.
- Support initiatives that contribute to growth of a diversified economy.
- Develop and maintain a skilled labor force.
- Provide educational and employment opportunities in fields that will enable and encourage younger generations to remain in the Fraser Valley.
- Support initiatives that provide employment opportunities in rural communities and electoral areas, including indigenous communities.
- Encourage mixed-use development and development that locates employment centres near residential areas to increase accessibility and minimize commuting.

- Improve the viability of smaller communities, including Indigenous communities, and help them adapt to economic change by advocating for improvements to internet access and other basic services that encourage innovative entrepreneurship in remote locations.
- Support equal access to employment or educational programs and initiatives for Indigenous Peoples.
- Work with local governments, Indigenous communities, senior governments, the private sector and the public to implement the recommendations of the Clean Economy in the Fraser Valley study.

〉 2.2 Protect Employment Lands

- Expand economic growth and productivity by exploring opportunities for clustering industrial development in a manner that will create competitive advantages and foster collaboration between Indigenous communities, businesses, organizations, and government agencies.
- In collaboration with local governments, develop and maintain an employment lands inventory to ensure an adequate supply of industrial, agricultural, and commercial lands.
- Protect the supply of industrial lands from non- industrial conversion to ensure future needs can be met.
- Work with Indigenous governments and the Province to ensure sustainable management of natural resources by using an integrated management approach, developing natural resource plans for the region, and acknowledging cumulative impacts on the environment and culturally sensitive sites.
- Work with the Agricultural Land Commission and other stakeholders to develop innovative approaches to address urban land requirements without compromising the intent of the Agricultural Land Reserve.

Appendix II | Baseline Scenario Proforma

Development Assumptions		
Land Area (Acre)	(Acre)	10.00
Land Area (sf)	(sf)	435,602
Site Coverage Ratio	(%)	50%
FAR	(#)	0.50
Number of Floors	(#)	1
Building footprint	(sf)	217,801
Gross Floor Area	**(sf)**	**217,801**
Gross Floor Area - industrial	(sf)	217,801
Industrial Area FAR	(#)	0.50
Net Salable Area	**(sf)**	**213,445**
Net Salable Industrial Area	(sf)	213,445
Efficiency	(%)	98%
Parking Stalls Required	(#)	218
Surface Parking Stalls Provided	(#)	218
Revenue		
Industrial Space Strata Price per SF - Blended		460.00
Industrial Space Strata Price per SF-1st Floor	($/sf)	460.00
Sales Revenue from Industrial Space	($)	98,184,633
Gross Revenue	($)	98,184,633
Commissions Rate	(%)	3.00%
Commissions	($)	(2,945,539)
Revenue after Commissions	**($)**	**95,239,094**

Development			
Hard Cost Rate	($/sf)		125
Hard Costs	($)		27,225,109
Soft Cost Rate (of Hard Costs)	(%)		22%
Soft Costs	($)		5,987,391
Architect & Consultants Rate (of Hard Costs)	(%)		4.0%
Architect & Consultants Cost	($)		1,089,004
Development Management Fee Rate (% of Total Project C	(%)		4.0%
Development Management Fee	($)		1,414,852
Permits and Development Charges Rate(of Hard Costs)	(%)		5.0%
Permits and Development Charges Costs	($)		1,361,255
Property Taxes Rate (of Total Project Costs)	(%)		1.5%
Property Taxes During Construction	($)		530,570
Financing Costs Rate	(%)		4.5%
Financing Costs	($)		1,591,709
Contingency (% of Total Hard Costs and Soft Costs)	(%)		6.50%
Contingency Costs	($)		2,158,812
Total Capital Costs	($)		35,371,312
Total Capital Costs per Building Square Foot	($/sf)		162

Valuation			
Revenue after Commissions	($)		95,239,094
Total Project Costs (Excl.Land)	($)		(35,371,312)
Developer's Profit Rate	(%)		13%
Developer's Profit	($)		(10,956,710)
Residual Land Value	**($)**	**48,911,071**	
Residual Price Per Acre	**($)**	**4,891,107**	
Comparables Land Value per Acre	**($)**	**6,161,115**	

Market Requirement			
Required Industrial Space Strata Price per SF-Blanded	($/sf)		530.00
Gross Revenue	($)		113,125,773
Commission	($)		(3,393,773)
Revenue after Commissions	($)		109,731,999
Created Value per Square Foot	($/sf)		504
Revenue after Commissions	($)		109,731,999
Total Project Costs (Excl.Land)	($)		(35,371,312)
Developer's Profit Rate	(%)		13%
Developer's Profit	($)		(12,624,035)
Residual Land Value	**($)**	**61,736,652**	
Residual Price Per Buildable Per Acre	**($)**	**6,173,665**	
Comparables Land Value per Acre	**($)**	**6,161,115**	

Appendix III | Scenario 1a Proforma

Development Assumptions		
Land Area (Acre)	(Acre)	10.00
Land Area (sf)	(sf)	435,602
Site Coverage Ratio	(%)	60%
FAR	(#)	0.60
Number of Floors	(#)	1
Building footprint	(sf)	261,361
Gross Floor Area	**(sf)**	**261,361**
Gross Floor Area - industrial	(sf)	261,361
Industrial Area FAR	(#)	0.60
Net Salable Area	**(sf)**	**256,134**
Net Salable Industrial Area	(sf)	256,134
Efficiency	(%)	98%
Parking Stalls Required	(#)	261
Roof Parking Stalls Provided	(#)	261
Revenue		
Industrial Space Strata Price per SF - Blended		460.00
Industrial Space Strata Price per SF-1st Floor	($/sf)	460.00
Sales Revenue from Industrial Space	($)	117,821,559
Gross Revenue	($)	117,821,559
Commissions Rate	(%)	3.00%
Commissions	($)	(3,534,647)
Revenue after Commissions	**($)**	**114,286,913**

Development			
Hard Cost Rate	($/sf)		175
Hard Costs	($)		45,738,183
Soft Cost Rate (of Hard Costs)	(%)		22%
Soft Costs	($)		10,058,817
Architect & Consultants Rate (of Hard Costs)	(%)		4.0%
Architect & Consultants Cost	($)		1,829,527
Development Management Fee Rate (% of Total Project C	(%)		4.0%
Development Management Fee	($)		2,376,952
Permits and Development Charges Rate(of Hard Costs)	(%)		5.0%
Permits and Development Charges Costs	($)		2,286,909
Property Taxes Rate (of Total Project Costs)	(%)		1.5%
Property Taxes During Construction	($)		891,357
Financing Costs Rate	(%)		4.5%
Financing Costs	($)		2,674,071
Contingency (% of Total Hard Costs and Soft Costs)	(%)		6.50%
Contingency Costs	($)		3,626,805
Total Capital Costs	($)		59,423,805
Total Capital Costs per Building Square Foot	($/sf)		227

Valuation			
Revenue after Commissions	($)		114,286,913
Total Project Costs (Excl.Land)	($)		(59,423,805)
Developer's Profit Rate	(%)		13%
Developer's Profit	($)		(13,148,052)
Residual Land Value	**($)**	**41,715,056**	
Residual Price Per Acre	**($)**	**4,171,506**	
Comparables Land Value per Acre	**($)**	**6,161,115**	

Market Requirement			
Required Industrial Space Strata Price per SF-Blanded	($/sf)		551.00
Gross Revenue	($)		141,129,737
Commission	($)		(4,233,892)
Revenue after Commissions	($)		136,895,845
Created Value per Square Foot	($/sf)		524
Revenue after Commissions	($)		136,895,845
Total Project Costs (Excl.Land)	($)		(59,423,805)
Developer's Profit Rate	(%)		13%
Developer's Profit	($)		(15,749,080)
Residual Land Value	**($)**	**61,722,961**	
Residual Price Per Buildable Per Acre	**($)**	**6,172,296**	
Comparables Land Value per Acre	**($)**	**6,161,115**	

Appendix IV | Scenario 1b Proforma

Development Assumptions		
Land Area (Acre)	(Acre)	10.00
Land Area (sf)	(sf)	435,602
Site Coverage Ratio	(%)	50%
FAR	(#)	1.00
Number of Floors	(#)	2
Building footprint	(sf)	217,801
Gross Floor Area	**(sf)**	**435,602**
Gross Floor Area - industrial	(sf)	435,602
Industrial Area FAR	(#)	1.00
Net Salable Area	**(sf)**	**413,822**
Net Salable Industrial Area	(sf)	413,822
Efficiency	(%)	95%
Parking Stalls Required	(#)	435
Surface Parking Stalls Provided	(#)	435
Revenue		
Industrial Space Strata Price per SF - Blended		445.00
Industrial Space Strata Price per SF-1st Floor	($/sf)	460.00
Industrial Space Strata Price per SF-2st Floor	($/sf)	430.00
Sales Revenue from Industrial Space	($)	184,150,637
Gross Revenue	($)	184,150,637
Commissions Rate	(%)	3.00%
Commissions	($)	(5,524,519)
Revenue after Commissions	**($)**	**178,626,118**

Development			
Hard Cost Rate	($/sf)		225
Hard Costs	($)		98,010,392
Soft Cost Rate (of Hard Costs)	(%)		22%
Soft Costs	($)		21,554,608
Architect & Consultants Rate (of Hard Costs)	(%)		4.0%
Architect & Consultants Cost	($)		3,920,416
Development Management Fee Rate (% of Total Project C	(%)		4.0%
Development Management Fee	($)		5,093,469
Permits and Development Charges Rate(of Hard Costs)	(%)		5.0%
Permits and Development Charges Costs	($)		4,900,520
Property Taxes Rate (of Total Project Costs)	(%)		1.5%
Property Taxes During Construction	($)		1,910,051
Financing Costs Rate	(%)		4.5%
Financing Costs	($)		5,730,153
Contingency (% of Total Hard Costs and Soft Costs)	(%)		6.50%
Contingency Costs	($)		7,771,725
Total Capital Costs	($)		127,336,725
Total Capital Costs per Building Square Foot	($/sf)		292

Valuation			
Revenue after Commissions	($)		178,626,118
Total Project Costs (Excl.Land)	($)		(127,336,725)
Developer's Profit Rate	(%)		13%
Developer's Profit	($)		(20,549,907)
Residual Land Value	**($)**	**30,739,485**	
Residual Price Per Acre	**($)**	**3,073,949**	
Comparables Land Value per Acre	**($)**	**6,161,115**	

Market Requirement			
Required Industrial Space Strata Price per SF-Blanded	($/sf)		532.00
Gross Revenue	($)		220,153,121
Commission	($)		(6,604,594)
Revenue after Commissions	($)		213,548,527
Created Value per Square Foot	($/sf)		490
Revenue after Commissions	($)		213,548,527
Total Project Costs (Excl.Land)	($)		(127,336,725)
Developer's Profit Rate	(%)		13%
Developer's Profit	($)		(24,567,530)
Residual Land Value	**($)**	**61,644,273**	
Residual Price Per Buildable Per Acre	**($)**	**6,164,427**	
Comparables Land Value per Acre	**($)**	**6,161,115**	

Appendix V | Scenario 1c Proforma

Development Assumptions		
Land Area (Acre)	(Acre)	10.00
Land Area (sf)	(sf)	435,602
Site Coverage Ratio	(%)	50%
FAR	(#)	1.50
Number of Floors	(#)	3
Building footprint	(sf)	217,801
Gross Floor Area	**(sf)**	**653,403**
Gross Floor Area - industrial	(sf)	653,403
Industrial Area FAR	(#)	1.50
Net Salable Area	**(sf)**	**614,198**
Net Salable Industrial Area	(sf)	614,198
Efficiency	(%)	94%
Parking Stalls Required	(#)	653
Surface Parking Stalls Provided	(#)	622
Revenue		
Industrial Space Strata Price per SF - Blended		436.67
Industrial Space Strata Price per SF-1st Floor	($/sf)	460.00
Industrial Space Strata Price per SF-2st Floor	($/sf)	430.00
Industrial Space Strata Price per SF-3st Floor	($/sf)	420.00
Sales Revenue from Industrial Space	($)	268,199,993
Gross Revenue	($)	268,199,993
Commissions Rate	(%)	3.00%
Commissions	($)	(8,046,000)
Revenue after Commissions	**($)**	**260,153,993**

Development			
Hard Cost Rate	($/sf)		240
Hard Costs	($)		156,816,627
Soft Cost Rate (of Hard Costs)	(%)		25%
Soft Costs	($)		38,571,366
Architect & Consultants Rate (of Hard Costs)	(%)		5.0%
Architect & Consultants Cost	($)		7,840,831
Development Management Fee Rate (% of Total Project C	(%)		5.0%
Development Management Fee	($)		10,404,411
Permits and Development Charges Rate(of Hard Costs)	(%)		5.0%
Permits and Development Charges Costs	($)		7,840,831
Property Taxes Rate (of Total Project Costs)	(%)		1.5%
Property Taxes During Construction	($)		3,121,323
Financing Costs Rate	(%)		4.5%
Financing Costs	($)		9,363,970
Contingency (% of Total Hard Costs and Soft Costs)	(%)		6.50%
Contingency Costs	($)		12,700,220
Total Capital Costs	($)		208,088,213
Total Capital Costs per Building Square Foot	($/sf)		318

Valuation			
Revenue after Commissions	($)		260,153,993
Total Project Costs (Excl.Land)	($)		(208,088,213)
Developer's Profit Rate	(%)		13%
Developer's Profit	($)		(29,929,220)
Residual Land Value	**($)**	**22,136,560**	
Residual Price Per Acre	**($)**	**2,213,656**	
Comparables Land Value per Acre	**($)**	**6,161,115**	

Market Requirement			
Required Industrial Space Strata Price per SF-Blanded	($/sf)		512.00
Gross Revenue	($)		314,469,610
Commission	($)		(9,434,088)
Revenue after Commissions	($)		305,035,522
Created Value per Square Foot	($/sf)		467
Revenue after Commissions	($)		305,035,522
Total Project Costs (Excl.Land)	($)		(208,088,213)
Developer's Profit Rate	(%)		13%
Developer's Profit	($)		(35,092,582)
Residual Land Value	**($)**	**61,854,726**	
Residual Price Per Buildable Per Acre	**($)**	**6,185,473**	
Comparables Land Value per Acre	**($)**	**6,161,115**	

Appendix VI | Scenario 2a Proforma

Development Assumptions		
Land Area (Acre)	(Acre)	0.70
Land Area (sf)	(sf)	30,492
Site Coverage Ratio	(%)	95%
FAR	(#)	3.00
Number of Floors	(#)	3
Building footprint	(sf)	28,968
Gross Floor Area	**(sf)**	**91,476**
Gross Floor Area - industrial	(sf)	60,984
Industrial Area FAR	(#)	2.00
Gross Floor Area - Office	(sf)	30,492
Office Area FAR	(#)	1.00
Net Salable Area	**(sf)**	**83,243**
Net Salable Industrial Area	(sf)	55,496
Efficiency	(%)	91%
Net Salable Office Area	(sf)	27,748
Efficiency	(%)	91%
Parking Stalls Required	(#)	123
Underground Parking Stalls Provided	(#)	123

Revenue		
Industrial Space Strata Price per SF - Blended		570.00
Industrial Space Strata Price per SF-1st Floor	($/sf)	580.00
Industrial Space Strata Price per SF-2st Floor	($/sf)	560.00
Sales Revenue from Industrial Space	($)	31,632,527
Office Space Strata Price per SF-Blanded	($/sf)	750.00
Sales Revenue from Office Space	($)	20,810,873
Price per Parking Stall	($/stall)	50,000.00
% of Parking Stalls for Sale	(%)	50%
Sales Revenue from Parking Space	($)	3,063,089.18
Gross Revenue	($)	55,506,490
Commissions Rate	(%)	3.00%
Commissions	($)	(1,665,195)
Revenue after Commissions	**($)**	**53,841,295**

Development			
Hard Cost Rate	($/sf)		300
Hard Costs	($)		27,415,924
Soft Cost Rate (of Hard Costs)	(%)		27%
Soft Costs	($)		7,372,848
Architect & Consultants Rate (of Hard Costs)	(%)		5.0%
Architect & Consultants Cost	($)		1,370,796
Development Management Fee Rate (% of Total Project C	(%)		5.0%
Development Management Fee	($)		1,852,502
Permits and Development Charges Rate(of Hard Costs)	(%)		5.0%
Permits and Development Charges Costs	($)		1,370,796
Property Taxes Rate (of Total Project Costs)	(%)		2.0%
Property Taxes During Construction	($)		741,001
Financing Costs Rate	(%)		5.5%
Financing Costs	($)		2,037,752
Contingency (% of Total Hard Costs and Soft Costs)	(%)		6.50%
Contingency Costs	($)		2,261,270
Total Capital Costs	($)		37,050,042
Total Capital Costs per Building Square Foot	($/sf)		405

Valuation			
Revenue after Commissions	($)		53,841,295
Total Project Costs (Excl.Land)	($)		(37,050,042)
Developer's Profit Rate	(%)		15%
Developer's Profit	($)		(7,022,778)
Residual Land Value	**($)**	**9,768,475**	
Residual Price Per Buildable Per SF (PPBSF)	**($)**	**107**	
Comparables Land Value per Buildable SF		170	

Market Requirement			
Required Industrial Space Strata Price per SF-Blanded	($/sf)		646.00
Required Office Space Strata Price per SF-Blanded	($/sf)		846.00
Gross Revenue	($)		62,387,952
Commission	($)		(1,871,639)
Revenue after Commissions	($)		60,516,313
Created Value per Square Foot	($/sf)		662
Revenue after Commissions	($)		60,516,313
Total Project Costs (Excl.Land)	($)		(37,050,042)
Developer's Profit Rate	(%)		15%
Developer's Profit	($)		(7,893,432)
Residual Land Value	**($)**	**15,572,839**	
Residual Price Per Buildable Per SF (PPBSF)	**($)**	**170**	
Comparables Land Value per SF	**($)**	**170**	

Appendix VII | Scenario 2b Proforma

Development Assumptions		
Land Area (Acre)	(Acre)	0.70
Land Area (sf)	(sf)	30,492
Site Coverage Ratio	(%)	95%
FAR	(#)	6.00
Number of Floors	(#)	6
Building footprint	(sf)	28,968
Gross Floor Area	**(sf)**	**182,953**
Gross Floor Area - industrial	(sf)	60,984
Industrial Area FAR	(#)	2.00
Gross Floor Area - Office	(sf)	121,968
Office Area FAR	(#)	4.00
Net Salable Area	**(sf)**	**164,657**
Net Salable Industrial Area	(sf)	54,886
Efficiency	(%)	90%
Net Salable Office Area	(sf)	109,772
Efficiency	(%)	90%
Parking Stalls Required	(#)	307
Underground Parking Stalls Provided	(#)	174

Revenue		
Industrial Space Strata Price per SF - Blended		570.00
Industrial Space Strata Price per SF-1st Floor	($/sf)	580.00
Industrial Space Strata Price per SF-2st Floor	($/sf)	560.00
Sales Revenue from Industrial Space	($)	31,284,917
Office Space Strata Price per SF-Blanded	($/sf)	750.00
Sales Revenue from Office Space	($)	82,328,729
Price per Parking Stall	($/stall)	50,000.00
% of Parking Stalls for Sale	(%)	50%
Sales Revenue from Parking Space	($)	4,356,017.42
Gross Revenue	($)	117,969,664
Commissions Rate	(%)	3.00%
Commissions	($)	(3,539,090)
Revenue after Commissions	**($)**	**114,430,574**

Development			
Hard Cost Rate	($/sf)		305
Hard Costs	($)		55,831,075
Soft Cost Rate (of Hard Costs)	(%)		27%
Soft Costs	($)		15,014,413
Architect & Consultants Rate (of Hard Costs)	(%)		5.0%
Architect & Consultants Cost	($)		2,791,554
Development Management Fee Rate (% of Total Project C	(%)		5.0%
Development Management Fee	($)		3,772,522
Permits and Development Charges Rate(of Hard Costs)	(%)		5.0%
Permits and Development Charges Costs	($)		2,791,554
Property Taxes Rate (of Total Project Costs)	(%)		2.0%
Property Taxes During Construction	($)		1,509,009
Financing Costs Rate	(%)		5.5%
Financing Costs	($)		4,149,774
Contingency (% of Total Hard Costs and Soft Costs)	(%)		6.50%
Contingency Costs	($)		4,604,957
Total Capital Costs	($)		75,450,445
Total Capital Costs per Building Square Foot	($/sf)		412

Valuation			
Revenue after Commissions	($)		114,430,574
Total Project Costs (Excl.Land)	($)		(75,450,445)
Developer's Profit Rate	(%)		15%
Developer's Profit	($)		(14,925,727)
Residual Land Value	**($)**	**24,054,402**	
Residual Price Per Buildable Per SF (PPBSF)	**($)**	**131**	
Comparables Land Value per Buildable SF		170	

Market Requirement			
Required Industrial Space Strata Price per SF-Blanded	($/sf)		608.00
Required Office Space Strata Price per SF-Blanded	($/sf)		808.00
Gross Revenue	($)		126,422,080
Commission	($)		(3,792,662)
Revenue after Commissions	($)		122,629,418
Created Value per Square Foot	($/sf)		670
Revenue after Commissions	($)		122,629,418
Total Project Costs (Excl.Land)	($)		(75,450,445)
Developer's Profit Rate	(%)		15%
Developer's Profit	($)		(15,995,141)
Residual Land Value	**($)**	**31,183,831**	
Residual Price Per Buildable Per SF (PPBSF)	**($)**	**170**	
Comparables Land Value per SF	**($)**	**170**	

metrovancouver
SERVICES AND SOLUTIONS FOR A LIVABLE REGION

To: Regional Planning Committee

From: Mark Seinen, Senior Planner, Regional Planning and Housing Services

Date: April 11, 2021 Meeting Date: May 7, 2021

Subject: **Metro 2050 Regional Resilience Framework**

RECOMMENDATION

That the MVRD Board receive for information the report dated April 11, 2021, titled "Metro 2050 Regional Resilience Framework".

EXECUTIVE SUMMARY

This report conveys the *Metro 2050* Regional Resilience Framework, which investigated how to integrate resilience into *Metro 2050* and *Transport 2050,* the two long-range regional growth management and transportation plans currently being developed by Metro Vancouver and TransLink. The framework includes a definition of resilience as it pertains to regional growth management and transportation, an evaluation framework to test the resilience of *Metro* 2050 and *Transport 2050,* an assessment of *Metro 2040*'s policies, and recommendations to increase the resilience of proposed policies for *Metro 2050*. The recommendations include actions for Metro Vancouver to:

- support member jurisdictions in adopting Hazard, Risk and Vulnerability Analysis into long-range planning;
- regionally coordinate data and mapping of critical infrastructure;
- incorporate the updated Regional Greenways Network to increase active transportation options;
- couple climate mitigation and adaptation strategies to increase climate resilience;
- focus on strategies to reduce the need for travel, in addition to transportation capital investment; and
- work with member jurisdictions to address social inequity to decrease vulnerability to a wide range of stresses and shocks.

PURPOSE

The purpose of this report is to convey the *Metro 2050* Regional Resilience Framework (Attachment 1) to the Regional Planning Committee and MVRD Board for information, and to provide a summary of opportunities to integrate the findings into *Metro 2050* and other future regional planning work.

BACKGROUND

At its May 1, 2020 meeting, in response to the COVID-19 pandemic, the Regional Planning Committee endorsed a process to update the *Metro 2050* workplan (Reference 1). This revised approach included the two significant directions, which have been addressed, in part, by completing the Metro Vancouver Regional Resilience Framework:

- leveraging the 2019 Long-Range Growth and Transportation Scenarios to develop a COVID-19-informed resiliency lens for *Metro 2050* projections, targets, and policies; and
- continuing to further integrate *Metro 2050* with TransLink's *Transport 2050*, as well as *Climate 2050*.

At its meeting on June 12, 2020, the Regional Planning Committee received a subsequent update on the resilience framework (Reference 2). The framework has been completed and the results, recommendations and opportunities to integrate its findings into *Metro 2050* and other future regional planning work are being provided to the Regional Planning Committee and MVRD Board for information.

FRAMEWORK OVERVIEW

In July 2020, Metro Vancouver and TransLink partnered and engaged a consultant (WSP) to initiate a study of long term regional resilience related to regional growth management and transportation planning, and inform the work underway on *Metro 2050* and *Transport 2050* respectively. While the framework does not focus on COVID-19 specifically, many of the issues reviewed (physical, social and economic) have been highlighted and amplified by the pandemic over the past year.

The framework set out to address the following questions:

1. What is a resilient region?
2. How can we measure resilience?
3. How can we assess the resilience of different policies, strategies, and actions?
4. How should we incorporate a resilience assessment into decision-making?
5. What existing strategies and actions improve resilience that the region should commit to continuing?
6. What new strategies and actions could improve the resilience of regional growth management and transportation system management for consideration in *Metro 2050* and *Transport 2050*?

Definition of Regional Resilience

The framework reviewed best practices in resilience planning, focusing primarily on strategies from 100 Resilient Cities (Reference 3), academic literature, and reports from public agencies and non-governmental organizations. Reviewing these resources informed the following definition of regional resilience for Metro Vancouver:

> ***Regional resilience*** *is the capacity of regional communities and organizations to prepare, avoid, absorb, recover and adapt to the effects of shocks and stresses in an efficient manner through the preservation, restoration, and adaptation of essential services and functions, while learning from shocks and stresses to build back better.*

Regional Resilience Assessment

Next, the framework developed a tool to test the resilience of regional long-range growth management and transportation planning in this region. The resulting outputs summarized have been categorized by four groups of shocks and stresses in Table 1, each with its own subcategories.

Table 1. Shock and Stress Groups Assessed by the Regional Resilience Framework

Shock and Stress Groups	Example Shocks and Stresses
Environmental	Flooding | Snowstorms | Windstorms | Air Pollution | Wildfire & Smoke | Landslides | Earthquakes | Natural Resource Depletion | Climate Change
Technology & Infrastructure	Cyber Attacks | Industrial Incidents | Transport Incidents (Road & Rail) | Power Network and Energy Supply Disruptions | Global Supply Chain Disruptions | Aging Infrastructure | Regional Food Supply Disruptions
Sociopolitical & Economy	Terrorism |Aging Population | Unemployment | Unaffordability | Social Inequity | Immigration | Global Recession | War & Political Conflict
Human Health	Infectious Disease | Chronic Disease | Mental Health

Using the shock and stress groups, the strategies in *Metro 2040* and *Transport 2040* were assessed against the four resilience principles of: robustness, redundancy, resourcefulness, and rapidity. This assessment allowed the project team to estimate each strategy's contribution towards resilience and identify where gaps exist. The gap assessment for *Metro 2040* generally found that:

- many strategies contribute positively to *robustness* and *redundancy*;
- only some strategies address *resourcefulness*; and
- few to no strategies address *rapidity*.

FRAMEWORK RECOMMENDATIONS

The framework includes 18 recommendations to increase resilience in long-range growth management planning; 4 of the recommendations are specifically for Metro Vancouver, 3 are for TransLink, and the remaining 11 pertain to both agencies. The recommendations relevant to Metro Vancouver can be separated into *Metro 2050* recommendations (Table 2) and general recommendations for Regional Planning (Table 3):

Table 2. Recommendations for *Metro 2050*

#	Recommendation
1.	Support member jurisdictions in adopting Hazard, Risk and Vulnerability Analysis into long-range planning procedures.
2.	There is currently no coordinated effort in developing regional data, modelling, and mapping of key hazards of concern. Metro Vancouver and TransLink can act as regional conveners for mapping critical infrastructure, and support municipalities that lack the resources to undertake such a task.
3.	Support member jurisdictions in continuing to develop active transportation and transit links to improve resilience.
4.	Add actions that speak to increasing resilience in the region, specifically Metro Vancouver's role and leadership in providing robust and redundant infrastructure. Actions should also lay out expectations for member jurisdictions, and highlight partnerships, roles, and coordination capabilities for preparing and responding to shocks and stresses.

5.	Incorporate the updated Regional Greenways Network into *Metro 2050* to increase active transportation options in the region.
6.	Strategies to mitigate greenhouse gas emissions should be coupled with adaptation strategies to increase climate resilience.
7.	Clearly articulate what is required in Regional Context Statements for withstanding climate change impacts.

Table 3: General Recommendations for Regional Planning

#	Recommendation
1.	Determine opportunities for improved disaster risk reduction and response to regionally-significant stresses and shocks. Establish and increase inter-agency collaboration.
2.	Consider developing a social vulnerability index for Metro Vancouver.
3.	Develop safe-to-fail protocols for regional infrastructure and assets.
4.	Undertake infrastructure relationship mapping with partners and member jurisdictions to strengthen the understanding of system interdependencies.
5.	Expand state of good repair programs to cover stresses and shocks that are currently not discussed in *Metro 2040* and *Transport 2040* (e.g. cyber-attacks) and continually evaluate the state of regional assets and services (e.g. infrastructure, operations, funding).
6.	Work with member jurisdictions to address social inequity to decrease vulnerability to a wide range of stresses and shocks.
7.	Seek out demand-side solutions (transportation demand management) before supply-side solutions (infrastructure expansion). Focusing growth in Urban Centres and Frequent Transit Development Areas contributes to improved transportation performance and increases resilience to a wide range of stresses and shocks.

REGIONAL PLANNING TAKE-AWAYS

There are several themes presented in the recommendations:

- **Identify opportunities to provide leadership on regional resilience.** No single agency is currently responsible for long-term resilience planning in the region. There is an opportunity for Metro Vancouver to take leadership on this front, consistent with recent corporate efforts to advance resilience through the Resilient Region Strategic Framework.

- **Advance data collection, analysis, research and monitoring.** A lack of data and analytics is a barrier to advancing sound regional resilience approaches. To address this, Metro Vancouver, TransLink and member jurisdictions can partner to develop Hazard, Risk and Vulnerability Analyses (including social vulnerability) and assess inter-relationships between infrastructure and identify shared vulnerabilities. This will allow more targeted resilience policies to be developed around specific geographic areas, infrastructure types, and shock and stress groups.

- **Increase efforts on demand-side transportation strategies.** Demand-side solutions should be sought prior to investing in transportation expansion. Directing growth toward compact, complete communities creates a baseline level of resilience in the transportation system and economy by activating transportation options and reducing reliance on any individual piece of infrastructure. As has been seen during the COVID-19 pandemic, walking and cycling are flexible modes that tend not to be susceptible to infrastructure failure, and these modes are particularly practical for short trips in compact areas with grid-based street networks. As the region grows, a development pattern that reinforces Urban Centres and Frequent Transit Development Areas, focusing on shortening trips and encouraging active transportation, will increase resilience to climate change and other hazards.

INFORMING *METRO 2050*

The completion of the *Metro 2040* assessment and the findings and recommendations of the framework have been used to support the development of all of the new and amended policy areas for *Metro 2050*. In particular, the strategies of Goal 1 (Complete Communities), Goal 3 (Climate Change and Natural Hazards), and Goal 5 (Support Sustainable Transportation Choices) have benefitted from the completion of the framework.

ALTERNATIVES

This is an information report. No alternatives are provided.

FINANCIAL IMPLICATIONS

The budget for the Metro 2050 / Transport 2050 Regional Resilience Framework was provided by TransLink. Metro Vancouver provided in-kind staff support.

CONCLUSION

This report conveys the results of the Metro 2050 Regional Resilience Framework. The purpose of the framework is to investigate the concept of resilience in relation to two regional long-range plans, *Metro 2050* and *Transport 2050*. The framework includes a definition of regional resilience, an evaluation framework, an assessment of existing *Metro 2040* and *Transport 2040* policies, and recommendations to increase the resilience of these policies for *Metro 2050*.

Regional Planning staff will use the framework's findings and recommendations to:

- support the development of *Metro 2050* policies; and
- undertake supplemental data collection and analysis, including a regional Hazard, Risk and Vulnerability Analysis and mapping of critical infrastructure.

Attachment *(44252474)*

Metro 2050 Regional Resilience Framework Final Report, Prepared for TransLink and Metro Vancouver, WSP, January 2021

References

1. Updating the Regional Growth Strategy: A Proposed Response in Light of COVID-19, Regional Planning Committee Report, May 1, 2020

2. Developing a Shared Resiliency Framework for *Metro 2050* and *Transport 2050*, Regional Planning Committee Report, June 12, 2020
3. 100 Resilient Cities

44276091

TRANSLINK & METRO VANCOUVER

FINAL REPORT

METRO 2050 / TRANSPORT 2050 REGIONAL RESILIENCE FRAMEWORK

APRIL 29, 2021

SUBMITTED BY WSP

REVISION HISTORY

FIRST ISSUE

January 12, 2021	Draft Final Report			
Prepared by	Reviewed by	Approved By		
Blair Underhill	Alec Knowles	Adrian Lightstone		
REVISION				
January 25, 2021	Final Report			
Prepared by	Reviewed by	Approved By		
Blair Underhill	Alec Knowles	Adrian Lightstone		
REVISION				
April 29, 2021	Final Report			
Prepared by	Reviewed by	Approved By		
Blair Underhill	Alec Knowles	Adrian Lightstone		

EXECUTIVE SUMMARY

TransLink and Metro Vancouver are in the process of updating their long-range plans, the Regional Transportation Strategy (RTS), and the Regional Growth Strategy (RGS), respectively. As part of this update process, the topic of resilience is being explored in greater detail, and in a more structured and explicit manner. This report explores how resilience is represented in existing plans, and how it can be incorporated in the updated strategies.

This project defines regional resilience, develops a framework for assessing strategic resilience, highlights strategies that contribute to resilience, and identifies resilience gaps in the existing RTS and RGS. This project reviews resilience from a strategic perspective, regarding a wide-range of regionally significant stresses and shocks, with a focus on TransLink's and Metro Vancouver's mandates and powers.

The first step of the project was developing a definition for regional resilience. A range of academic, NGO, and peer agency plans were reviewed, and attributes were compiled to establish the following definition.

Regional resilience is the capacity of regional communities and organizations to prepare, avoid, absorb, recover and adapt to the effects of shocks and stresses in an efficient manner through the preservation, restoration, and adaptation of essential services and functions, while learning from shocks and stresses to build back better.

The second step of this project was to develop a regional resilience framework. This was undertaken through review of resilience frameworks, and project team consensus building.

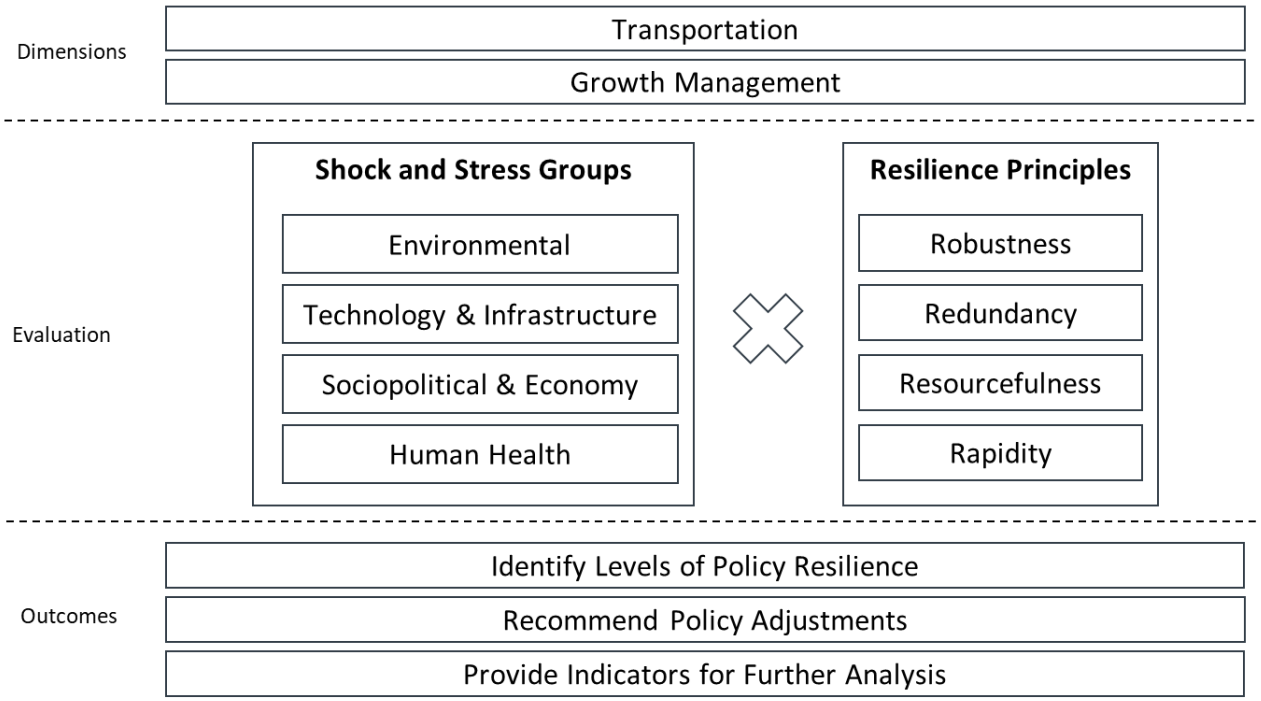


Figure 1: Regional Resilience Framework

The last step of the project was to undertake an assessment of the two long-range strategies, to determine gaps, and identify opportunities to further incorporate resilience into strategic planning. The following recommendations are highlighted as key initiatives that can be undertaken to improve resilience through regional action by Metro Vancouver and TransLink.

— **Review governance models** to determine opportunities for improved disaster risk reduction and response to regionally significant stresses and shocks. Establish and increase inter-agency

collaboration. Mechanisms and coordination committees need to be adapted to various hazards and risks.

- Support member jurisdictions in **adopting Hazard, Risk and Vulnerability Analysis** into their long-range planning procedures, and collecting a set of consistent data for baseline, trend, and monitoring purposes. Determine a **suite of asset-resilience indicators** to gauge vulnerability and resilience of assets over time. This recommendation will contribute to undertaking an HRVA with more information, precision, and confidence, and indicators will allow for a better understanding of implications of various shocks and stresses.
- Consider **developing a social vulnerability index** for Metro Vancouver, to anchor decisions to data and local community knowledge and experience, and also to illustrate where risk and vulnerability are located in the region. This could be connected with future HRVA efforts by municipalities and a regional index would help assess across municipal boundaries.
- Develop **safe-to-fail protocols** for regional infrastructure and assets. Regardless of how much preparation and investment takes place, there will be unanticipated and severe shocks that cause regional disruption.
- Undertake **infrastructure relationship mapping** with partners and member jurisdictions to strengthen understanding of system interdependencies. Stresses and shocks are frequently associated with one another, and require better understanding of cascading impacts stresses and shocks may have on infrastructure and operations.
- There is currently no coordinated effort in **developing regional data, modelling, and mapping of key hazards of concern**. Metro Vancouver and TransLink can act as regional convenors for mapping critical infrastructure, and support municipalities that lack the resources to undertake such a task.
- Take a leadership role in adding definition to **post-event intervention capability** among member jurisdictions, and formalizing **post-event reviews**. No two events will be exactly alike, but learning from shocks and stresses allows capacity and strategy to be developed over time.
- Continue developing **active transport and transit links** to improve resilience. Developing redundancy in low-cost, low-emission travel options aligns with priorities in both the RGS and RTS, and provides infrastructure for resilient modes.
- **Expand state of good repair programs** to cover stresses and shocks that are currently not discussed in the RGS or RTS (e.g., cyber attacks) and continually evaluate the state of **regional assets and services** (infrastructure, operations, funding). This will improve understanding of regional vulnerability and severity against a range of stresses and shocks.
- **Assessing social cohesion** is largely omitted from this evaluation, but could be considered in future assessments, along with opportunities to engage communities across the region, in analysis through to recommendations. Work with member jurisdiction to **address social inequity in communities across the region**, to decrease vulnerability to a wide range of stresses and shocks. Communities that tend to recover the fastest and most equitably from stresses and shocks are those that have strong social cohesion and can use this social capital in government decision-making, and to spur collective action.
- **Seek out demand-side solutions** (transportation demand management) before supply-side solutions (infrastructure expansion). Continuing to **focus growth** in Urban Centres and Frequent Transit Development Areas contribute to improved transportation performance and are resilient a wide range of stresses and shocks due to redundancy.

Recommendations for individual authorities and stress- and shock-specific recommendations can be found within the report, along with additional information on approach, and opportunities for next steps.

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FIGURES

1 INTRODUCTION

1.1 PROJECT CONTEXT

TransLink and Metro Vancouver are in the process of updating their long-range plans, the Regional Transportation Strategy (RTS), and the Regional Growth Strategy (RGS), respectively. These existing long-range plans were adopted in 2013 and 2011, and each comprises a package of strategies and actions to guide regional decision-making for transportation and growth management. These strategies are being reviewed, updated, and extended to the year 2050, considering new drivers of change and integrating the two strategies in a meaningful way to implement policy improvements in a number of areas. As part of the review process, three concurrent projects are being undertaken which focus on how climate, equity, and resilience are represented through the plans. While items related to resilience exist within each of these long-range plans, resilience was not considered in a comprehensive, structured, or explicit manner when the existing long-range plans were published. This report is an assessment of how resilience is currently addressed in these regional strategies, and provides recommendations for incorporating resilience into the Strategy updates. These future plans are referred to as Transport 2050 for TransLink, and Metro 2050 for Metro Vancouver, while the existing RTS and RGS are referred to with their acronyms.

This assessment defines resilience, develops a framework for assessing strategic resilience, highlights strategies that contribute to resilience, and identifies resilience gaps in the RTS and RGS. The assessment reviews resilience from a strategic perspective, regarding regionally significant stresses and shocks, with a focus on TransLink's and Metro Vancouver's mandates and powers. Emergency management and personal resilience have ties to the scope of this work, but are not the focus of the work, as seen in Figure 1 below.

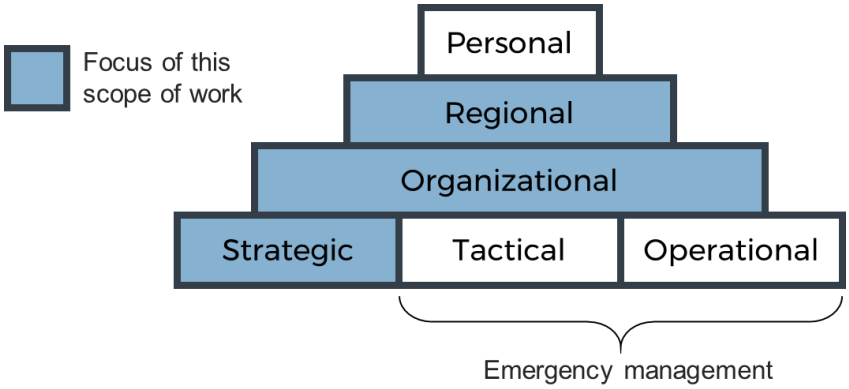


Figure 2: Conceptual Levels of Resilience (TransLink, 2020)

Several key questions guided the development of this project:

- What is a resilient region?
- How can we measure resilience?
- How can we assess the resilience of different policies, strategies, and actions?
- How should we incorporate a resilience assessment into decision-making?
- What existing strategies and actions improve resilience that the region should commit to continuing?
- What new strategies and actions could improve the resilience of regional growth management and transportation system management for consideration in Transport 2050 and Metro 2050?

A NOTE ON COVID-19

While COVID-19 is not the focus of this project, infectious disease is represented as one of many shocks, and is discussed in terms of how the strategies of these plans relate to COVID-19. Findings from this work may inform the rebuilding and recovery phase.

1.2 REPORT OVERVIEW

The report is split into the following sections and appendices. The body of the report presents a summary of findings and assessment approaches. The appendices provide technical details of the methodology and findings.

Section 2: Defining Regional Resilience

This section catalogues resilience attributes (e.g., resilience to what, resilience of what, resilience for whom), and establishes a working definition for regional resilience.

Section 3: Establishing a Resilience Evaluation Framework

This section describes the process undertaken to develop a regional resilience framework, highlighting key components observed in similar resilience frameworks from municipalities, regional authorities, government and non-government agencies, and academia. It also discusses modifications to make the proposed framework applicable to TransLink and Metro Vancouver.

Section 4: Undertaking the Resilience Assessment

This section provides an overview of the resilience assessment of the strategies within the RTS and RGS, and indicates the limitations of the assessment process.

Section 5: Summary of Recommendations

This section outlines a set of recommendations for TransLink and Metro Vancouver (for each agency separately as well as combined), and defines a high-level timeline determining whether it is a short-term or long-term action.

Section 6: Next Steps

This section provides concluding statements, next steps, and considerations for TransLink and Metro Vancouver.

Appendix A: Definitions Backgrounder

This appendix contains an annotated bibliography with definitions of resilience from a wide range of sources (academic, government agencies, and non-governmental organizations).

Appendix B: Framework Backgrounder

This appendix provides examples of resilience frameworks and components of resilience frameworks to complement the summary provide in Section 3.

Appendix C: Strategy Evaluation & Gap Assessment

This appendix provides a detailed strategy-by-strategy assessment from a resilience perspective for each strategy contained in the RTS and RGS. It includes a general resilience summary for each strategy, along with discussion and recommendations. It also includes a brief discussion on the state of resilience indicators and their applicability for hazard risk and vulnerability analysis (HRVA[1]).

Appendix D: External Review Comments

This appendix summarizes key comments from reviewers and recommendations for further refinements.

Appendix E: Glossary of Terms

There are several terms that are used in this report that may have different meanings in different contexts. A glossary of terms has been developed for ease of readability.

[1] HRVA is described in Section 3.2.

2 DEFINING REGIONAL RESILIENCE

2.1 RESILIENCE ATTRIBUTES

There are many published definitions of resilience and assessment frameworks for particular geographies and organizations. The first stage in assessing the strategies in the RTS and RGS for resilience was defining regional resilience in consideration of the mandate and powers of TransLink and Metro Vancouver. Several questions were considered prior to developing a definition for regional resilience (Table 1), which helped scope the extent of this review. Table 2 builds on these questions and summarizes common resilience attributes as seen in definitions from academic, municipal, and other government/non-governmental publications. These are divided into primary and secondary attributes. Evaluation for this project was limited to primary attributes to maintain a manageable assessment length. Future resilience evaluations could consider adding secondary attributes for a more wide-ranging assessment. These terms are expanded on in **Appendix E**.

Table 1: Questions for Defining Resilience

Question	Response
Resilience for whom?	The Metro Vancouver population, regional travellers, and visitors.
Resilience of what?	Metro Vancouver & TransLink infrastructure, operations, and prioritization (and how long-range strategy supports these investments).
Resilience to what?	A wide range of shocks and stresses[2] within environmental, technological, infrastructure, sociopolitical, economic, and human health fields.

Table 2: Attributes of Resilience

Primary Attributes	Short Definition
Robustness	Ability of systems to withstand a given level of stress or demand without suffering degradation.
Redundancy	The extent to which systems are substitutable or capable of satisfying function in the event of disruption.
Resourcefulness	The capacity to identify problems, establish priorities, and mobilize resources when conditions exist that threaten to disrupt a system.
Rapidity	The capacity to meet priorities in a timely manner, recover quickly, and to contain losses while avoiding future disruption.
Secondary Attributes	**Short Definition**
Reflective	Systems accepting of the inherent uncertainty and change in today's world, and using past experiences to inform future decisions.
Flexible/Adaptable	Implies that systems can change and evolve in response to changing circumstances.
Inclusive/Equitable	Emphasizes the need for broad consultation and engagement of communities, including the most vulnerable groups.
Integrated	Evaluating through a systems lens and understanding interdependencies. Promotes consistency in decisions and ensures investments are supportive of a common outcome.
Benefit-Cost	Determination of whether the anticipated benefits outweigh the anticipated costs for any planned investment to improve resilience.

[2] Shocks are sudden events such as earthquakes, floods, or cyber attacks. Stresses are chronic conditions that weaken a system on an ongoing or recurring basis, such as social inequity, and affordability.

2.2 REGIONAL RESILIENCE DEFINITION

With the above attributes and questions being considered, alongside the mandate and powers of TransLink and Metro Vancouver, the following definition of regional resilience was developed. The definition is largely based on work from Tierney and Bruneau (2007)[3] and the United Nations Office for Disaster Risk Reduction, or UNDRR (2015)[4]. This definition was the anchor for developing the framework outlined in the following section.

Regional resilience is the capacity of regional communities and organizations to prepare, avoid, absorb, recover and adapt to the effects of shocks and stresses in an efficient manner through the preservation, restoration, and adaptation of essential services and functions, while learning from shocks and stresses to build back better.

3 ESTABLISHING A RESILIENCE EVALUATION FRAMEWORK

3.1 RESILIENCE FRAMEWORK COMPONENTS

The resilience evaluation framework provides a consistent way to assess whether strategies in the RTS and RGS support regional resilience. A literature review was undertaken to identify template frameworks for consideration. However, few published examples were found that specifically evaluate policies/strategies for resilience. Therefore, the literature review pivoted to look at components underlying resilience frameworks. These components were then considered for application in the resilience framework for TransLink and Metro Vancouver. The main components observed in literature that were considered are summarized in Table 3. A more in-depth discussion of these components can be found in **Appendix B**.

Table 3: Components of Resilience Frameworks

Component	Explanation
Key Dimensions	Resilience frameworks require a central theme to determine what is being evaluated. For this project, the focus is regional growth management and the regional transportation system.
Stresses, Shocks, and Disruptions	Determining one or more stresses or shocks is required for most resilience assessments. For this project, TransLink and Metro Vancouver are interested in a wide range of stresses and shocks within environmental, technological, sociopolitical, economic, and human health fields. These groups generally follow UNDRR hazard classes with minor adjustments to align with stresses and shocks of interest to Metro Vancouver and TransLink.[5]
Impacted Assets and Vulnerability	Determining which assets are being assessed is another necessary component of a resilience framework. Metro Vancouver and TransLink infrastructure are the primary assets being assessed, with focus on how strategies within the RGS and RTS influence these assets.
Resilience Attributes and Principles	Assessing resilience is difficult without determining the attributes that best describe resilience. Robustness, redundancy, resourcefulness, and rapidity were selected as evaluation criteria based on resilience theory work by Tierney & Bruneau.[6]
Measurement and Evaluation	An evaluation framework requires a measurement process that is consistent and replicable. Guiding questions were developed for each of the resilience attributes.
Implementation	After evaluation takes place, there needs to be a way to implement findings. Outcomes from this project will be considered in the RGS and RTS updates.
Interdependencies	Consider interdependencies and cascading impacts for stresses/shocks and assets. E.g., an earthquake could destroy a dyke, increasing vulnerability to tsunamis.

[3] Tierney, K. & Bruneau, M. (2007) Conceptualizing and Measuring Resilience: A key to Disaster Loss Reduction
[4] UNDRR. (2015). Sendai Framework for Disaster Risk Reduction 2015-2030
[5] UNDRR. (2020). Hazard Definition & Classification Review – Technical Report. UN Office for Disaster Risk Reduction.
[6] Tierney, K. & Bruneau, M. (2007). Conceptualizing and Measuring Resilience: A Key to Disaster Loss Reduction

3.2 METRO 2050 / TRANSPORT 2050 REGIONAL RESILIENCE FRAMEWORK

Using other framework examples and integrating the above components from Table 3, a Regional Resilience Framework was developed for strategy assessment. Figure 2 below shows the dimensions, evaluation structure and outcomes that are part of the Metro 2050 / Transport 2050 Regional Resilience Framework. In brief, the dimensions of transportation and growth management (through the RTS and RGS) are evaluated through resilience principles as they pertain to stress and shock groups. The evaluation leads to identifying levels of policy resilience within the RTS and RGS, provides strategy recommendations, and provides commentary on indicators for further analysis. The evaluation is further explained in **Section 4** and **Appendix C**.

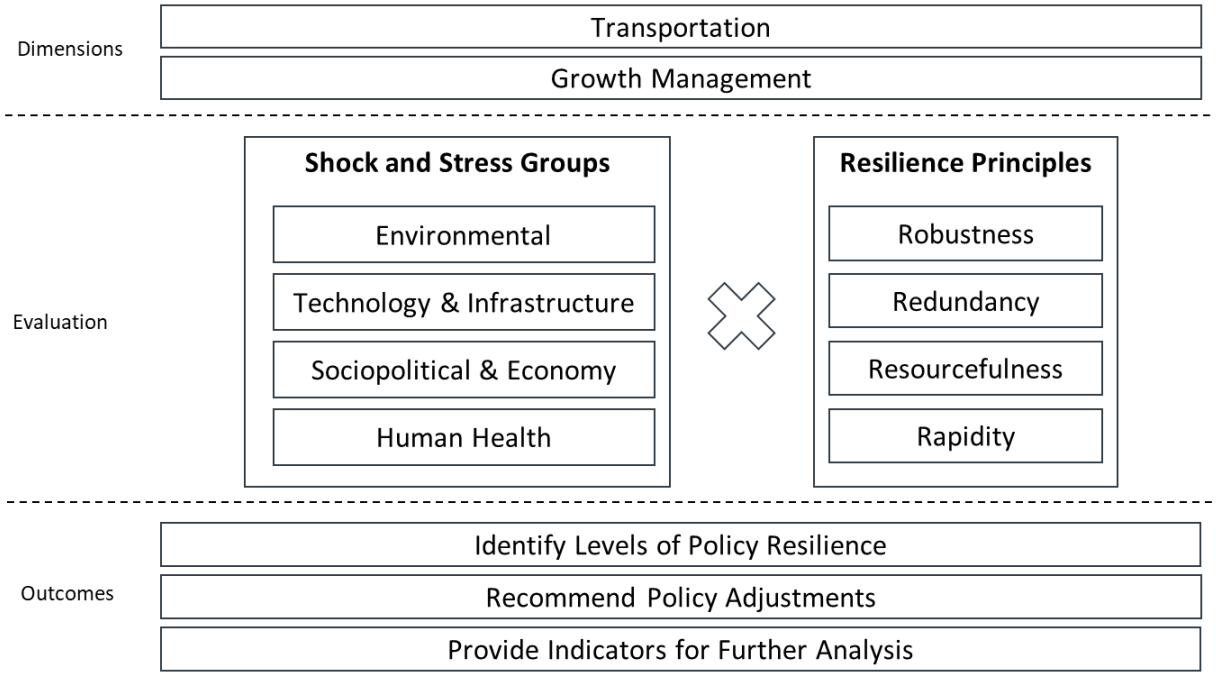


Figure 3: Metro 2050 / Transport 2050 Regional Resilience Framework

A NOTE ON FURTHER ANALYSIS

The measurement and evaluation of resilience was discussed in detail as there was insufficient data to assess strategy resilience quantitatively for most stresses/shocks. Accordingly, a recommendation from this project is to establish appropriate indicators so that detailed hazard analysis can take place going forward.

There are existing frameworks that are applicable for this style of analysis and assessment. One example is the Hazard, Risk, and Vulnerability Analysis (HRVA) framework. An HRVA helps address vulnerabilities, mitigate hazards, and prepare for response to, and recovery from, a range of hazard events. This assists communities (and regions) in better understanding disaster risk, which is a top priority in the UN Sendai Framework for Disaster Risk Reduction.[7] Emergency Management BC has already developed an HRVA tool and companion guide to assist with this process.[8] Once indicators and baseline data have been established with the adoption of the updated long-range strategies, it will be appropriate to undertake specific analysis pertaining to individual assets that TransLink and Metro Vancouver are responsible for, and focusing on a subset of stresses and shocks, rather than reviewing the wide range that is included in this project process.

An HRVA will continue to be an applicable tool for further analysis on an ongoing basis led by TransLink and Metro Vancouver after the adoption of Transport 2050 and Metro 2050.

[7] UNDRR. (2015). Sendai Framework for Disaster Risk Reduction.
[8] Emergency Management BC. (2020). Hazard, Risk and Vulnerability Analysis (HRVA) for Local Authorities and First Nations.

4 UNDERTAKING THE RESILIENCE EVALUATION

4.1 EVALUATION APPROACH

The resilience of existing strategies in the RTS and RGS was evaluated against a wide range of stresses and shocks, which were clustered into four groups. These groups generally follow UNDRR hazard classes with minor adjustments to align with stresses and shocks of interest to Metro Vancouver and TransLink.[9]

The list of shocks and stresses is not meant to be inclusive of everything that Metro Vancouver and TransLink should be prepared to navigate. This list is meant to posit a broad-enough set of disruptions such that the resilience of strategies can be evaluated, allowing more critical assessment to occur going forward. As outlined in **Section 3.2**, in order to prioritize preparedness, a comprehensive HRVA should be undertaken by TransLink and Metro Vancouver for stresses and shocks presented within this report.

Table 4: Shock and Stress Groups

Environmental	Technology & Infrastructure	Sociopolitical & Economy	Human Health
• Flooding • Snowstorms • Windstorms • Air Pollution • Wildfire & Smoke • Landslides • Earthquakes • Natural Resource Depletion • Climate Change	• Cyber Attacks • Industrial Incidents • Transport Incidents (Road & Rail) • Power Network and Energy Supply Disruptions • Global Supply Chain Disruptions • Aging Infrastructure • Regional Food Supply Disruptions	• Terrorism • Aging Population • Unemployment • Unaffordability • Social Inequity • Immigration • Global Recession • War & Political Conflict	• Infectious Diseases • Chronic Disease • Mental Health

Stresses and shocks can range in severity and spatial impact, as well as the capabilities of those impacted (i.e., vulnerability). For the purposes of this evaluation, only regionally significant stresses and shocks were assessed. Figure 3 shows a conceptual diagram of what could constitute a "regionally significant" stress or shock, while recognizing that severity and spatial impact play a role in this determination. A few regionally significant stresses and shocks are provided below:

- A multi-lane incident on Highway 1 would be a regionally significant event, disrupting many travellers across the region. Meanwhile, a smaller incident on a local road, while still impactful to some individuals, is unlikely to present a regional disruption and, therefore, is not regionally significant.
- A snowstorm that results in SkyTrain service failure, along with road-related closures would constitute a regionally significant event. Snowfall that results in sporadic slowdowns of local transport systems would not be regionally significant.

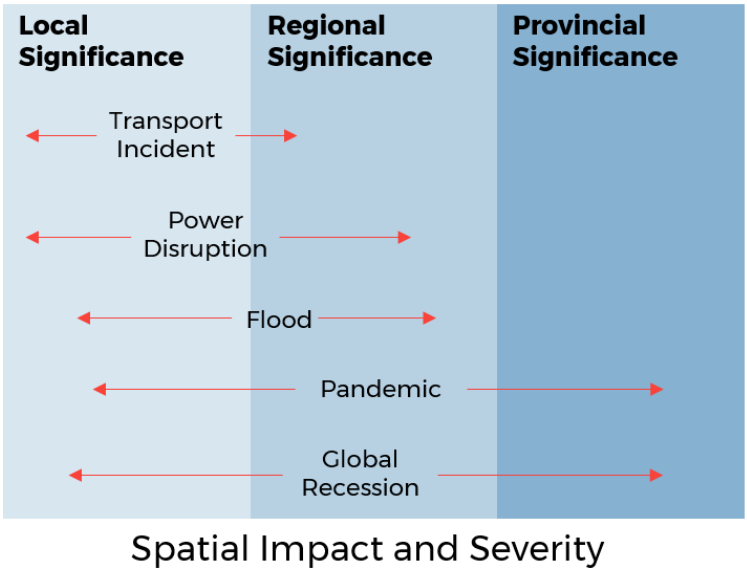


Figure 4: Conceptual diagram of regionally significant stresses and shocks

[9] UNDRR. (2020). Hazard Definition & Classification Review – Technical Report. UN Office for Disaster Risk Reduction.

- An ongoing progression of air quality advisory days is a regionally significant stress. A single air quality advisory day in a given year would not be. Similar rationale could be applied to number of heat warning days in a given period compared to a single event.

There are many interdependent stresses and shocks that may impact or amplify the severity of others. For example, climate change is expected to exacerbate several stresses and shocks in the environmental group and bring new hazards to the region like sea level rise, extreme precipitation, and summer heat waves. Similarly, increasing social inequity will exacerbate impacts and vulnerability for many other shocks and stresses above, such as homelessness and exposure to extreme cold/heat events. This may impact the ability of Metro Vancouver and TransLink to respond effectively. Furthermore, from a temporal perspective, some shocks could result in ongoing stresses.

This assessment identifies which strategies within the RGS and RTS are anticipated to help, hinder or not impact regional resilience. Each strategy is evaluated against four principles: Robustness, Redundancy, Resourcefulness, and Rapidity, as discussed in **Section 3** of this report.[10] Guiding questions were developed for these four principles to aid the evaluation as shown in Table 5 below.

Table 5: Resilience Principles and Guiding Questions

Robustness	Redundancy	Resourcefulness	Rapidity

Does the strategy…
• contribute to **withstanding stresses/shocks** while minimizing degradation or loss of function?
• contribute to **improving the quality** of an asset, operation, or program?
• contribute to **safe-to-fail outcomes** so that vulnerability is decreased?
• **reduce the risk** that an asset or operation will fail against a stress/shock?
	Does the strategy…
	• provide **alternative strategies** or supplies for navigating stresses/shocks?
	• contribute to **additional components** of an asset, network, operation or program to allow for ongoing functioning in case there is a failure of primary components?
		Does the strategy…
		• **contribute capacity to identify problems**, establish priorities, or mobilize resources for navigating stresses/ shocks?
		• **contribute to improved coordination** among partner agencies?
		• **add resources available to respond** to a stress/shock?
		• **clarify responsibilities and relationships** for preparation and response?
			Does the strategy…
			• **contribute to improved efficiency** by:
			  • meeting priorities in a timeline fashion?
			  • Adding to planning response process?
			  • Creating early detection capabilities?

4.2 LIMITATIONS

This study is a first step in beginning a culture shift of incorporating resilience into decision-making at the strategic level. More work can be done to build on the initial analysis undertaken in this report. The strategy evaluation tables and discussions in **Appendix C** can be built up on to conclusively assess likelihood, severity, and vulnerability across various shocks and stresses. Increasing data availability through performance indicators and monitoring can build upon the initial analysis included within this report to undertake a more comprehensive and data-driven investigation. While there are limitations to the depth of analysis included in this report due to data availability, it remains a valuable starting point for driving the conversation of regional resilience, and the role regional authorities have. As is the case with all policy analysis, resourcing is what is impactful. Embedding a feasibility analysis and tying costs and trade-offs along with HRVA work undertaken in the future would aid in determining key investments needed to improve the resilience in the region

[10] Tierney, K. & Bruneau, M. (2007) Conceptualizing and Measuring Resilience: A key to Disaster Loss Reduction

5 SUMMARY OF RECOMMENDATIONS

Each strategy in the RGS and RTS (14 in each) was assessed for robustness, redundancy, resourcefulness, and rapidity against the four shock and stress groups for its anticipated contribution towards resilience (positive, negative, mixed, or no significant contribution). After review of gaps within strategies and gaps between strategies, the following are recommended as key considerations for the Transport 2050 and Metro 2050 updates for better incorporating resilience into long-range transportation and growth management planning. Recommendations are listed below both agencies (MV/TL), and for Metro Vancouver (MV) and TransLink (TL) separately along with a high-level indication of timeline, listed as *short-term* for recommendations to undertake in the next 10 years or *ongoing* for recommendations to undertake throughout the life span of these strategies (i.e., 2050). Recommendations for specific strategies and gaps between strategies can be found in **Appendix C**.

Table 6: Summary of Recommendations and Timeline

Recommendation	Agency	Timeline
Review governance models to determine opportunities for improved disaster risk reduction and response to regionally significant stresses and shocks. Establish and increase inter-agency collaboration. Mechanisms and coordination committees need to be adapted to various risks.	MV/TL	Ongoing
Support member jurisdictions in adopting **Hazard, Risk and Vulnerability Analysis** into their long-range planning procedures, and collecting a set of consistent data for baseline, trend, and monitoring purposes. Determine a **suite of asset-resilience indicators** to gauge vulnerability and resilience of assets over time. This recommendation will contribute to undertaking an HRVA with more information, precision, and confidence, and indicators will allow for a better understanding of implications of various shocks and stresses.	MV/TL	Short-term
Consider **developing a social vulnerability index** for Metro Vancouver, to anchor decisions to data and local community knowledge and experience, and also to illustrate where risk and vulnerability are located in the region. This could be connected with future HRVA efforts by municipalities and a regional index would help assess across municipal boundaries.	MV/TL	Ongoing
Develop **safe-to-fail protocols** for regional infrastructure and assets. Regardless of how much preparation and investment takes place, there will be unanticipated and severe shocks that cause regional disruption.	MV/TL	Ongoing
Undertake **infrastructure relationship mapping** with partners and member jurisdictions to strengthen understanding of system interdependencies. Stresses and shocks are frequently associated with one another, and require better understanding of cascading impacts stresses and shocks may have on infrastructure and operations.	MV/TL	Ongoing
There is currently no coordinated effort in **developing regional data, modelling, and mapping of key hazards of concern**. Metro Vancouver and TransLink can act as regional convenors for mapping critical infrastructure, and support municipalities that lack the resources to undertake such a task.	MV/TL	Short-term
Take a leadership role in adding definition to **post-event intervention capability** among member jurisdictions, and formalizing **post-event reviews.** No two events will be exactly alike, but learning from shocks and stresses allows capacity and strategy to be developed over time.	MV/TL	Ongoing
Continue developing **active transport and transit links** to improve resilience. Developing redundancy in low-cost, low-emission travel options aligns with priorities in both the RGS and RTS, and provides infrastructure for resilient modes.	MV/TL	Short-term
Expand state of good repair programs to cover stresses and shocks that are currently not discussed in the RGS or RTS (e.g., cyber attacks) and **continually evaluate the state of regional assets and services** (infrastructure, operations, funding). This will improve understanding of regional vulnerability and severity against a range of stresses and shocks.	MV/TL	Ongoing
Assessing social cohesion is largely omitted from this evaluation, but could be considered in future assessments, along with opportunities to engage communities across the region, in analysis through to recommendations. Work with member jurisdiction to **address social inequity in communities across the region**, to decrease vulnerability to a wide range of	MV/TL	Ongoing

stresses and shocks. Communities that tend to recover the fastest and most equitably from stresses and shocks are those that have strong social cohesion and can use this social capital in government decision-making, and to spur collective action.		
Seek out demand-side solutions (transportation demand management) before supply-side solutions (infrastructure expansion). Continuing to **focus growth** in Urban Centres and Frequent Transit Development Areas contribute to improved transportation performance and are resilient a wide range of stresses and shocks due to redundancy.	MV/TL	Ongoing
Focus on **improving the robustness** of the transportation system (physical, organizational, and financial) as the region will be increasingly reliant on certain portions of the transportation system as growth occurs in UC/FTDAs. A number of RTS initiatives are already being pursued to improve the level of robustness, but it could be **expanded to non-physical assets** and also include a response to emerging stresses and shocks, such as cyber attacks.	TL	Ongoing
The **effects and feedback from non-transportation-related shocks** and stresses could be further incorporated into Transport 2050. This includes a greater focus on affordability and social equity.	TL	Short-term
Include a greater **focus on building resources for rapid response and recovery**. This includes capacity-building prior, during, and after various events, and improved collaboration and coordination with partners in the region.	TL	Short-term
Add actions that specifically speak to increasing resilience in the region. This should speak to Metro Vancouver's role and leadership in providing robust and redundant infrastructure. It should speak to expectations from member jurisdictions. It should highlight partnerships, expectations, roles, and coordination capabilities for preparing and responding to both shocks and stresses. This would provide an opportunity to speak specifically to robustness, redundancy, resourcefulness, and rapidity in Metro 2050.	MV	Short-term
Incorporate the **updated regional greenways network** into Metro 2050 to provide redundancy and options for travellers in the region.	MV	Short-term
Any strategy to reduce GHG emissions should be coupled with **considerations for climate resilience**, to promote adaptability in the face of climate change. Include integration of climate resilience as a **required procurement criterion** for all infrastructure projects.	MV	Short-term
Clearly articulate what is required in Regional Context Statements **for withstanding climate change impacts**. Metro Vancouver can support this initiative by developing templates for specific stresses and shocks that would allow member jurisdictions to select appropriate requirements based on the hazards they anticipate facing.	MV	Short-term

6 NEXT STEPS

This study assessed regional resilience of TransLink's and Metro Vancouver's long-range strategies – the Regional Transportation Strategy and the Regional Growth Strategy. This report identifies several recommendations for consideration as the agencies update and finalize Transport 2050 and Metro 2050.

Resilience has played a limited and unstructured role to date in strategic decision-making at the regional level in Metro Vancouver. This report is a first step in starting a culture shift to incorporating resilience into decision-making from a strategic perspective. Beyond recommendations listed above, the following steps will aid in establishing resilience as part of the strategic decision-making process in years to come:

1. Incorporate key indicators and monitoring processes into Transport 2050 and Metro 2050 so that data and trends can be analyzed on an ongoing basis for hazard risk and vulnerability;
2. Align the framework developed in this report with hazard risk and vulnerability analysis for independent shock and stress assessments that provide a greater level of detail and precision; and
3. Review Transport 2050 and Metro 2050 on an ongoing basis to ensure resilience is being considered in strategic decision-making.

APPENDIX A – DEFINITIONS BACKGROUNDER

OVERVIEW

This appendix includes definitions of resilience. As Figure 1 outlines, the scope of this project is focused on regional, organizational, and strategic resilience. The definitions review follows these bounds.

This literature review of resilience definitions is split into 4 sections:

- Academic literature focused on resilience;
- Resilience Strategies From 100 Resilient Cities;
- Resilience Reports & Strategies from NGOs And Government Agencies; and
- Other Reports Reviewed Without Resilience Definitions

ACADEMIC LITERATURE FOCUSED ON RESILIENCE

Lead Agency / Author	Bruneau, M. et al.
Publication Title	A Framework to Quantitatively Assess and Enhance the Seismic Resilience of Communities
Year	2003

Background and Purpose:
The paper presents a conceptual framework to define seismic resilience of communities and quantitative measures of resilience that can be useful for a coordinated research effort focusing on enhancing resilience. The framework relies on complementary measures of resilience: reduced failure probabilities, reduced consequences from failures, and reduced time to recovery. The measures are integrated into four dimensions of community resilience: technical, organizational, social, and economic, which can be used to quantify measures of resilience for various types of physical and organizational systems.

Definition(s) of Resilience:

- One dictionary definition defines resilience as **"the ability to recover quickly from illness, change, or misfortune."**
- Resilience has been defined as **"the capacity to cope with unanticipated dangers after they have become manifest, learning to bounce back".**
- **"The ability of a system to withstand stresses of 'environmental loading' … a fundamental quality found in individuals, groups, organizations, and systems as a whole."**
- **"The capacity to adapt existing resources and skills to new situations and operating conditions."**
- Community seismic resilience is defined as **"the ability of social units (e.g., organizations, communities) to mitigate hazards, contain the effects of disasters when they occur, and carry out recovery activities in ways that minimize social disruption and mitigate the effects of future earthquakes."**

Lead Agency / Author	Tierney, K. and Bruneau, M.
Publication Title	Conceptualizing and Measuring Resilience A Key to Disaster Loss Reduction
Year	2007

Background and Purpose:
The paper presents ways to conceptualize and measure disaster resilience, define disaster resilience, develop measures appropriate for assessing resilience, and demonstrate the utility of the concept through research. The Multidisciplinary Center for Earthquake Engineering Research (MCEER), developed a framework that focused on resilience including concepts from ecology, economics, engineering, organizational research, and psychology. The R4 framework of resilience includes the following:

- **Robustness**—the ability of systems, system elements, and other units of analysis to withstand disaster forces without significant degradation or loss of performance;
- **Redundancy**—the extent to which systems, system elements, or other units are substitutable, that is, capable of satisfying functional requirements, if significant degradation or loss of functionality occurs;

- **Resourcefulness**—the ability to diagnose and prioritize problems and to initiate solutions by identifying and mobilizing material, monetary, informational, technological, and human resources; and
- **Rapidity**—the capacity to restore functionality in a timely way, containing losses and avoiding disruptions.

Definition(s) of Resilience:

- Resilience reflects a concern for improving **"the capacity of physical and human systems to respond to and recover from extreme events."**
- **"the ability of social units (e.g., organizations, communities) to mitigate hazards, contain the effects of disasters when they occur, and carry out recovery activities in ways that minimize social disruption and mitigate the effects of future disasters"** *(MCEER)*

Lead Agency / Author	University of Toronto - John H. Daniels Faculty of Architecture, Landscape, and Design
Publication Title	Resilience Planning Guide
Year	2017

Background and Purpose:

This guide is intended to assist engineers, architects, constructors, and building owners become aware of how to better plan for the improved security of inhabitants, maintain the continuity of business operations/services, and to enhance the protection of building assets. The guide includes built environment resilience strategies, resilient building enclosure design, integrative design for resilience, and emergency planning. The guide includes the following 10 principles when designing for resilience: 1) Resilience transcends scales, 2) Resilient systems provide for basic human needs, 3) Diverse and redundant systems are inherently more resilient, 4) Simple, passive, and flexible systems are more resilient, 5) Durability strengthens resilience, 6) Locally available, renewable, or reclaimed resources are more resilient, 7) Resilience anticipates interruptions and a dynamic future, 8) Find and promote resilience in nature, 9) Social equity and community contribute to resilience, and 10) Resilience is not absolute.

Definition(s) of Resilience:

- **"The act of rebounding or springing back"**
- **"The capacity to adapt to changing conditions and to maintain or regain functionality and vitality in the face of stress or disturbance."**

Lead Agency / Author	Kythreotis, A. P. & Bristow, G. I.
Publication Title	The 'resilience trap': exploring the practical utility of resilience for climate change adaptation in UK city-regions
Year	2016

Background and Purpose:

This paper examines how adaptation is interpreted across different UK city-regions, finding that the discourse of adaptation is giving way to resilience. Resilience has greater appeal as a framing device over adaptation given its potential to enable buy-in from a wider city-regional governance network. The paper also highlights the 'resilience trap': the dangers of adopting short-term strategies, and re-badging existing strategies. The paper reflects on ways that government actors may act to avoid the resilience trap.

Definition(s) of Resilience:

- The socio-ecological notion of resilience defined as **"the ability of human communities to withstand external shocks and to recover".**
- Engineering conception of resilience: **"the resistance of a system to shocks and the speed of its return or 'bounce-back' to a pre-shock state or equilibrium".**
- Ecological conception: **"A system's ability to withstand or absorb changes of state variables as well as its capacity to respond and recovery quickly from a shock and thus to return to an equilibrium state after a temporary disturbance".**
- *[This paper goes on to explain that many agencies are using adaptation and resilience interchangeably and that the definition of resilience is fuzzy and that resilience can mean different things to different people.]*

Lead Agency / Author	Pendall, R., Foster, K. A., and Cowell, M.
Publication Title	Resilience and regions: Building understanding of the Metaphor
Year	2007

Background and Purpose:
This paper reviews literature that explains and extends the meaning of resilience across several fields: ecology, psychology, economics, disaster studies, geography, political science, and archaeology. There are several common themes that may apply to metropolitan economic, social, political and environmental dynamics. The paper goes on to explore four themes of resilience: equilibrium, systems perspective, path-dependence, and the long-view. Given the many factors shaping regional impacts and responses, regional resilience is inevitably highly complex. We expect it to vary by scale (local to global) and time (immediate to slow-moving), the paper suggests that an array of studies—of small-scale impacts in the short term for a modest challenge to large-scale impacts over a long period are necessary.

Definition(s) of Resilience:

- A first definition of resilience ("engineering resilience") **"concentrates on stability at a presumed steady-state, and stresses resistance to a disturbance and the speed of return to the equilibrium point"**
- The important measure of resilience is **"the magnitude or scale of disturbance that can be absorbed before the system changes in structure by the change of variables and processes that control system behaviour. Resilience in this context is a measure of robustness and buffering capacity of the system to changing conditions."**

Lead Agency / Author	Aldrich, D. P. and Meyer, M.
Publication Title	Social Capital & Community Resilience
Year	2014

Background and Purpose:
This article highlights the critical role of social capital and networks in disaster survival and recovery and lays out recent literature and evidence on the topic. The article concludes with policy recommendations for disaster managers, government decision makers, and NGOs for increasing resilience to catastrophe through strengthening social infrastructure at the community level. One proven way to increase levels of social capital in communities has come from the practices of time banking and community currency. Another way to increase trust and social cohesion comes from focus group meetings and social events (e.g., parades, fairs, block parties). A final way to increase social capital is through the deliberate and careful planning of community layout and architectural structures. The physical layout of communities affect creation and maintenance of social capital (e.g., introduction of third places that are not residential locations such as coffee shops, bookstores, bars, salons, public squares, and libraries).

Definition(s) of Resilience:
Community resilience describes **"the collective ability of a neighborhood or geographically defined area to deal with stressors and efficiently resume the rhythms of daily life through cooperation following shocks."**

Lead Agency / Author	Patel, S. S. et al.
Publication Title	What Do We Mean by 'Community Resilience'? A Systematic Literature Review of How It Is Defined in the Literature
Year	2017

Background and Purpose:
This report undertakes a literature review of definitions of community resilience related to disasters. Further, a thematic analysis was undertaken to determine proposed characteristics of community resilience prior to, during, and after a disaster. Eighty relevant papers were identified, with no evidence of a common agreed upon definition of community resilience. However, nine core elements of community resilience were common among definitions: 1) local knowledge, 2) community networks and relationships, 3) communication, 4) health, 5) governance and leadership, 6) resources, 7) economic investment, 8) preparedness, and 9) mental outlook. A focus on individual elements may be more productive than attempting to define and study community resilience as a distinct topic.

Definition(s) of Resilience:

- The Communities Advancing Resilience Toolkit (CART) describes a resilient community as one that **"has the ability to transform the environment through deliberate, collective action" and "requires that the community as a whole must cope effectively with and learn from adversity".**
- **The Conjoint Community Resilience Assessment Measure (CCRAM) defines community resilience as "the community's ability to withstand crises or disruptions".**
- *Lemyre and colleagues* called the construct of resilience **"a process or the attainment of positive outcomes at the individual, family, and community levels despite adversity (e.g., natural disaster, terrorist attack).**
- *Norris and colleagues* defined community resilience as **"a process linking a set of networked adaptive capacities to a positive trajectory of functioning and adaptation in constituent populations after a disturbance".**
- *Paton and colleagues, Norris and colleagues, Cox and Perry* defined community resilience as **"a reflection of people's shared and unique capacities to manage and adaptively respond to the extraordinary demands on resources and the losses associated with disasters".**
- *Castleden and colleagues* defined community resilience as **"a capability (or process) of a community adapting and functioning in the face of disturbance".**
- *Gibson* stated in a paper exploring the 2009 Victorian Bushfire in Australia that **" … resilience is not a process, it is not a management system standard, nor is it a consulting product. Resilience is a demonstrable outcome of an organization's capability to cope with uncertainty and change in an often volatile environment. Resilience is thus a product of an organization's capabilities interacting with its environment".**
- *UK Cabinet Office* which defined community resilience, as **"communities and individuals harnessing local resources and expertise to help themselves in an emergency, in a way that complements the response of the emergency services".**
- Research carried out by *Coles and Buckle* into community resilience in Australia and the United Kingdom, led them to see resilience as **"a multi-dimensional attribute that in its different forms contributes in various but equally important ways to disaster recovery".**
- *Ostadtaghizadeh and colleagues* produced a definition of community resilience now used by the United Nations International Strategy for Disaster Reduction: **the "ability of a system, community, or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner including through the preservation and restoration of its essential basic structures and functions".**
- *Pfefferbaum and colleagues* generally defined resilience **"as an attribute (e.g., ability, capacity), a process, and/or an outcome associated with successful adaption to, and recovery from adversity" and that it "differs depending on context and purpose".**

Lead Agency / Author	Maru, Y. T.
Publication Title	Resilient Regions: Clarity Of Concepts And Challenges To Systemic Measurement
Year	2010

Background and Purpose:

This paper reviews concepts of regional resilience that lack clarity and are understood differently by different people in an attempt to provide clarity of meaning and to contribute to a shared understanding of the concepts among both researchers and practitioners. The paper emphasizes systems approaches to regional resilience and highlights related measurement challenges.

Definition(s) of Resilience:

- Resilience often refers to **"a system's ability to absorb perturbation and still maintain the same key structures and functions and therefore identity".** *(Walker et al., 2002)*

- An important prerequisite question in resilience assessment is "resilience of what to what?" For examples, if the disturbance of concern or the answer to "resilience to what?" is a hurricane, then the proximity to coast might matter thus, in response to the "resilience of what" question, one can identify coastal and inland regions.
- According to the Oxford English Dictionary resilience is a common term derived from the Latin word "resilire" meaning **to 'leap back'**.
- In hazards studies, a city, a community or a region is called resilient if it has **"the capacity to reduce or avoid losses, contain the effects of disaster and recover with minimal social disruptions".** *(Tierney & Bruneau, 2007)*
- In climate change studies *Timmerman (1981)* defined resilience as "**the measure of a system's or part of a system's capacity to absorb and recover from the occurrence of a hazardous event".**
- In economic studies, "**recovery to pre-shock levels and trajectories of economic performance"** are considered as measures of resilience *(Hill et al., 2008).*
- In national security studies resilience is defined as "**an ability of a nation-state, to cope, adapt and preserve social cohesion when it is confronted by external and internal stresses caused by socio-political change and/or violent disturbances such as a terrorist attack**" *(Long, 2008).*
- From an ecological position, resilience is a **"measure of the persistence of systems and of their ability to absorb change and disturbance and still maintain the same relationships between populations or state variables"** *(Holling, 1973)*
- Engineering resilience refers to **"the extent of resistance to disturbances and the speed at which a system returns to stable state following a disturbance"** *(Pimm, 1991)*
- **"The amount of change that a system can undergo while still maintaining the same controls on structure and function; the system's ability to self-organize; and the degree to which the system is capable of learning and adaptation**." *(Carpenter et al., 2001)*
- *Walker et al (2004)* characterise resilience of a system as having four crucial dimensions:
    - **Latitude: the maximum amount a system can be changed before losing its ability to recover**
    - **Resistance: the ease or difficulty of changing the system; how resistant it is to being changed.**
    - **Precariousness: how close the current state of the system is to a limit or threshold.**
    - **Panarchy: because of cross-scale interactions, the resilience of a system at a particular focal scale will depend on the influences from states and dynamics at scales above and below.**

Lead Agency / Author	Dawley, S., Pike, A., and Tomaney, J.
Publication Title	Towards the Resilient Region?
Year	2010

Background and Purpose:

The article critiques static notions of resilience and advances a more dynamic approach to explain local and regional resilience. It also seeks to address the widening gap between resilience thinking and its transfer to practical policy prescription. A case study from north-east England is used to demonstrate the enduring role of policy intervention in stimulating change and building resilience in peripheral regions.

Definition(s) of Resilience:

- There are two popular and interrelated strands of resilience thinking. The first is the notion of resistance, the ability of places to resist disruptive changes. The second is the ability of regions to be able to 'bounce-back' or come back from economic shocks and disruptions.
- **"The ability of a socio-economic system to recover from a shock or disruption".**
- **"The ability of a regional economy to maintain a pre-existing state in the presence of some type of exogenous shock".**
- **"The extent to which a regional or national economy that has experienced an external shock is able to return to its previous level and/or growth rate of output, employment or population".**
- Engineering resilience defines resilience on the basis of elasticity: **"a system's ability to resist disturbance and/or the speed of its return to a pre-existing equilibrium or steady state."**

Lead Agency / Author	Williams, T. A. et al.
Publication Title	Organizational Response to Adversity: Fusing Crisis Management and Resilience Research Streams
Year	2017

Background and Purpose:
This paper reviews the literatures on crisis management and resilience and discusses opportunities to integrate and advance these streams of research. Crisis-as-an-event and crisis-as-a-process are both reviewed. An integrative framework is developed around key themes of both crisis and resilience, including capabilities for durability, organizing and adjusting, responding to major disturbances, and a feedback loop from these experiences.

Definition(s) of Resilience:

- Resilience generally has been used to describe **"organizations, systems, or individuals that are able to react to and recover from duress or disturbances with minimal effects on stability and functioning".** *(Linnenluecke, 2015; Sutcliffe & Vogus, 2003)*
- **"The capacity to cope with unanticipated dangers as they become manifest, learning to bounce back."** *(Wildavsky, 1988)*
- The **"capacity of a social system (e.g., an organization, city, or society) to proactively adapt to and recover from disturbances that are perceived within the system to fall outside the range of normal and expected disturbance."** *(Boin, Comfort, and Demchak, 2010)*
- **"The process by which an actor (i.e., individual, organization, or community) builds and uses it capability endowments to interact with the environment in a way that positively adjusts and maintains functioning prior to, during, and following adversity."**

Lead Agency / Author	Ettouney, M. M.
Publication Title	Resilience & Risk Management
Year	2016

Background and Purpose:
This presentation was delivered at the National Institute of Building Sciences Conference and Expo 2016. It provides several graphics of resilience as a function of recovery time and operational level and quality. It introduces the R4 framework (Robustness, resourcefulness, recovery, and redundancy).

Definition(s) of Resilience:
Resilience is **"the ability to reduce the magnitude and/or duration of disruptive events. The effectiveness of a resilient infrastructure or enterprise depends upon its ability to anticipate, absorb, adapt to, and/or rapidly recover from a potentially disruptive event".**

Lead Agency / Author	Mitchell, T. and Harris, K. (Overseas Development Institute (ODI))
Publication Title	Resilience: A risk management approach
Year	2012

Background and Purpose:
This background note provides an overview of integrating resilience into the context of development planning. It highlights the slow drivers of change that influence systems and the potential for non-linearity and transformation processes. Programming resilience means supporting interventions to increase diversity, connectivity, learning, reflexivity, redundancy, equity, inclusion and cohesion, while brokering the blending of knowledge.

Definition(s) of Resilience:

- **"The ability of a system and its component parts to anticipate, absorb, accommodate, or recover from the effects of a shock or stress in a timely and efficient manner."** *(Based on IPCC Special Report on Extreme Events).*

- Recent literature *(e.g., Norris et al., 2008)*, including this Background Note, have tended to focus on resilience more as a process than an outcome, involving learning, adaptation, anticipation and improvement in basic structures, actors and functions.
- *Bahadur et al. (2010*), identify characteristics of a resilient system that can be synthesised as follows:
    - **a high level of diversity, in terms of access to assets, voices included in decision-making and in the availability of economic opportunities**
    - **level of connectivity between institutions and organisations at different scales and the extent to which information, knowledge, evaluation and learning propagates up and down across these scales**
    - **the extent to which different forms of knowledge are blended to anticipate and manage processes of change**
    - **the level of redundancy within a system, meaning some aspects can fail without leading to whole system collapse**
    - **the extent to which the system is equal and inclusive of its component parts, not distributing risks in an imbalanced way**
    - **the degree of social cohesion and capital, allowing individuals to be supported within embedded social structures.**

Lead Agency / Author	Huang, W. and Ling, M.
Publication Title	System resilience assessment method of urban lifeline system for GIS
Year	2018

Background and Purpose:
The paper proposes a system resilience evaluation indicators framework with an algorithm to dynamic assign weights and classify resilience levels. Indicators were nested under five dimensions: 1) Materials and Environmental Resources, 2) Society and Well-being, 3) Economy, 4) Built Environment and Infrastructure, and 5) Governance and Institutes. A GIS-based platform was used for spatial visualization. The framework and visualization were applied to an urban water supply system.

Definition(s) of Resilience:
System Resilience is defined as **"the ability of a system to withstand and recover from deliberate attacks, accidents, or naturally occurring threats or incidents".**

Lead Agency / Author	Da Silva, J., Kernaghan, S., and Luque, A.
Publication Title	A systems approach to meeting the challenge of urban climate change
Year	2012

Background and Purpose:
This article identifies the future challenges that cities face in their ability to create well-being, particularly for urban poor communities, as a result of the effects generated by climate change. It recommends a simplified conceptual model and resilience characteristics be used to analyse urban systems, along with spatial analysis, to target action at multiple levels to reduce exposure and improve the adaptive capacity of urban populations simultaneously.

Definition(s) of Resilience:

- Resilience is a broader concept which reflects **"the ability of a system to respond and reorganise or return to functional stability after a perturbation"**
- Definitions of resilience vary slightly, but they all link the concept to **"the ability to recover and achieve a stable state, after physical shocks and stresses".**
- The Intergovernmental Panel on Climate Change defines resilience as **"the ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organisation, and the capacity to adapt to stress and change".**

- Resilience in the context of cities has been defined as "**the degree to which cities are able to tolerate alteration before reorganising around a new set of structures and processes [which] can be measured by how well a city can simultaneously balance ecosystem and human functions".**

Lead Agency / Author	Levin, S.
Publication Title	Ecological Resilience
Year	2013

Background and Purpose:
This is an entry into Encyclopaedia Britannica. The author goes on to explain that ecological resilience has been an important concept in ecology and natural history based on Darwin's description of interdependencies between species. Ecological resilience is acknowledged as important to humans as well; the loss of an ecosystem's ability to recover from a disturbance, whether due to natural events such as hurricanes or volcanic eruptions or due to human influences such as overfishing and pollution, endangers the benefits (food, clean water, aesthetics) that humans derive from that ecosystem.

Definition(s) of Resilience:

- Ecological resilience, also called ecological robustness, **"is the ability of an ecosystem to maintain its normal patterns of nutrient cycling and biomass production after being subjected to damage caused by an ecological disturbance".**
- Resilience is **"the ability of a system to continue functioning amid and recover from a disturbance".**

Lead Agency / Author	Kirmayer, L. J. et al.
Publication Title	Rethinking Resilience from Indigenous Perspectives
Year	2011

Background and Purpose:
This article provides summaries of how indigenous populations across Canada have grappled with histories of adversity and examples of long-term resilience that allowed communities and individuals to persevere against difficult social realities that include displacements caused by colonization, subsequent loss of autonomy, political oppression, and bureaucratic control. This article looks primarily at psychological resilience of individuals and communities.

Definition(s) of Resilience:

- **"The ability to do well despite adversity"**
- **"The ability to return to an original state after being stressed, perturbed, or otherwise bent out of shape."** The author goes on to reject this definition as it is too static to capture human adaptation.

Lead Agency / Author	Meerow, S., Pajouhesh, P., and Miller, T.R.
Publication Title	Social Equity in Urban Resilience Planning
Year	2019

Background and Purpose:
This paper is a macro-study that reviews early releases from cities that are part of the 100 Resilient Cities initiative and analyses their approach in terms of equity. A tripartite framework of equity was developed by the authors that includes distributional, recognitional, and procedural dimensions and was used to analyse goals, priorities, and strategies of the plans. The analysis found that there was significant variation in consideration of equity through the ten plans reviewed and that there are clear areas for improvement.

Definition(s) of Resilience:
Resilience generally implies that **"cities accept disruptions and change as inevitable, and focus on enhancing the ability of institutions, the built environment, and communities to cope with them and adapt."**

Lead Agency / Author	Matin, N., Forrester, J., and Ensor, J.
Publication Title	What is equitable resilience?
Year	2018

Background and Purpose:

This article reviews what is equitable resilience. It questions whether resilience runs the risk of passivity, favouring the already advantaged and privileged existing social relations, or whether it creates opportunity for increasing equity. The authors find that equitable resilience is increasingly likely when resilience takes into account issues of social vulnerability and differential access to power, knowledge, and resources. The author suggests that resilience is a divisive rather than an integrating concept.

Definition(s) of Resilience:

- Equitable resilience is "the development of social-ecological systems that are contextually rooted, responsive to chance, and socially just, and thus relevant to global sustainability challenges".
- Resilience is **"the capacity of social-ecological systems to absorb disturbance and reorganize while undergoing change so as to you still retain essential the same function, structure, identity, and feedbacks"** *(Folke et al, 2005)*

Lead Agency / Author	Mackinnon, D. and Driscoll Derickson, K.
Publication Title	From resilience to resourcefulness: A critique of resilience policy and activism
Year	2012

Background and Purpose:

This paper highlights three points when critiquing the concept of resilience and how it has been applied to places. It highlights that the ecological concept of resilience is conservative when applied to social relations, that resilience is externally defined by state agencies and experts, and that the resilience of places is misplaced in terms of spatial scale, as processes that shape resilience operative primarily at a scale of capitalist social relations. The authors suggest that the concept of resourcefulness may be a more appropriative alternative approach for communities to foster.

Definition(s) of Resilience:

A table in the paper shows a wide range of resilience definitions:

Table 1. Selected definitions of resilience.

Author, date	Discipline	Level of analysis	Definition
Gordon, 1978	Physics	Physical system	The ability to store energy and deflect elasticity under a load without breaking or being deformed
Holling, 1973	Ecology	Ecological system	The persistence of relationships within a system; the ability of systems to absorb change and still persist
Resilience Alliance, undated	Ecology	Ecological system	The capacity to tolerate disturbance without collapsing into a qualitatively different state (http://www.resalliance.org/index.php/resilience)
Egeland et al., 1993	Psychology	Individual	The capacity for successful adaptation and functioning despite high risk, stress or trauma
Agder, 2000	Geography	Community	The ability of communities to withstand external shocks to their social infrastructure
Katz, 2004	Geography	Community	Ways in which people adapt to changing circumstances to get by and 'make do' through the exercising of autonomous initiative
Hill et al., 2008	Urban and regional development	Region	The ability of a region to recover successfully from shocks to its economy

RESILIENCE STRATEGIES FROM 100 RESILIENT CITIES

Lead Agency / Author	City of Vancouver
Publication Title	Resilient Vancouver Strategy
Year	2019

Background and Purpose:
Resilient Vancouver is a comprehensive strategy that lays out priority areas, objectives and actions for the City of Vancouver to improve resilience to both shocks and stresses over the short, medium and long term. The strategy is built upon 5 guiding principles (reconciliation, equity and intersectionality, sustainability, recovery, and reciprocity) and 3 priorities (thriving and prepared neighborhoods, proactive and collaborative city, and safe and adaptive buildings and infrastructure). Objectives and actions are nested under the three priorities. The strategy acknowledges resilience in action and provides examples of where resilience exists through previous projects and work in the city.

Definition(s) of Resilience:
Resilience is **"the capacity of individuals, communities, institutions, businesses and systems within a city to survive, adapt and thrive, no matter what kinds of chronic stresses and acute shocks they experience."**

Lead Agency / Author	City of Montreal
Publication Title	Resilient Montreal
Year	2018

Background and Purpose:
Montréal's Resilient City Strategy starts at the citizen level as a starting point, and then shifts its focus to the community, municipal administration, and to public and private organizations, with the focus on pooling efforts at all levels to make the city more resilient. It includes an initial 5-year action plan with 4 orientations (take action in support of a unified and safe community, take action to protect our living environment, take action to maintain a diversified and innovative economy, and take action to promote integrated governance in the service of the community) which are supported by 12 objectives targeting challenges specific to Montreal.

Definition(s) of Resilience:
Urban resilience refers to **"the capacity of a City's people, communities, institutions, and businesses and systems to survive, adapt, and grow, regardless of the types of chronic stresses and acute shocks they experience."**

Lead Agency / Author	City of Toronto
Publication Title	Resilient TO
Year	2019

Background and Purpose:
Toronto's First Resilience Strategy sets out a vision, goals, and actions to help Toronto survive, adapt, and thrive in the face of any challenge, particularly climate change and growing inequities. There are 10 goals and 27 actions to deliver on the vision. There are three focus areas (People and Neighbourhoods, Infrastructure, Leading a Resilient City). The Strategy includes four priority actions which each address immediate needs and build on existing investments by the City. The strategy outlines 6 resilience challenges (equity, climate and environment, civic engagement, communities and neighborhoods, housing, and mobility) that represent Toronto's most pressing issues affecting resilience, and the most significant opportunities for improving resilience.

Definition(s) of Resilience:
Urban resilience is **"the capacity of individuals, communities, institutions, and systems within a city to survive, adapt, and thrive in the face of the chronic stresses and acute shocks they experience."**

Lead Agency / Author	City of Calgary
Publication Title	Resilient Calgary
Year	2019

Background and Purpose:

The Resilient Calgary strategy includes four pillars and a shared theme (the future of Calgary's economy, inclusive futures, the future of Calgary's natural infrastructure, future ready infrastructure, and a future focused Calgary). Under the four pillars are a series of actions, and outcomes, along with excerpts of resilience in action, recognizing efforts that are currently being undertaken with the City that align with resilience.
Definition(s) of Resilience: Urban resilience is **"the capacity of individuals, institutions, businesses and systems within a city to adapt, survive and thrive no matter what kind of chronic stresses and acute shocks they experience."**

Lead Agency / Author	Paris
Publication Title	Paris Resilience Strategy
Year	2020
Background and Purpose: The Paris Resilience Strategy has taken on the motto of "Fluctuat nec Mergitur", which translates to "Beaten by the waves but not sunk", which has been used since the 16th century, recognizing the origins of the City's adjacency of the river. The strategy indicates that resilient systems are characterised by seven qualities - becoming inclusive, integrated, reflective, resourceful, robust, redundant, and flexible. The strategy goes on to outline resilience challenges that Paris faces (1- Social economic and spatial inequalities, and social cohesion; 2- The terror threat and security context; 3- Climate change; 4- Air pollution, a challenge for environmental health; 5- The Seine and river-related risks; and 6- Territorial governance). The strategy aligns goals and 35 actions under 3 pillars (1- An inclusive and cohesive city, which builds on the strength of its residents to become more resilient; 2- A city built and developed to meeting the challenges of the 21st century; and 3- A city in transition that mobilises collective intelligence, adapts its operations, and cooperates with its surrounding territories). The strategy provides actions against a 10-year timeline between 2014 and 2024.	
Definition(s) of Resilience: Resilience is **"the capacity of individuals, communities, institutions, businesses, and systems within a city to survive, adapt, and thrive no matter what kinds of chronic emergencies and acute shocks they experience."**	

RESILIENCE REPORTS & STRATEGIES FROM NGOS AND GOVERNMENT AGENCIES

Lead Agency / Author	American Planning Association
Publication Title	Planning for Resilience
Year	2017
Background and Purpose: This is a website blog post by the American Planning Association (APA). It acknowledges climate change, rapid urbanization, and globalization as threats to Cities and the importance of considering urban resilience as we plan for the future. Takeaways for resilience planning include: Collaboration and coordination, planning for vulnerable populations, and the importance of considering resilience in every part of a city and every department of government.	
Definition(s) of Resilience: • Urban resilience is **"the capacity of individuals, communities, institutions, businesses, and systems within a city to survive, adapt, and grow no matter what kinds of chronic stresses and acute shocks they experience."** • **Like illnesses, there are chronic stresses — high unemployment, poor or overtaxed infrastructure, water shortages — that weaken cities. Acute shocks are the devastating occurrences that often get conversations about resilience going: earthquakes, floods, disease outbreaks, terrorist attacks.**	

Lead Agency / Author	The Rockefeller Foundation & Arup
Publication Title	City Resilience Framework
Year	2015
Background and Purpose:	

This report presents a framework for articulating city resilience to underpin the City Resilience Index. This framework will form the basis of a tool that should enable all parties interested in city resilience to convene around a common understanding of that idea, and begin to baseline what matters most for making cities more resilient. Both the framework and index are intended to facilitate a process of engagement with and within cities that generates deeper dialogue and deeper understanding. *[This report was a precursor to the 100 Resilient Cities work and strategies that took place under the umbrella of the Rockefeller Foundation.]*

Definition(s) of Resilience:

City resilience describes **"the capacity of cities to function, so that the people living and working in cities – particularly the poor and vulnerable – survive and thrive no matter what stresses or shocks they encounter."**

Lead Agency / Author	JRC Science for Policy Report
Publication Title	Building a Scientific Narrative Towards a More Resilient EU Society
Year	2017

Background and Purpose:

This report explains the main elements of a conceptual framework for resilience to create a more common understanding of the concept and paving the way towards a measurement and monitoring facility. The framework for resilience has five main aspects: 1) it is individual centric and takes the societal perspective, 2) it takes a dynamic perspective, 3) it emphasizes interactions, feedbacks, and possible nonlinearities among various entities and layers of the system, 4) interventions may contribute actively to the resilience of the overall system, by enhancing the entities' own abilities to cope with disturbances, and 5) a crucial aspect is to be able to bounce forward instead of bouncing back, to learn from past difficulties, and come out stronger from a witnessed storm.

Definition(s) of Resilience:

- **"the ability to face shocks and persistent structural changes in such a way that societal well-being is preserved, without compromising the heritage for future generations."** *(JRC EU Website)*
- A resilient society is able to cope with and react to shocks or persistent structural changes by either resisting to it (absorptive capacity) or by adopting a degree of flexibility and making small changes to the system (adaptive capacity).

Lead Agency / Author	Smart Growth America
Publication Title	Building Resilient States: A framework for agencies
Year	2015

Background and Purpose:

This report focuses on shocks and stresses resulting from natural disaster but recognizes that resilience is a concept that applies to economic, social, and other shocks as well. States vary widely in their readiness to face disasters, and better preparedness will allow for time, money, and lives to be saved. States can influence resilience by:(1- Deciding how and where development occurs; 2- establishing guidelines for local land use plans; 3- designing, building, and funding critical infrastructure; 4- Funding and approving the siting of hospitals, schools, and state government buildings; 5- setting guidelines for construction of state-subsidized housing; 6- Controlling conservation funding and overseeing environmental remediation; 7- Providing tools and expertise, such as hazard mapping and long-term planning capacities to local governments; 8- Disbursing federal resources; and 9- Building local capacity and commitment to disaster resilience.

It's acknowledged that state powers are different to the regional powers that MV/TL have, however with BC Public Service as a partner in this project, it may be worth visiting powers at a regional and provincial level.

Definition(s) of Resilience:

Resilience is **"the capacity of individuals, communities and systems to survive, adapt, and grow in the face of shock and stresses, and even transform when conditions require it."**

Lead Agency / Author	NIST (USA)
Publication Title	Community Resilience Planning Guide
Year	2015

Background and Purpose:
The National Preparedness Goal developed by the Federal Emergency Management Agency (FEMA) envisions "a secure and resilient nation with the capabilities required across the whole community to prevent, protect against, mitigate, respond to, and recover from the threats and hazards that pose the greatest risk." This guide supports that goal by addressing the role buildings and infrastructure systems play in assuring the health and vitality of the social and economic fabric of the community. There is a 6-step planning process for local governments to enable communities to improve their resilience over time.

Definition(s) of Resilience:

- *(Presidential Policy Directive [PPD]-8, 2011)* defines resilience as **"the ability to adapt to changing conditions and withstand and rapidly recover from disruption due to emergencies."**
- *(PPD-21, 2013)* expanded the definition to **"the ability to prepare for and adapt to changing conditions and to withstand and recover rapidly from disruptions. Resilience includes the ability to withstand and recover from deliberate attacks, accidents, or naturally occurring threats or incidents."**
- In the context of this Guide, the phrase **"prepare for and adapt to changing conditions"** refers to preparing for conditions that may occur within the lifetime of a facility or infrastructure system.
- The second part of the definition of resilience, **"withstand and recover quickly from disruptions"** requires that a range of possible hazard events be considered. In a more resilient community, a hazard event that occurs at the intensity that the affected structures were designed to meet under relevant codes and standards may cause local disruptions tolerated by the community without long-term detrimental effects (e.g., permanent relocation of residents or business). If an unanticipated or extreme event occurs, planning and preparation for planned events likely will reduce the extent of disruption and time for recovery.

Lead Agency / Author	Intergovernmental Panel on Climate Change (IPCC)
Publication Title	Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation: Glossary of Terms
Year	2012

Background and Purpose:
The report assesses scientific literature on issues that range from the relationship between climate change and extreme weather and climate events to the implications of these events for society and sustainable development. The assessment concerns the interaction of climatic, environmental, and human factors that can lead to impacts and disasters, options for managing the risks posed by impacts and disasters, and the important role that non-climatic factors play in determining impacts.

Definition(s) of Resilience:
Resilience is **"The ability of a system and its component parts to anticipate, absorb, accommodate, or recover from the effects of a hazardous event in a timely and efficient manner, including through ensuring the preservation, restoration, or improvement of its essential basic structures and functions."**

Lead Agency / Author	Transportation Research Circular
Publication Title	Transportation Systems Resilience: Preparation, Recovery, and Adaptation
Year	2017

Background and Purpose:
The Transportation Systems Resilience Section was established in 2015 to promote discussions among principals, disseminate research findings, and identify priority research topics in the area of transportation systems and services before, during, and after periods of increased stress, services disruptions, and human need in order to increase resilience and enhance communications among interested parties. The goals include promoting communication among transportation stakeholders, building understanding of the sources of risk and potential mitigation options, developing

an integrated conceptual framework for increasing transportation resilience, identifying transportation requirements during emergencies from the community perspective, promoting research that will lead to new methodologies, and supporting the needs of end users by incorporation of system resilience and sustainability into routine activities.

Definition(s) of Resilience:

- **"The capacity of the system to function in spite of external drivers (both shocks and directed change)."** *(Resilience in a Transportation System: A Whole System Approach)*
- **"The capacity to sustain a shock, recover, and continue to function and, more generally, cope with change."**
- **"The ability of a system to absorb disturbance and still retain its basic function and structure."**
- **"Resilience is the ability of households, communities, and nations to absorb and recover from shocks, while positively adapting and transforming their structures and means for living in the face of long-term stresses, change, and uncertainty."**
- Underlying elements in the above definitions are systems and abilities to absorb and recover from shocks. One nuanced element of the definition is in relation to transforming abilities. Especially with climate change, social equity, and obesity, epidemics becoming linked to our built environment and the transportation systems we currently have in North America cities, change to our current systems is required, making the aspect of transformation very important to consider.
- When considering what resilience is not: **"Resilience is not the same thing as stability, which we can define here as relative constancy over time. Resilient systems can be very unstable. Short-term oscillations, or periodic outbreaks, or long cycles of succession, climax, and collapse may in fact be the normal unstable condition, which resilience acts to restore".**
- Resilience, traditionally defined as returning to a previous state, subsequently has signified withstanding adverse changes, and moving to a stronger state (adaptation). Resilience has been adapted with metrics for cyber systems, and integrates risk assessment and risk management. *(Benefits and Needs for an Integrated Approach to Cyber-Physical Security for Transportation)*
- Resilience is **"the ability to survive in the face of a complex, uncertain, and ever-changing future".** *(Research for Resilient Road Infrastructure)*

Lead Agency / Author	National Cooperative Highway Research Program (NCHRP)
Publication Title	Resilience in Transportation Planning, Engineering, Management, Policy, and Administration
Year	2019

Background and Purpose:

The purpose of this synthesis is to document resilience efforts and how they are organized, understand, and implemented within transportation agencies' core functions and services. This information can help agencies in regaining functionality after a major disruption or disaster. It includes a literature review on the topic of resilience, a survey of transportation agencies, and the development of four case examples based on results of the survey.

Definition(s) of Resilience:

- **"the ability of a system to resist, absorb, recover from, or successfully adapt to a change in environment or conditions"**
- **"the ability to prepare and plan for, absorb, recover from, and more successfully adapt to adverse events"** *(NRC)*
- The effectiveness of a resilient infrastructure or enterprise depends upon **"its ability to anticipate, absorb, adapt to, and/or rapidly recover from a potentially disruptive event"**
- **"the ability to function through an attack or natural event or the speed by which an asset can return to virtually full function"** *(ASME)*
- **"the ability of an asset or system to withstand an attack or natural hazard without interruption of performing the asset or system's function or, if the function is interrupted, to restore the function rapidly" (***American Water Works Association)*

- The Multidisciplinary Center for Earthquake Engineering Research developed a framework (R4 Framework) that examines four main attributes of resilience:
    - **Robustness—the ability of systems, system elements, and other units of analysis to withstand disaster forces without significant degradation or loss of performance;**
    - **Redundancy—the extent to which systems, system elements, or other units are substitutable, that is, capable of satisfying functional requirements, if significant degradation or loss of functionality occurs;**
    - **Resourcefulness—the ability to diagnose and prioritize problems and to initiate solutions by identifying and mobilizing material, monetary, informational, technological, and human resources; and**
    - **Rapidity—the capacity to restore functionality in a timely way, containing losses and avoiding disruptions.**
- These attributes are described in terms of resilience as **"the ability of the system to withstand a disaster without significant degradation or loss of performance, the extent to which the system is capable to maintain functional requirements if significant degradation or loss of function occurs, the ability to diagnose and prioritize problems and to initiate solutions by identifying and mobilizing material, monetary, informational, technological, and human resources and the capacity to restore functionality in a timely way, containing losses and avoiding disruptions"** *(Tierney and Bruneau, 2017)*
- The resilience of freight systems is described as **"The ability for the system to absorb effects from a disruption and continue moving traffic in an uninhibited manner"** *[Ta et al., 2009].*
- Transportation resilience can be defined in ways that include the following:
    - **A system's ability to maintain its demonstrated level of service or return to that level of service in a specified time frame;**
    - **A system's ability to compensate for losses to allow functionality, even when that system is damaged or destroyed;**
    - **A system's ability to cope with unexpected conditions without complete failure; and;**
    - **A system's ability to absorb consequences of disruptions to reduce effects and maintain freight mobility.** *(Heaslip et al. 2012)*

Lead Agency / Author	American Association of State Highway Transportation Officials (AASHTO)
Publication Title	Understanding Transportation Resilience: A 2016–2018 Roadmap
Year	2017

Background and Purpose:

The purpose of this report is to provide the Special Committee on Transportation Security and Emergency Management (SCOTSEM) and other AASHTO and TRB resilience-oriented committees and projects a discussion tool to guide their approach to sponsoring and participating in national transportation resilience-related activities.

Definition(s) of Resilience:

- Originally the term [resilience] and its application were developed in human psychology and referred to the human trait of being **"able to "bounce back" or recover from illness, adversity, depression, and other life misfortunes."**
- Other related ideas focus on **"the ability to adapt to the demands of stressful situations or to cope successfully with significant change, adversity, or difficulty".**
- **"The ability to prepare for and adapt to changing conditions and withstand and recover rapidly from disruptions. Resilience includes the ability to withstand and recover from deliberate attacks, accidents, or naturally occurring threats or incidents."** *(Presidential Policy Directive PPD21)*
- **"The ability to resist, absorb, recover from, or successfully adapt to adversity or a change in conditions,"** *(Department of Homeland Security)*

- **"The ability of systems, infrastructures, government, business, and citizenry to resist, absorb, recover from, or adapt to an adverse occurrence that may cause harm, destruction, or loss of national significance."** *(Department of Homeland Security)*
- **"The ability of a system to provide and maintain an acceptable level of service or functionality in the face of major shocks or disruptions to normal operations."** *(AASHTO)*
- **"the ability to prepare and plan for, absorb, recover from, or more successfully adapt to adverse events"** *(AASHTO SCOTSEM adapted from NRC 2012)*
- **"the ability to prepare and plan for, absorb, recover from, or more successfully adapt to actual or potential adverse events."** *(The National Academies of Sciences, Engineering, and Medicine's Resilient America Roundtable)*
- **"The ability to anticipate, prepare for and adapt to changing conditions and withstand, respond to and recover rapidly from disruptions."** *(FHWA Order 5520)*
- **"The capability to expeditiously recover and reconstitute vital services with minimum disruption."** *(Harbor Safety Committee Conference)*

Lead Agency / Author	RAND Corporation
Publication Title	Incorporating Resilience into Transportation Planning and Assessment
Year	2019

Background and Purpose:
This report provides an approach for incorporating resilience into transportation planning and assessment in the United States. It is built upon the FHWA's Vulnerability Assessment and Adaptation Framework to better incorporate the principles of resilience into the decision-making process for long-term transportation planning. The approach includes stakeholder interviews and reviews of transportation resilience literature. The development of metrics was determined under the AREA approach (absorptive capacity, restorative capacity, equitable access, and adaptive capacity). The approach focuses on the criticality and exposure of various assets in of the transportation network. The approach provides a means to discover alternative options or strategies that can be considered when planning to improve resilience of the transportation system.

Definition(s) of Resilience:

- Resilience of critical infrastructure is defined **as "the ability to prepare for and adapt to changing conditions and withstand and recover rapidly from disruptions. Resilience includes the ability to withstand and recover from deliberate attacks, accidents, or naturally occurring threats or incidents"** *(Presidential Policy Directive 21, 2013).*
- Transportation resilience is **"the ability to adapt to, recover from, and respond to - and bounce back quickly from - threats to physical infrastructure and operations and threats of cybersecurity, terrorism, and all hazards. Furthermore, it is the ability to minimize impact and ensure that the transportation system is still usable following a shock or stressor."** (Collective understanding of interviewees from this project).
- The precise definition of resilience varies across transportation entities but **reflects "the ability to adapt to, recover from, and respond to a variety of threats to physical infrastructure, operations, cyber security, terrorism, and all hazards."**
- "**The ability to anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions."** *(FHWA Order 5520, 2014).*

Lead Agency / Author	United Nations Office for Disaster Risk Reduction (UNDRR)
Publication Title	Sendai Framework for Disaster Risk Reduction 2015 - 2030
Year	2015

Background and Purpose:
The Sendai Framework for Disaster Risk Reduction 2015–2030 represented an opportunity for countries to 1) adopt a concise, focused, forward-looking and action-oriented post-2015 framework for disaster risk reduction; 2) compete the

assessment and review of the implementation of the Hyogo Framework for action 2005–2015: Building the Resilience of Nations and Communities to Disasters; 3) consider the experience gained through the regional and national strategies/institutions and plans for disaster risk reduction and their recommendations, as well as relevant regional agreements for the implementation of the Hyogo Framework for Action; 4) identify modalities of cooperation based on commitments to implement a post-2015 framework for disaster risk reduction; and 5) determine modalities for the periodic review of the implementation of a post-2015 framework for disaster risk reduction.

The seven targets of the Sendai Framework are: 1) Substantially reduce global disaster mortality by 2030, aiming to lower average per 100,000 global mortality between 2020–2030 compared to 2005–2015; 2) Substantially reduce the number of affected people globally by 2030, aiming to lower the average global figure per 100,000 between 2020–2030 compared to 2005–2015; 3) Reduce direct disaster economic loss in relation to global gross domestic product (GDP) by 2030; 4) Substantially reduce disaster damage to critical infrastructure and disruption of basic services, among them health and educational facilities, including through developing their resilience by 2030; 5) Substantially increase the number of countries with national and local disaster risk reduction strategies by 2020; 6) Substantially enhance international cooperation to developing countries through adequate and sustainable support to complement their national actions for implementation of this framework by 2030; 7) Substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to people by 2030

Definition(s) of Resilience:
Resilience is defined as **"The ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions"** UNDRR 2009 terminology on disaster risk reduction.

Lead Agency / Author	United Nations Office for Disaster Risk Reduction (UNDRR)
Publication Title	How To Make Cities More Resilient A Handbook For Local Government Leaders
Year	2017

Background and Purpose:
The handbook is designed for local government leaders and policy makers to implement activities to reduce disaster risk and build resilience. The handbook showcases the knowledge and expertise of several campaign cities, and provides an overview of key strategies and actions as part of an overall sustainable urban development strategy. The approach to resilience, as described, also applies to sub-national administration of different sizes and levels, including at regional and provincial levels.

Definition(s) of Resilience:
Resilience - as agreed through an intergovernmental process- is **"the ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner."**

Lead Agency / Author	New Zealand Transportation Authority (NZTA)
Publication Title	NZTA Resilience Framework
Year	2018

Background and Purpose:
The purpose of the framework is to provide a clear expression of the Transport Agency's strategic approach to resilience and to prioritise, guide, and coordinate the Transport Agency's ongoing activity and strategic work programme to improve resilience. NZTA outlines objectives, and targets, along with the approach and workstreams to accomplish these.

Definition(s) of Resilience:
Resilience is **"the transport system's ability to enable communities to withstand and absorb impacts of unplanned disruptive events, perform effectively during disruptions, and respond and recover functionality quickly."**

Lead Agency / Author	New Zealand Transportation Authority (NZTA)
Publication Title	Measuring the resilience of transport infrastructure
Year	2014

Background and Purpose:
The purpose of the report and associated research was to develop a framework and assessment tool to measure the resilience of transport infrastructure, one that is applicable to the wider land transport system and will allow consideration of various scales, and a framework that can link to broader criticality and risk management approaches allowing prioritisation of improvements and interventions. Part of the purpose of the framework is to deliver better value for money through public investment and ultimately better outcomes and service delivery to the public.

Definition(s) of Resilience:
This report summarizes a range of resilience definitions:

- Resilience is **"the capability of a system to maintain its functions and structure in the face of internal and external change and to degrade gracefully when it must"** *(Allenby and Fink 2005).*
- Resilience is **"the ability of systems, infrastructures, government, business and citizenry to resist, absorb, and recover from or adapt to an adverse occurrence that may cause harm, destruction, or loss of national significance"** *(USDHS 2009a).*
- Resilience is **"the ability to survive a crisis and to thrive in a world of uncertainty"** *(Seville 2009).*
- Resilience is **"the ability of a locale to withstand an extreme natural event without suffering devastating losses, damage, diminished productivity, or quality of life and without a large amount of assistance from the outside community"** *(Mileti 1999).*
- **"The ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organisation, and the capacity to adapt to stress and change"** *(Solomon et al 2007).*
- **"The concept of resilience is wider than natural disasters and covers the capacity of public, private and civic sectors to withstand disruption, absorb disturbance, act effectively in a crisis, adapt to changing conditions, including climate change, and grow over time"** *(NIU 2011). [<- This is the definition used for the study]*

Lead Agency / Author	LA County Metropolitan Transportation Authority (MTA)
Publication Title	Resiliency Indicator Framework
Year	2015

Background and Purpose:
The purpose of this document is to introduce a set of resilience indicators that have been developed for Metro's transit programs to help address climate change. The framework is intended to help prioritize and evaluate climate adaptation implementation priorities to ensure infrastructure resilience and maintain a good state of repair. The document primarily focuses on climate stressors of precipitation and heat.

Definition(s) of Resilience:
Metro defines resilience as **"the ability to provide core functions in the face of threats, and recover quickly from major shocks or changing conditions".**

Lead Agency / Author	Adaptation to Climate Change Team - SFU
Publication Title	Measuring Progress on Adaptation and Climate Resilience: Recommendations to the Government of Canada
Year	2018

Background and Purpose:
This report captures recommendations and perspectives of the Expert Panel on Climate Change Adaptation and Resilience Results which was launched by the federal government in 2017 to measure progress on adaptation and climate resilience. The panel proposed 54 indicators to measure progress on adaptation and climate resilience in

Canada, with a subset of 18 indicators from within the larger set that could serve as a starting point. In addition to advising on proposed indicators, the Expert Panel also considered how to implement a sustainable approach to monitoring progress on implementation. Key elements essential to implementation of a monitoring and evaluation program include the following:

- The importance of working with Indigenous Peoples and Indigenous Knowledge Systems to measure progress on adaptation and climate resilience and respond to the results from monitoring and evaluation; and
- The need for continuous improvement to both the indicator set and monitoring and evaluation program, necessary to reflect the rapid evolution of climate change science and the information and results of monitoring and evaluation efforts.

Definition(s) of Resilience:

- Resilience: **"The capacity of social, economic and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity and structure, while also maintaining the capacity for adaptation, learning and transformation"** *(IPCC, 2014b)*
- Climate Resilience: **"The capacity of a community, business, or natural environment to anticipate, prevent, withstand, respond to, and recover from a climate change related disruption or impact"** *(Working Group on Adaptation and Climate Resilience, 2016).*

Lead Agency / Author	Building Resilient Neighbourhoods (BRN)
Publication Title	Building Resilient Neighbourhoods (company website)
Year	2020

Background and Purpose:

BRN is a collaborative effort to help create more resilient communities and neighbourhoods in BC. It is currently delivered and hosted by the non-profit Building Resilient Neighbourhoods Society. Social, environmental and economic issues are challenging human and community well-being. Meeting basic needs closer to home through expanding local, co-operative and self-reliant communities is a key strategy to help reduce impact on the environment, while enhancing community prosperity and strengthening social ties and community cohesion. By focusing on what can be done at a neighbourhood level, resilient communities create new ways to support each other as neighbours, to live in harmony with natural environments, and strengthen local economies.

Definition(s) of Resilience:

Resilience is all about **"strengthening our community's ability to respond and adapt to big changes and deep challenges. It's about all of us working together to build a stronger, more connected neighbourhood where everyone's basic needs are met and everyone belongs."**

Lead Agency / Author	Government of BC, Nodelcorp, Pacific Climate Impacts Consortium
Publication Title	A Primer for Understanding Concepts, Principles and Language Use Across Disciplines
Year	2014

Background and Purpose:

This primer outlines concepts, principles, and language terms used across disciplines that have led to communication issues on climate change vulnerability-risk assessment projects. This primer indicators where misunderstanding in communication can occur and where definitional clarity may be required.

Definition(s) of Resilience:

- The **engineer will define resilience in terms of the infrastructure's ability to absorb projected weather events.** Typically, they will not include a broader definition of societal and ecological resilience with respect to a population's or an ecosystem's ability to absorb and adapt to anticipated changes. **The engineer's definition will tend to focus on the hardware and systems directly within their engineering or management control**. They will be much less comfortable expressing opinions on broader social or environmental adaptive actions unless part of the project scope.

- The **scientist may define resilience in much broader terms, including within their definition social and ecological responses to anticipated changes. They will tend to see the issue in a more holistic way and may wish to contemplate adaptation considerations that are outside of the engineer's direct management or engineering control.**

Lead Agency / Author	Engineers And Geoscientists British Columbia
Publication Title	Developing Climate Change-Resilient Designs For Highway Infrastructure In British Columbia
Year	2020

Background and Purpose:
These professional practice guidelines were developed to guide professional practice related to resilience, reliability, and sustainable of provincial highway assets under changing climate conditions. Specific factors addressed in these guidelines include how extreme weather events are considered and incorporated into infrastructure design in projects.

Definition(s) of Resilience:
Resilience or resilience is **"the ability to anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions."** *[This definition is embedded in the appendix and refers to the BCMoTI Technical Circular T-04/19.]*

Lead Agency / Author	Government of BC
Publication Title	Local Government Planning for Sustainability & Resilience
Year	2020

Background and Purpose:
This is a webpage that provides resources for local government planning to build community sustainability and resilience. It includes the following characteristics of sustainable and resilient communities:

- **Compact** development that avoids sprawl, is appropriate for the local context, and supports access and affordability
- **Complete** and mixed land use that supports the efficient movement of people, goods and services and contributes to business efficiency and quality of life
- **Centred** focal points that support business, commerce, festivals and gatherings and serve as transportation hubs
- **Connected** development nodes linked by transit and active transportation routes and public spaces that contribute to social connectedness and community safety
- **Consideration of natural assets** ensuring a productive resource base that includes agricultural and forest land, and protecting assets such as tree canopies, streams, groundwater and aquifers
- **Consideration of hazards** to ensure that development reduces vulnerability to hazards (for example, more frequent intense storms, sea level rise).

Definition(s) of Resilience:
A resilient community has **"the capacity to adapt to changes such as shifting demographics and housing affordability, and "bounce back" from events such as economic downturns and the effects of a changing climate"** (for example, more frequent and intense storms, temperature increases or sea level rise).

Lead Agency / Author	Fainstein, S. (Melbourne Sustainable Society Institute)
Publication Title	Resilience and Justice
Year	2013

Background and Purpose:
The paper presents a Marxist critique of resilience practices, and outlines a variety of examples where adaptation and resilience have taken place in the face of climate change, from incremental change in Houston, to systematic change in Rotterdam. There is an emphasis on building resilience through social and physical infrastructure in the near future before it is too late. "Focusing solely on physical infrastructure runs the risk of overlooking another critical component of

resilience – social infrastructure." Through examples, Fainstein argues that the current resilience framework that is used and applied by city-builders focuses too much on the assumption that improving general resilience will benefit the entire constituency, meanwhile it is more often the case that resilience-based projects will disproportionately benefit the wealthy and leave the poorer parts of population without significant help.
Definition(s) of Resilience: Where sustainability aims to put the world back into balance, resilience looks for ways to manage in an unbalanced world.

Lead Agency / Author	Trivedi, K. S., Kim, D. D., and Ghosh, R.
Publication Title	Resilience in Computer Systems and Networks
Year	2015
Background and Purpose: This paper presents resilience definitions from a computer system and network perspective. It provides dependability metrics such as availability, performance, and performability. Examples are used to show quantification of resilience via availability, performance, and survivability models.	
Definition(s) of Resilience: • A combination of trustworthiness (dependability, security, performability) and tolerance (survivability, disruption tolerance, and traffic tolerance). • Fast recovery from a downgraded system state. • The persistence of service delivery that can justifiably be trusted, when facing changes.	

OTHER REPORTS REVIEWED WITHOUT RESILIENCE DEFINITIONS

Additional reports were reviewed that were excluded due to lack of a definition of resilience. These may be considered further when developed a resilience evaluation framework.

Lead Agency / Author	Aldrich, D. P.
Publication Title	The Right Way to Build Resilience to Climate Change
Year	2018
Background and Purpose: The paper outlines a variety of examples where adaptation and resilience have taken place in the face of climate change, from incremental change in Houston, to systematic change in Rotterdam. There is an emphasis on building resilience through social and physical infrastructure in the near future before it is too late. "Focusing solely on physical infrastructure runs the risk of overlooking another critical component of resilience – social infrastructure."	
Definition(s) of Resilience: No definition provided.	

Lead Agency / Author	BC Ministry of the Environment - Climate Action Secretariat
Publication Title	Adaptation Planning: the Local Government Experience in BC
Year	2013
Background and Purpose: This is a case study of the BC Regional Adaptation Collaborative that was co-led by Fraser Basin Council and BC Ministry of Environment. The RAC explored the drivers and barriers to local government action on climate change adaptation. Key lessons from the study include: • Strategic allocation of funding can leverage existing momentum, resulting in greater success • Concerns about legal liability can both aid and hinder adaptation planning • Creative communication tools help to build awareness and momentum • Collaboration and partnerships can increase awareness and mobilize support.	

Definition(s) of Resilience:
No definition provided.

Lead Agency / Author	BC Ministry of Environment and Climate Change Strategy
Publication Title	Preliminary Strategic Climate Risk Assessment
Year	2019
Background and Purpose:	
The report was led by BC's Climate Action Secretariat. A risk assessment framework was developed and was applied to create an initial assessment of climate risks to BC at the provincial level. The framework was designed to be consistent with the Risk Management Guidelines for the BC Public Service and follows for high-level steps to evaluate climate risks: 1) Understand the context, 2) Identify risk events, 3) Analyze Risks, and 4) Evaluate Risks. High risk events include severe wildfire seasons, seasonal water shortages, heat waves, ocean acidification, glacier mass loss, and long-term water shortages.	
Definition(s) of Resilience:	
No definition provided.	

Lead Agency / Author	Bonds, A.
Publication Title	Refusing resilience: the racialization of risk and resilience
Year	2018
Background and Purpose:	
This essay suggests that resilience discourses must be situated within the context of racial capitalism. The author suggests embracing other planning approaches and refusing the concept of resilience, emphasizing structural change, rather than adaption. The author uses case studies (particularly focused on the Milwaukee Uprising of 2016) to suggest that racially uneven participation and outcomes existed in the resilience narrative of building back up after traumatizing events (such as a shooting in the above case). Resilience is seen as racial capitalism in the sense that resilience planning is a technocratic, risk-focused agenda that has little to do with structural change, or building a more just city.	
Definition(s) of Resilience:	
No definition provided.	

Lead Agency / Author	Metro Vancouver
Publication Title	Climate 2050 Discussion Papers
Year	2020 - 2021
Background and Purpose:	
Metro Vancouver is introducing Climate 2050 through a series of discussion papers. Six (Buildings, Industry, Transportation, Nature and Ecosystems, Agriculture, and Waste) are published, with more on the way through 2020 and early 2021. These papers will be used to develop a parallel series of Roadmaps for climate action in this region, with long-term goals, targets, strategies and actions. Each paper includes information on greenhouse gas reductions, climate adaptation, and air quality issues. Resilience content can be found in the "adaptation" section of each thematic paper.	
Definition(s) of Resilience:	
Climate resilience describes the capacity of ecosystems, economies, infrastructure and communities to absorb the impacts of climate change while maintaining essential services and functions needed to support health and well-being. In some cases, resilience involves changing services and functions so they are more sustainable.	

Lead Agency / Author	National Association for the Advancement of Colored People (NAACP)
Publication Title	Equity in Building Resilience in Adaptation Planning
Year	2015
Background and Purpose:	

This report contains a list of equity based indicators that are measures of vulnerability and resilience specifically (or predominantly) focused on climate change impacts. The indicators were developed for both pre-existing vulnerabilities and assets as well as for processes and results of resilience planning. The resource can be used by city planners, community organizations, elected officials, and other decision makers in order to better consider equity in climate adaptation plans. The focus of climate change impacts is primarily around shifts in agricultural yields, sea level rise, and extreme weather. Indicators include infrastructure, economic development/jobs, food security, housing, education, health care services, emergency management services, gender responsive emergency management, adaptation specific planning/decision-making, politics/policies/democracy, health wellness, and culture.

Definition(s) of Resilience:
No definition provided.

Lead Agency / Author	Yu J. et al. (UBC)
Publication Title	Mapping spatial patterns in vulnerability to climate change-related health hazards
Year	2019

Background and Purpose:
The objective of this paper and project was to create health vulnerability indices to map variability in community risks to inland flooding, sea level rise, extreme heat, wildfire smoke, and ozone across neighbourhoods in the Vancouver Coastal Health and Fraser Health regions in BC. As more than 250,000 people live within a [vertical] metre of mean sea level, Metro Vancouver is the most vulnerable urban area in Canada to sea level rise. Through provincial audits, it was found that BC lacks appropriate climate change adaptation policies, especially related to wildfires and flooding. This project was commissioned to assess and map the vulnerability of climate change-related health hazard within Vancouver Coastal Health and Fraser Health regions. This paper includes a significant number of indicators tied to climate change impact vulnerability.

Definition(s) of Resilience:
No definition provided.

APPENDIX B – FRAMEWORK BACKGROUNDER

OVERVIEW

This appendix provides a synthesis of findings when reviewing resilience frameworks for applicability to Metro Vancouver. As outlined in Section 3 of the report, there are limited examples of frameworks that specifically evaluate policy (or strategy) for impact on resilience. This adjusted the approach to the literature review to then look at common components of resilience frameworks. These components were adapted and built upon to develop the Metro 2050 / Transport 2050 Regional Resilience Framework.

Seven common components to resilience frameworks were identified: **Key Dimensions; Stresses, Shocks, and Disruptions; Impacted Assets and Vulnerability; Resilience Attributes and Principles; Measurement and Evaluation; Implementation; and Interdependencies.**

Along with these components, **Notable and Relevant Resilience Framework examples** are also provided. These examples provide additional clarity and context for how components of resilience frameworks are combined and applied, dependent on what is being evaluated.

Each common component and framework example has a summary box at the end of the section that discusses the relevance and application to the Metro 2050 / Transport 2050 Regional Resilience Framework.

COMMON RESILIENCE FRAMEWORK COMPONENTS

KEY DIMENSIONS

Most frameworks reviewed began with identifying relevant key dimensions. Some of these dimensions are common across all frameworks reviewed, while others are different depending on jurisdiction. This introductory concept is shown in the report Building and Measuring Community Resilience: Actions for Communities and the Gulf Research Program.[11] The following figure displays the multidimensional nature and interconnectedness of community resilience with capital dimensions shown. Measurement efforts are undertaken within each of these dimensions.

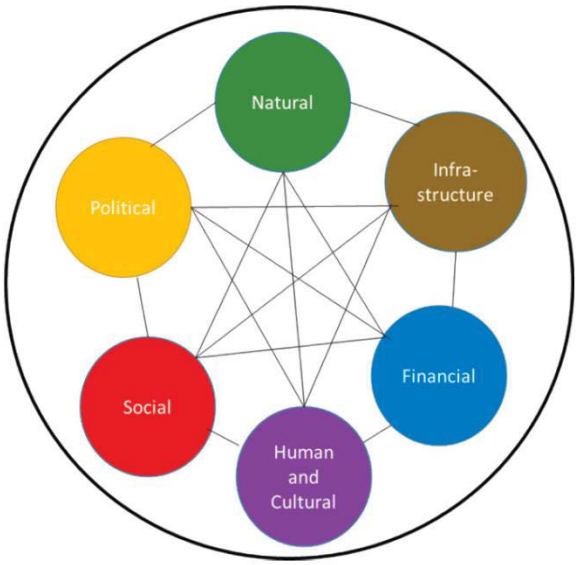


Figure 5: Capital Dimensions[12]

[11] National Academies of Sciences, Engineering, and Medicine; Policy and Global Affairs; Office of Special Projects; Committee on Measuring Community Resilience. Building and Measuring Community Resilience: Actions for Communities and the Gulf Research Program. Washington (DC): National Academies Press (US); 2019 Mar 20. Evaluation of Existing Resilience Measurement Efforts.
[12] Ibid.

Similar key dimensions can be seen as primary foci for frameworks and assessments in a macro-level study that was undertaken by Sharifi,[13] where five common dimensions were identified: environmental, social, economic, built environment and infrastructure, and institutional. Bruneau et. al maintain four interrelated dimensions: technical, organizational, social, and economic.[14] These four dimensions have also been used by Tierney for conceptualizing and measuring resilience of natural disasters, such as Hurricane Katrina in 2005.[15]

Dimensions are partly influenced by purpose and jurisdiction. Some jurisdictions, such as municipalities, may have the ability to influence a wide range of dimensions. Other jurisdiction may need to limit their dimensions to what can be influenced within their mandate and power

Relevance to the Metro 2050 / Transport 2050 Regional Resilience Framework

Dimensions are a reasonable starting point for any resilience framework. This needs to be tempered with what can be influenced through long-range strategy as it pertains to Transportation System Management and Growth Management).

STRESSES, SHOCKS, AND DISRUPTIONS

Stresses, shocks and disruptions all point to chronic or acute events that impact a system. There are multi-hazard and single hazard resilience frameworks that exist. Most frameworks tend to focus on shocks (or one-time events) rather than stresses (chronic longer-term shifts). There are limited examples of frameworks that opt to not specify the type of stress, shock, or disruption. This is largely because it is difficult to evaluated beyond a conceptual level if a hazard has not been selected. Selecting a stress/shock, or set of stresses and shocks, is recommended for any resilience framework.

Shock and stress Types

In order to undertake multi-hazard assessments in a meaningful yet manageable way, stresses and shocks can be grouped into types. Several agencies have developed classification lists to better organize their approach to navigating hazards in a categorical way.[16] The World Health Organization (WHO) developed a hazard classification table that covers a range of hazards including geophysical, hydro-meteorological, biological, extraterrestrial, technological, societal and environmental degradation.[17] Integrated Research on Disaster Risk developed a similar classification structure where broad hazard categories include geophysical, hydrological, meteorological, climatological, biological, and extraterrestrial.[18] Classification can include main events and further sub-types (e.g., for Hydrological, it is further split into floods, landslides, and wave action).

[13] Sharifi, A. (2019). Resilient urban forms: A macro-scale analysis. Cities, 85, 1-14.
[14] Bruneau, M., Chang, S. E., Eguchi, R. T., Lee, G. C., O'Rourke, T. D., Reinhorn, A. M., Shinozuka, M. Tierney, K., Wallace, W. A., & Von Winterfeldt, D. (2003). A framework to quantitatively assess and enhance the seismic resilience of communities. Earthquake spectra, 19(4), 733-752.
[15] Tierney, K. & Bruneau, M. (2007) Conceptualizing and Measuring Resilience: A key to Disaster Loss Reduction
[16] Stresses and shocks are not synonymous with hazards. Hazard classification lists are more commonly available for discussion than stress and shock lists.
[17] WHO. (2019). Health Emergency and Disaster Risk Management Framework. World Health Organization (WHO), Geneva.
[18] IRDR. (2014). Peril Classification and Hazard Glossary. IRDR DATA Publication No. 1. Integrated Research on Disaster Risk (IRDR), Beijing.

Hazard Category	Number Reported
Biological hazards	34
Environmental hazards	13
Geological or geophysical hazards	44
Hydrometeorological hazards	120
Technological hazards	79
Societal and other uncategorised hazards	28
Total	**318**

Figure 6: Sendai Framework Hazard Monitoring[19]

Figure 7: IRDR Hazard Classification Structure[20]

As seen in the figures above, the creation of a hazard classification structure allows for looking at different categories of shocks within a single framework. It is important to note that there is a trade off with multi-hazard assessments where broader inclusion of hazards means less depth can be achieved in the assessment process. Events can incorporate multiple hazards, despite the above figures giving the impression that events are singular (for example earthquakes can often be associated with tsunamis, landslides, flooding, etc.). This is discussed further in the Interdependencies component section.

Shock/Stress Severity, Longevity, and Surprise

Beyond determining the stress/shock, or set of stresses/shocks, for evaluation purposes, attention must also be given to how to determine severity, longevity, and breadth of the impact. This is introduced by Norris et al. in their article about community resilience for disaster readiness by considering severity, duration, and surprise.[21] For surprise, the authors outline that with the world becoming increasingly complex, it is more common to encounter surprise than predictability. This builds off the work of Longstaff, who revisits the concept of known unknowns and unknown unknowns, finding that

[19] UNDRR. (2020). Hazard Definition & Classification Review – Technical Report. UN Office for Disaster Risk Reduction.
[20] IRDR. (2014). Peril Classification and Hazard Glossary. IRDR DATA Publication No. 1. Integrated Research on Disaster Risk (IRDR), Beijing.
[21] Norris, F. H., Stevens, S. P., Pfefferbaum, B., Wyche, K. F., & Pfefferbaum R. L. (2008). Community Resilience as a Metaphor, Theory, Set of Capacities, and Strategy for Disaster Readiness. American Journal of Community Psychology, Vol. 41, No. 1-2, pp. 127–150.

surprise can capture the difference between what is expected and what is experienced.[22] Recognizing that these surprises are difficult to predict, Longstaff recommends developing broad resilience strategies that can be applied to a wide variety of stresses and shocks. The black swan analogy is fitting here, recognizing that people did not believe black swans existed for centuries, until some were discovered; similarly, the stresses and shocks we witness today are not necessarily the same that we will see in years to come.

Relevance to the Metro 2050 / Transport 2050 Regional Resilience Framework

Organizing stresses and shocks into groups will allow for a wide range to be considered within a framework. Severity and longevity will need to be considered, recognizing that some stresses and shocks will have more impact (from a regional perspective) than others. Considering the element of surprise introduced by Norris et al., broad resilience strategies should be considered to integration into long-range strategies, and for the resilience gap assessment.

IMPACTED ASSETS AND VULNERABILITY

In order to determine resilience of a system, there needs to be an initial assessment of system vulnerability and anticipated impacts of a shock/stress. Consequences of stresses and shocks are the result of spatial impact and severity, and the vulnerability of the society or system exposed to the stress or shock.

Hazard, Risk and Vulnerability Assessments

Undertaking Hazard, Risk and Vulnerability Analysis (HRVA) and/or Hazard Vulnerability Assessments (HVA) is an important step to understanding, and reducing consequences of stress/shock risk. Several challenges exist when undertaking vulnerability assessments, including:

- Integrating components of vulnerability such as exposure, sensitivity, or adaptive capacity;
- Different methods are used within different disciplines; and
- Target dimensions of vulnerability differ from assessment to assessment.[23]

These challenges are important to consider along with the fact that humans and systems change over time, creating a dynamic outcome that is difficult to account for.[24] Regardless of these challenges, HRVA, HVA, and Vulnerability Assessment Frameworks (VAF) continue to be applied by agencies to better understand their vulnerability to a hazard or set of shocks and/or stresses.

Emergency Management BC developed an online HRVA tool and companion guide to assist communities in identifying hazards and assessing consequences to develop appropriate plans and strategies to prevent or reduce hazard risk.[25]

Similarly, VAFs can be used as a starting point for incorporating resilience into planning, as documented within RAND's report on Incorporating Resilience into Transportation Planning and Assessment.[26] The Federal Highway Administration developed a VAF to account for climate change and extreme weather events in planning processes.[27] It provides information on assessment methods for consideration, data to use, and case examples of what other relevant agencies are doing in terms of climate change and extreme weather events.

[22] Longstaff, P. (2005). Security, resilience, and communication in unpredictable environments such as terrorism, natural disasters, and complex technology. Syracuse, New York.
[23] Fuchs S, Kuhlicke C, & Meyer V. (2011). Editorial for the special issue: vulnerability to natural hazards—the challenge of integration. Nat Hazards 58(2):609–619
[24] Ibid.
[25] Emergency Management BC. (2020). Hazard, Risk and Vulnerability Analysis (HRVA) for Local Authorities and First Nations.
[26] Weilant, S., Strong, A., & Miller, B. (2019). Incorporating Resilience into Transportation Planning and Assessment. RAND.
[27] US Department of Transportation, Federal Highway Administration. (2018). Vulnerability Assessment Framework Conceptual Diagram.

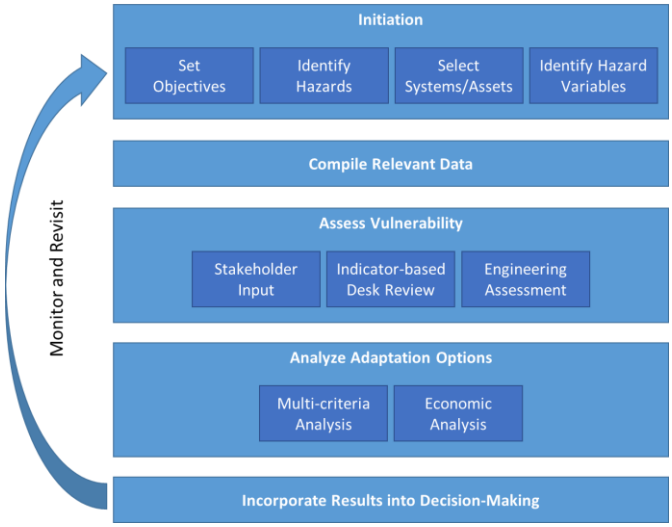


Figure 8: Adapted Vulnerability Assessment & Adaptation Framework[28]

This VAF is used as a starting point for incorporating resilience into transportation planning by RAND, as it guides planners in making decisions that may reduce vulnerability (and increase resilience). Vulnerability is assessed through three main mechanisms: stakeholder input, indicator-based desktop review, and engineering-informed assessment, and across various structural dimensions (organizational, physical, policy, infrastructure, etc.). Adaptation options can then be undertaken through a multi-criteria analysis or economic analysis (or a combination of the two).

Relevance to the Metro 2050 / Transport 2050 Regional Resilience Framework

A form of hazard, risk and vulnerability assessment or analysis should be included within the Metro 2050 / Transport 2050 Regional Resilience Framework for further resilience planning. TransLink and Metro Vancouver will need to collaborate with partners to develop a more comprehensive and deeper understanding of each shock/stress beyond the high-level assessment provided through the scope of this project. A comprehensive vulnerability assessment could be a multi-year undertaking.

RESILIENCE ATTRIBUTES AND PRINCIPLES

Once shocks and stresses have been selected, and assets have been determined (the *resilience to what* and the *resilience of what*) the next step is to identify the attributes of resilience. This can vary significantly through different frameworks, as is displayed in the following section. At a high level, there are several principles of resilience through which resilience evaluation is undertaken. Several of these are listed in Table 2 for context, in **Section 2** of the report.

Table 7: Resilience Attributes by Source

Source	Principles of Resilience
Bruneau et al., 2003[29]	4Rs: Robustness, Redundancy, Resourcefulness, Rapidity
Da Silva & Morera, 2014[30]	R4+: Reflective, Robust, Redundant, Resourceful, Flexible, Inclusive, Integrated
Weilant, Strong, and Miller, 2019[31]	AREA: Absorptive Capacity, Restorative Capacity, Equitable Access, Adaptive Capacity

[28] Ibid.
[29] Bruneau, M., Chang, S. E., Eguchi, R. T., Lee, G. C., O'Rourke, T. D., Reinhorn, A. M., Shinozuka, M. Tierney, K., Wallace, W. A., & Von Winterfeldt, D. (2003). A framework to quantitatively assess and enhance the seismic resilience of communities. Earthquake spectra, 19(4), 733-752.
[30] Da Silva, J., & Morera, B. (2014). City Resilience Framework. London: Arup.
[31] Weilant, S., Strong, A., & Miller, B. (2019). Incorporating Resilience into Transportation Planning and Assessment. RAND.

Despite some variance in definitions, the following list provides a general perspective on principles considered.

- **Robustness**: strength, or the ability of elements, systems, and other units of analysis to withstand a given level of stress or demand without suffering degradation or loss of function.
- **Redundancy**: the extent to which elements, systems, or other units of analysis exist that are substitutable, i.e., capable of satisfying functional requirements in the event of disruption, degradation, or loss of functionality.
- **Resourcefulness**: the capacity to identify problems, establish priorities, and mobilize resources when conditions exist that threaten to disrupt some element, system, or other unit of analysis; resourcefulness can be further conceptualized as consisting of the ability to apply material (i.e., monetary, physical, technological, and informational) and human resources to meet established priorities and achieve goals.
- **Rapidity**: The capacity to meet priorities and achieve goals in a timely manner in order to contain losses and avoid future disruption.
- **Reflective**: Reflective systems are accepting of the inherent and ever-increasing uncertainty and change in today's world. They have mechanisms to continuously evolve, and will modify standards or norms based on emerging evidence, rather than seeking permanent solutions based on the status quo. As a result, people and institutions examine and systematically learn from their past experiences, and leverage this learning to inform future decision-making.
- **Flexible**: Flexibility implies that systems can change, evolve and adapt in response to changing circumstances. This may favour decentralised and modular approaches to infrastructure or ecosystem management. Flexibility can be achieved through the introduction of new knowledge and technologies, as needed. It also means considering and incorporating indigenous or traditional knowledge and practices in new ways.
- **Inclusive**: Inclusion emphasises the need for broad consultation and engagement of communities, including the most vulnerable groups. Addressing the shocks or stresses faced by one sector, location, or community in isolation of others is an anathema to the notion of resilience. An inclusive approach contributes to a sense of shared ownership or a joint vision to build city resilience.
- **Integrated**: Integration and alignment between city systems promotes consistency in decision-making and ensures that all investments are mutually supportive to a common outcome. Integration is evident within and between resilient systems, and across different scales of their operation. Exchange of information between systems enables them to function collectively and respond rapidly through shorter feedback loops throughout the city.
- **Absorptive Capacity**: the ability of the transportation system to absorb shocks and stresses and maintain normal functioning. This capacity can be increased by hardening assets or reducing exposure to risk.
- **Restorative Capacity**: The ability of the system to recover quickly after a shock or stress to normal functioning. This capacity can be increased by establishing disaster response plans and quick-response capabilities.
- **Equitable Access**: The ability of the system to provide the opportunity for access across the entire community during a shock or stress and when the system is undisrupted.
- **Adaptive Capacity**: The ability of the system to change in response to shocks and stresses to maintain normal functioning. One commonly used set of measures involves the availability of alternate routes and alternative mode choices.

Relevance to the Metro 2050 / Transport 2050 Regional Resilience Framework

Establishing a set of principles through which to gauge resilience and set parameters for evaluation is needed for a framework. The above list provides a range of options to select from. These can either be evaluation parameters themselves, or can incorporate more specific metrics and indicators which is discussed in the sub-section below.

MEASUREMENT AND EVALUATION

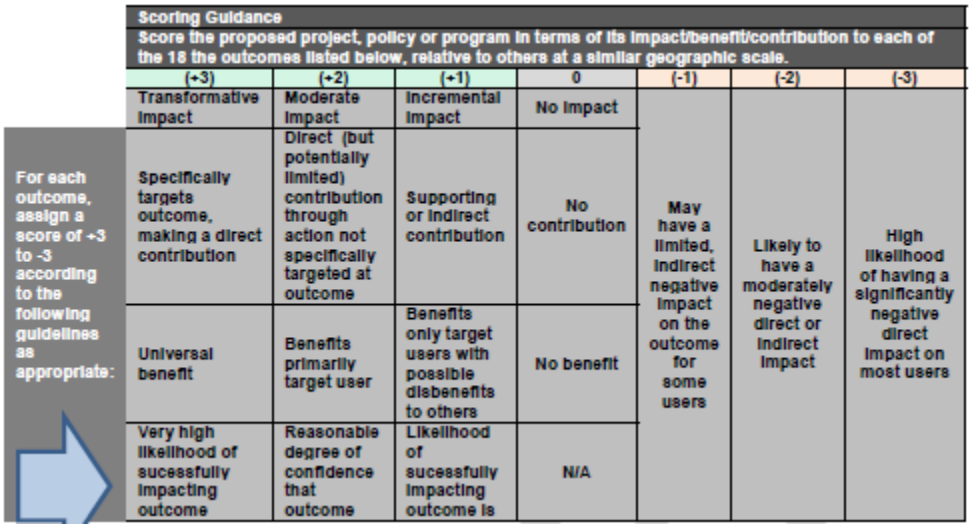
Evaluation can be undertaken using a variety of scales of measurement. There are four scales of measurement used to describe characteristics of a variable these are summarized in the following table.

Table 8: Measurement Scales

Scale	Description	Data Type
Nominal Data	Categories with no ordering or direction.	Qualitative Data
Ordinal Data	Ordered categories with rankings, order, or scaling.	Qualitative Data
Interval Data	Relative differences between measurements, no true zero.	Quantitative Data
Ratio Data	Differences between measurements with true zero.	Quantitative Data

This is important to consider as evaluation can use all scales of measurement and it is important to discern what data is available prior to determining an appropriate evaluation method. The examples below show different approaches that can be used when assessing policy, programs, and projects for resilience or general effectiveness.

The first example below is from the Metrolinx Evaluation Process for the 2041 Regional Transportation Plan Update.[32] This plan used a multi-method approach for evaluating projects, programs and policies from a long list submitted by municipalities and regional authorities. After preliminary screening, a qualitative assessment was undertaken where initiatives were scored against criteria that aligned with the Regional Transportation Plan vision, goals, and objectives. Scoring criteria were developed to support the qualitative assessment. The simplified rubric is shown below.



Scoring Guidance: Score the proposed project, policy or program in terms of its impact/benefit/contribution to each of the 18 the outcomes listed below, relative to others at a similar geographic scale.						
(+3)	(+2)	(+1)	0	(-1)	(-2)	(-3)
Transformative impact	Moderate impact	Incremental impact	No impact			
For each outcome, assign a score of +3 to -3 according to the following guidelines as appropriate: Specifically targets outcome, making a direct contribution	Direct (but potentially limited) contribution through action not specifically targeted at outcome	Supporting or indirect contribution	No contribution	May have a limited, indirect negative impact on the outcome for some users	Likely to have a moderately negative direct or indirect impact	High likelihood of having a significantly negative direct impact on most users
Universal benefit	Benefits primarily target user	Benefits only target users with possible disbenefits to others	No benefit			
Very high likelihood of sucessfully impacting outcome	Reasonable degree of confidence that outcome	Likelihood of sucessfully impacting outcome is	N/A			

Figure 9: Metrolinx Evaluation Process Scoring[33]

A more granular approach to determining resilience is by way of using specific indicators. This can be seen through LA Metro's Resiliency Indicator Framework below.[34] The assessor selects a score for each indicator based on a measurement scale from 1 (least resilient) to 4 (most resilient) that has been determined for each indicator. Each technical indicator is weighted on a 4-tier scale to generate a comparative index. Note that there is still an ordinal scale of measurement applied through this framework, similar to the process undertaken by Metrolinx. However, technical indicators provide more specific data that is then mapped to a similar scale as the organizational 4-tier scale. Technical indicators are assessed against specifics assets or systems while organizational indicators are measured at the agency

[32] Metrolinx. (2018). The 2041 Regional Transportation Plan Evaluation Process Backgrounder. Metrolinx.
[33] Ibid.
[34] LA County Metropolitan Transportation Authority (MTA). (2015). Resiliency Indicator Framework

level. Indicator scores are aggregated into one overall weighted resiliency score on a 10-point scale (1 = least resilient, 10 = most resilient). Indicators are grouped within three principles: robustness, redundancy, and safe-to-fail for infrastructure and systems, while change readiness, and leadership & culture are measured at the organizational level. It should be noted that the indicators in this framework are primarily focused on infrastructure and systems evaluation for resilience, not strategy evaluation.

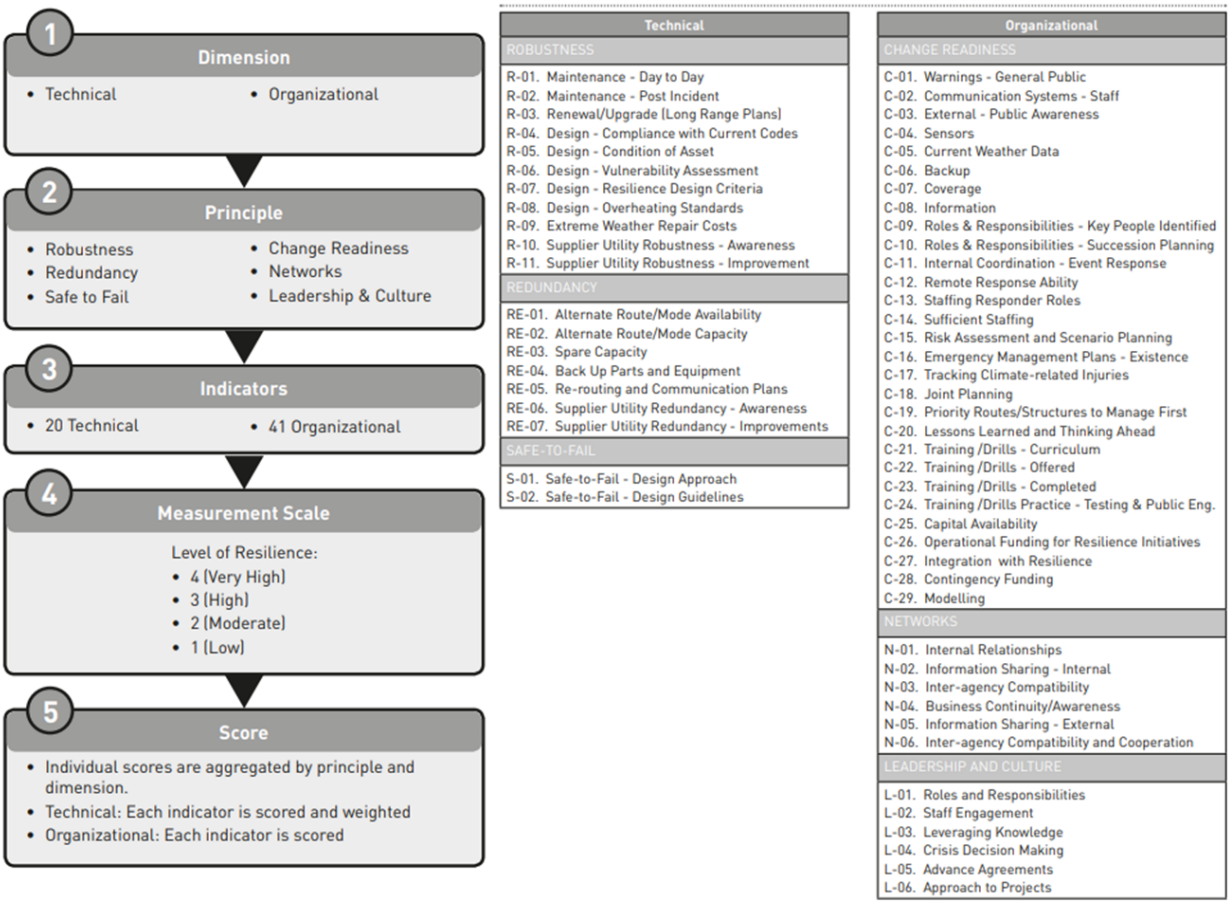


Figure 10: Resiliency Framework and List of Indicators[35]

Relevance to the Metro 2050 / Transport 2050 Regional Resilience Framework

Quantitative measurement scales are appropriate when there is sufficient interval or ratio data available for analysis and comparison. Qualitative measurement scales are appropriate when incorporating expert opinion creating ranked categories (ordinal specifically). Ordinal assessment allows comparability, so that focused response can be applied to strategies that are seen to either have a mixed or negative contribution toward resilience.

IMPLEMENTATION

Following resilience evaluation, one of the last components to a framework is to implement the findings in a meaningful way. Many resilience frameworks, as exemplified through this appendix, are for evaluating infrastructure against stresses/shocks. Therefore, findings from these assessments can be integrated into the design of the infrastructure that was evaluated. Using similar logic, the opportunity to implement findings from a policy evaluation for resilience is to incorporate the recommendations into future policy adjustments

[35] Ibid.

Relevance to the Metro 2050 / Transport 2050 Regional Resilience Framework

The scope of this project is somewhat unique compared to other resilience frameworks in that it focuses on strategy evaluation instead of infrastructure or asset evaluation. The purpose of evaluating the *resilience of what* and the *resilience to what* is to make meaningful changes to a system. In the case of this project and framework, the findings and recommendations are intended to be taken under consideration by Metro Vancouver and TransLink and integrated into Transport 2050 and Metro 2050

INTERDEPENDENCIES

The last component for consideration within a resilience framework falls under the topic of interdependencies. Particularly when it comes to critical infrastructure (which both Metro Vancouver and TransLink have within their purview), there are many relationships that exist where if one component fails or is disrupted, there will be secondary and tertiary effects to other parts of the system. Figure 10 below maps the interdependencies of what happened in California when there was a disturbance to electric power generation in 2001. This in turn impacted oil and natural gas production, pipeline transport, water distribution for crop irrigation, and a variety of other secondary effects. The magnitude and scale of a shock or stress will often expose more interrelationships.[36] Resilient systems are those that document, learn, and adapt by building a greater understanding on interdependencies (i.e. resourcefulness).

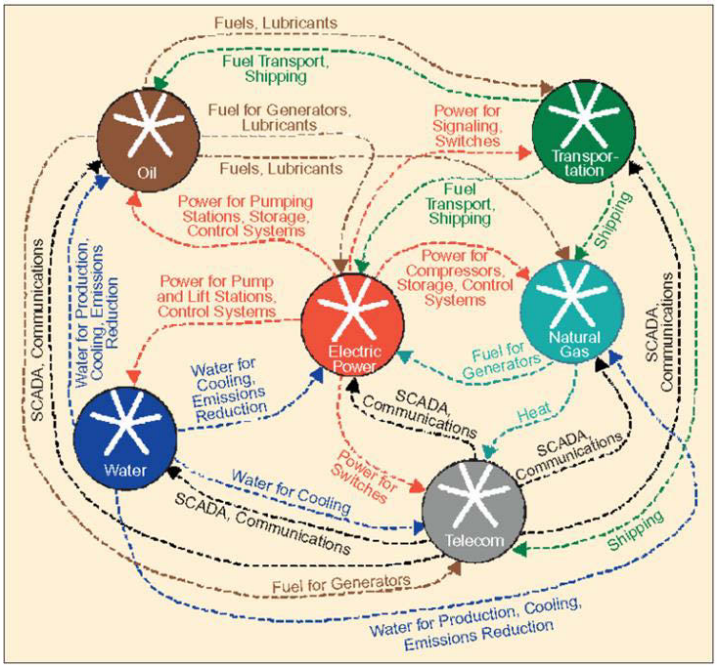


Figure 11: Critical Infrastructure Interdependencies Map[37]

Figure 11 uses the same example as above, and presents first-, second- and third-order effects. Similar interrelationships were exposed in other significant events like Hurricane Sandy where the loss of the electrical grid led to reduced fuel distribution, which led to loss of emergency power, which accentuated flooding damage and slowed recovery efforts. Similar effects were also seen in Japan and South America after earthquakes. This relates to Metro Vancouver and TransLink as operations and infrastructure within these jurisdictions could be impacted by other cascading effects and/or could impact downstream services (e.g., a region-wide power disruption could lead to impacted water supply to agricultural facilities in the region, which in turn could result in crop losses and food supply impacts). While long-range

[36] Rinaldi, S. M., Peerenboom, J. P., & Kelly, T. K. (2001). Identifying, understanding, and analyzing critical infrastructure interdependencies. IEEE control systems magazine, 21(6), 11-25.
[37] Ibid.

strategy (the focus of the evaluation in Section 4) is not necessarily impacted be the cascading effects per se, there is opportunity to establish strategy to plan and prepare for these interdependencies.

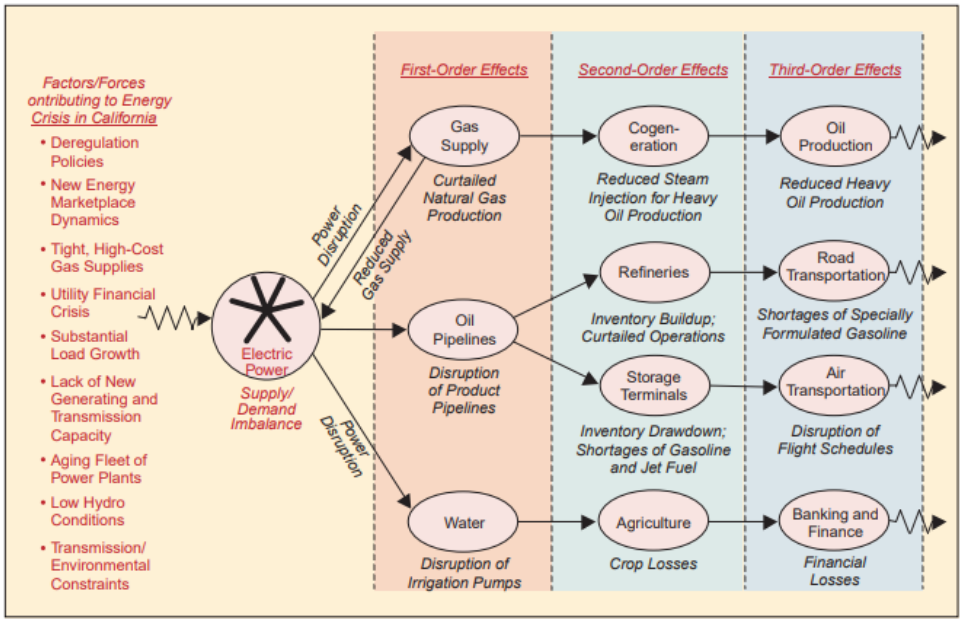


Figure 12: Examples of Cascading effects[38]

Relevance to the Metro 2050 / Transport 2050 Regional Resilience Framework

Identifying, understanding, and analysing interdependencies that exist for both TransLink and Metro Vancouver is an important component of evaluating resilience. This can be achieved at a high level within this project scope, but should be followed up with more robust analysis, engaging a broad set of stakeholders (e.g., municipalities, BC Hydro, FortisBC, Telecommunication Agencies, etc.) to understand any interdependencies and cascading effects where TransLink or Metro Vancouver infrastructure is impacted beyond a first-order effect, and areas where other jurisdictions have control over the initial asset in question.

NOTABLE AND RELEVANT RESILIENCE FRAMEWORK EXAMPLES

These common components are incorporated by a number of resilience frameworks for different applications. This section of the Appendix provides examples of resilience frameworks and introduces their application and purpose. While each framework provides ideas for integrating into the Metro 2050 / Transport 2050 Regional Resilience Framework, no single framework is a perfect fit. The following frameworks are summarized:

- Critical Infrastructure Resilience Framework (Bruneau et al., 2003)
- Framework of Resilience (Norris et al., 2008)
- Sendai Framework for Disaster Risk Reduction (UNDRR, 2015)
- Vulnerability Assessment Framework (Weilant, Strong, and Miller, 2019)
- Resilience Framework and Capacities (Francis and Bekera, 2014)
- City Resilience Framework (Da Silva and Morera, 2014)
- Resilience Framework for Policy Effectiveness (Pradhan et al., 2017)
- Policy Resilience Framework for Alternative Scenarios (WSP, 2017)

[38] Ibid.

CRITICAL INFRASTRUCTURE RESILIENCE FRAMEWORK[39]

This framework was developed in part to quantitively assess seismic resilience of communities. It relies on three measures of resilience: "reduced failure probabilities, reduced consequences from failures, and reduced time to recovery". It includes quantitative measures in the four principles of resilience (robustness, redundancy, resourcefulness, and rapidity) which are integrated into four dimensions of resilience (technical, organizational, social, and economic as seen in Figure 11). These can be used to quantify measures of resilience for various types of physical and organizational systems.

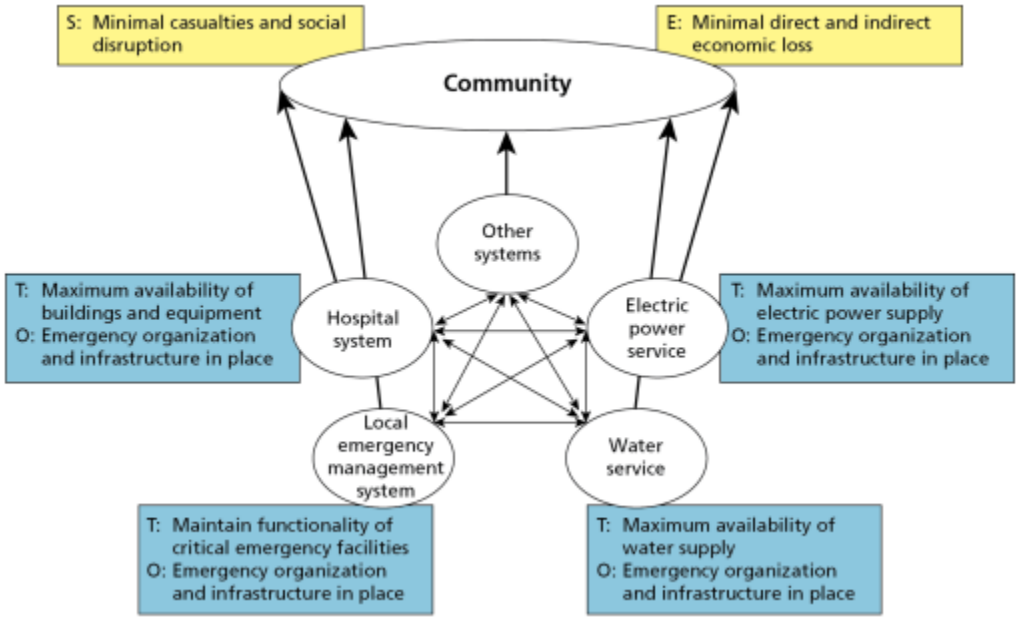


Figure 13: System and Community Performance Measures[40]

Relevance to the Metro 2050 / Transport 2050 Regional Resilience Framework

There are several relevant perspectives that are raised in this article:

- Bruneau et al. acknowledge that to measure community resilience, you must quantify the "difference between the ability of a community's infrastructure to provide community services prior to the occurrence of an [event] and the expected ability of that infrastructure to perform after an [event]." In other words, there is an aspect of forward-looking measurement that will need to be based on assumptions. This provides some precedent for measuring anticipated impact of policy on resilience.
- Bruneau et al. highlight the importance of recognizing interdependent systems. Improving performance on all these is essential for comprehensive resilience. Interdependency will be addressed in the Metro 2050 / Transport 2050 Regional Resilience Framework, while also recognizing the limits of influence that TransLink and Metro Vancouver have within their mandates.
- The dimensions of technical, organization, social, and economic are also essential for consideration. These aspects are presented in the shock and stress groups selected for this project. 'Organizational' is a dimension that is considered more holistically within the scope, as the dimensions selected for the framework (Transportation and Growth Management) limit the ability to address resilience to what the mandates of TransLink and Metro Vancouver allow for.

[39] Bruneau, M., Chang, S. E., Eguchi, R. T., Lee, G. C., O'Rourke, T. D., Reinhorn, A. M., Shinozuka, M. Tierney, K., Wallace, W. A., & Von Winterfeldt, D. (2003). A framework to quantitatively assess and enhance the seismic resilience of communities. Earthquake spectra, 19(4), 733-752.
[40] Ibid.

FRAMEWORK OF RESILIENCE[41]

This paper reviews literature through several disciplines to present a framework that encompasses understandings of stress, adaptation, wellness, and resource dynamics. The authors outline that resilience is a process of linking adaptive capacities of a network to adaptation after a disturbance (shock or stress). Norris et al. see community resilience emerging from four main sets of adaptive capacities: economic development, social capital, information and communication, and community competence. These determine a strategy for disaster readiness. The framework (or model) that is presented in Figure 13 shows that when resources are sufficiently robust, redundant, or rapid (components from the 4R framework) to buffer immediate effects, that no dysfunction occurs (and post-event functioning adapts to pre-event environment). Similarly, these three traits are measured to determine degree of resilience and vulnerability of communities. Additional variables that are considered within the framework are severity, duration, and surprise of the stressor (or shock).

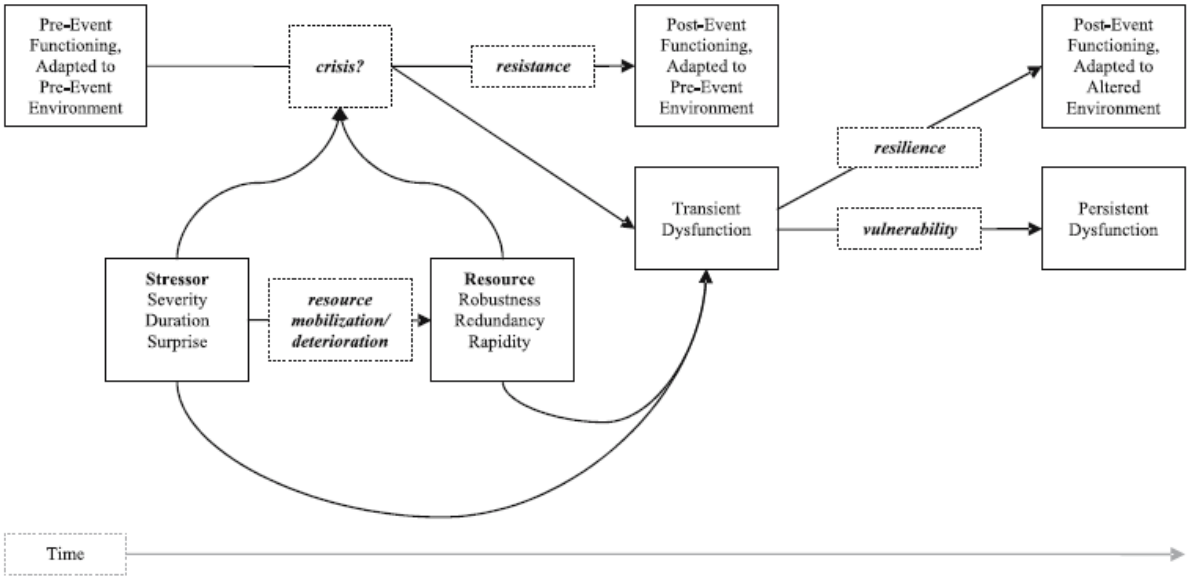


Figure 14: Conceptual Resilience Framework[42]

Relevance to the Metro 2050 / Transport 2050 Regional Resilience Framework

The 4R set of principles (Resourcefulness, Robustness, Redundancy, and Rapidity) are the units of analysis and measurement for determining capacity to resist a shock or stress, along with associated resilience and vulnerability. This is an approach that can be adopted for the Metro 2050 / Transport 2050 Regional Resilience Framework to evaluate policy resilience.

SENDAI FRAMEWORK FOR DISASTER RISK REDUCTION[43]

The Sendai Framework applies to small- and large-scale, frequent and infrequent, sudden and slow-onset disasters, caused by natural or human-made hazards as well as related environmental, technological and biological hazards and risks. It aims to guide the multi-hazard management of disaster risk in development at all levels as well as within and across all sectors.

[41] Norris, F. H., Stevens, S. P., Pfefferbaum, B., Wyche, K. F., & Pfefferbaum R. L. (2008). Community Resilience as a Metaphor, Theory, Set of Capacities, and Strategy for Disaster Readiness. American Journal of Community Psychology, Vol. 41, No. 1-2, pp. 127–150.
[42] Ibid.
[43] UNDRR. (2015). Sendai Framework for Disaster Risk Reduction 2015-2030

The goal of the framework is to prevent new and reduce existing disaster risk through the implementation of integrated and inclusive economic, structural, legal, social, health, cultural, educational, environmental, technological, political and institutional measures that prevent and reduce hazard exposure and vulnerability to disaster, increase preparedness for response and recovery, and thus strengthen resilience.

There are four priorities that are presented within the framework where there is a need for focused action within and across sectors at a local, national, regional and international scale:

- Understanding disaster risk;
- Strengthening disaster risk governance to manage disaster risk;
- Investing in disaster risk reduction for resilience; and
- Enhancing disaster preparedness for effective response, and to build back better in recovery, rehabilitation, and reconstruction.

Relevance to the Metro 2050 / Transport 2050 Regional Resilience Framework

The Sendai Framework along with associated documentation (Hazard Definition and Classification Review, UNDRR, 2020; and the Disaster Resilience Scorecard for Cities, UNDRR, 2019) have a number of relevant contributions for consideration

- The Sendai Framework includes disaster reduction targets and a timeline. Metro Vancouver and TransLink can consider this in the updates of their long-range strategies in terms of goal setting for resilience.
- The Sendai Framework includes priorities for action that are globally relevant regardless of jurisdiction or authority.
- The Hazard Definition and Classification Review provides a good starting point for clustering stresses and shocks into groups, something that TransLink and Metro Vancouver may want to follow to have sufficient breadth of stresses/shocks while maintaining structure.
- The Disaster Resilience Scorecard for Cities has 10 essentials for making cities resilient. The scope of the scorecard primarily looks at acute shocks, while TransLink and Metro Vancouver have indicated that considering stresses is also an important feature of this project.

CONCEPTUAL TRANSPORT SYSTEM RESILIENCE FRAMEWORK[44]

RAND's conceptual framework is organized into inputs and activities (i.e. means) that needed to achieve outputs and outcomes in a more resilient transportation system, along with adjacent social, economic and environmental systems (i.e. ends). The framework moves from left to right, from inputs to activities, to outputs, to outcomes of both the transportation system as well as well as other system outcomes seen in Figure 14. It should be noted that this is partly a framework and partly a 'how to' manual on improving resilience of a transportation system.

Of the five main inputs, the main input to conceptualize is multi-modal infrastructure. This is the suite of assets with a transportation system including roads, rail, grey and green infrastructure, and pathways for pedestrians, cyclists, and other forms of micromobility. Inputs also include income streams, a skilled workforce for accomplishing planning goals, partnerships for influencing transportation investments, and data and information to determine areas that are vulnerable to risk.

Activities are the actions that can be employed to achieve outputs. This includes modifications to infrastructure for adaptation or strengthening. Prioritizing income streams is another activity that can be undertaken to achieve outputs, either by investing in infrastructure, or in a skilled workforce that can determine where changes would best be targeted.

[44] Weilant, S., Strong, A., & Miller, B. (2019). Incorporating Resilience into Transportation Planning and Assessment. RAND.

Collaboration and coordination with partners is another way through which outputs can be achieved. Diversity in partnerships can allow for improved decision-making processes and increased data availability while growing the talent pool of workforce that can improve a system.

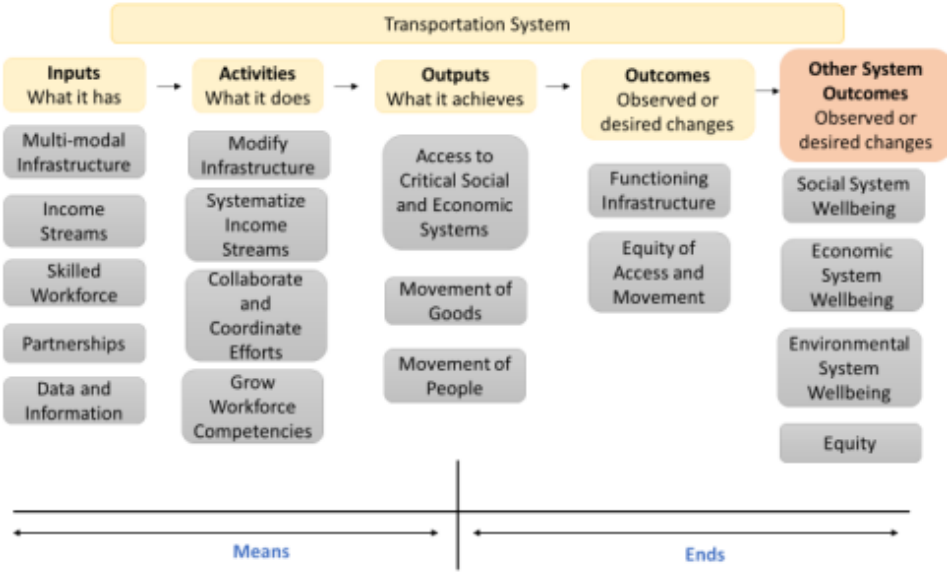


Figure 15: Transportation System Inputs, Activates, Outputs, and Outcomes[45]

Inputs and activities are seen to achieve three main outputs: access to critical social and economic systems, movement of goods, and movement of people in a safe and efficient manner.

There are two main outcomes that are desired from the transport system within this framework: access and movement. When access and movement are achieved, a system functions normally. There are already small-scale measures put in place within most transport systems to allow a system to continue to function even in the face of minor stresses or shocks (e.g., an incident occurs, and travellers are alerted to seek a different route, also known as redundancy). Other system outcomes follow suit in a similar manner. Economic system wellbeing can be challenged with shocks and stresses to transport systems. A simple example is an unreliable transport system resulting in someone being late for an important meeting. Similarly, this can be applied for social systems as well.

This report goes on to outline hazard application to the framework and determining aspects of resilience and characteristics through which a resilient system can be evaluated. These follow a 4R+ framework and the AREA framework (absorptive capacity, restorative capacity, equitable access, and adaptive capacity), outlined earlier in this Appendix.

Relevance to the Metro 2050 / Transport 2050 Regional Resilience Framework

This report primarily focuses on transportation resilience (with limited discussion on growth management). However, the linear movement of the framework provides a relatively simple path to follow. The nested feature is also an efficient way to focus on what is occurring at the underlying levels of the framework. While the concept is effective and clear, the framework does not articulate how resilience evaluation actually occurs. The report goes on to provide metrics for resilience, suggesting that a primarily quantitative method is applied, departing from the focus of the Metro 2050 / Transport 2050 Regional Resilience Framework that looks to evaluate long-range policy for resilience. Nonetheless, the linear nature of this framework can be applied for its easy to understand flow.

[45] Ibid.

RESILIENCE FRAMEWORK AND CAPACITIES[46]

This framework example builds on Norris' approach that is outlined above in this section. This framework is more easily incorporated into decision making processes. It is divided into five components: system identification, vulnerability analysis, resilience objective setting, stakeholder engagement, and resilience capacities.

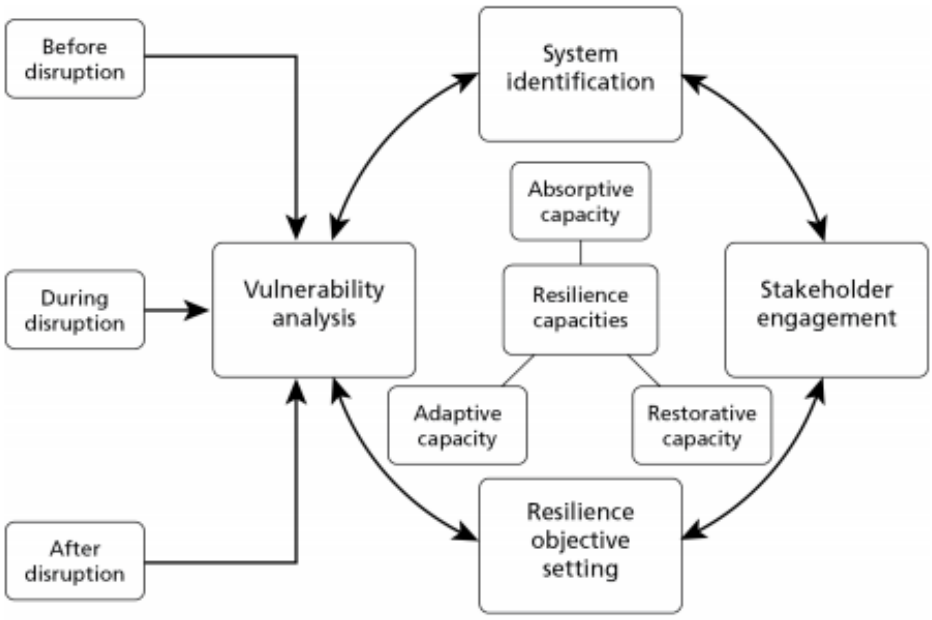


Figure 16: Capacity-based Resilience Framework[47]

This framework discusses goals and objectives setting for increasing resilience. This is something that is not seen in other frameworks reviewed. The goals dictate the metrics that will measure progress towards increasing resilience. The three resilience capacities selected for measurement are:

- Absorptive capacity – degree to which a system can absorb the impacts of perturbations and minimize consequences;
- Adaptive capacity – ability of a system to adjust to undesirable situations by changing; and
- Restorative capacity – the rapidity of return to normal of improved operations of system reliability.

This framework also provides the basis of a vulnerability analysis, which is broken into before, during and after disruption. This is obviously dependent on the disruption event(s) through which the system is analysed. Once likelihood of event(s) is determined, the temporal assessment needs to take place, which is where this framework differs from a traditional risk assessment. The authors outline the importance of including before, during and after for resilience assessments because resistance and recovery are key components of resilience itself, rather than solely preparedness and absorptive capacity. The vulnerability assessment would then dictate appropriate resilience actions to be taken.

Lastly, this framework specifically incorporates stakeholder engagement into its assessment and is an integral part of resilience analysis and management. Coordination amongst stakeholders is a requirement during all time periods (before disruption, during disruption, and after disruption).

46 Francis, R., & Bekera, B. (2014). A metric and frameworks for resilience analysis of engineered and infrastructure systems. Reliability Engineering & System Safety, 121, 90-103.
47 Ibid.

Relevance to the Metro 2050 / Transport 2050 Regional Resilience Framework

This article highlights the importance of vulnerability analysis as part of a resilience framework. This can be incorporated into the Metro 2050 / Transport 2050 Regional Resilience Framework, integrating the relevant state of systems prior to disruptions, and any known information to date on how systems performs during and after disruptive events.

CITY RESILIENCE FRAMEWORK[48]

The City Resilience Framework (The Rockefeller Foundation & Arup) measures and compares cities based on available data. It approached the framework development by undertaking a broad literature review, learning from case studies, and undertaking interviews with six cities that had either recently experienced a major shock or are suffering chronic stresses: Cali, Colombia; Concepción, Chile; New Orleans, USA; Cape Town, South Africa, Surat, India; and Semarang, Indonesia. From this approach, twelve indicators were developed that fall under four categories. Each indicator is complemented with seven qualities that distinguish a resilient city from one that is 'simply liveable, sustainable, or prosperous'. These can be seen in the figure below.

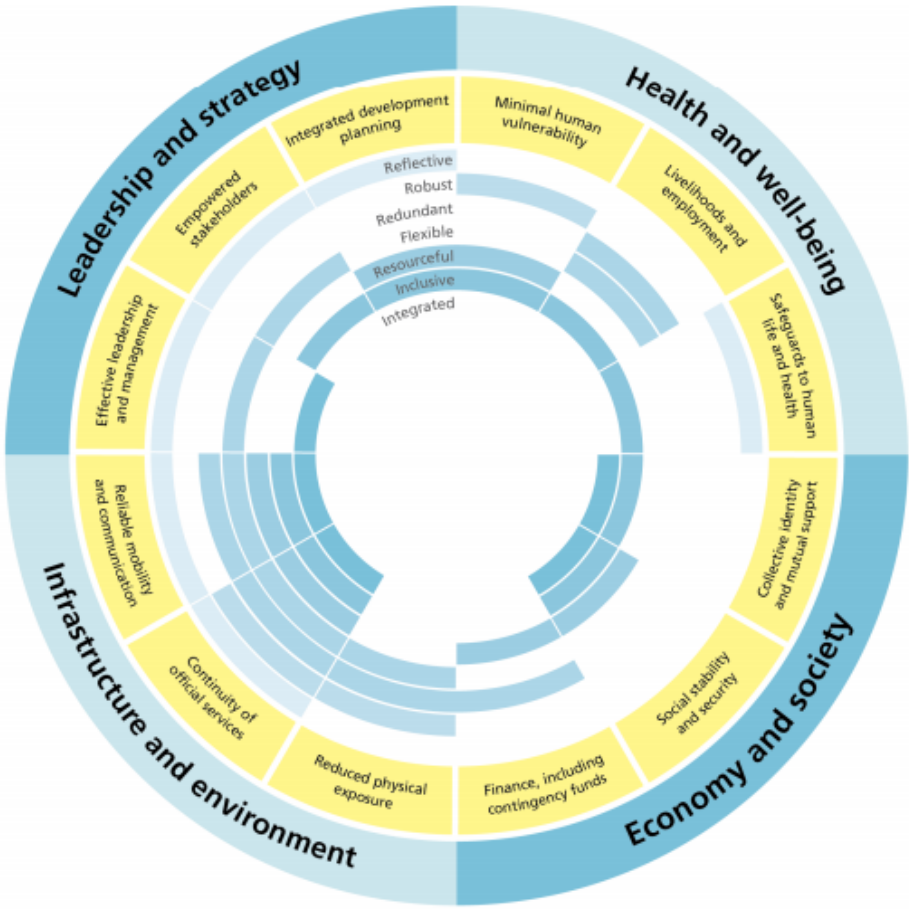


Figure 17: City Resilience Framework[49]

[48] Da Silva, J., & Morera, B. (2014). City Resilience Framework. London: Arup.
[49] Ibid.

Relevance to the Metro 2050 / Transport 2050 Regional Resilience Framework

The framework provides an expanded and adjusted set of principles (or qualities in this case) beyond Bruneau's 4R set. While this set does not include rapidity, it adds reflective, inclusive, integrated, and flexible to the list of attributes for consideration in evaluation. The framework also provides a set of 12 indicators that can be considered for evaluation alongside policies from TransLink and Metro Vancouver.

Actual scoring and development of the resilience index is undertaken with a mixed qualitative and quantitative method, whereby measurement is executed with ordinal scoring (a five-point scale is presented to provide a relative spectrum, rather than focus on a specific number). This is adapted from the Global Cities Index by AT Kearney (2012).

RESILIENCE FRAMEWORK FOR POLICY EFFECTIVENESS[50]

This framework is from an article that aims to measure effectiveness of government policies and projects. The study area is for Yunnan Province in China, with the purpose of drought-related policy implementation. The authors recognize that there are very few studies that have looked at how to measure effectiveness of policy, and that very few frameworks have been found acceptable as the basis for acceptable analysis of policy effectiveness. The modified framework presented defines policy, practice, and performances, as well as a feedback loop by which to share lessons learned (with the concept of policy improvement).

The "effectiveness triangle" is adapted from Sadler's work that was developed for environmental assessments, and evaluating practice to improve performance (Sadler, 1996). The term effectiveness is defined as whether a policy works as intended and meets the purpose for which it is designed. The three criteria that were used to evaluate effectiveness are: procedural (to meet accepted principles and provisions), substantive (to achieve established purposes and objectives), and transactive (to determine the extent to which the procedural principles deliver the substantive objectives at the least cost and in the minimum time possible). Overall effectiveness is achieved if it supports policy and institutional reforms to the decision-making process of environmental protection and sustainable development.

This framework was expanded by Baker and McLelland (2003) to focus on policy as a function of different aspects of efficacy that surround the policy including practice, performance, and proficiency, which represented the circular effectiveness cycle linking together four aspects to analyze policy effectiveness.

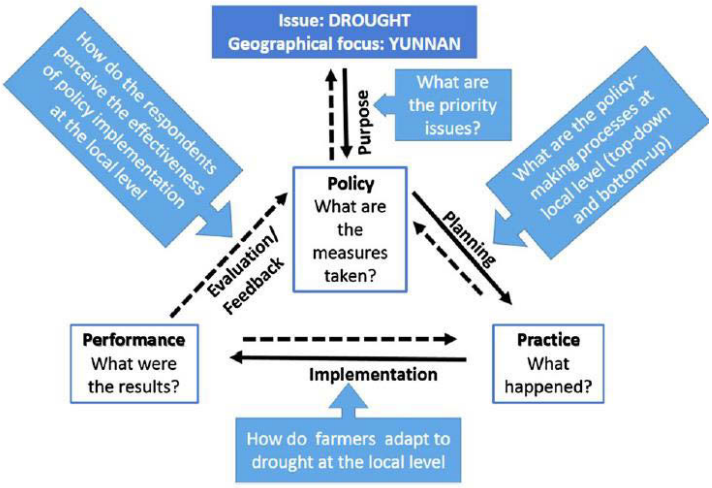


Figure 18: Framework to analyze effectiveness of policy implementation[51]

[50] Pradhan, N. S., Su, Y., Fu, Y., Zhang, L., & Yang, Y. (2017). Analyzing the effectiveness of policy implementation at the local level: a case study of management of the 2009–2010 Drought in Yunnan Province, China. International Journal of Disaster Risk Science, 8(1), 64-77.
[51] Ibid.

Relevance to the Metro 2050 / Transport 2050 Regional Resilience Framework

This is the only external framework discovered for evaluating policy and therefore deserves consideration for application. The most difficult aspect to conceptualize from this framework for application to the Metro 2050 / Transport 2050 Regional Resilience Framework is determining how the above noted framework can be expanded to capture the dimensions of both growth management and transportation, as well as multiple disruption lenses.

Furthermore, as TransLink and Metro Vancouver have broad-reaching capacity and associated policy, this policy evaluation framework is more applicable in theory, and less applicable in practice. To expand on this note, there is a stronger ability to evaluate policy impacts on single events. Meanwhile, taking into account the wide array of policies to be evaluated between the RGS and RTS, a broader framework or assessment may need to be taken into consideration.

Lastly, the point of evaluating policy effectiveness is not lost, despite it needing to be undertaken through a different lens. In the article, Pradhan et al. outlined the importance of evaluating the effectiveness of policy implementation as being a segue to asking important questions such as "are the policies working? What needs to be improved? What could be the feedback mechanism in the policy cycle?". Ultimately, these are similar thesis questions that Metro Vancouver and TransLink are facing in this project. These questions can be adapted to align with outcomes of this project:

- Are the policies working to improve resilience?
- If not, what needs to be improved? (which will be undertaken via a gap analysis)

POLICY RESILIENCE FRAMEWORK FOR ALTERNATIVE SCENARIOS[52]

In 2017, Metrolinx released a background study for its Regional Transportation Plan update called Navigating Uncertainty through Scenario Planning. Through the project, six scenarios were developed, which were then used to test the resilience of policy portfolios that were being developed concurrently. The five potential investment portfolios each had a different area of emphasis (infrastructure, transit operations, active transportation, pricing/TDM, and land-use. Two scores were created for each portfolio, one to describe the portfolio performance against anticipated conditions of the base case, and the other to describe the portfolio's average performance against the six alternative futures. Criteria were developed and weighting was determined prior to developing resilience scores for the five portfolios.

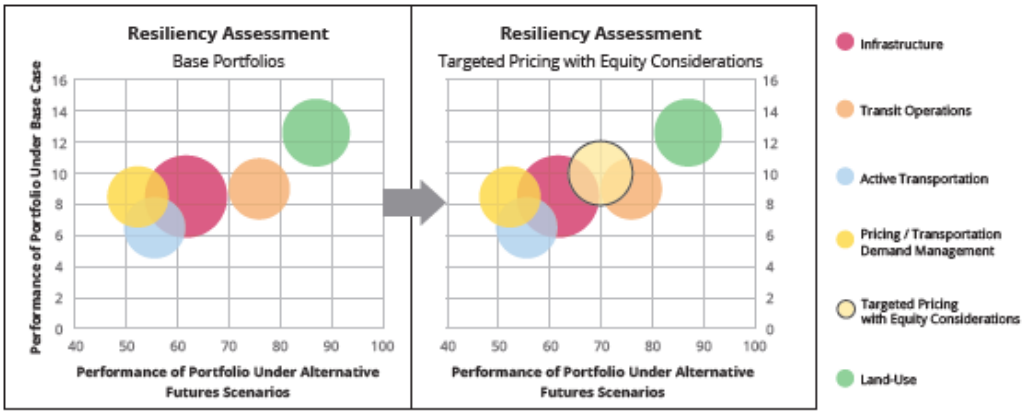


Figure 19: Visualization of Portfolio Resilience Evaluation against Scenarios[53]

[52] WSP. (2017). Navigating Uncertainty: Exploration of Alternative Futures for the Greater Toronto and Hamilton Area. Background Report for the Regional Transportation Plan. Metrolinx.
[53] Ibid.

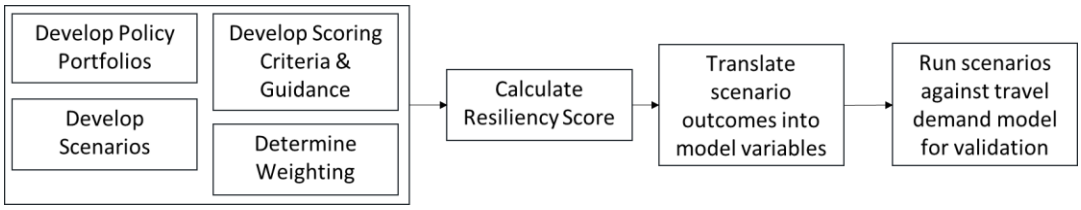


Figure 20: Framework of Portfolio Resilience against Scenarios[54]

Relevance to the Metro 2050 / Transport 2050 Regional Resilience Framework

This report provides a qualitative and relative scoring mechanism for evaluating policy for resilience. The criteria were developed with written rationale for scoring on a +3 to -3, where -3 means policy is anticipated to have a detrimental effect on regional goals within a certain scenario, 0 is no change from current trajectory, and +3 is anticipated to have a significant positive contribution to regional goals. A similar type of ordinal scoring is applicable to the Metro 2050 / Transport 2050 Regional Resilience Framework to evaluate policy. As mentioned with the framework developed by Pradhan et al., there is limited precedent for evaluating policy effectiveness or for resilience. These two frameworks provide the closest relevance for replicating and building from, while recognizing developing replicable scoring guidance and criteria, along with clear rationale, remains a critical component of robust evaluation.

[54] Ibid.

APPENDIX C – EVALUATION & GAP ASSESSMENT

Appendix C includes a gap assessment summary followed by an assessment of each strategy in the RGS and RTS. Key recommendations have been highlighted in **Section 4.2** above.

GAP ASSESSMENT SUMMARY

Recognizing that strategy resilience may fall outside of the specific strategies evaluated, a gap assessment was undertaken that highlights strategies and actions for consideration for Metro Vancouver and TransLink that relate to the mandate of the respective agencies.

STRATEGY EVALUATION STRUCTURE

EVALUATION

Each strategy in the RTS and RGS was assessed using a 4x4 matrix which evaluated shock and stress groups against evaluation principles, creating a total of 16 cells for assessment. Each cell provides a brief rationale on how the strategy is anticipated to contribute to resilience (or not) for each shock and stress group. Cells are colour-coded as follows:

	Strategy is anticipated to have a **primarily positive contribution** towards resilience.
	Strategy is anticipated to have a **primarily negative contribution** towards resilience.
	Strategy is anticipated to have a **mixed contribution** towards resilience.
	Strategy is anticipated to have **no significant contribution** towards resilience.

It should be noted that this assessment has some degree of subjectivity involved. It is based on the perspectives of the evaluators, along with contributing commentary from the client review panel, along with external experts. The primary rationale behind using a basic scoring rubric is to draw attention to areas of mixed or negative contribution.

Cells were evaluated in as consistent a manner as possible, while recognizing that in some cases, guiding questions within primary attributes were not applicable to a specific strategy or the stresses and shocks within a group, and in other cases, strategies would align with one or more of the guiding questions. Not all questions are required to respond with a positive (or negative) demarcation. For example, a strategy could be given the colour blue (positive contribution) for adding to the ability of withstanding a stress or shock, while not necessarily adding to safe-to-fail outcomes. This would still warrant the colour blue, assuming there is no mixed or negative anticipated contribution within this cell.

GENERAL RESILIENCE SUMMARY

For each strategy, a resilience summary is provided, synthesizing main points on the effectiveness of the strategy at contributing towards resilience.

STRATEGY DISCUSSION AND RECOMMENDATIONS

Following the evaluation and summary, each shock and stress group is discussed in greater detail where explanation or rationale is required, focusing on where strategies are anticipated to have a negative contribution or mixed contribution towards resilience. **Recommendations or adjustments that could be applied to improve resilience are provided under the rationale as bullets**. These recommendations are for consideration as inputs into the overarching strategy review process that each agency is currently undertaking as they update their long-range plans.

HAZARD, RISK, & VULNERABILITY ANALYSIS (HRVA) FRAMEWORK INDICATOR POTENTIAL

As outlined in **Section 3** of this report, it is recommended to apply an HRVA for future resilience assessments, which will be a more quantitative approach. This component provides a table that outlines ideal indicators for undertaking an HRVA in the future, along with current indicators that exist for Metro Vancouver and TransLink. The current indicators are based on what is publicly available. For Metro Vancouver, this is referring to the Metro 2040 performance monitoring dashboard[55] and, for TransLink, this is referring to the 2017 Regional Trip Diary[56] and Accountability Centre[57] metrics. The recommended indicators are generally intended to highlight likelihood of, severity of, or vulnerability to stresses and shocks for the purposes of alignment with HRVA inputs and requirements. Specific justification for each set of ideal indicators is described briefly under individual strategies.

SUMMARY OF RGS & RTS STRATEGIES

Metro Vancouver Regional Growth Strategy (2011) – Strategies

Strategy #	Strategy Wording
RGS 1.1	Contain urban development within the Urban Containment Boundary
RGS 1.2	Focus growth in Urban Centres and Frequent Transit Development Areas
RGS 1.3	Protect Rural areas from urban development
RGS 2.1	Promote land development patterns that support a diverse regional economy and employment close to where people live
RGS 2.2	Protect the supply of industrial land
RGS 2.3	Protect the supply of agricultural land and promote agricultural viability with an emphasis on food production
RGS 3.1	Protect Conservation and Recreation lands
RGS 3.2	Protect and enhance natural features and their connectivity
RGS 3.3	Encourage land use and transportation infrastructure that reduce energy consumption and greenhouse gas emissions, and improve air quality
RGS 3.4	Encourage land use and transportation infrastructure that improve the ability to withstand climate change impacts and natural hazard risks
RGS 4.1	Provide diverse and affordable housing choices
RGS 4.2	Develop healthy and complete communities with access to a range of services and amenities
RGS 5.1	Coordinate land use and transportation to encourage transit, multiple-occupancy vehicles, cycling and walking
RGS 5.2	Coordinate land use and transportation to support the safe and efficient movement of vehicles for passengers, goods and services

TransLink Regional Transportation Strategy (2013) – Strategies

Strategy #	Strategy Wording
RTS 1.1	Maintain what is needed in a state of good repair
RTS 1.2	Make early investments to complete the walkway and bikeway networks
RTS 1.3	Invest in the road network to improve safety, local access and goods movement
RTS 1.4	Make investments in the transit network to increase ridership
RTS 1.5	Ensure the continued provision of coverage transit service in low-demand neighborhoods
RTS 2.1	Make travel safe and secure for all users
RTS 2.2	Make travel easy and attractive for all users
RTS 2.3	Optimize roads and transit for efficiency, safety, and reliability
RTS 2.4	Use integrated mobility pricing for fairness, efficiency, and revenue
RTS 2.5	Manage parking for fairness, efficiency, and revenue
RTS 3.1	Support regional land use objectives
RTS 3.2	Ensure effective coordination through strong partnerships
RTS 3.3	Establish funding that is stable, sufficient, appropriate, and influences travel choices
RTS 3.4	Monitor progress towards our desired outcomes

[55] Metro 2040 Performance Monitoring Dashboard.
[56] TransLink 2017 Regional Trip Diary.
[57] TransLink Accountability Centre.

RGS STRATEGY SHOCK AND STRESS GAP ASSESSMENT

This table provides an overview of shocks and stresses that Metro Vancouver addresses through the RGS and recommendations for additional consideration where there are gaps. It is important to note that although the following shocks and stresses are discussed independently, some of the greatest risks could be due to a combination of the following and amplified through a cascading effect.

Environmental

Stress/Shock	Discussion
Flooding	Strategy 3.4 acknowledges flooding. • Clarifications are required on what is expected from Regional Context Statements for flood management and preparedness.
Snowstorms	Snowstorms are not acknowledged in the RGS. Snowstorms have a regionally significant impact on the region every few years. However, snowpack in the region is anticipated to decrease based on Metro Vancouver forecasting.[58] TransLink is currently undertaking the Burnaby Mountain Gondola project that will improve one of the most disrupted locations from snowstorms.[59] • Develop preparedness measures to facilitate travel in snowstorms. An example of this would be working with municipalities to ensure transit routes are plowed first, allowing transit to reliably function during snowstorms.
Windstorms	Windstorms are not acknowledged in the RGS. High wind events can result in power outages and transport infrastructure closures at a regionally significant level. • Expanded agency partners and coordinate closely with BC Hydro for power outage related issues, while coordinating with TransLink and BC MOTI for transportation-related impacts. • An HRVA should be undertaken to further determine the significance of this shock.
Air Pollution	Air pollution is addressed several times throughout the RGS. Recommendations are included above in 2.3, 3.3, 4.2, and 5.2.
Wildfire & Smoke	Strategy 3.4 acknowledges interface fires. It does not clearly indicate what impacts and risks should be considered when extending utilities and transportation infrastructure. • Clearer guidance for interface fires is required, particularly for developing in interface areas adjacent to forested lands.
Landslides	Strategy 3.4 acknowledges mudslides. This could be expanded to provide municipalities with additional guidance on requirements for building and development. • Provide clear guidance within Metro 2050 requiring municipalities to articulate development requirements for areas that are susceptible to landslides. Require (or lead) vulnerability mapping as required.
Earthquakes	Strategy 3.4 acknowledges earthquakes. This could be expanded to provide municipalities with additional guidance on requirements for building and development, and working with the province to clarify expectations for developing in areas susceptible to liquefaction. • Clarify what is expected from Regional Context Statements for earthquake preparedness in municipal development and building permit processes. Require (or lead) vulnerability mapping as required.
Natural Resource Depletion	Strategies 3.2 and 3.3 along with supporting plans and strategies provide a strong evidence base for minimizing the impact on our natural resources and sensitive ecosystems in the region. • Work with member jurisdictions to align natural feature protection and enhancement, using the SEI as guidance.
Climate Change	The RGS addresses climate change, particularly through Goal 3 strategies and actions. It outlines how growth management actions can reduce greenhouse gas emissions, along with strategies that promote sustainable transportation and reduce energy use. The Clean Air Plan and Climate 2050 will identify and prioritize actions to reduce GHG emissions and transition the region to one that is carbon neutral in the next 30 years. • Clear implementation guidance will be required to ensure all parties are aware of their expectations against this ongoing stress.

Technology & Infrastructure

Stress/Shock	Discussion
Cyber Attacks	Cyber attacks are unaddressed in the RGS. The region is progressing towards a more digital future. This means there is an increased number of vulnerabilities that will exist when it comes to maintaining and operating any infrastructure that is linked to control through a digital system. • While digital security is dependent on specific system design, the RGS could acknowledge the importance of cyber security for all regional infrastructure that relates to liquid and solid waste, storm water, and drinking water as examples, for Metro Vancouver and its member jurisdictions. • Similarly, Metro Vancouver can seek to have cyber attacks acknowledged in regional context statements to ensure municipal adherence to high digital security standards, along with partners such as TransLink, and the province.
Industrial Incidents	While Metro Vancouver seeks to protect Industrial Lands, preparedness and recovery for industrial-related shocks and stresses are not highlighted as a clear responsibility for long-range planning. • Protecting the supply of industrial land could be expanded to incorporate aspects of maintaining industrial land that are in a state of good repair. Siting and storing dangerous materials in floodplains and other at-risk areas increases risk and decreases resilience.
Transport Incidents (Road & Rail)	Safe and efficient transport is addressed in Strategies 5.1 and 5.2. Minimizing transport incidents results in increased reliability of the network, which is important for people and for goods movement. Since the RGS was adopted in 2011, TransLink has developed their Regional Goods Movement Strategy, which provides several strategies and actions for minimizing transport incidents to facilitate the efficient movement of goods. • A notable gap in the RGS and RTS is exploring the application and adoption of automated vehicles for the movement of people and goods. Roughly 94% of vehicle collisions have an element of human error, suggesting significant opportunity for improvement.[60] • Expand action 5.2.5 with a standalone implementation plan for protecting rail rights-of-way and develop additional strategies for maintaining efficient goods movement in the region. Work with the Port of Vancouver and Transport Canada to execute this plan.
Power Network and Energy Supply Disruptions	As infrastructure becomes increasingly dependent on digitalization, there will be a need for near-100% uptime for most operations. Increased severe weather events (through climate change) will continue to put pressure on our power systems. While power outages and uptime are not necessarily within Metro Vancouver's provision mandate, outages could impact some of the services that Metro Vancouver provides, such as water and wastewater services. • Any expansion of services due to growth in the region will need to ensure that power reliability exists at a high standard.
Global Supply Chain Disruptions	There will continue to be events that shock the global supply chain and leave the region with unexpected shortages of goods for weeks, months, or even years. This could occur due to an event like COVID-19, or a trade war, act of terrorism, regulatory change, labour dispute, supplier bankruptcy, or spikes in demand. • While not directly linked to growth management, Metro Vancouver could seek to develop a more robust partnership with the Port of Vancouver, and other industry participants in the supply network to create a regional digital supply network (DSN).[61] A

[58] Metro Vancouver. (2016). Climate Projections for Metro Vancouver.
[59] TransLink. (2020). Burnaby Mountain Gondola.
[60] NHTSA. (2019). Automated Vehicles for Safety.
[61] Deloitte. (2016). The rise of the digital supply network.

	DSN can provide early detection capabilities on shipments and deliveries, improve transparency of supply chain health, and become an integral part of strategic planning and decision making. This would require buy-in from participants in the supply chain in order to be effective at a regional summary level.
Aging Infrastructure	Metro Vancouver is an infrastructure provider to the region. Previously, infrastructure has been delivered with a fail-safe mentality, where infrastructure is designs to resist functional and structural failure, but may not endure non-stationary variables from climate change. More recently, there has been an increased call to make infrastructure "safe-to-fail".[62] This change in perspective recognizes that despite best planning intentions, there may be shocks and stresses that we are not aware of, and therefore cannot prepare for. The theory anticipates the failure of infrastructure and strategically designs the system to minimize and contain the failure. • Work with partners and member jurisdictions to develop infrastructure that is adaptable and safe-to-fail, to limit the severity of impacts to residents and travellers in the region.
Regional Food Supply Disruptions	• Encourage municipalities to promote agroforestry, silvopasture, and regenerative farming strategies with the goal of improving local food production, GHG sequestration, and climate resilience. • If agricultural intensification is not a viable path forward, it is recommended that Metro Vancouver, along with its member jurisdictions, explore the opportunity of vertical farming on non-agricultural lands through pilot projects prior to building it into regional growth strategy.

Sociopolitical & Economy

Stress/Shock	Discussion
Terrorism	Terrorism is not addressed in the RGS. Growth management policy does not influence resilience to terrorism through any meaningful first or second order effect. • As acts of terrorism can result in infrastructure failure, it is recommended to adopt a safe-to-fail approach, as discussed above. • Establish clear coordination mediums for anticipated acts of terrorism in the region, to improve resourcefulness. • An HRVA should be undertaken to further determine the significance of this shock.
Aging Population	The seniors' population is anticipated to grow from 13% to 25% of Canada's population between 2010 and 2036.[63] When managing growth in the region, there are several considerations that align with the RGS that can mitigate the stress of an aging population. • Ensure that transit services are provided that are accessible for all ages and abilities. • Continue working with municipalities to develop walkable UC/FTDAs that limit travel requirements to access a wide range of services and amenities. • Continue working with municipalities to design and develop housing options that meet universally accessible design.
Unemployment	The RGS Goal 2 speaks to actions to support regional employment and economic growth. • Continue to promote a diverse regional economy and protect industrial lands as ways to provide employment opportunities, along with encouraging growth in UC/FTDAs that provide accessible transport options.
Unaffordability	Strategy 4.1 speaks to providing affordable housing choices. A wide range of solutions have been identified in Metro Vancouver's "What Works" report.[64] Transportation affordability has also been explored through Metro Vancouver's Housing and Transportation Cost Burden Study, but is limited in terms of material within the RGS. • Catalogue measures from Metro Vancouver's "What Works" report for consideration for inclusion in Metro 2050. Municipalities can speak directly to which of these measures have been implemented to improve affordability in the region. • Identify growth patterns that best serve housing and transportation affordability by incorporating Census affordability data, transportation data, and additional costs (such as daycare). Use study information to develop clear goals and timelines to support affordability for housing and transportation.
Social Inequity	The RGS acknowledges 50% of equity seeking groups in the plan but does not discuss discrimination, obstacles, or aspects of disparity.[65] • Add a section to the Metro 2050 update that speaks to how the RGS supports equity-seeking groups. • This could be further cross-referenced with how strategies or actions directly support equity-seeking groups. See Portland Plan for icons used to articulate this connectivity.[66]
Immigration	There is a lack of specific discussion on how the RGS supports recent immigrants to the region. This is indirectly discussed through Strategy 4.2 by encouraging complete communities with a wide range of services and amenities. • Add a section to the Metro 2050 update that speaks to how the RGS supports newcomers to the region. • It is recommended that actions and recommendations are clearly mapped to how they will support immigrants.
Global Recession	• An HRVA should be undertaken to further determine the significance of this shock. • Task Metro Vancouver's Regional Economic Prosperity service with creating strategies for navigating global recession to maintain economic opportunities for residents and businesses that are consistent with regional objectives.
War & Political Conflict	Political conflict is not addressed in the RGS. Given the low likelihood of disruptive political conflict in the region, it is reasonable for this to be omitted in the RGS update. Local political conflict could be addressed as it pertains to regional goods movement, safety, and reliability. • Expand action 5.2.5 with an implementation plan for protecting rail rights-of-way along with developing additional strategies for maintaining efficient goods movement in the region.

Human Health

Stress/Shock	Discussion
Infectious Diseases	Infectious disease can impact the economy, transportation, population, and employment throughout the region (as seen with COVID-19). • Incorporate learnings from the current pandemic for long-range growth planning. Specifically, improved coordination and clarifying responsibility among partners and member jurisdictions can assist in effective response and messaging. • Develop adaptable operations protocols for ensuring critical services are maintained at all times, regardless of pandemic severity. • Prioritize park access to provide safe access to recreational opportunities and natural areas during pandemics similar to that of COVID-19. • Work with member jurisdictions and the Province to maintain consistent messaging and clarity on best safety practices. • Liaise with the Province to maintain economic opportunities for residents and businesses during economic downturns caused by disruptions caused by infectious disease.
Chronic Disease	The RGS provides actions and strategies to support health and reduce chronic disease for people in the region. Strategy 3.1 and 3.2 preserve recreation lands and the expansion of the Regional Greenway Network. Strategy 4.2 speaks specifically to healthy

[62] Kim, Y. (2018). Safe-To-Fail Infrastructure for Resilient Cities under Non-Stationary Climate.
[63] City of Vancouver. (2010). Seniors in Vancouver.
[64] Metro Vancouver. (2012). What Works: Affordable Housing Initiatives in Metro Vancouver Municipalities.
[65] EcoPlan. (2019). A Review of Social Equity in Regional Growth Management. Metro Vancouver.
[66] City of Portland. (2012). The Portland Plan.

	communities. Strategy 5.1 and 5.2 encourage safe and sustainable transportation options. Health impacts could be assessed in a more structured framework for anticipated changes to land use and built form. • Integrate a form of health impact assessment or social impact assessment to determine infrastructure or development impacts on communities.
Mental Health	Mental health is supported through several strategies in the RGS. Strategy 3.1 and 3.2 protect and enhance natural features, and conservation and recreation lands which can benefit mental health. Strategy 4.1 and 4.2 seek to provide more affordable housing and complete communities, improving access to opportunities while decreasing financial stress that can have negative contributions to mental health. Strategy 5.1 and 5.2 encourage sustainable modes of travel and seek to improve safety and efficiency of the transportation network, which also have mental health benefits. Similar to chronic disease, applying a more structured framework for anticipated changes to land use and built form could be useful in assessing impacts to mental health. • Integrate a form of health impact assessment or social impact assessment to determine infrastructure or development impacts on communities.

RGS STRATEGY RESILIENCE PRINCIPLES GAP ASSESSMENT

Resilience Principle	Discussion
Robustness	Many strategies within the RGS contribute positively to robustness across most shock and stress groups. More specifically, actions and strategies seek to reduce greenhouse gas emissions, maintain food security in the region, and provide a focused growth land use pattern that provides supports for many sociopolitical stresses such as unemployment, affordability, aging population, social inequity, and immigration. • While strategies generally contribute positively to robustness, further research and investigation is recommended, particularly when it comes to integrating a safe-to-fail development approach to regional infrastructure.
Redundancy	The strategies within the RGS generally contribute towards redundancy, protecting against a range of shocks and stresses. Metro Vancouver provides infrastructure to the region for high quality drinking water, liquid waste treatment, and solid waste management. Through the RGS, it provides strategies and actions for effective growth management. The plan could incorporate more focus on redundancy both through provision of services, along with expectations from member jurisdictions. • Add clarity to strategies 1.1, and 1.2 to incorporate safe-to-fail language, and provide additional components to existing and new infrastructure for improved redundancy of services. • Assess through HRVA the key needs of redundancy (e.g., work with experts to determine whether it's more important to have redundancy for all services, or just drinking water, or just liquid waste. Determine what aspects of these systems are vulnerable). • Add language to what is expected from regional context statements in terms of redundant and safe-to-fail infrastructure.
Resourcefulness	The strategies within the RGS occasionally speak to resourcefulness based on the definition and associated questions outlined at the beginning of this evaluation. • Articulate how Metro Vancouver will work with member jurisdictions and partners to identify problems, establish priorities, learn from shocks, communicate lessons learned, and/or mobilize resources for navigating shocks and stresses. • Articulate how coordination among partner agencies will contribute to preparing for and responding to shocks/stresses. • Specify how resources will be added to respond to a shock/stress (and whether this is the responsibility of Metro Vancouver, IPREM, or individual municipalities). • Clarify responsibilities among member jurisdictions and partners for hazard preparation and response.
Rapidity	The strategies within the RGS do not effectively speak to rapidity based on the definition and associated questions outlined at the beginning of this evaluation. • Add actions to the RGS to indicate how it will contribute to meeting priorities in a timely fashion to contain losses and avoid future disruptions against shocks and stresses. • Add actions to the RGS to indicate how it can contribute to improved efficiency for preparing for shocks and stresses. • Indicate how Metro Vancouver can contribute to planning response procedures for responding to a shock/stress. • Focus on developing early detection and/or intervention capabilities for regional shocks and stresses.

RGS STRATEGY 1.1

Contain urban development within the Urban Containment Boundary (UCB)

EVALUATION

	Robustness	Redundancy	Resourcefulness	Rapidity
Environmental Stresses and Shocks	Containing development to the UCB can minimize exposure of residents to natural hazards prevalent outside the UCB. There are still areas within the UCB that are at risk to stresses/shocks.	Focusing infrastructure in a contained area facilitates improved redundancy but, due to concentration, is also more at risk from a single incident. Generally, redundancy is more difficult to achieve over a larger area.	The cost-effectiveness of servicing growth within the UCB increases resources available for spending on other items, such as fortifying or upgrading infrastructure.	By way of containing development in the region, the strategy contributes to faster response to stresses/shocks as shorter distances generally means faster response time.
Technology & Infrastructure Stresses and Shocks	Limiting services to the UCB means limiting new infrastructure and maintenance requirements and network range. This is paired with increased exposure should events occur within the UCB.			By way of containing development to within the UCB, the strategy contributes to rapidity of responding to stresses/shocks within this type (power outages).
Sociopolitical & Economy Stresses and Shocks				
Human Health Stresses and Shocks				

GENERAL RESILIENCE SUMMARY

This strategy generally supports resilience against shock and stress groups by way of limiting the service area of the region to the UCB, and focusing population and job growth within the Urban Containment Boundary. While this decreases exposure by concentrating growth to certain areas, it can increase severity if stresses/shocks occur. Enhancing building design and codes will be important when facing technological and environmental stresses and shocks.[67]

STRATEGY DISCUSSION AND RECOMMENDATIONS

Environmental Resilience	Adherence to a UCB strategy is generally effective for improving resilience against environmental stresses and shocks. By way of containing growth, areas that experience an environmental stress or shock can receive expedited support compared to that of a region without an equivalent UCB strategy. By decreasing developable area, exposure to natural hazards adjacent to development can be reduced. However, this containment redirects growth to more specific areas of the region, which might increase the severity (in terms of number of people impacted) of an environmental stress/shock, such as low-lying areas vulnerable to flooding. This alone should not be a reason to densify; instead, if regional plans propose densification, this should be supported by enhanced design and infrastructure resilience to protect these communities from natural hazards. Overall, a UCB strategy also supports municipal efforts for denser urban development with the dual goals of reducing GHG emissions while improving quality of life by reducing daily travel requirements. Further, this makes more efficient use of infrastructure through economies of scale. • Expanding this strategy to require multi-hazard mapping by member jurisdictions for consideration with future development could reduce future risk and severity from stresses/shocks.
Technology & Infrastructure Resilience	As outlined above, adherence to a UCB strategy is generally effective for improving resilience against some technological stresses/shocks, namely power outages and infrastructure failure. Decreasing the service area will result in an expedited response opportunity. It also concentrates more people and jobs to within the UCB. This requires infrastructure to be increasingly robust in these areas, but also results in increased severity (with increased population and employment density). Creating and adhering to an Urban Containment Boundary establishes a precedent for decreasing development pressure on agricultural lands within the region. On a similar note, it decreases the pressure on greenspace within the Metro Vancouver boundary that may face increased pressure for development in the future, such as conservation and recreation lands. No strategy adjustments are suggested for this shock and stress group.
Sociopolitical & Economy Resilience	Containing growth to the UCB contributes to positive second-order impacts around sociopolitical stresses and shocks. More specifically, the strategy focuses growth to within the UCB, increasing density of services and amenities that can support an aging population, unemployment, and immigration. No strategy adjustments are suggested for this shock and stress group.
Human Health Resilience	No strategy adjustments are suggested for this shock and stress group.

HRVA FRAMEWORK INDICATOR POTENTIAL

Ideal Indicators	Current Indicators
• Regional growth (population, jobs, dwelling units) • Growth occurring within Urban Containment Boundary • Remaining urban lands • Development in hazardous areas • % of people with nearby access to redundant service options (e.g., hospitals, grocery stores, pharmacies) and redundant modes. *These will assist future HRVA with assessing likelihood and consequences across for environmental and technology and infrastructure shock and stress groups.*	• Regional growth (population, jobs, dwelling units) • Growth occurring within Urban Containment Boundary • Remaining urban lands

[67] Burby, R. J., Nelson, A. C., Parker, D., & Handmer, J. (2001). Urban containment policy and exposure to natural hazards: is there a connection? Journal of Environmental Planning and Management, 44(4), 475-490.

RGS STRATEGY 1.2

Focus Growth in Urban Centres (UCs) and Frequent Transit Development Areas (FTDAs)

EVALUATION

	Robustness	Redundancy	Resourcefulness	Rapidity
Environmental Stresses and Shocks	Provides people with alternative ways to travel without relying on private vehicles. However, there is greater exposure if a UC/FTDA is directly impacted by a stress/shock, by way of larger populations.	UC/FTDAs have a denser road network, providing increased mobility options and alternate destinations if an event occurs. Multiple mobility options also exist in UC/FTDAs.		Improves coverage for emergency response and improves access to hospitals However, traffic congestion in urban areas can impact access.
Technology & Infrastructure Stresses and Shocks				UCs have more network redundancy, improving emergency response times to most technological shocks.
Sociopolitical & Economy Stresses and Shocks	Provides people with more travel options (supports affordability and social equity). However, UC/FTDAs have higher density, and associated higher land costs, making the construction of new affordable housing challenging.	Focusing growth could result in more mobility and economic impacts in the case of large-scale protests in urban areas, regardless of good walking and cycling infrastructure.	Adds resources available to respond to a stress such as unemployment, by way of concentrating employment in UC/FTDAs and creating more opportunities.	
Human Health Stresses and Shocks	UCs are generally close to medical facilities and can better withstand health emergencies.		UCs are generally close to medical facilities, adding resources to respond to a stress/shock.	

GENERAL RESILIENCE SUMMARY

Focusing growth in UC/FTDAs generally contributes towards resilience. The creation of denser urban nodes in the region generally improves resilience by way of redundancy (of the road network, services, and amenities), resourcefulness (based on more resources being available within a dense urban form) and rapidity (when considering the counterfactual of responding to a shock over a broader developed area). Accessibility to destinations improves through this strategy which contributes to resilience across most shock and stress groups.

STRATEGY DISCUSSION AND RECOMMENDATIONS

Environmental Resilience	Concentrating growth in most UC/FTDAs is an effective way of limiting jobs and housing in areas that are higher risk in the region (e.g., flood plains). However, depending on the stress/shock, compact development may result in increased severity of disruption or displacement if hazard-specific strategies are not in place (e.g., flood management plans, resilient infrastructure design). Beyond the examples provided in the table above, Chang et al.[68] found through seismic modelling that compact development in the Metro Vancouver region resulted in a significantly higher displaced population, compared to a status quo or sprawled development pattern, largely due to concrete frame structures. • Work with municipalities and the Province to ensure development within UC/FTDAs meet long-range seismic material requirements. • Require municipalities to incorporate seismic risk mapping, and update seismic design criteria, into planning and development procedures, while also limiting development in areas that have higher seismic risk (see Figure 6.2 in Chang et al.). Similar requirements could be considered for other shocks of similar magnitude (e.g., flooding, snowstorms, heatwaves). • Consider a regional-scale multi-hazard map to inform policies related to focused growth, including risk of UC/ FTDAs.
Technology & Infrastructure Resilience	There are trade offs with this strategy from a resilience perspective. Concentrating more people and jobs in UC/FTDAs will result in increased shock/stress exposure when compared to lower density development patterns. There are significant amounts of urban planning literature that point to the negative outcomes that come from sprawling communities, some of which are highlighted above. However, redundancy, resourcefulness, rapidity and greater access to amenities and services may all be better positioned to act quickly with necessary resources based on this strategy, while providing alternatives through back-up systems or alternate routes. The strategy contributes to more efficient access (and more opportunities) for emergency and support services. Despite the above trade-offs, no strategy adjustments are suggested for this shock and stress group.
Sociopolitical & Economy Resilience	This strategy is generally a positive contributor to sociopolitical resilience. In particular, focusing growth in UC/FTDAs can support employment, immigration, and an aging population. This is largely through redundancy and resourcefulness by way of providing an increased number of services and amenities within a given area due to sufficient urban density. Urbanization of some UCs (e.g., Metrotown), may result in decreased affordability through redevelopment of existing affordable housing stock, and consequent decreases in social equity. • Cross reference Strategy 1.2 with Strategy 1.1 and Strategy 4.1 to ensure diverse and affordable housing choices continue to exist in UC/FTDAs, particularly if new development decreases existing affordable housing stock. • Incorporate transit-oriented affordable housing (TOAH) policy recommendations from the TOAH Study Phase 2, such as establishing a TOAH fund to provide low-interest loans to help finance new affordable housing in the region.[69]
Human Health Resilience	Focusing growth in UC/FTDAs allows more people with close access to hospitals and professional services to support mental and chronic disease, as well as for pandemic response. • Metro Vancouver can play a role in a coordinated regional response to current and future pandemics through sharing information and resources across municipal boundaries.

HRVA FRAMEWORK INDICATOR POTENTIAL

Ideal Indicators	Current Indicators
• Growth in UC/FTDAs (people, jobs, dwelling units) • Transit Frequency between UC/FTDAs • Income inequality index • Housing affordability index *These will assist future HRVA with assessing likelihood and consequences across all shock and stress groups.*	• Growth in UC/FTDAs (people, jobs, dwelling units)

[68] Chang, S. E., McDaniels, T. L., Yumagulova, L., & Stevens, M. (2019). Dynamics and Governance of Risk in Metro Vancouver. Planning on The Edge: Vancouver and the Challenges of Reconciliation, Social Justice, And Sustainable Development, 144.
[69] Metro Vancouver. (2019). Transit-Oriented Affordable Housing Study Executive Summary.

RGS STRATEGY 1.3

Protect Rural areas from urban development

EVALUATION

	Robustness	Redundancy	Resourcefulness	Rapidity
Environmental Stresses and Shocks	Limiting rural area population and employment improves robustness against most environmental shocks by way of decreased exposure and severity.		Rural areas are less likely to be prioritized compared to urban areas when responding to a stress or shock. However, limiting growth in rural areas results in fewer people being impacted if this is the case.	
Technology & Infrastructure Stresses and Shocks	Limiting growth and commercial activities in rural areas reduces the necessity to improve robustness of expensive infrastructure upgrades.		This strategy provides better use of scarce infrastructure resources to urban areas.	
Sociopolitical & Economy Stresses and Shocks				
Human Health Stresses and Shocks				

GENERAL RESILIENCE SUMMARY

This strategy has limited impact on resilience against the stresses and shocks in Rural areas, but does contribute to better allocation of infrastructure resources to communities within the Urban Containment Boundary. It has a minor positive contribution towards robustness for similar reasons provided for Strategies 1.1 and 1.2 above. This rationale is based on limiting service areas and concentrating population and employment growth to areas where urban development is desirable to ensure efficient use of infrastructure investments. This designation exists primarily to limit growth outside the Urban Containment Boundary and as a result protects sensitive ecosystems and natural assets (i.e. aquifers, waterways) and some agricultural lands. Further clarity on the definition of Rural use as recommended in the Metro 2040 Rural Policy Review, can support a more resilient region by limiting growth in areas unintended for development and reduce demand for utility and transit infrastructure investments.

STRATEGY DISCUSSION AND RECOMMENDATIONS

Environmental Resilience	Protecting Rural areas from urban development means decreased services (e.g., sewer, transit) to these areas, allowing for increased focus on service provision and climate resilience to these services elsewhere in the region, which can contribute to withstanding the stress of most environmental shocks. Some Rural areas can help create a buffer against certain shocks (such as landslides and flooding) given their proximity to steep slows and the Fraser River, and given their low population density. No strategy adjustments are suggested for this shock and stress group.
Technology & Infrastructure Resilience	Protecting Rural areas from urban development means decreased services (e.g., sewer, transit) to these areas, allowing for increased focus on service provision elsewhere in the region, which can increase efficiency and contribute to withstanding most technological stresses and shocks. No strategy adjustments are suggested for this shock and stress group.
Sociopolitical & Economy Resilience	No strategy adjustments are suggested for this shock and stress group.
Human Health Resilience	No strategy adjustments are suggested for this shock and stress group.

HRVA FRAMEWORK INDICATOR POTENTIAL

Ideal Indicators	Current Indicators
• Number of dwelling units and % of dwelling unit growth on Rural land use designation • Area and type of sensitive ecosystems within the Rural designation. • Designated Rural land (absolute area) *These will assist future HRVA with assessing likelihood and consequences related to food supply.*	• % of dwelling unit growth on Rural land use designation

RGS STRATEGY 2.1

Promote land development patterns that support a diverse regional economy and employment close to where people live

EVALUATION

	Robustness	Redundancy	Resourcefulness	Rapidity
Environmental Stresses and Shocks	Situating employment close to where people live improves accessibility to jobs and services, in case shocks impact transport infrastructure.		Developing a stronger economy allows for greater ability to build resources that will aid in response to stresses/shocks.	
Technology & Infrastructure Stresses and Shocks	More jobs have the opportunity to work remotely, limiting travel requirements.			
Sociopolitical & Economy Stresses and Shocks	This strategy contributes to withstanding the effects of some sociopolitical stresses (unaffordability, unemployment) by way of promoting employment close to where people live.			
Human Health Stresses and Shocks	As seen with COVID-19, many sectors have been significantly impacted (e.g., tourism), despite Metro Vancouver having a diverse economy.	Due to COVID-19, many commuting patterns have changed to working remotely, making part of this strategy less relevant if these trends continue.		

GENERAL RESILIENCE SUMMARY

This strategy was assessed through two primary lenses: whether having a diverse regional economy helps or hinders when faced with stresses and shocks; and whether situating employment close to where people live helps or hinders when faced with stresses and shocks. There is limited empirical evidence on whether economic diversity leads to improved resilience against stresses and shocks. In 2014, Xiao and Drucker found economic diversity to contribute towards resilience and recovery, with research of the 1993 US Midwest flood.[70] Further, with COVID-19, there have also been observations that communities focused on a specific sector (e.g. tourism) have been impacted more severely than communities with a diverse economy.[71]

STRATEGY DISCUSSION AND RECOMMENDATIONS

Environmental Resilience	This strategy improves robustness against environmental shocks through land development patterns that support a diverse regional economy. Situating employment, services, and retail close to where people live improves accessibility and decreases vulnerability of shocks that can impact transport infrastructure (e.g., More people will be able to walk to work in a snowstorm if transit services are not reliable and roads are also in poor condition with increased focus on supporting economic activity UC/FTDAs). No strategy adjustments are suggested for this shock and stress group.
Technology & Infrastructure Resilience	Supporting employment close to where people live will improve robustness when facing technological shocks such as transport incidents or infrastructure failure. From the other lens, supporting a diverse regional economy also contributes towards technological resilience when considering global supply chain disruptions. Strategy 2.1.6 and 2.1.7 in Metro 2040 encourage use of airport and port land for industrial activities. Focusing industrial activity in these areas decreases the vulnerability to technological shocks such as industrial explosion, spills, and contamination in more populated residential and commercial areas, further improving technological resilience. No strategy adjustments are suggested for this shock and stress group.
Sociopolitical & Economy Resilience	Within the actions under this strategy, there is indication to work with the federal government and the province and municipalities to investigate fiscal reform to ensure the property tax system is equitable and supports sound land use decisions. This contributes towards the stress of inequity in the region. No strategy adjustments are suggested for this shock and stress group.
Human Health Resilience	As outlined in in the General Resilience summary, a diverse economy is associated with improved resilience when confronted with an infectious disease such as COVID-19.[72] That said, many businesses in Metro Vancouver and BC have been significantly impacted during this pandemic. The BC tourism industry is anticipating a 69% reduction in revenue for 2020 compared to the previous year.[73] • Increase collaboration between government and the tourism industry to identify changes necessary to be competitive during the pandemic recovery period, and put in place strategy for future disruptions of a similar magnitude.

HRVA FRAMEWORK INDICATOR POTENTIAL

Ideal Indicators	Current Indicators
• Jobs by sector • Jobs to residents • % of people within walking distance to frequent transit • % of jobs within walking distance to frequent transit • % of GDP by sector • # of sectors > x% GDP *These will assist future HRVA with assessing consequences related to all shock and stress groups.*	• Employment in priority areas • Office in priority areas • Retail in priority areas • Jobs by sector • Jobs to residents

[70] Xiao, Y., & Drucker, J. (2013). Does economic diversity enhance regional disaster resilience? Journal of the American Planning Association, 79(2), 148-160.
[71] OECD estimates that international tourism in OECD countries has declined 60-80%, having an impact both on tourism-related GDP, and associated employment.
[72] City of Toronto. (2020). COVID-19: Impacts and Opportunities.
[73] Tourism Task Force. (2020). The Future of Travel: Positioning BC to Accelerate Recovery and Growth.

RGS STRATEGY 2.2

Protect the supply of industrial land

EVALUATION

	Robustness	Redundancy	Resourcefulness	Rapidity
Environmental Stresses and Shocks	Industrial lands in low-lying areas may be susceptible to impacts by environmental stresses (e.g., sea-level rise).	Maintaining supply of industrial lands provides better opportunities for regional redundancy of critical facilities and industries	Port lands and airport lands can aid in mobilizing resources against stresses/shocks. The Port of Vancouver and YVR airport serve national functions as well, not just for the region.	
Technology & Infrastructure Stresses and Shocks	Decreases vulnerability to industrial incidents for other land uses. Maintaining industrial land will also contribute to better withstanding global supply chain and border disruptions.			
Sociopolitical & Economy Stresses and Shocks	Industrial lands provide opportunities for improving the stress of unemployment by way of being an employment generator.	Diverse industrial activities contribute to economic variability, and provide significant employment opportunities.		
Human Health Stresses and Shocks				

GENERAL RESILIENCE SUMMARY

Metro Vancouver conducted a comprehensive Regional Industrial Lands Strategy in 2018-2020. While resilience was not a primary focus of the study, several findings do relate to the stresses and shocks being explored through this work. Economic resilience is highlighted several times throughout the report, indicating the importance of maintaining the supply of industrial lands to limit the increase in its value (via speculation and decreased supply). Failing to ensure sufficient industrial land exists may result in businesses moving elsewhere (to other west coast port cities in the US for instance), resulting in second-order effects of associated trade activity being moved as well. Industrial lands comprise 4% of the region's land base and accommodate 27% of the region's jobs. These jobs pay a higher wage than the regional average.[74] There is also discussion regarding climate change vulnerability. A significant portion of the region's industrial land supply is within low-lying flood-prone areas. Between seasonal riverine or rainfall-induced flooding, and anticipated sea level rise, many industrial areas may no longer be considered viable for long-term development, reducing opportunities for economic development, and potentially decreasing supply. Mitigation opportunities may arise, but these may be too cost prohibitive for land owners or renters to consider.

STRATEGY DISCUSSION AND RECOMMENDATIONS

Environmental Resilience	As highlighted in the Regional Industrial Lands Strategy, there is value to ensuring that consideration is given to Industrial Lands in a Regional Flood Management Strategy.[75] This specific strategy and associated actions do not provide sufficient long-range consideration for maintaining the supply of industrial land, given the external pressure that may be felt from flooding and/or sea level rise by 2050. Further, siting and storing dangerous materials in floodplains and other at-risk areas increases risk and decreases resilience. The Industry Discussion paper to Support Climate 2050 and the Clean Air Plan provides several actions to reduce GHG emissions for industry that could be integrated into actions of Metro 2050.[76] Industrial activity in the region contributes to 25% of regional emissions, making this a substantial emitter. • Consider adding an action that seeks to relocate and/or increase industrial land supply, and protect or adapt existing land as necessary. • Transition siting and storage of dangerous materials out of the floodplain and locate in less at-risk industrial lands where possible. • Require municipalities to include in their Regional Context Statements how they intend to work with Industrial tenants to decrease emissions. • Work with the Port of Vancouver to implement a region-wide industrial emissions program.
Technology & Infrastructure Resilience	Although there is always a risk of industrial-related shocks occurring, explosions, leaks, and spills are rare occurrences given the scale of industrial activity in the region. Maintaining and protecting the supply of industrial land decreases their vulnerability should one of these events occur. Increasing goods movement (via rail, road, or marine transport) creates a higher likelihood of an industrial incident. No strategy adjustments are suggested for this shock and stress group.
Sociopolitical & Economy Resilience	Repeating a finding from the Regional Industrial Lands Strategy: Industrial lands comprise 4% of the region's land base and accommodate 27% of the region's jobs. This provides a strong rationale for protecting the supply of industrial land or seeking to expand this land base. As unemployment continues to be a stress of the region, this is an opportunity to continue to provide regional jobs (which are found to pay wages that are 10% higher than the regional average, highlighted by the same Strategy). • Consider adding an action that seeks to relocate and/or increase industrial land supply, and protect or adapt existing land as necessary.
Human Health Resilience	Maintaining separation of industrial land use from residential land can improve mental health. The Port of Vancouver is the owner of most industrial lands in the region. They have developed a series of guidelines for minimizing the impact of industrial activity on communities.[77] No strategy adjustments are suggested for this shock and stress group.

HRVA FRAMEWORK INDICATOR POTENTIAL

Ideal Indicators	Current Indicators
• Industrial land use (developed and vacant) • Industrial emissions *These will assist future HRVA with assessing likelihood and consequences related to technology and infrastructure shocks.*	• Industrial land use (developed and vacant)

[74] Metro Vancouver. (2020). Metro Vancouver Regional Industrial Lands Strategy.
[75] Ibid.
[76] Metro Vancouver (2020). Industry Discussion paper to Support Climate 2050 and the Clean Air Plan.
[77] Port of Vancouver. (2020). Guidelines.

RGS STRATEGY 2.3

Protect the supply of agricultural land and promote agricultural viability with an emphasis on food production

EVALUATION

	Robustness	Redundancy	Resourcefulness	Rapidity
Environmental Stresses and Shocks	Much of the agricultural land in the region is in areas susceptible to flooding (e.g., Richmond, Delta). However, this land provides improved resilience to flooding for more densely populated areas. Maintaining drainage and irrigation infrastructure is an important contributor to robustness.		As a second order effect, this strategy contributes to maintaining some local food production in the case of a major environmental event or climate impact in other food producing regions.	
Technology & Infrastructure Stresses and Shocks	Protecting agricultural land enables regional food supply which will contribute to withstanding a stress/shock.	Global supply chain disruptions can occur, impacting food supply and supply chain security for the region. Protecting the supply of agricultural land can help mitigate against this shock.	Emphasizing food production will improve resourcefulness of food supply for the region by way of increasing resource availability for a shock response.	Protecting agricultural land allows for more rapid access to food in the case of broader stresses/shocks that impact access outside the region.
Sociopolitical & Economy Stresses and Shocks			Protection of agricultural land is multi-jurisdictional and therefore improved gov't coordination and clarifying roles and responsibilities needs further work.	
Human Health Stresses and Shocks				

GENERAL RESILIENCE SUMMARY

Protecting the supply of agricultural land contributes to general resilience against stresses/shocks in the region. Food supply is a stress that will continue to exist with anticipated population growth in Metro Vancouver. Agricultural land also provides carbon sequestration and flood management (ecosystem services).

STRATEGY DISCUSSION AND RECOMMENDATIONS

Environmental Resilience	The removal of trees and land clearing for agricultural production can lead to higher runoff rates, erosion, and increased downstream flooding. At the same time, stormwater from development areas can further exasperate water management issues. Solutions such as agroforestry and silvopasture (integrating forests with agriculture) can allow for reduced disruption to natural environments, improved resilience, and carbon sequestration when incorporated into an economically viable farm operation. Additionally, organic and regenerative farming measures could be prioritized for reduced GHGs in agriculture and rebuilding soil matter to accelerate carbon sequestration. • Encourage municipalities to promote agroforestry, silvopasture, and regenerative farming strategies with the goal of improving local food production, GHG sequestration, and climate resilience.
Technology & Infrastructure Resilience	This strategy contributes to resilience across all principles when faced with the stress of food supply in the region. Approximately 32% of the food supply for Metro Vancouver is sourced from BC and 14% of the Metro Vancouver food supply is sourced within the region.[78] With global supply chain disruptions exemplified with the COVID-19 pandemic in early 2020, food supply and access is a stress to continually monitor. Increasing capacity to produce food within the region will help mitigate against future global supply chain disruptions and allow for improved regional self-sufficiency. Continuing to protect the supply of agricultural land and emphasize food production will assist in combatting the stress of regional food supply. It could be noted that the anticipated population growth in the region may decrease food supply from a per capita perspective. Accordingly, supporting additional agricultural opportunities across the region could be valuable to keep up with demand. • Explore the opportunity of vertical farming on non-agricultural lands through pilot projects to determine viability.
Sociopolitical & Economy Resilience	Protection of agricultural land is a multi-jurisdictional effort. There needs to be improved government coordination and clarification of roles and responsibilities going forward. Metro Vancouver can play a key role as a regional convenor on this topic. • Improve government coordination and clarify roles and responsibilities for agricultural land.
Human Health Resilience	No strategy adjustments are suggested for this shock and stress group.

HRVA FRAMEWORK INDICATOR POTENTIAL

Ideal Indicators	Current Indicators
• Amount of agricultural land that his used for agricultural production • Regional food supply / self-sufficiency • Number of parcels and hectares assessed as Farm Class within all regional designations • % of Agricultural regional designation that has Farm Class assessment • Total growth in dwelling units on lands with an Agricultural designation *These will assist future HRVA with assessing consequences related to global supply chain and food supply stresses/shocks.*	• Agricultural Land Use • Food production

[78] Davies Transportation Consulting Inc. (2020) Food Flows in Metro Vancouver Final Report.

RGS STRATEGY 3.1

Protect Conservation and Recreation lands

EVALUATION

	Robustness	Redundancy	Resourcefulness	Rapidity
Environmental Stresses and Shocks	This strategy will contribute to decreasing severity to many environmental shocks/stresses through ecosystem services. However, the RGS does not include explicit polices to ensure these lands stay healthy and can continue to provide ecosystem services. Sensitive ecosystems are being lost (logging on Crown lands and research forests) so there is vulnerability from a natural resource depletion perspective. Conservation and Recreation lands do not currently include coastal areas, which are vulnerable to sea-level rise or many riparian areas, which are vulnerable to flooding and pollution from runoff.			
Technology & Infrastructure Stresses and Shocks	Limits infrastructure shocks since sewerage service connections are not allowed in Con/Rec lands, except under exceptional circumstances.			
Sociopolitical & Economy Stresses and Shocks	Supports the local outdoor recreation and tourism economy since Con/Rec lands are often destinations.			
Human Health Stresses and Shocks	Access to nature (through Conservation and Recreation lands) is associated with positive outcomes for mental and physical health.			

GENERAL RESILIENCE SUMMARY

Protecting Conservation and Recreation lands generally contributes to resilience. Similar to the rationale provided under Strategy 2.3, a direct positive benefit from protecting Conservation and Recreation lands is through ecosystem services, particularly with regard to flood control, carbon sequestration, and clean air. There are also second order effects to respond to the impacts of stresses such as heat waves, by way of providing increased canopy cover and shade, particularly in these dedicated lands, and reducing urban heat island impacts. This strategy contributes against most Environmental and Human Health stresses and shocks (e.g., mental health, chronic disease).

STRATEGY DISCUSSION AND RECOMMENDATIONS

Environmental Resilience	Conservation and Recreation lands aid in maintaining natural runoff patterns to decrease flood hazards. These lands also act as carbon sequestration areas, contributing to decreased GHG emissions and cleaner air. Millions of tonnes of carbon are stored in vegetation and soil in the Metro Vancouver region.[79] Coastal conservation areas also protect shorelines from coastal storms, provide habitat for fish and wildlife, and sequester carbon. From an alternative perspective, decreasing or degrading Conservation and Recreation lands will result in release of carbon and can cause decreased slope stability, which increase the likelihood of landslides, and increase runoff, potentially increasing flooding events.
	Accordingly, there are opportunities for Metro Vancouver and its member jurisdictions to consider for adaptation purposes. These include some actions that are already underway in the region such as the Green Shores initiative[80], and Improving Ecological Health and Carbon Sequestration Potential at Burns Bog.[81] Metro Vancouver's corporate ecological health initiatives and opportunities are catalogued further in Metro Vancouver's *Ecological Health Framework*.[82]
	• Seek to expand, better protect, and enhance Conservation and Recreation lands and improve ecological function and diversity.
	  ○ Include coastal areas as Conservation and Recreation lands and collaborate with member jurisdictions, First Nations, other governments and non-profit organizations to better protect these areas.
	  ○ Include Regional Parks Land Acquisition 2050 Strategy, which aims to build a system of regional parks that are resilient to the impacts of climate change, land use change, and growing visitation.
	• Advocate to the provincial government for the protection of Crown lands designated as Conservation and Recreation.

Technology & Infrastructure Resilience	No strategy adjustments are suggested for this shock and stress group.
Sociopolitical & Economy Resilience	• Seek to expand, better protect, and enhance Conservation and Recreation lands in line with regional population and tourism growth.
Human Health Resilience	Providing access to nature (through Conservation and Recreation lands) is important for mental health. This has been particularly demonstrated during the COVID-19 pandemic where Regional Park data shows a 43% visitation increase compared to 2019. • Seek to expand, better protect, and enhance Conservation and Recreation lands in line with regional population growth.

HRVA FRAMEWORK INDICATOR POTENTIAL

Ideal Indicators	Current Indicators
• Hectares Conservation and Recreation Lands designated, and protected *These will assist future HRVA with assessing consequences related to environmental stresses/shocks and human health stresses.*	*No indicators provided on the Metro 2040 dashboard.*

[79] Metro Vancouver. (2020). Nature and Ecosystems Discussion Paper to support Climate 2050 and the Clean Air Plan.
[80] Stewardship Centre for British Columbia. (2014). Green Shores Coastal Development Rating System Demonstration and Training Project.
[81] Metro Vancouver. (2017). Improving Ecological Health and Carbon Sequestration Potential at Burns Bog.
[82] Metro Vancouver (2018). Ecological Health Framework.

RGS STRATEGY 3.2

Protect and enhance natural features and their connectivity

EVALUATION

	Robustness	Redundancy	Resourcefulness	Rapidity
Environmental Stresses and Shocks	Decreases severity of many environmental stresses and shocks (heat waves, windstorms, flooding, and landslides, natural resource depletion).	Increases active transportation options by way of the Regional Recreation Greenway Network. This decreases GHGs and provides alternative travel options in the case of transport incidents.	Enhancing natural features also enhances flood control.	
Technology & Infrastructure Stresses and Shocks	Contributes to developing a regional cycling network via the Regional Recreation Greenway Network to better withstand shocks such as transport incidents and infrastructure failure.			
Sociopolitical & Economy Stresses and Shocks	Supports the local outdoor recreation and tourism economy since Con/Rec lands are often destinations. Improves equity as the Regional Recreation Greenway Network connects more communities to recreational opportunities and natural areas.			
Human Health Stresses and Shocks	Access to nature is associated with positive outcomes for mental and physical health.	Enhancing natural features and expanding the Regional Recreation Greenway Network can contribute to mental and physical health.		

GENERAL RESILIENCE SUMMARY

The region's natural assets provide ecosystem services that decrease the severity and vulnerability to several stresses and shocks (particularly environmental) that may occur in Metro Vancouver. Ecosystem services can contribute to better runoff management, increased carbon sequestration, and cleaner air in the region. The intent of this strategy is to enhance ecological connectivity, but it also contributes to recreational connectivity through the Regional Recreation Greenway Network (3.2.1) and developing a regional cycling network (3.2.8). The contribution towards transportation resilience is further addressed under Goal 5. Since Metro 2040 was developed, there has been a focus to develop a Sensitive Ecosystems Inventory (SEI) that includes sensitive ecosystems in the region. The Conservation and Recreation lands include most of these sensitive ecosystems (that supports action 3.2.2).

STRATEGY DISCUSSION AND RECOMMENDATIONS

Environmental Resilience	Similar to rationale provided under Strategy 3.1, protecting and enhancing natural features improves environmental robustness when facing several environmental stresses/shocks (extreme weather events, heat waves, flooding, air pollution, windstorms, and landslides). Many of the natural features highlighted on Map 10 in Metro 2040 contribute to carbon storage and sequestration, important for reducing GHGs that contribute to climate change. Creating redundancy against these stresses/shocks is also attained by enhancing natural features. Actions within 3.2.2, and 3.2.4 currently have ambiguity as Map 10 refers to conceptual display of natural features and land cover. The SEI is an effective replacement for this map.[83] For municipalities to effectively meet the expectations of regional standards in this regard, Metro Vancouver could work with member jurisdictions to adhere to the Conservation and Recreation designation and protect and enhance natural features by way of the SEI. Assuming municipalities previously adopted Regional Context Statements in line with action 3.2.4, these ecologically important areas should already be identified by each municipality. Removing forest canopy can also have benefits for decreasing vulnerability to heatwaves but this needs to be researched further to clarify the role tree coverage has on air quality benefits and impacts.[84] The Urban Forest Climate Adaptation Initiative[85] is a project example that shows initiative on this topic. Another key focus of Strategy 3.2 is ecological connectivity. This can improve resilience to environmental stresses/shocks through absorbing rainwater, reducing heat island effects, improving mental health, and retaining biodiversity. This can be achieved through establishing and enhancing a regional green infrastructure network as defined in Metro Vancouver's Ecological Health Framework.[86] • Work with member jurisdictions to align natural feature protection and enhancement, using the SEI as guidance. • Improve ecological connectivity by protecting, restoring and enhancing a regional green infrastructure network. • Promote enhanced assets (urban tree coverage and bioswales) to manage rainfall and reduce heat island impacts.
Technology & Infrastructure Resilience	Several actions within this strategy point to developing a regional cycling network on the Metro Vancouver Regional Recreation Greenway Network. This provides improved ability to withstand a technological shock (such as transport incidents and/or infrastructure failure) as well as providing alternative options for people to travel, improving redundancy. This has been further developed by way of the Greenways Strategy adopted by the Metro Vancouver Board in November 2020.[87] • Replace Map 9 in Metro 2040 with the Greenways Strategy Map 1 and collaborate with member jurisdictions to build missing greenway segments.
Sociopolitical & Economy Resilience	• Prioritize park access to improve social equity and connect more communities to recreational opportunities and natural areas.
Human Health Resilience	Natural areas are important for mental health. This has been demonstrated during the COVID-19 pandemic where Regional Park data shows a 43% visitation increase compared to 2019.

HRVA FRAMEWORK INDICATOR POTENTIAL

Ideal Indicators	Current Indicators
• Hectares of Sensitive and Modified Ecosystems and quality • Tree canopy cover and imperviousness • Ecological Connectivity Index • Carbon storage • Hectares of park within 10-minute walk *These will assist future HRVA with assessing consequences related to environmental stresses/shocks, technological shocks, and human health stresses.*	• Hectares of Sensitive and Modified Ecosystems

[83] Metro Vancouver (2012). Sensitive Ecosystems Inventory.
[84] Ibid.
[85] Diamond Head Consulting Ltd. (2017). Urban Forest Climate Adaptation Framework for Metro Vancouver.
[86] Metro Vancouver (2018). Ecological Health Framework.
[87] Metro Vancouver (2020). Greenways Strategy.

RGS STRATEGY 3.3

Encourage land use and transportation infrastructure that reduce energy consumption and greenhouse gas emissions, and improve air quality

EVALUATION

	Robustness	Redundancy	Resourcefulness	Rapidity
Environmental Stresses and Shocks	Improves robustness if energy strategies involve renewable or micro-grid solutions, allowing infrastructure to be self sufficient in the case of a power outage. Actions within this strategy contribute to developing a regional cycling network to better withstand shocks such as transport incidents and infrastructure failure.	The regional cycling network provides alternative ways for people to travel in the region, increasing resilience in the case of a shock through redundancy.		Investing in UC/FTDAs will allow for rapid response times in the face of an environmental stress/shock because of proximity and shorter average trip distances.
Technology & Infrastructure Stresses and Shocks				
Sociopolitical & Economy Stresses and Shocks	Investing in compact, complete communities can support an aging population, employment, immigration with growth in strategic locations and provision of improved transit services.		Encouraging investment in building retrofits can be costly in the short term but can meet priorities in the medium term against ongoing affordability issues through spot maintenance and high energy bills.	
Human Health Stresses and Shocks	Improving air quality will have a direct positive impact on mental health and chronic disease.			

GENERAL RESILIENCE SUMMARY

Action 3.3.1 seeks to implement strategies in the RGS that contribute to GHG reductions, cross-referencing several other actions that are evaluated elsewhere in this assessment report. Locating infrastructure and growth in strategic locations (UC/FTDAs) can reduce energy consumption and greenhouse gases. Dense areas allow for energy savings through examples like district heating which already exist in Urban Centres of Downtown Vancouver and Surrey City Centre.[88]

This strategy and its actions generally contribute to resilience across all shock and stress groups. However, the actions within this strategy do not clearly establish priorities for navigating stresses/shocks, contribute to improved coordination, nor add resources available to respond to an event. Considering ways to improve resourcefulness in the RGS update process is advised.

STRATEGY DISCUSSION AND RECOMMENDATIONS

Environmental Resilience	This strategy improves the robustness and rapidity for navigating environmental shocks/stresses. Encouraging land use and transportation infrastructure that reduce greenhouse gas emissions and improve air quality directly and indirectly contribute to robustness. Creating a redundant regional cycling network creates alternatives for people to travel, further decreasing GHG emissions by way of active transportation. Increasing active modes will also decrease reliance on the energy grid. • Any strategy to reduce GHG emissions should be coupled with considerations for climate resilience, to promote adaptability in the face of climate change.
Technology & Infrastructure Resilience	• See rationale and recommendations provided for RGS Strategy 3.2 and 1.2.
Sociopolitical & Economy Resilience	Energy efficient buildings tend to be more expensive to build, while producing cost savings in the long run. For new builds, the BC Energy Step Code outlines requirements and methods for achieving higher energy efficiency.[89] While designs, materials, and systems will become more cost-effective over time, it is a challenge to address affordability and energy efficiency simultaneously, due to short-term costs associated with improvements. When it comes to building retrofits, buildings that tend to be the most affordable as rentals are also often those that need the most energy efficiency improvements due to the age of the rental building stock. Retrofits may make homes more affordable in the long run, through decreased spot maintenance and decreased energy costs.[90] • Work with member jurisdictions to investigate methods for achieving low-cost retrofits that achieve high energy efficiency where possible, to maintain the existing housing stock in the region that is more affordable for residents. • Investigate opportunities for loan programs for bridge financing for owners and landlords where funds may not otherwise be available.
Human Health Resilience	Air pollution is the largest environmental risk for early death, responsible for premature deaths from heart attacks, strokes, diabetes, and respiratory diseases. Air pollution contributed to almost 5 million deaths globally in 2017.[91] While Canada is a country with one of the lowest national $PM_{2.5}$ exposure levels, the point remains that maintaining high air quality should remain an important objective. No strategy adjustments are suggested for this shock and stress group.

HRVA FRAMEWORK INDICATOR POTENTIAL

Ideal Indicators	Current Indicators
• Air pollutant emissions (by land use type and NAICs sector) • Greenhouse gas emissions (by land use type and NAICs sector) *These will assist future HRVA with assessing consequences related to air pollution.*	• Exceedances of ambient air quality objectives • Greenhouse gas emissions from buildings and on-road transportation

[88] City of Surrey (2020). Surrey City Energy.
[89] Energy Step Code (2018). How the BC Energy Step Code Works.
[90] Entuitive. (2020). Solving the Affordable Housing Crisis: Retrofitting Existing Buildings.
[91] Health Effects Institute. (2019). State of Global Air 2019.

RGS STRATEGY 3.4

Encourage land use and transportation infrastructure that improve the ability to withstand climate change impacts and natural hazard risks

EVALUATION

	Robustness	Redundancy	Resourcefulness	Rapidity
Environmental Stresses and Shocks	Improves robustness of land use, transportation, and utility infrastructure to withstand climate change and natural hazard impacts (3.4.2.a, 3.4.3)	Adds components of an asset, network or operation to allow for ongoing functioning in case there is a failure of primary components (3.4.5).	Contributes to identifying problems (3.4.5, 3.4.6.a), establishing priorities (3.4.6.b) improving coordination (3.4.7.b) and adding resources available to respond to a stress/shock (3.4.7.a).	Providing financial assistance, and timely data and information will expedite efficiency for preparing for environmental stress/shock (3.4.7.a).
Technology & Infrastructure Stresses and Shocks				
Sociopolitical & Economy Stresses and Shocks				
Human Health Stresses and Shocks	This strategy improves the ability to withstand climate change impacts, contributing to improved mental health and chronic disease.			

GENERAL RESILIENCE SUMMARY

While the actions in this strategy are effective at improving resilience against natural hazards, many of these actions are requested of other agencies that do not have a requirement to comply with the policies. Metro Vancouver can take more of a leadership role to promote adaptation practices among partners and member jurisdictions. Metro Vancouver can also facilitate data and knowledge sharing on risk and hazards. This strategy sets intention at improving resilience but requires additional strength for implementing actions. While this item relates directly to mitigating the impacts of climate change, an environmental stress, building resilience to the impacts of climate change will also mitigate technology, infrastructure, and sociopolitical stresses and shocks.

STRATEGY DISCUSSION AND RECOMMENDATIONS

Environmental Resilience	This strategy could be improved through several adjustments to existing actions. • Include integration of climate resilience as a required procurement criterion for all infrastructure projects. • Action 3.4.5 could be reviewed for strength of language. Stronger language should replace the word 'consider'. Climate change is not a consideration, it is a non-disputable impact that must be integrated into long-term planning and designs. Municipalities should incorporate HRVA and climate resilience assessments into the planning and design of municipal utilities, assets, and operations. • Action 3.4.4 could also be made stronger by clarifying what policies can be used to encourage settlement patterns that minimize risks. Seismic risk and flood risk can be more thoroughly investigated and integrated into future planning requirements.[92] Commit to undertaking research and formally designating hazard areas so that there can be development policy specific to those locations. • The above noted examples could be expanded to include erosion, subsidence, mudslides, and more. When considering resourcefulness, there is lack of action when it comes to clarifying roles and responsibilities for hazard preparation and response. This may already be deemed to be the role of IPREM, but continuing to engage municipalities, IPREM, and other relevant agencies could be highlighted through IPREM's coordination role in 3.4.7.b. • The way this strategy is written is quite broad. Policies that help against flooding are likely to be different than those that protect against drought. It is recommended that actions clearly articulate what is required in regional context statements for acceptance. This could include clear indicators for measuring success of climate change strategies, either prescribed by Metro Vancouver, or determined by municipalities and accepted by Metro Vancouver. Templates could be developed for specific stresses and shocks that would allow member jurisdictions to select appropriate requirements based on the hazards they anticipate facing.
Technology & Infrastructure Resilience	The strategy will improve resilience against technological failure, service disruptions, and power outages by making infrastructure more resilient to the effects of climate change. • Within Regional Context Statements, municipalities should identify climate change risks, and how this will impact agricultural lands and regional food supply, along with providing intention for mitigating this issue.
Sociopolitical & Economy Resilience	The strategy does not directly improve or inhibit resilience against this shock and stress group. • Metro Vancouver can act as a coordinator for the region, to better understand climate change impacts on immigration, and liaise with the provincial government in terms of anticipating and managing growth that is in line with regional objectives.
Human Health Resilience	Extreme weather events are anticipated to become more severe with climate change. This has impacts for both chronic disease and mental health. No strategy adjustments are suggested for this shock and stress group.

HRVA FRAMEWORK INDICATOR POTENTIAL

Ideal Indicators	Current Indicators
• Municipal climate change adaptation efforts • Municipal climate change mitigation/response plans *These will assist future HRVA with assessing likelihood and consequences environmental stresses and shocks.*	• Municipal climate change adaptation efforts • Regional climate change projections

[92] Fraser Basin Council. (2016). Lower Mainland Flood Management Strategy: Phase 1 Summary Report.

RGS STRATEGY 4.1

Provide diverse and affordable housing choices

EVALUATION

	Robustness	Redundancy	Resourcefulness	Rapidity
Environmental Stresses and Shocks	Providing diverse and affordable housing enables densities that contribute to GHG reductions. The densities are also associated with more complete communities, creating easier access to amenities in the event of a shock or stress.			Actions within this strategy aim to increase the rapidity of bringing more affordable housing to the region, avoiding future disruptions against affordability (4.1.1, 4.1.4, 4.1.5, 4.1.7.a). However, there is currently a growing supply gap for affordable rental housing which needs more efficient solutions. The lack of timelines within this Strategy reduce the ability to meet priorities.
Technology & Infrastructure Stresses and Shocks				
Sociopolitical & Economy Stresses and Shocks	Actions within this strategy contribute to withstanding affordability stresses and improve the supply and diversity of housing across the region.	Actions within this strategy provide a number of alternative strategies for navigating housing affordability, along with contributing additional components to housing supply on the whole (4.1.1,4.1.4, 4.1.5, 4.1.6, 4.1.9)	Actions within this strategy increase the resourcefulness for navigating housing affordability (4.1.2, 4.1.3).	
Human Health Stresses and Shocks	The strategy contributes to decreasing financial worries for accessing housing in the region and freeing up financial resources that would otherwise be dedicated to housing. This can improve mental health and reduce chronic disease.			

GENERAL RESILIENCE SUMMARY

This strategy generally does an effective job of directly improving resilience of housing affordability in the region. Emphasis should be placed on determining more rapid ways of bringing affordable rental housing to market, recognizing the growing supply gap for affordable rental housing in the region.

STRATEGY DISCUSSION AND RECOMMENDATIONS

Environmental Resilience	No strategy adjustments are suggested for this shock and stress group.
Technology & Infrastructure Resilience	No strategy adjustments are suggested for this shock and stress group.
Sociopolitical & Economy Resilience	Housing affordability is a major concern in the Metro Vancouver region. There is an increasing gap between incomes and housing costs, preventing access to home ownership for many in the region, and increasing pressure on the rental market[93] and crowds out rental development opportunities.[94] This strategy recognizes the different roles that Metro Vancouver can play when it comes to provision of affordable housing. Metro Vancouver is also a housing provider directly (via Metro Vancouver Housing Corporation). Expanding the supply of affordable rental housing is the key initiative required as affordability continues to stress residents in the region. As documented in the Transit-Oriented Affordable Housing Study, there is a particular need for affordable rental housing in transit-oriented locations.[95] Metro Vancouver has developed several plans and strategies since Metro 2040 was adopted (Metro Vancouver Housing 10-Year Plan and Metro Vancouver Regional Affordable Housing Strategy)[96] to support diverse and affordable housing. While the actions in these two housing strategies provide several solutions, the primary requirement for improving affordability is to expand the supply of affordable rental housing in the region. • Take a needs-based approach to delivering affordable housing, recognizing the anticipated annual population growth (~35,000). Metro Vancouver can act as a regional convenor, an advocate to the federal government and the province, and through implementation via Metro Vancouver Housing Corporation. • Incorporate transit-oriented affordable housing (TOAH) policy recommendations from the Transit-Oriented Affordable Housing Study Phase 2, such as establishing a TOAH fund to provide low-interest loans to help finance new affordable housing in the region.[97] • Investigate opportunities to decrease the gap between local incomes and land costs (e.g. by limiting speculation).
Human Health Resilience	Providing diverse and affordable housing choices can improve mental health. Financial worries are a contributor to mental health issues. Creating housing for a variety of household incomes and needs in the region can decrease financial worries and allow access to home ownership and rental capabilities for residents. No strategy adjustments are suggested for this shock and stress group.

HRVA FRAMEWORK INDICATOR POTENTIAL

Ideal Indicators	Current Indicators
Current indicators are appropriate for future HRVA. These will assist future HRVA with assessing social inequity and affordability.	• Combined Housing and Transportation Costs • Municipal Housing Action Plans • Housing Choices (housing type and house tenure) • Rental housing demand and supply

[93] Metro Vancouver. (2019). Metro Vancouver Housing 10-Year Plan.
[94] Metro Vancouver. (2019). Transit-Oriented Affordable Housing Study.
[95] Metro Vancouver. (2015). Metro Vancouver Housing and Transportation Cost Burden Study.
[96] Metro Vancouver. (2016). Metro Vancouver Regional Affordable Housing Strategy.
[97] Metro Vancouver. (2019). Transit-Oriented Affordable Housing Study.

RGS STRATEGY 4.2

Develop healthy and complete communities with access to a range of services and amenities

EVALUATION

	Robustness	Redundancy	Resourcefulness	Rapidity
Environmental Stresses and Shocks	This strategy identifies air quality as a stress for health considerations. (4.2.2, 4.2.4f)		Complete communities facilitate social connections and improved community relationships for shock and stress preparation and response.	No timelines have been identified for actions within this Strategy, reducing the ability to meet priorities or create early detection capabilities.
Technology & Infrastructure Stresses and Shocks	Developing complete communities improves ability to withstand transport incidents. It also supports local food production. (4.2.4a, 4.2.4h)			
Sociopolitical & Economy Stresses and Shocks	Providing a range of nearby services and amenities contributes to withstanding stresses for all ages and abilities.	Providing a range of services and amenities creates alternative supplies for navigating stresses and shocks.		
Human Health Stresses and Shocks	Including parks, green space, and recreational opportunities in communities can improve mental health of and chronic disease within communities.			

GENERAL RESILIENCE SUMMARY

Strategy 4.2 emphasizes the importance of designing neighbourhoods within Urban Centres and Local Centres accessible for all ages and abilities. These complete communities promote sustainable transportation, provide access to employment, social, and cultural opportunities, as well as to parks, greenways and recreational opportunities. Developing complete communities promotes healthy living and improves social connectedness. This strategy integrates direction from other Goals in Metro 2040, creating some overlap in actions. The largest omission from this strategy is identification of a timeline for implementation.

STRATEGY DISCUSSION AND RECOMMENDATIONS

Environmental Resilience	Supporting compact, mixed use, transit-oriented communities can help withstand both environmental shocks and stresses. Compact, walkable living is associated with decreased reliance on private vehicles, and decreased associated GHGs. As mentioned in the overview of this assessment (**Section 4.1**), GHGs and climate change will exacerbate most environmental stresses and shocks and bring new stresses and shocks to the region like sea-level rise, extreme precipitation, and summer heat waves, potentially limiting the ability of Metro Vancouver to respond effectively. This strategy also specifically incorporates actions that consider air quality in making land use and infrastructure decisions, and requires municipal plans to include health implications considering air quality. Action 4.2.4e also supports green roofs and community gardens. These initiatives will improve resilience to shocks and stresses such as heat waves and air pollution. This strategy omits discussion of appropriate locations for complete communities. Several parts of the region are in higher-risk locations for environmental shocks (e.g. coastal and riverine flooding). • In line with recommendations under Strategy 1.2, develop multi-hazard mapping to inform appropriate locations for further development (for complete communities and development in general).
Technology & Infrastructure Resilience	Having a more compact built form, with more amenities within walking distance, allows more people in the region to meet their daily needs, even if faced with technological shocks such as infrastructure failure or a significant transport incident. However, adjusting travel behaviour is required to maximize the benefits of complete communities. Working with TransLink to develop travel behaviour programs, through incentives, disincentives, and educational campaigns, can support active travel. Action 4.2.4e also provides a basis for increasing urban food production, supporting roof top gardens and community gardens, as well as facilitating farmers' markets near housing and transit services. If this type of local and urban farming is scaled, this could result in improved access to healthy and local food supply. • Work with municipalities and TransLink to develop educational campaigns for supporting active and health travel behaviour. • Support municipalities in increasing urban farming opportunities to increase Metro Vancouver's local food supply.
Sociopolitical & Economy Resilience	Complete communities that have access to a range of services and amenities provide individuals with a wide range of employment, social, and cultural opportunities. These can be within urban areas, Urban Centres, and Local Centres are accessible for people of all ages and abilities. Fulfilling this strategy benefits recent immigrants, and people who are unemployed through proximity to opportunities and access to destinations and services through less expensive transport (walking, cycling and taking transit as opposed to driving). A diverse mix of housing types can respond to the needs of an aging population, and for a variety of household incomes and needs in the region. While there are numerous benefits at overcoming stresses in this shock and stress group, quantitative progress is difficult to point to. Metro Vancouver previously investigated the application of Health Impact Assessments and developed a toolkit for evaluating impact of developments and infrastructure on communities.[98] This could be more readily applied for better understanding the benefits and costs as it relates to many of these stresses. • Integrate a form of health impact assessment or social impact assessment to determine infrastructure or development impacts on communities.
Human Health Resilience	Developing healthy and complete communities contributes to human health resilience. Actions 4.2.4c and 4.2.4d provide public spaces, parks, trails, and recreation opportunities for improved mental health and reduction of chronic diseases. Recently, opportunities for social connectedness have decreased with necessary precautions regarding COVID-19. As a regional convenor, Metro Vancouver could work with municipalities and partners to create more digital opportunities for connection. • Work with municipalities to increase free wireless internet coverage across the region, decreasing inequities (decreasing financial requirements for personal internet service) while improving access to services, employment opportunities, and social connectedness. However, many people may not have access to smartphones or knowledge on using devices, which would require additional education services and provision of devices.

HRVA FRAMEWORK INDICATOR POTENTIAL

Ideal Indicators	Current Indicators
• Walkability index (expand to include % of people within walking distance to services/amenities, % of people within walking distance to frequent transit, and % of people within walking distance to parks and recreation space) • Perceived social cohesion/connectedness *These will assist future HRVA with severity/vulnerability based on access to employment, services and amenities.*	*From Metro 2040 Dashboard: An appropriate measure for complete communities has not yet been developed for the region.*

[98] Metro Vancouver (2015). Health Impact Assessment of Transportation and Land Use Activities: Guidebook.

RGS STRATEGY 5.1

Coordinate land use and transportation to encourage transit, multiple-occupancy vehicles, cycling and walking

EVALUATION

	Robustness	Redundancy	Resourcefulness	Rapidity
Environmental Stresses and Shocks	Improving sustainable travel options will contribute to withstanding many environmental stresses/shocks.	Connected regional active transportation networks increase redundancy of the system by providing alternatives to driving and transit. (5.1.4)	Implementing land use and transportation data collection programs and targets can contribute to identifying problems and establishing priorities. (5.1.3)	A multi-modal region with many travel options can adapt rapidly to changing circumstances because it's more flexible.
Technology & Infrastructure Stresses and Shocks	Shifting more trips to sustainable modes will improve reliability of the road network, improving supply chain and food supply.			
Sociopolitical & Economy Stresses and Shocks	Actions within this strategy contribute positively to withstanding the pressures of affordability through lower-cost transportation options (walking, cycling).	Coordinating land use and transportation provides improved access and opportunity to services and amenities.		
Human Health Stresses and Shocks	Cycling, walking, and taking transit are all associated with improved physical health (e.g., reduced cardiovascular disease and obesity).			

GENERAL RESILIENCE SUMMARY

Coordinating land use and transportation to encourage transit, multiple-occupancy vehicles, cycling and walking generally contributes to withstanding stresses and shocks. Redundancy is achieved through creating more travel options against many stresses and shocks, and active modes are generally more resilient to environmental and technological/infrastructure shocks.

STRATEGY DISCUSSION AND RECOMMENDATIONS

Environmental Resilience	Coordinating land use, housing and transportation to support regional land use objectives means that the benefits of focused growth in UC/FTDAs will occur. This type of built form is more resilient to withstanding stresses and shocks, when compared to a more diffuse development model. There is also opportunity for this strategy to expand on demand management strategies and determine whether remote working is something that Metro Vancouver can support. • Support large organizations and institutions in the region to develop strategies for increased work from home and/or remote work opportunities, to further decrease congestion and reduce vehicle use.
Technology & Infrastructure Resilience	Similar to contributions laid out in Strategy 1.2, this strategy will primarily have a positive impact on resilience. Providing more people with sustainable mode options by coordinating land use with transportation will create more options for travel, which is essential, particularly in the case of technological shocks such as infrastructure failure or transport incidents. This will also lead to less congestion for jobs and people that require vehicles to travel. Congestion can decrease response times from a rapidity perspective, thus decreasing resilience. No strategy adjustments are suggested for this shock and stress group.
Sociopolitical & Economy Resilience	Due to the connection between this Strategy and Strategy 1.2, there are similar contributions to resilience that are listed previously. Specific to this Strategy, there is value to implementing user-based road pricing and regional parking policy (5.1.7d) in terms of affordability and equity (though rebates and credits will need to be implemented for mobility pricing to mitigate fairness). While analysis has been undertaken by the Mobility Pricing Independent Commission[99] and more recently by the City of Vancouver, there is opportunity to investigate how revenue from these initiatives can be re-invested to subsidize sustainable modes (e.g. discounted transit fares, tax rebate for purchase of a bicycle, etc.). • Expand user-based road pricing strategy to align with recommendations and findings from the 2018 Metro Vancouver Mobility Pricing Study.
Human Health Resilience	There is a mounting body of evidence that supports coordinating land use and transportation to better support sustainable travel options, particularly as it relates to chronic disease. Cycling, walking, and taking transit are all found to decrease cardiovascular disease and obesity, when compared to driving a vehicle.[100] [101] There are also positive contributions of non-vehicle modes to mental health and reducing stress.[102] More recently with the COVID-19 epidemic there has been significant decreased transit ridership around the world. However, even in large cities where transit usage has begun to recover, no outbreaks have been traced to taking transit.[103] • In the short-term, work with TransLink to develop educational and awareness campaigns regarding COVID-19 associations with transit. In the long-term, develop early warning systems regarding the spread of any future infectious disease, and deploy appropriate tactics for ensuring safety across all modes, particularly those that support sustainable travel.

HRVA FRAMEWORK INDICATOR POTENTIAL

Ideal Indicators	Current Indicators
• Mode share • % of people living within walking distance of frequent transit • % of jobs within walking distance of frequent transit • % of jobs capable of working remotely (or from home) *These will assist future HRVA with consequences related to road incidents and severity/vulnerability based on access to employment, services and amenities.*	• Mode share • % of people living within walking distance of frequent transit

[99] Mobility Pricing Independent Commission. (2018). Metro Vancouver Mobility Pricing Study.
[100] She, Z., King, D. M., & Jacobson, S. H. (2017). Analyzing the impact of public transit usage on obesity.
[101] Panter J, Mytton O, Sharp S, et al. (2018). Using alternatives to the car and risk of all-cause, cardiovascular and cancer mortality.
[102] Legrain, A., Eluru, N., & El-Geneidy, A. (2015). Am stressed, must travel: The relationship between mode choice and commuting stress.
[103] Sam Schwartz Consulting. (2020). Public Transit and COVID-19 Pandemic: Global Research and Best Practices. Commissioned by APTA.

RGS STRATEGY 5.2

Coordinate land use and transportation to support the safe and efficient movement of vehicles for passengers, goods and services

EVALUATION

	Robustness	Redundancy	Resourcefulness	Rapidity
Environmental Stresses and Shocks	Directly considering air quality and vehicle emissions in this strategy will contribute towards decreasing air pollution.	Management and maintenance of the goods-movement network is important for keeping multiple route options available for people and goods movement in the region (5.2.4a)	Increased monitoring and data provide improved understanding of issues. This allows for establishing priorities and minimizing impact across all shock and stress groups.	
Technology & Infrastructure Stresses and Shocks	Improving the safe and efficient movement of goods and services will contribute to food supply and decreasing supply chain disruptions.	Increased reliance on Intelligent Transport Systems both can help and hinder withstanding shocks in this category (potential risk with cyber attacks and power outages, while a benefit for navigating transport incidents).		
Sociopolitical & Economy Stresses and Shocks	Political conflict (e.g. protests/ blockades) can result in decreased reliability for goods movement.			
Human Health Stresses and Shocks	The focus on safety contributes to physical health. However, there is limited reference to alternative fuels and other demand management strategies to improve mental health and chronic disease.			

GENERAL RESILIENCE SUMMARY

This strategy contributes towards environmental and technological resilience through decreasing emissions and improving safety. There are some opportunities for considering how this strategy can be strengthened from a sociopolitical and human health perspective.

STRATEGY DISCUSSION AND RECOMMENDATIONS

Environmental Resilience	TransLink's Regional Goods Movement Strategy (Moving the Economy) has been developed since Metro 2040 was adopted. The actions within this Goods Movement Strategy can be supported through Metro 2050. • Adjust language in 5.2.1 to support the implementation of the Goods Movement Strategy through the provision of land use and growth management information and forecasts, and evaluation of land use and vehicle emissions impacts.
Technology & Infrastructure Resilience	Further research and consideration could be given to integration of urban consolidation centres or microhubs near urban areas in the region as a response to the changing nature of e-commerce. This would require significant partnership agreements among logistics providers but would yield land use benefits (smaller footprint) and transportation benefits (fewer independent trips). It would also create an opportunity for many trips within a certain distance to be delivered by sustainable modes, such as electric assist cargo bicycles.[104] Variations of consolidation centres have been implemented (or are planned to be implemented) in cities such as Montréal, London[105], Brussels[106], and Seattle[107]. Another solution that is being explored in other jurisdictions is the deployment of lockers in urban areas for centralized and secure pick up and drop off.[108] • Beyond emissions reductions, improving consolidation in and around urban areas should result in improved reliability, and redundancy in the face of transport incidents and infrastructure failure, if delivery by sustainable modes is considered.
Sociopolitical & Economy Resilience	Throughout 2020, there have been several examples of protests and blockades disrupting goods movement by truck and rail. These result in late or missed deliveries, creating economic distress, as well as second-order supply effects for other businesses and consumers in the region. • Expand action 5.2.5 with a standalone implementation plan for protecting rail rights-of-way and develop additional strategies for maintaining efficient goods movement in the region. Work with the Port of Vancouver and Transport Canada to execute this plan.
Human Health Resilience	Strategy 5.2 points to supporting the implementation of TransLink's Regional Goods Movement Strategy, which was adopted in 2017. This Regional Goods Movement Strategy contains strategies and actions that will contribute to physical health of travellers and residents of the region through emissions from heavy vehicles. Some of these actions could be highlighted in the M2050 update including referencing off-peak delivery, alternative fuels, and quieter, cleaner, and lower-carbon goods movement innovations to improve mental wellbeing of communities. • Integrate recommendations from TransLink's Regional Goods Movement Strategy that support mental and physical wellbeing.

HRVA FRAMEWORK INDICATOR POTENTIAL

Ideal Indicators	Current Indicators
• Vehicle (and Truck) Kilometres Travelled (VKT) by vehicle type • Vehicle (and Truck) Hours Travelled (VHT) • Vehicle (and Truck) Hours of Unreliability (VHU) for non-recurrent congestion • Collisions where someone is killed or serious injured (KSI) *These will assist future HRVA with consequences related to road incidents.*	• Vehicle Kilometres Travelled (VKT)

[104] Pembina Institute. (2019). Modernizing urban freight deliveries with microhubs.
[105] Transport for London. (2019). Freight and Servicing Action Plan.
[106] WWF. (2016). International Case Studies for Scotland's Climate Plan: Freight Consolidation, Brussels, Belgium.
[107] Seattle Department of Transportation. (2016). City of Seattle Freight Master Plan.
[108] Amazon. (2020). Amazon Lockers.

RTS STRATEGY SHOCK AND STRESS GAP ASSESSMENT

This table provides an overview of shocks and stresses that TransLink addresses within the RTS as well as a consolidated list of recommendations for additional consideration where there are gaps. It is important to note that although the following shocks and stresses are discussed independently, some of the greatest risks could be due to a combination of the following and amplified through a cascading effect.

Environmental

Stress/Shock	Discussion
Flooding	Flooding upgrades are considered as part of the state of repair strategy for some critical assets. • Review major road network and Frequent Transit Network for locations where coastal and riverine is likely to occur and incorporate strategy to adapt and mitigate
Snowstorms	Although snowstorms occur on an (almost) annual basis, significant snowstorms could disrupt movement within the region. TransLink is currently undertaking the Burnaby Mountain Gondola project that will improve one of the most disrupted locations from snowstorms.[109] • In the short-term, it is recommended that preparedness measures are in place to facilitate travel in snowstorms. An example of this would be working with municipalities to ensure transit routes are plowed first, which allows transit to reliably function during snowstorms. • An HRVA should be undertaken to further determine the significance of this shock.
Windstorms	Although wind storms occur on an ongoing basis, significant wind could disrupt movement within the region between knocking down trees that block major arterials/highways or impacting power and energy supply. • An HRVA should be undertaken to further determine the significance of this shock.
Air Pollution	The promotion of lower emissions modes through multiple actions in the RTS will assist in reducing air pollution in the region. • Include strategy around electric and alternative-fuel vehicle technologies for further reduction in air pollution.
Wildfire & Smoke	Wildfire and smoke can have a direct impact on the transportation system (e.g. visibility, air quality impacts for some modes). Smoke from wildfires can result in air quality advisories, as exemplified for several weeks in Metro Vancouver during the summer of 2020.
Landslides	Landslides are not directly acknowledged within the RTS. Hazard planning could incorporate landslides as an outcome from heavy rain or earthquake events. Ongoing work of the Metro Vancouver Seismic Microzonation Project by University of Western Ontario in concert with Emergency Management BC may yield relevant results for TransLink that can be applied to service planning, along with preparedness and recovery planning in the case of a landslide event in the region.[110] • Ensure updated modelling projections are observed for slope stability in the region for future infrastructure projects.
Earthquakes	• Seismic upgrades are considered as part of the state of repair strategy for some critical assets. That said, other portions of the system could be exposed due to associated natural hazards, supply chain disruption, or disruptions in utilities.
Natural Resource Depletion	The RTS acknowledges the RGS and supports its regional land use objectives (3.1). This includes making transportation investment decisions concurrent with partner-mandated land use decisions.
Climate Change	• While climate change is acknowledged, it is recommended to better understand (or exhibit) the implications of climate change and required mitigations and adaptations that could be implemented to reduce severity and vulnerability to this ongoing stress. Ongoing study of the impacts of climate change in Metro Vancouver will be required.

Technology & Infrastructure

Stress/Shock	Discussion
Cyber Attacks	Cyber attacks are not specifically mentioned in the RTS. An increasing reliance on pricing mechanisms, intelligent transit systems, intelligent and connected vehicles, and further reliance on high-order transit, will increase the vulnerability of the transportation system to cyber attacks. • If not already built into existing systems, clear cyber security capabilities and protocols should be developed.
Industrial Incidents	• An HRVA should be undertaken to further determine the significance of this shock.
Transport Incidents (Road & Rail)	The RTS provides strategy and actions to improve safety through all modes. There is no discussion of automated vehicles and travel, and how this is anticipated to affect traveller safety. • Utilize emerging technologies to make the system more efficient and safe where possible. • An HRVA should be undertaken to further determine the significance of this shock.
Power Network and Energy Supply Disruptions	Power outages, when prolonged, can be very disruptive to travelling in the region. They are often the result of various environmental and technological stresses and shocks. • An HRVA should be undertaken to further determine the significance of this shock. It would be specifically valuable to review this both as an independent hazard, as well as a second-order disruption caused by a separate stress/shock.
Global Supply Chain Disruptions	Global supply chain disruptions are not specifically addressed in the RTS. A concern for the transportation system could be whether materials, supplies and labour can be easily sourced to repair critical assets after a significant shock has occurred, especially if an event occurs in an adjacent region. • Develop a global supply chain disruption plan for continuity of operations to the transit system and Major Road Network in the case of extended disruption. This would include developing an inventory of key materials and supplies, along with a skills assessment of the local labour market.
Aging Infrastructure	Aging infrastructure is addressed through the state of good repair strategy. That said, this will remain a significant challenge to ensure that assets can be well maintained, particularly with anticipated increased severity of extreme weather events associated with climate change.
Regional Food Supply Disruptions	The RTS acknowledges the RGS and supports its regional land use objectives (3.1). This includes making transportation investment decisions concurrent with partner-mandated land-use decisions. TransLink can influence the state of food supply through maintaining an efficient road and rail network, and supporting safety improvements for these modes. The RTS introduces this topic of goods movement but has limited actions specific to support efficient movement of goods. • Apply key findings from the Regional Goods Movement Strategy to the RTS update to maintain the safe and efficient movement of goods.

Sociopolitical & Economy

Stress/Shock	Discussion
Terrorism	• An HRVA should be undertaken to further determine the significance of this shock.
Aging Population	An aging population will modify travel patterns and transport needs throughout the region. • The needs of an aging population could be examined more directly in the RTS update.

[109] TransLink. (202). Burnaby Mountain Gondola.
[110] University of Western Ontario. (2020). Metro Vancouver Seismic Microzonation Project.

	• Investigate small-scale dynamic transit opportunities (potentially aligned with HandyDART services) for those who needs require door-to-door access.
Unemployment	Increased unemployment could result in lower transit ridership (due to lower overall trip rate) or higher transit ridership (due to lack of alternative affordable transportation options). Unemployment can be a stress or a shock (e.g. as seen during COVID-19). • A diversification of funding streams could be explored to maintain low fares for affordable travel by transit. • Work with the BC Government to identify potential funding and priorities for potential expansion of discounts for low income residents (as indicated the TransLink's Transit Fare Review).[111]
Unaffordability	The impact on transportation networks on housing affordability could be better explored or presented as part of the RTS. The current RTS does not address affordability of housing, nor aims to increase the affordability of transportation choices considering that car ownership is a very significant portion of many household budgets. A combined housing and transportation cost approach could be developed to guide both the RTS and RGS in coordinated decision-making through providing better access to parts of the region and various housing strategies. Transportation could play a key role to increase accessibility to housing, allow densification to increase supply, and also reduce the number of private vehicles, all of which could improve affordability. These linkages are not evident in the RTS.
Social Inequity	Transport plays a critical role to improve accessibility to employment from all parts of the region. • The level of access to transportation from vulnerable and equity-seeking groups could be further explored as an objective and action as part of the RTS.
Immigration	Immigration rates are controlled at a federal level while needing to be planned for at a regional and local level. These rates can change as exemplified recently, with the Government of Canada indicating that immigration rates will increase substantially from 2021-2023 to make up for lack of immigration in 2020 due to COVID-19.[112] An influx of people could have travel impacts on the region. • An HRVA should be undertaken to further determine the significance of this stress.
Global Recession	• An HRVA should be undertaken to further determine the significance of this stress/shock.
Political Conflict	Political conflict is not addressed in the RTS. Given the likelihood of political conflict in the region, it is reasonable for this to be omitted in the RTS update. Local political conflict (i.e. protests and road/rail blockades) could be addressed as it pertains to regional goods movement, safety, and reliability. • An HRVA should be undertaken to further determine the significance of this stress/shock.

Human Health

Stress/Shock	Discussion
Infectious Diseases	• TransLink should continue investing in infrastructure and practices that will reduce the spread of COVID-19 for the duration of the pandemic: this could include maximizing air circulation, encouraging quiet cars, requiring face coverings, and enforcing physical distancing. It could also include awareness campaigns to encourage riders to practice safe riding habits (taking shorter trips, avoid talking, sitting by a window), promote understanding of TransLink's mitigation measures, and grow public confidence in the safety of the transit system.[113]
Chronic Disease	The vision of the RTS acknowledges leading healthier and active lives. This contributes to several actions and strategies to further improve health of travellers in the region. There is no discussion of shared micromobility as part of the RTS and how these services (bike-share, scooter-share, etc.) support active living. • Support municipalities in developing shared micromobility services that allow for more trips to be made through active transportation.
Mental Health	Transportation can help and hinder mental health and illness. The network provides travellers with ability to access locations, services, jobs, and institutions. It can also be a source of stress, discomfort, and danger, that can negatively contribute to mental health. Provision of active transportation facilities, pedestrian infrastructure, real-time information systems, and reliable public transit services can contribute to mental health.[114]

RTS STRATEGY RESILIENCE PRINCIPLES GAP ASSESSMENT

Resilience Principle	Discussion
Robustness	The general orientations of the RTS will gradually increase the dependency of the region on certain portions of the transportation system (e.g., in UC/FTDAs) for all modes of travel. This notion of robustness not only includes physical assets and systems, but also funding streams. For example, increased transit use will increase the reliance of the region on sustained funding for transit operations. • Improving the robustness of critical assets through state of good repair initiatives and increasing the reliability of operations is critical to reducing vulnerability from high reliance on specific assets. • The RTS specifically mentions seismic and flooding upgrades, but this could be expanded to include other stresses/shocks.
Redundancy	Further development of transit and active transportation will increase the level of redundancy of the transportation network. • Redundancy could be explored as part of project planning and considered in project prioritization, especially when developing active transportation and transit projects. • Redundancy could be further explored as a strategy where robustness is not feasible.
Resourcefulness	The building of resilience capabilities, either to better plan and mitigate stresses and shocks, improve emergency response capabilities or post-event response capabilities is not directly addressed by the previous RTS. Numerous strategies could be investigated including: • Undertaking HRVA to identify weaknesses in recovery for the likeliest and most impactful events. • Pre-event planning to identify vulnerabilities and various potential post-event responses. Develop contingency and response plans for the likeliest events. Undertake event simulations to identify gaps in communication, coordination or potential supply chain disruptions that could hinder recovery efforts. • Promote participation in information-sharing and research-based organizations/committees to learn from other jurisdictions with similar challenges across Canada and elsewhere. • Create or widen the scope of hazard-specific or asset-based hazard coordination capabilities including TransLink, Metro Vancouver, provincial and federal entities, municipalities, utilities and others. • Creating post-event intervention resources (staff, skills, material, financial, etc.) to better recover after events. • Instituting mandatory post-event review processes to learn from shocks and stresses, and assessing the adequacy of the response. This includes a review of less impactful events since some vulnerabilities could be exposed during large events.
Rapidity	Rapidity is also not directly addressed in the RTS. • Similar strategies suggested for resourcefulness could be explored to improve the rapidity of the response.

[111] TransLink. (2018). Transit Fare Review.
[112] The Globe and Mail. (2020). Canada aims to accept far more immigrants in next three years.
[113] Sam Schwartz Consulting. (2020). Public Transit and COVID-19 Pandemic: Global Research and Best Practices. Commissioned by APTA.
[114] McCay, L. et al. (2017). Scoping assessment of transport design targets to improve public mental health.

RTS STRATEGY 1.1

Maintain what is needed in a state of good repair

EVALUATION

	Robustness	Redundancy	Resourcefulness	Rapidity
Environmental Stresses and Shocks	Upgrading infrastructure for seismic risk will have a direct positive contribution to robustness for earthquake preparedness. This strategy is an opportunity to incorporate safe-to-fail into upgrades.	The strategy will improve any existing redundancies but does not directly create new alternatives, except for localized elements.		Maintaining infrastructure in a state of good repair will allow for improved rapidity in responding to shocks and stresses. This strategy reduces the risk of infrastructure failure.
Technology & Infrastructure Stresses and Shocks	Maintaining assets in good condition is an opportunity to protect against technological risks, although this is not mentioned specifically within policies to support this strategy.			
Sociopolitical & Economy Stresses and Shocks	This strategy may create additional robustness to protect some assets against terrorist activities although it is not a stated objective. However, there is significant uncertainty when predicting terrorist activity.			
Human Health Stresses and Shocks				

GENERAL RESILIENCE SUMMARY

This strategy contributes to resilience. There are several suggestions listed below to expand on the definition of which assets are considered within this strategy. An expansion that could be considered for all shock and stress groups is to improve resourcefulness by working with partners to create better information-sharing for shared and adjacent resources, along with intervention procedures, roles, and responsibilities should a shock or stress occur.

STRATEGY DISCUSSION AND RECOMMENDATIONS

Environmental Resilience	Upgrading infrastructure to be more resilient to climate change will also decrease the exposure and damage to these systems due to natural hazards exacerbated by climate change. • A policy consideration is the state of good repair definition could be expanded to incorporate associated elements such as ensuring that assets are safe to fail against environmental shocks (such as floods and/or earthquakes). • Consider prioritizing the state of good repair of assets where there is little or no redundancy available. Lastly, creating redundancy to allow for the rehabilitation/replacement of critical assets could also be integrated into this strategy.
Technology & Infrastructure Resilience	• The state of good repair definition could be expanded to incorporate specific assets such as SkyTrain stations and plans if a shock occurs such as a power outage. • Consider clearly articulating digital assets and cyber security within the state of good repair mandate, and ensure robustness to withstand cyber security attacks of system controls.
Sociopolitical & Economy Resilience	Maintaining assets in a state of good repair contributes to sociopolitical resilience, or is not anticipated to inhibit resilience against shocks and stresses within this group. • While difficult to prepare, prevent and predict terrorist activity, TransLink should closely coordinate with the Federal Government to ensure that the major road network, SkyTrain, West Coast Express, and other critical infrastructure are logged as assets with Federal Government's Critical Infrastructure Intelligence Team, and that there are efficient watchdog opportunities for citizens to log suspicious incidents via their Suspicious Incident Reporting system.[115] This recommendation could also be applied to technological resilience, with a set of digital assets to protect from a cyber security perspective.
Human Health Resilience	No strategy adjustments are suggested for this shock and stress group.

HRVA FRAMEWORK INDICATOR POTENTIAL

Ideal Indicators	Current Indicators
• Condition of critical assets and systems *This will assist future HRVA with assessing likelihood of some shocks (aging infrastructure) and consequences related to infrastructure shocks.*	*No directly relatable indicators from TransLink's Accountability Centre or Regional Trip Diary.*

[115] Government of Canada. (2013). Building Resilience Against Terrorism: Canada's Counter-terrorism Strategy.

RTS STRATEGY 1.2

Make early investments to complete the walkway and bikeway networks

EVALUATION

	Robustness	Redundancy	Resourcefulness	Rapidity
Environmental Stresses and Shocks	The active transportation system can be more robust compared to other modes in the face of natural hazards. The increased use of active transportation will decrease reliance on fuels (electricity, gasoline, etc.), and improving robustness for travel.	The development of active transportation will increase the level of redundancy to auto and transit modes of travel in case of a disruption. The further development of active transportation links will also provide redundancy within the active transportation network by providing more alternatives.		Active transportation links can be faster and easier to recover after a shock since they are more flexible than roads or transit. Interim solutions and repairs can often be done more quickly.
Technology & Infrastructure Stresses and Shocks	The active transportation network is the least vulnerable to certain technological shocks, especially cyber attacks, although technological risks remain (e.g. road safety in power outages). The increased use of active transportation aligns with increased robustness of the transportation system.	Improving active transport networks provides some redundancy to auto and transit modes of travel in case of a technological disruption. That said, the active transportation system is as vulnerable as other modes at bottlenecks (e.g. river crossings).		
Sociopolitical & Economy Stresses and Shocks	The development of the active transportation network provides some help to transport affordability since it is the most affordable transport option and provides a means to connect some areas not as well connected to rapid transit.			
Human Health Stresses and Shocks	The strategy adds public health resilience by promoting physical and mental health outcomes through active transportation.			

GENERAL RESILIENCE SUMMARY

The development of the active transportation system will decrease the reliance on road networks, while providing some level of redundancy and integration to other modes of travel. Although not typically used for longer distance travel or goods transport, this mode is essential to providing a level of redundancy if there are major disruptions to other modes of travel, especially when considering that it is not as reliant on fuel distribution networks. Furthermore, it is possible that there will be an increase in regional trips made by active modes with the onset of e-assist devices (e.g. e-bikes, e-scooters). The prioritization of active transportation interventions should consider their ability to provide some redundancy to other road-based links. That said, the bulk of the benefit will likely be generated by improvements across the entire network, and not necessarily specific interventions. Replacement and rapid repair of active transportation links should be considered in developing rapid response capabilities, since they might provide one of the only means of travelling after a major event and accessing any particularly impacted areas. Active networks would also provide redundancy in the case of regional supply chain disruptions to fuel distribution or outages of telecommunication networks.

STRATEGY DISCUSSION AND RECOMMENDATIONS

Environmental Resilience	While travel by vehicle is usually faster over longer distances, travelling by bicycle or by walking provides flexibility in changing routes, and avoiding obstacles that may exist because of an environmental shock. A windstorm may knock over larger trees, making it difficult to pass in a vehicle. Similarly, snowstorms can significantly impact road travel, while walking (albeit slower) allows reasonable movement. Some key active transportation links are located in areas susceptible to natural hazards (flooding, sea level rise, etc.). • Add language to this strategy to ensure that appropriate planning and design is considered to withstand climate change impacts and other natural hazards for active transportation infrastructure. Contingency plans should be developed for emergency management and response for these key routes in the case of a disruption, and these systems should be designed and constructed with climate resilience in mind. In some cases, the safe-to-fail approach may be appropriate.
Technology & Infrastructure Resilience	Maintaining intersections that have key regional active crossings is critical (e.g. on greenways). • Work with municipalities to identify these active crossings and ensure that signals have back up power in case of a power outage.
Sociopolitical & Economy Resilience	Walking and cycling are the most cost-efficient and equitable ways to travel, decreasing the stresses of unaffordability and social inequity. These modes also have the fewest externalities from a social marginal cost perspective, resulting in no emissions and few costs to others from travelling. No strategy adjustments are suggested for this shock and stress group.
Human Health Resilience	Improving walking and cycling networks across the region will result in increased active transportation mode share. Walking and cycling are associated with improved mental health and chronic disease outcomes. • Work with municipalities on conflict intersections with multiple modes. Prioritize walking and cycling moves along these networks to improve safety and efficiency for these modes.

HRVA FRAMEWORK INDICATOR POTENTIAL

Ideal Indicators	Current Indicators
• Mode share (% sustainable mode share) • % of people within walking distance of walkway network • % of people within biking distance of bikeway network *These will assist future HRVA with assessing consequences related to travel modes for all shocks and stresses.*	• Mode share

RTS STRATEGY 1.3

Invest in the road network to improve safety, local access and goods movement

EVALUATION

	Robustness	Redundancy	Resourcefulness	Rapidity
Environmental Stresses and Shocks	The replacement of the Pattullo Bridge and the Massey Tunnel will improve the robustness of transportation links crossing the Fraser River against environmental shocks. Improved maintenance on roads will increase the robustness of critical segments by decreasing their susceptibility to failure.			
Technology & Infrastructure Stresses and Shocks	Improvements to road safety and access will increase the robustness of the road network.	The strategy will provide some localized redundancy to increase connectivity to specific areas. That said, no redundancy is added across major river crossings where fewer options are available.		
Sociopolitical & Economy Stresses and Shocks				
Human Health Stresses and Shocks	Improving safety has a direct contribution to improved mental health and chronic disease outcomes.			

GENERAL RESILIENCE SUMMARY

Although the regional road network is mature and there are at least two links crossing each major water crossing, the region will be even more dependent on the existing road network when considering anticipated population and job growth, especially as it pertains to goods movement. This strategy could be supplemented by further improving the robustness and reliability of the regional road network. This could be supplemented by further developing rapid recovery for the most critical and vulnerable links, especially water crossings. The feasibility of the deployment of rail or water transport to supplement this network in case of an emergency could be investigated. Without capacity expansion, TransLink should investigate travel demand strategies for reducing peak congestion, to maintain reliability of travel times in the region.

STRATEGY DISCUSSION AND RECOMMENDATIONS

Environmental Resilience	• An HRVA of critical road segments should identify means to improve the robustness of these links and rapid recovery after an event. These could include seismic upgrades, additional protection for flooding or rapid repair capabilities. • Developing safe-to-fail tactics is an important shift (away from a fail-safe perspective), recognizing that shocks can surpass natural hazard forecasting.
Technology & Infrastructure Resilience	Redundancy, if required, can take a significant amount of time to identify and implement. • Major upgrades to address aging infrastructure to critical segments of the road network should be identified in advance if a closure (mimicking infrastructure failure or power outage) is anticipated to be particularly disruptive.
Sociopolitical & Economy Resilience	No strategy adjustments are suggested for this shock and stress group.
Human Health Resilience	No strategy adjustments are suggested for this shock and stress group.

HRVA FRAMEWORK INDICATOR POTENTIAL

Ideal Indicators	Current Indicators
• Total road incidents • % of incidents where someone is killed or seriously injured (KSI) *These will assist future HRVA with consequences related to road incidents.*	*No directly relatable indicators from TransLink's Accountability Centre or Regional Trip Diary.*

RTS STRATEGY 1.4

Make investments in the transit network to increase ridership

EVALUATION

	Robustness	Redundancy	Resourcefulness	Rapidity
Environmental Stresses and Shocks	Increasing transit ridership and decreasing vehicle trips will decrease emissions and contributes to reduction in climate change impacts over time.	Some localized redundancy will be developed through transit network investments in the face of environmental shocks (e.g. implementing a Burnaby Mountain gondola will aid access particularly in snowstorms that decrease road access due to slippery conditions).		
Technology & Infrastructure Stresses and Shocks	Improving transit service levels and transit infrastructure will improve the level of robustness of each link by reducing the impact of a specific disruption on users. That said, with substantial transit ridership increases, the region will be more reliant on these corridors, requiring improved robustness on these segments.	Improving transit service on high demand corridors will provide redundancy for the overall transportation system by adding alternatives to auto-based and active transportation throughout the region. Improving frequency on crossings or parallel corridors will also add some level of redundancy within the transit network to better distribute demand during a disruption.		
Sociopolitical & Economy Stresses and Shocks	Transit can decrease stresses of unaffordability and inequity. However, improving transit service (e.g., SkyTrain along Broadway corridor) is likely to drive up costs of real-estate.			
Human Health Stresses and Shocks	Investing in the transit network contributes towards human health by limiting possible transmission of infectious diseases. Increasing transit frequency can increase ridership, decreasing concerns of crowding and potential spread.			

GENERAL RESILIENCE SUMMARY

This strategy will increase overall redundancy by increasing the transit network through the region. Internal redundancy is provided through some specific expansions of the rapid transit network. As the rapid transit network is expanded and ridership increases, interruptions in service will become increasingly disruptive to the entire region. This strategy could be accompanied by a number of supporting actions to increase redundancy of the Frequent Transit Network (FTN), improve the reliability of the system to major shocks and increase capabilities to quickly intervene after a disruption.

This strategy could be supplemented by incorporating the level of redundancy provided by specific transit improvements into the prioritization process that will be conducted after the adoption of Transport 2050. The identification of the most critical segments or components of the FTN should be identified and a full risk and vulnerability review of these links should be prepared to ensure their continued operation over time.

Projects that significantly increase reliance on specific corridors of the FTN could also incorporate elements to increase the robustness of the corridor (improved reliability, seismic upgrades, flooding risk reduction, etc.) or contingency plans in case of a major disruption (e.g. plans to redirect buses to another transit corridor, etc.). Examining these vulnerabilities could be part of the planning and implementation of all FTN improvements.

STRATEGY DISCUSSION AND RECOMMENDATIONS

Environmental Resilience	High reliance on critical segments will lead to further vulnerability to some environmental shocks and stresses. Increasing capacity and dependable parallel transit options improves redundancy, whereas increasing capacity on existing lines has little impact on redundancy. • Resilience initiatives could be implemented in parallel to increase the robustness and rapid recovery capabilities by ensuring critical supplies for repairs are stocked or repair teams can be quickly mobilized.
Technology & Infrastructure Resilience	Redundancy, if required, can take a significant amount of time to identify and to implement solutions. Major upgrades to address aging infrastructure to critical segments of the FTN should be identified decades in advance when a closure would be particularly disruptive. • Notions of asset resilience should also include examining less traditional shocks like cyber attacks and prolonged power outages. RTS Strategy 1.1 (State of Good Repair) is associated with this shock.
Sociopolitical & Economy Resilience	While transit-oriented communities are associated with fewer costs (due to less need to own and operate a vehicle for mobility), there is generally a correlation between transit improvements and increased value of adjacent real estate.[116] • Coordinate with municipalities, Metro Vancouver, the province, and other partners to ensure sufficient affordable housing is secured and located along corridors that receive transit improvements.
Human Health Resilience	While previous planning efforts have focused significantly on improving speed and reliability, COVID-19 has adjusted traveller priorities, with an increased interest in maintaining personal space on transit, and at transit stations and stops. This is despite data suggesting that virus transmission via public transit is almost non-existent.[117] • In the short term, maintain or increase frequent transit service, to allow for safe distancing while travelling. Also, develop educational campaigns to inform travellers on the low risk of COVID-19 transmission when using public transit (note that this will not necessarily be true for all pandemics).

HRVA FRAMEWORK INDICATOR POTENTIAL

Ideal Indicators	Current Indicators
• Ridership (boardings and journeys, boardings by service type, historic ridership trend) • Transit mode share *These will assist future HRVA with assessing social inequity, and redundancy across all shock and stress groups.*	• Ridership (boardings and journeys, boardings by service type, historic ridership trend)

[116] Teale, C. (2019). Property values 'thrive' near transit, study finds. Smart Cities Dive.
[117] Sam Schwartz Consulting. (2020). Public Transit and COVID-19 Pandemic: Global Research and Best Practices. Commissioned by APTA.

RTS STRATEGY 1.5

Ensure the continued provision of coverage transit services in low-demand neighbourhoods

EVALUATION

	Robustness	Redundancy	Resourcefulness	Rapidity
Environmental Stresses and Shocks	Maintaining transit coverage in low demand areas will improve access in the case of many environmental shocks where vehicle use is impacted.			
Technology & Infrastructure Stresses and Shocks	Maintaining transit coverage in low demand areas will improve access in the case of a technology or infrastructure shocks.			
Sociopolitical & Economy Stresses and Shocks	Maintaining transit coverage in low demand areas will improve access to services, employment, and education for all travellers.			
Human Health Stresses and Shocks				

GENERAL RESILIENCE SUMMARY

This strategy is important towards decreasing the stress of social inequity by ensuring that accessibility to opportunities by non-vehicle modes exist for all parts of the region. Some benefit is also associated with provision of redundant mobility options in the face of an environmental, technology or infrastructure shock.

STRATEGY DISCUSSION AND RECOMMENDATIONS

Environmental Resilience	No strategy adjustments are suggested for this shock and stress group.
Technology & Infrastructure Resilience	No strategy adjustments are suggested for this shock and stress group.
Sociopolitical & Economy Resilience	The strategy could be more explicit in achieving certain sociopolitical outcomes, such as promoting social inclusion, ensuring transport options for an aging society and reducing housing and transport household costs through providing the ability to own fewer vehicles in lower-demand areas. • Investigate this strategy in more detail to define measures of success, and clarify the definition of how service is provided with respect to 'those with few mobility options'. • Pursue further study on opportunities for on-demand service in low-demand neighbourhoods, and also explore whether right-sizing transit for low-demand fixed-route services may be a solution. While low-demand neighbourhoods can continue to be serviced by TransLink (and CMBC), there may be methods for maintaining high-quality service while decreasing costs for providing such service in low-demand areas. This recommendation partly contributes to optimization, allowing for increased resilience through redundancy in a cost-effective manner.
Human Health Resilience	No strategy adjustments are suggested for this shock and stress group.

HRVA FRAMEWORK INDICATOR POTENTIAL

Ideal Indicators	Current Indicators
• Ridership by service hour • Ridership in low-demand neighbourhoods *These will assist future HRVA when assessing stresses of social inequity.*	*No directly relatable indicators from TransLink's Accountability Centre or Regional Trip Diary.*

RTS STRATEGY 2.1

Make travel safe and secure for all users

EVALUATION

	Robustness	Redundancy	Resourcefulness	Rapidity
Environmental Stresses and Shocks	Increased transportation safety (to environmental stresses and shocks) will improve the robustness of the transportation system.		This strategy includes improvement of response capabilities to various stresses and shocks.	This strategy includes improvement of response capabilities to various stresses and shocks.
Technology & Infrastructure Stresses and Shocks	This strategy contributes to technological robustness. Supporting laws, enforcement, skills, training and designs will improve road safety to most technological stresses and shocks.			
Sociopolitical & Economy Stresses and Shocks				
Human Health Stresses and Shocks	The strategy seeks to maintain a high degree of safety and security, contributing to improved physical and mental wellbeing.			

GENERAL RESILIENCE SUMMARY

The strategy aims to improve transportation safety and improves resilience from several perspectives.

- Although the strategy mentions preparedness for responding to natural disasters and other emergencies, the strategy could be more explicit about the types of emergency response capabilities that will be improved or developed.
- The strategy could be clearer by not only responding to an event, but also developing resources and capabilities to rapidly recover (stockpile of replacement parts, emergency funds, rapid mobilization for repairs to critical infrastructure, etc.).
- Response capabilities could also include responses to more gradual and slow-moving events such as an aging society, migration, public health concerns and others.

A risk and vulnerability analysis of critical assets and response capabilities would help identify more specific action to improve response and recovery capabilities. While this may largely result in capabilities for emergency response, there are aspects that overlap between general resilience and emergency preparedness. Response capabilities could include the development of response and recovery plans with various partners to identify communication channels and responsibilities. These would be developed specifically for the most likely or impactful stresses and shocks. The various partners could also participate in recovery drills, supplementing emergency response drills.

STRATEGY DISCUSSION AND RECOMMENDATIONS

Environmental Resilience	• Response capabilities should be expanded to provide the ability to respond to a broader set of potential shocks and stresses, while ensuring that response capabilities to the most likely and impactful natural hazards are sufficient. Response capabilities were not assessed as part of the project but are a key input to an HRVA.
Technology & Infrastructure Resilience	• The notion of response capability could include ability to respond to events related to cybersecurity. Cyber security is recommended to be specifically noted as there may be different response and strategy involved for facilitating cyber attack resilience compared to preparing for response to other shocks and stresses. • The term ‘emergencies’ could be expanded to clarify what type of shocks and stresses would be considered within this strategy.
Sociopolitical & Economy Resilience	• Response capability could be extended to include physical security or more gradual phenomena such as an aging population.
Human Health Resilience	• Response capability could be extended to include a response to public health stresses.

HRVA FRAMEWORK INDICATOR POTENTIAL

Ideal Indicators	Current Indicators
• Total road incidents • % of incidents where someone is killed or seriously injured (KSI) *These will assist future HRVA with consequences related to road incidents.*	*No directly relatable indicators from TransLink’s Accountability Centre or Regional Trip Diary.*

RTS STRATEGY 2.2

Make travel easy and attractive for all users

EVALUATION

	Robustness	Redundancy	Resourcefulness	Rapidity
Environmental Stresses and Shocks	This strategy contributes to withstanding some environmental shocks by way of offering protection from the elements.			
Technology & Infrastructure Stresses and Shocks	Improved travel information will increase the robustness of the transport system by providing users additional information on disruptions.			
Sociopolitical & Economy Stresses and Shocks	This strategy supports vulnerable travellers (aging population, immigrants) and decreases social inequities with high quality accessible service.			
Human Health Stresses and Shocks	Making travel easy and attractive can reduce stress and improve mental health.			

GENERAL RESILIENCE SUMMARY

This strategy provides some marginal gains towards resilience.

STRATEGY DISCUSSION AND RECOMMENDATIONS

Environmental Resilience	Providing protection from elements is an effective action for improving the ability to withstand environmental shocks. It is possible that this action could be expanded to clarify types of elements under consideration. Many applications could be undertaken based on anticipated shocks and stresses, and their severity. For example, many Canadian cities have covered transit stops that face away from the curb to block direct vehicle emissions and spray from the road. Meanwhile, there are many stops that have glass overhead, which may not be the best material for shocks such as heatwaves. • Providing protection could be more clearly defined.
Technology & Infrastructure Resilience	Congestion calculations are built into many applications such as Waze and Google Maps. Pairing critical transportation events with a traveller mobile applications and alerts will allow users to safely travel in the region, while minimizing congestion and further delays. • A region-wide wayfinding system and real-time travel information for all modes should be expanded as a digital option available for users to customize by selecting their area of interest, and to receive real-time updates. This system should allow personalized settings to be maintained for preferred modes, preferred routes, and other settings to allow optimized travel recommendations.
Sociopolitical & Economy Resilience	• Maximizing accessibility for people of all abilities will be critical for developing a transport system that works for an aging population.
Human Health Resilience	With the ongoing COVID-19 epidemic there has been significant decreased transit ridership around the world. However, even in large cities where transit usage has begun to recover, no outbreaks have been traced to taking transit.[118] • In the short-term, develop educational and awareness campaigns regarding COVID-19 associations with transit. In the long-term, develop early warning systems regarding the spread of any future infectious disease, and deploy appropriate tactics for ensuring safety across all modes, particularly those that support sustainable travel.

HRVA FRAMEWORK INDICATOR POTENTIAL

Ideal Indicators	Current Indicators
• Mode share • Trip rate • Average commute time • % of people living within walking distance of frequent transit • % of jobs within walking distance of frequent transit *These will assist future HRVA for consequence/severity for all shock and stress groups.*	• Mode share • Trip rate

[118] Sam Schwartz Consulting. (2020). Public Transit and COVID-19 Pandemic: Global Research and Best Practices. Commissioned by APTA.

RTS STRATEGY 2.3

EVALUATION

Optimize roads and transit for efficiency, safety and reliability

	Robustness	Redundancy	Resourcefulness	Rapidity
Environmental Stresses and Shocks	The use of various strategies to better manage the road and transit networks should increase the robustness of the system against most shocks and stresses within these types. Integrating Intelligent Transportation Systems (ITS) among other smart solutions will improve the robustness of a network in the case of a shock, but does not add redundancy or capacity.	Reallocating road space for walking and cycling, along with transit and goods movement priority will contribute to redundancy in the case of road closures caused by a shock. The safety focus can also improve physical safety and mental health.	It is unclear based on the actions in this strategy whether reallocated savings from optimizations would be used to improve resilience.	
Technology & Infrastructure Stresses and Shocks			Efficiency and optimization are typically pursued to reduce resource expenditures. However, if these optimizations are not carefully evaluated, 'efficiency' could lead to a reduction in staff, supplies, funds or other resources to intervene in the case of future shocks.	
Sociopolitical & Economy Stresses and Shocks				
Human Health Stresses and Shocks	Low-carbon vehicles will improve community health. Self-driving automobiles will have mental health benefits, though may lead to increased usage and result in less physical activity, exacerbating some chronic disease issues.			

GENERAL RESILIENCE SUMMARY

Optimization and efficiency often represent trade-offs to system reliability and resilience. Although both goals are worthwhile, these elements should be carefully balanced. However, efficiency and optimization with respect to day-to-day operations can lead to a reduction in staff, supplies, funds or other resources to respond to shocks and stresses, potentially impacting road and transit networks. Although key actions do not directly inhibit the amount of resources available, efficiency or optimization should be considered using medium- or long-term metrics since the transportation system is complex and adaptive (for example, see: Martin, 2020[119]). Careful analysis and post-implementation review are required to ensure that this does not inhibit the ability to intervene during various types of incidents. The ability to rapidly scale-up resource investment as required during shocks and/or stresses is another appropriate way to facilitate efficiency during normal operations.

Improving system reliability often includes maintaining a state of good repair and developing resources to address minor incidents. These actions should increase the robustness of the system.

STRATEGY DISCUSSION AND RECOMMENDATIONS

Environmental Resilience	• Improvements in reliability should incorporate resilience to shocks/stresses in addition to day-to-day disruptions. • Some savings from optimization of practices or efficiencies could be redirected towards improving resilience.
Technology & Infrastructure Resilience	The increased use of intelligent transportation systems to manage road and transit networks will increase the reliance on various online and cloud-based systems to manage the system and distribute information. Cybersecurity should be integral to the development of intelligent transportation systems. • It is recommended that increased focus be given to integrating Intelligent Transportation Systems (ITS) and other smart solutions with easily accessible real-time feeds for consumption via personal devices. • Strategies to mitigate a capacity loss on parallel links using intelligent transportation systems as a tool could be investigated in parallel with RTS Strategy 2.4.
Sociopolitical & Economy Resilience	No strategy adjustments are suggested for this shock and stress group.
Human Health Resilience	This strategy includes long-range high-level actions to explore opportunities for low-carbon vehicles as well as self-driving vehicles. Low-carbon vehicles will have a direct positive benefit to human health, as over 1/3rd of regional GHG emissions are currently from the transportation sector.[120] Automated vehicles are anticipated to significantly improve safety of roads, as human error contributes to roughly 94% of vehicle collisions, suggesting significant opportunity for improvement.[121] However, there is currently concern that autonomous travel will decrease walking and cycling, and contribute towards obesity and other chronic diseases associated with inactive travel.[122] • Continue to explore opportunities and undertake research to anticipate human health impacts from new vehicle technologies.

HRVA FRAMEWORK INDICATOR POTENTIAL

Ideal Indicators	Current Indicators
• Mode share • Vehicle Kilometres Travelled (VKT) by vehicle type • Vehicle Hours Travelled (VHT) • Vehicle Hours of Unreliability (VHU) for non-recurrent congestion • Condition of assets and systems (e.g., % 'uptime') *These will assist future HRVA with determining state of assets and potential severity.*	• Mode share • Vehicle Kilometres Travelled (VKT) by vehicle type

[119] Roger L. Martin (2020). When more is not better: overcoming America's obsession with economic efficiency. Harvard Business Review Press.
[120] Metro Vancouver. (2020). Metro 2040 Dashboard.
[121] NHTSA. (2019). Automated Vehicles for Safety.
[122] Dean, J., Wray, A., Braun, L. et al. (2019). Holding the keys to health? A scoping study of the population health impacts of automated vehicles.

RTS STRATEGY 2.4

Use integrated mobility pricing for fairness, efficiency and revenue

EVALUATION

	Robustness	Redundancy	Resourcefulness	Rapidity
Environmental Stresses and Shocks	Mobility pricing could decrease congestion and associated greenhouse gas emissions, lowering contributions to climate change and air pollution.	Mobility pricing can better distribute demand over time and across various modes. This would create (or be a tool to create) some residual capacity if a parallel corridor is impacted by an environmental shock/stress.	This strategy could generate some additional financial resources, although it is unclear whether these will be redeployed to resilience initiatives.	
Technology & Infrastructure Stresses and Shocks	Mobility pricing will increase reliance on new technology and administration to manage assets, making these assets more vulnerable to cybersecurity threats. However, on the whole, pricing will also facilitate better funding of transportation infrastructure and enable more robust equipment.	Integrated mobility pricing can better distribute demand over time and across various modes. This would create (or be a tool to create) some residual capacity if a parallel corridor is impacted by an industrial incident or transport incident.		Reduced peak traffic improves efficiency and consistency while potentially lowering cost of global supply chain through improved reliability.
Sociopolitical & Economy Stresses and Shocks	This strategy could lead to amplifying social inequities in the short term if not carefully implemented. However, it will improve ability to meet work-life proximity goals as outlined above.	Integrated mobility pricing can better distribute demand over time and across various modes. This would create (or be a tool to create) some residual capacity if a parallel corridor is impacted by a security incident.		
Human Health Stresses and Shocks				

GENERAL RESILIENCE SUMMARY

Depending on implementation of mobility pricing and associated regulation, this strategy could spread transportation demand across times-of-day and across network links. This will reduce demand on critical transportation links at peak times and better distribute demand across various modes of travel. If carefully implemented, this will increase the level of resilience through decongested corridors, and demand shifts could increase the level of robustness of some transportation assets.

Mobility pricing could be an effective tool to better distribute demand in cases of incidents (both minor and major) assuming dynamic pricing schemes are established. This also creates opportunity for improved rapidity, with increased capacity on the road.

Within existing actions, it is unclear whether revenue generated by mobility pricing could be used to fund various resilience initiatives. Further research on policy options is also recommended to ensure that any pricing scheme does not add to social inequity, or affordability issues in the region. Improving system reliability often includes state of good repair and developing resources to address minor incidents. These actions should increase the robustness of the system.

STRATEGY DISCUSSION AND RECOMMENDATIONS

Environmental Resilience	No strategy adjustments are suggested for this shock and stress group.
Technology & Infrastructure Resilience	Mobility pricing will increase the reliance on various online and cloud-based systems to manage payments and information. Strategies to mitigate a loss of capacity on a parallel link could include the use of mobility pricing as a tool (associated with RTS strategy 2.3). Cybersecurity is integral to the development of these systems to protect user privacy and protect the system from malicious threats. • Incorporate cyber security precautions into all future digital assets.
Sociopolitical & Economy Resilience	Careful thought should be given to the implementation and roll-out of these measures and their effects on different groups as these can sometimes uncover social unrest (e.g., Yellow Vest movement in France). • Further examine mobility pricing effects on social equity, fairness, and affordability beyond what was developed in the Mobility Pricing study.[123] This may include the role of caps and discounts, and the opportunities for returning and redistributing revenues. This affordability metric could be supplemented by using a combined cost/spending on housing and transportation for households in different portions of the region, an expansion on the housing and transportation cost burden study.[124]
Human Health Resilience	No strategy adjustments are suggested for this shock and stress group.

HRVA FRAMEWORK INDICATOR POTENTIAL

Ideal Indicators	Current Indicators
• Mode share • Travel cost (by geography, income bracket, by distance, by period) *These will assist future HRVA for social inequity considerations across demographics as it pertains to pricing interventions of the transport system.*	• Mode share

[123] Mobility Pricing Independent Commission. (2018). Metro Vancouver Mobility Pricing Study.
[124] Metro Vancouver. (2015). Metro Vancouver Housing and Transportation Cost Burden Study.

RTS STRATEGY 2.5

Manage parking for fairness, efficiency and revenue

EVALUATION

	Robustness	Redundancy	Resourcefulness	Rapidity
Environmental Stresses and Shocks	Effectively managing and pricing vehicle parking across the region could result in fewer vehicle trips, decreasing emissions and contributions to greenhouse gases, climate change, and air pollution.		Reducing parking capacity could result in decreased staging area for response to shocks (e.g. field camps, helicopter loading zones). However, park space can potentially fill this gap.	
Technology & Infrastructure Stresses and Shocks				
Sociopolitical & Economy Stresses and Shocks				
Human Health Stresses and Shocks				

GENERAL RESILIENCE SUMMARY

Better managing parking has many 2nd and 3rd order effects on resilience by favouring non-auto modes of travel, better allocating space, and better use of resources. This strategy has a limited direct effect on overall resilience of the transportation system in terms of shocks and stresses. Policy direction could be given to the use of land that would be made available through a better management of parking such as pursuing environmental or housing affordability goals. By working with municipalities to manage parking, additional revenues can be anticipated. Some of these additional revenues could be directed towards funding various transportation resilience-related initiatives, such as installing sufficient bicycle parking in UC/FTDAs.

Reducing surface parking lots across the region could result in decreased staging area capacity in the event of a shock. However, recognizing that shocks do not discriminate on location, it is recommended to not maintain parking space solely for this purpose, and instead use parks, or block off specific streets in staging areas for hazard response.

STRATEGY DISCUSSION AND RECOMMENDATIONS

Environmental Resilience	The land dedicated to parking is substantial in Metro Vancouver and various pricing and sharing strategies will likely reduce the need for parking. • Some land currently used as parking areas could be repurposed to achieve various initiatives such as localized flood control or food supply initiatives, while recognizing that this is mostly the responsibility of municipalities and private landholders.
Technology & Infrastructure Resilience	No strategy adjustments are suggested for this shock and stress group.
Sociopolitical & Economy Resilience	• Some land currently dedicated to parking could be further dedicated for additional housing to help alleviate pressure on housing affordability. • Continue to support municipalities in reducing parking minimums (and/or charging for parking spaces separately from the cost of a unit) which can make housing more affordable by require less land for parking and require fewer high-cost parking structures.
Human Health Resilience	No strategy adjustments are suggested for this shock and stress group.

HRVA FRAMEWORK INDICATOR POTENTIAL

Ideal Indicators	Current Indicators
• Parking occupancy rates (location, time of day) • Parking demand (location, time of day) • Curbside supply *These will assist future HRVA for air pollution, and for determining how parking supply and policy influences mode share.*	*No directly relatable indicators from TransLink's Accountability Centre or Regional Trip Diary.*

RTS STRATEGY 3.1

Support regional land use objectives

EVALUATION

	Robustness	Redundancy	Resourcefulness	Rapidity
Environmental Stresses and Shocks	Implementing transport-related actions in the RGS, including connecting UC/FTDAs will result in increased resilience to environmental shocks with more travel options.		Focusing growth in UC/FTDAs will reduce resources needed for maintaining and operating the transport system. These 'savings' could be redeployed towards resilience initiatives.	Investing in UC/FTDAs will result in meeting priorities in a timely fashion to contain losses against future climate change and associated impacts.
Technology & Infrastructure Stresses and Shocks	Concentrating growth in UC/FTDAs will improve general resilience to technological stresses/shocks, but if infrastructure failure or power outages occur in these nodes, the result will be more severe.			
Sociopolitical & Economy Stresses and Shocks	Generally, supporting regional land use objectives will contribute to affordability, immigration support, unemployment, amongst other sociopolitical stresses through focusing growth in UC/FTDAs. However, left to market forces, housing affordability could decrease with this focus.	Focusing growth will allow for improved redundancy when facing sociopolitical stresses. UC/FTDAs have a higher density of amenities and are generally associated with walkable neighborhoods, resulting in improved access for older adults.		
Human Health Stresses and Shocks	Supporting regional land use objectives will lead to mental health and chronic disease benefits through access to services/amenities, access to nature, and safe and accessible travel options.			

Note: the RGS content evaluation is evaluated in the first half of **Appendix C**; its content is not entirely reflected within this specific assessment.

GENERAL RESILIENCE SUMMARY

Further integrating transport and land use can help better achieve some common goals surrounding resilience of the region. That said, the combination of the RTS and RGS are aimed towards creating a more compact and dense urban form with shorter trip distances and increased use of sustainable modes. These combined goals will increase the level of redundancy through the creation of more amenities and services close to people and creating more redundancy in the overall transportation network through increased road density (e.g. in downtown Vancouver). This dense land use also improves sociopolitical robustness with increased services nearby for many stresses (e.g. aging population, unemployment, affordability).

This concentration of built form will increase exposure should a shock occur near or within these dense areas. There will be a greater reliance on public transport infrastructure (e.g. SkyTrain), increasing the need for ongoing robustness and efficient response to shocks that may impact the transport network.

STRATEGY DISCUSSION AND RECOMMENDATIONS

Environmental Resilience	• This strategy could be more explicit in achieving some environmental goals contained in the RGS, such as ensuring that development of the transport network would not foster urban development in environmentally sensitive areas or agricultural lands, therefore alleviating future pressures to modify the urban containment boundary limits.
Technology & Infrastructure Resilience	In order to accommodate growth in UC/FTDAs, further measures are required to improve robustness of transport infrastructure to withstand the pressures of a shock. Infrastructure failure of a section of a SkyTrain line could leave many people without travel options. • Incorporate within this strategy a focus on emergency preparedness, and increased resilience, to ensure that travellers still have options in the case of a critical failure to transport infrastructure near or within UC/FTDAs.
Sociopolitical & Economy Resilience	Addressing the needs of an aging population, housing affordability and social equity require an integrated approach to decision-making involving many governmental and social society organizations. For example, prioritizing active transport and transit projects improving access to areas with significant housing potential could help increase affordability, especially if using a combined transport-housing spending metric, building from the housing and transportation cost burden study.[125] While transit-oriented communities are associated with fewer costs (due to less need to own and operate a vehicle for mobility), there is generally a correlation between transit improvements and increased value of adjacent real estate.[126] • This strategy could be more explicit with regards to better coordinating transportation and land use towards addressing some sociopolitical challenges.
Human Health Resilience	The Regional Growth Strategy provides a number of strategies and actions that can support improved mental health and chronic disease. Strategy 3.1 and 3.2 protect and enhance natural features, and conservation and recreation lands which can benefit mental health. Strategy 4.1 and 4.2 seek to provide more affordable housing and complete communities, improving access to opportunities while decreasing financial stress that can have negative contributions to mental health. Strategy 5.1 and 5.2 encourage sustainable modes of travel and seek to improve safety and efficiency of the transportation network, which also have mental health benefits. No strategy adjustments are suggested for this shock and stress group

HRVA FRAMEWORK INDICATOR POTENTIAL

Ideal Indicators	Current Indicators
• Mode share • Fleet GHG Emissions • Vehicle kilometres travelled • % of people living within walking distance of frequent transit • % of jobs within walking distance of frequent transit *These will assist future HRVA with proximity to services, different travel options, and length of travel in the region.*	• Mode share • Fleet GHG Emissions • Vehicle kilometres travelled

[125] Metro Vancouver. (2015). Metro Vancouver Housing and Transportation Cost Burden Study.
[126] Teale, C. (2019). Property values 'thrive' near transit, study finds. Smart Cities Dive.

RTS STRATEGY 3.2

Ensure effective coordination through strong partnerships

EVALUATION

	Robustness	Redundancy	Resourcefulness	Rapidity
Environmental Stresses and Shocks			Improved partnerships will increase resilience by creating additional coordination and information sharing channels within the region, both formal and informal. The strategy could be improved through specifically fostering partnerships aimed at resilience.	Convening and facilitating regional dialogues through stakeholder forums and advisory committees will lead to improved response and efficiency in the case of a stress or shock.
Technology & Infrastructure Stresses and Shocks		Actions ensure a skilled and qualified labour force is available to support the transportation system, which contributes to technological redundancy, and maintains ongoing functioning.		
Sociopolitical & Economy Stresses and Shocks	Ensuring that a skilled labour force is available will decrease the risk of skills shortage due to an aging population, and aid with unemployment stresses in the region.			
Human Health Stresses and Shocks				

GENERAL RESILIENCE SUMMARY

Fostering and improving partnerships will improve information-sharing, coordination and communication between public, civil society and private organisms. Whether these partnerships are formal or informal in nature, there will be a greater ability to communicate, share information and coordinate together. Even partnerships that have little to do with resilience create collaboration channels that can be useful to respond to some shocks and stresses, whether this is at the regional, provincial or national scale.

That said, this strategy could be improved by explicitly pursuing resilience as a goal for some of these partnerships or even creating specific partnerships to better coordinate responses to stresses and shocks. Collaboration channels could be established and organized around specific shocks and stresses, such as an aging society, cyber security or others, supplementing emergency coordination capacities. These channels could help plan to avoid, mitigate and intervene for specific events and ensure that these are not only focused on emergency response.

This strategy could expand to encourage a sense of rapidity towards meeting objectives and priorities by way of acting as a convenor and facilitator for all shock and stress groups.

This strategy could be expanded for hazards that require provincial, national and international coordination and information sharing, for early intervention opportunities, and clarity on roles and responsibilities in the face of a hazard event.

STRATEGY DISCUSSION AND RECOMMENDATIONS

Environmental Resilience	No strategy adjustments are suggested for this shock and stress group.
Technology & Infrastructure Resilience	No strategy adjustments are suggested for this shock and stress group.
Sociopolitical & Economy Resilience	No strategy adjustments are suggested for this shock and stress group.
Human Health Resilience	No strategy adjustments are suggested for this shock and stress group.

HRVA FRAMEWORK INDICATOR POTENTIAL

Ideal Indicators	Current Indicators
The desired outcomes of partnerships are very difficult to effectively monitor, especially in the case of resilience. That said, their number and the level of collaboration can be tracked, although these are not necessarily indicative of a potential outcome.	*No directly relatable indicators from TransLink's Accountability Centre or Regional Trip Diary.*

RTS STRATEGY 3.3

Establish funding that is stable, sufficient, appropriate and influences travel choices

EVALUATION

	Robustness	Redundancy	Resourcefulness	Rapidity
Environmental Stresses and Shocks	Stable and predictable long-term funding allows for a robust transportation network that will improve the withstanding of shock and stress impacts across all types.	Development of funding sources beyond traditional sources will add a level of redundancy to funding, although it may make the agency more vulnerable to economic shocks (as has been the case with some American transit agencies).	The establishment of stable funding is an opportunity to fund resilience initiatives, and establish a capital reserve for post-event recovery, although it is unclear to what extent this could or would be done.	
Technology & Infrastructure Stresses and Shocks				
Sociopolitical & Economy Stresses and Shocks				
Human Health Stresses and Shocks				

GENERAL RESILIENCE SUMMARY

Funding is an essential element to implement the strategies presented elsewhere in the RTS. Funding could be used to develop resilience capabilities, beyond operations, state of good repair and network development that are presented elsewhere in the RTS. Initiatives could include funding resilience-capability building, resilience initiatives, or establishing reserve funds that can be used to intervene after an event. These could apply to all shock and stress groups.

Additional funding sources will add robustness and resourcefulness to funding various initiatives. That said, the final mix of funding sources could expose TransLink and its partners to stresses and shocks, especially to economic downturns or changes in the economic structure of the region. Other related stresses and shocks can be associated or amplified by an economic downturn (e.g., political disruption). Some of these stresses and shocks would increase costs or decrease transit demand (which also increases the pressure on costs), at a time when funding levels are reduced. Many strategies can be pursued to alleviate this risk through a mix of funding sources, gradually replenishing reserve funds or ensuring continued access to credit during a downturn.

Increased use of transit generally increases the absolute cost (though not proportional or per-capita cost) of operations funding for transportation services. Reductions in operational funds would be felt more immediately if transit service is reduced than on active or auto modes where maintenance can be deferred with an effect that may only be felt years later, rather than immediately. In other words, reductions in funding would have a more immediate effect on transit users than an equivalent system more reliant on active or auto mode and highlights the need for stable and sufficient funding.

STRATEGY DISCUSSION AND RECOMMENDATIONS

Environmental Resilience	No strategy adjustments are suggested for this shock and stress group.
Technology & Infrastructure Resilience	No strategy adjustments are suggested for this shock and stress group.
Sociopolitical & Economy Resilience	Increasing the costs of travel may further exacerbate the affordability stress in the region. If TransLink seeks to pursue a significant change to how funding is secured in the region (e.g., through mobility pricing or other user-pay systems), there should be a significant focus on providing transit and active transportation systems that are affordable to not impact ability to travel in the region. No strategy adjustments are suggested for this shock and stress group.
Human Health Resilience	While transit revenues are an important revenue source, there are vulnerabilities to this source as seen with the recent COVID-19 pandemic.[127] With decreased ridership, anticipated revenue also decreases. • Explore a more diverse set of funding sources for stability during times of unprecedented ridership declines.

HRVA FRAMEWORK INDICATOR POTENTIAL

Ideal Indicators	Current Indicators
The availability of long-term funding for projects and operations should be tracked in addition to annual budgets and annual reports.	*No directly relatable indicators from TransLink's Accountability Centre or Regional Trip Diary.*

[127] TransLink. (2013). RTS Backgrounder #10: Transportation Funding.

RTS STRATEGY 3.4

Monitor progress towards our desired outcomes

EVALUATION

	Robustness	Redundancy	Resourcefulness	Rapidity
Environmental Stresses and Shocks			Monitoring progress will improve the ability to intervene by improving knowledge and information. That said, the effect would be significantly improved by incorporating resilience as part of the monitoring.	
Technology & Infrastructure Stresses and Shocks				
Sociopolitical & Economy Stresses and Shocks				
Human Health Stresses and Shocks				

GENERAL RESILIENCE SUMMARY

Monitoring implementation and outcomes are integral to the success of any strategy to better direct resources and interventions. This strategy could be improved by also monitoring and evaluating resilience as one of the desired outcomes. This could include:

- Establishing resilience baseline conditions for critical assets and conditions, including the development of resilience metrics
- Monitoring various shocks/stresses, their risks, and their likelihood of occurrence
- Monitoring risks and vulnerabilities of critical assets and systems to various shocks and stresses
- Monitoring and evaluating intervention capabilities on a regular basis (emergency, financial capabilities, interagency collaboration, information-sharing networks, etc.)

A mandatory post-event review process could be instituted after regionally significant events (flooding, earthquakes, security incidents, economic downturn, major industrial incident, etc.). These reviews could assess the response and recommend various improvements. Implicated partners would depend on the type of event and should involve opportunities for public participation. Reviews of smaller-scale events should not be neglected since “minor” problems could become significant during a major event. The focus of these reviews would be to identify areas for improvement and developing increased public confidence in agencies over time. Consideration could be given to having an independent body lead the review for very significant events, possibly modelled on the Transportation Safety Board or similar organisations, or could be created on an ad-hoc basis.

For stresses, it is recommended to develop ongoing reporting using a set of agreed-upon indicators, and tracking regionally significant investments over time to determine whether impacts are exacerbated or decreased.

STRATEGY DISCUSSION AND RECOMMENDATIONS

Environmental Resilience	Beyond the notes provided in the General Resilience row, no strategy adjustments are suggested for this shock and stress group.
Technology & Infrastructure Resilience	Beyond the notes provided in the General Resilience row, no strategy adjustments are suggested for this shock and stress group.
Sociopolitical & Economy Resilience	Beyond the notes provided in the General Resilience row, no strategy adjustments are suggested for this shock and stress group.
Human Health Resilience	Beyond the notes provided in the General Resilience row, no strategy adjustments are suggested for this shock and stress group.

HRVA FRAMEWORK INDICATOR POTENTIAL

Ideal Indicators	Current Indicators
• Mode share • Fleet GHG Emissions • Vehicle kilometres travelled • Trip rates • Vehicle hours of unreliability • Vehicle hours travelled • Condition of critical assets and systems *These will assist future HRVA with determining amount of travel exposure, along with better understanding of the condition of transportation infrastructure.*	• Mode share • Fleet GHG Emissions • Vehicle kilometres travelled • Trip rates

APPENDIX D – EXTERNAL REVIEW SUMMARY

As part of this project, an external review was undertaken with local resilience and hazard-specific experts. The reviewers provided comments on adjustments to the resilience framework, and considerations for subsequent evaluations and assessments at a regional level. These comments are summarized below by theme.

FRAMEWORK AND STRATEGY ASSESSMENT OPPORTUNITES

- There are many stresses and shocks that could exist in Metro Vancouver. It's recommended to review this list on an ongoing basis, with potential to include the following stresses/shocks in future iterations:
    - Drought and extreme heat
    - Trust in government and institutions
    - Opioid crisis
    - Water contamination
    - Species collapse
- There are many resilience attributes that could be included for future assessments. Consider adding Reflective, Insightful, Integrated, Inclusive/Equitable, Flexible/Adaptable, and Cost-Benefit/Feasible to future assessments.
- Consider dividing the initial framework and treat stresses and shocks separately in future analysis.
- There are other mediums through which to assess strategy that could be considered and how different strategies relate to the 4R (robustness, redundancy, resourcefulness, rapidity). These include the following:
    - Chronic/cumulative vs sudden/onset
    - Point/asset failure vs. system-wide disruption source
    - Physical system failure vs operational disruption vs institutional disruption
    - Hazard source external vs internal to Metro Vancouver and TransLink's systems
- Align the "regional significance" definition with that from IPREM's Metro Vancouver Regional Emergency Advisory Group which is "a major event that has (or has the potential to have) an extraordinary level of risk to lives, property, environment, social and/or economic well being across jurisdictional boundaries in the region, which could require one or more of the following: non-routine levels of coordination, sharing of situational awareness information, joint decision making, prioritizing resources, allocating resources, or response by multiple stakeholders (agencies and jurisdictions).

OPPORTUNITIES FOR INTEGRATION AND EXPANSION

- One of the largest gaps to improving resilience is the lack of clear funding and investment opportunities. Developing a clear investment and financing framework at a regional level would allow for more progress in disaster risk reduction, and the development of resilient systems and infrastructure.
- The existing governance model in the region does not allow for achieving resilience. Systems and frameworks are outdated, leading to disaster risk and increased vulnerability. Regional leaders can act as facilitators to lead regional decision-making around shock and stress resilience, particularly when it comes to discussing trade-offs that exist.

APPENDIX E – GLOSSARY OF TERMS

The following terms have been compiled from a range of resources. Some terms have been adjusted to be specific to this project. Terms are listed alphabetically.

- **Absorptive Capacity**: the ability of the transportation system to absorb shocks and stresses and maintain normal functioning. This capacity can be increased by hardening assets or reducing exposure to risk.
- **Adaptive Capacity**: The ability of the system to change in response to shocks and stresses to maintain normal functioning. One commonly used set of measures involves the availability of alternate routes and alternative mode choices.
- **(Infrastructure) Asset**: Infrastructure assets means physical assets, structures or facilities, systems and networks that provide or support essential public services.
- **Cascading Effect:** A chain of events that occur and affect a system. The impact of a physical event or the development of an initial failure generates a sequence of events that result in additional disruption.
- **Emergency Management**: managerial function charged with creating the framework within which communities reduce vulnerability to stresses and shocks, and cope with disasters.
- **Equitable Access**: The ability of the system to provide the opportunity for access across the entire community during a shock or stress and when the system is undisrupted.
- **Exposure**: People, property, systems, or other elements present in hazard zones that are thereby subject to potential losses.
- **Flexible**: Flexibility implies that systems can change, evolve and adapt in response to changing circumstances. This may favour decentralised and modular approaches to infrastructure or ecosystem management. Flexibility can be achieved through the introduction of new knowledge and technologies, as needed. It also means considering and incorporating indigenous or traditional knowledge and practices in new ways.
- **Green Infrastructure:** Green infrastructure is the natural, enhanced, and engineered assets that collectively provide society with ecosystem services required for healthy living. *(Metro Vancouver definition)*
- **Hazard**: A dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage.
- **Hazard, Risk and Vulnerability Analysis**: An HRVA is a process to identify hazards that have a likelihood to cause an emergency or disaster. It also assesses consequences should the emergency or disaster occur.
- **Inclusive**: Inclusion emphasises the need for broad consultation and engagement of communities, including the most vulnerable groups. Addressing the shocks or stresses faced by one sector, location, or community in isolation of others is an anathema to the notion of resilience. An inclusive approach contributes to a sense of shared ownership or a joint vision to build city resilience.
- **Indicator**: A measurable value or trend that demonstrates the effectiveness of a strategy or set of actions over time.
- **Interdependency**: The dependence of two or more things on each other. More specifically, the direct and indirect effect on other infrastructure when one infrastructure is impacted or disrupted.
- **Integrated**: Integration and alignment between city systems promotes consistency in decision-making and ensures that all investments are mutually supportive to a common outcome. Integration is evident within and between resilient systems, and across different scales of their operation. Exchange of information between systems enables them to function collectively and respond rapidly through shorter feedback loops throughout the city.
- **Natural Hazard**: all atmospheric, hydrologic, geologic, and wildfire phenomena that, because of their location, severity, and frequency, have the potential to affect humans, their structures, or their activities.
- **Preparedness**: The knowledge and capacities developed by governments, professional response and recovery organizations, communities and individuals to effectively anticipate, respond to, and recover from, the impacts of likely, imminent or current hazard events or conditions.
- **Prevention**: The outright avoidance of adverse impacts of stresses and shocks, and related disasters.
- **Rapidity**: The capacity to meet priorities and achieve goals in a timely manner in order to contain losses and avoid future disruption.

- **Recovery**: The restoration, and improvement where appropriate, of facilities, livelihoods and living conditions of disaster-affected communities, including efforts to reduce disaster risk factors.
- **Redundancy**: the extent to which elements, systems, or other units of analysis exist that are substitutable, i.e., capable of satisfying functional requirements in the event of disruption, degradation, or loss of functionality.
- **Reflective:** Reflective systems are accepting of the inherent and ever-increasing uncertainty and change in today's world. They have mechanisms to continuously evolve, and will modify standards or norms based on emerging evidence, rather than seeking permanent solutions based on the status quo. As a result, people and institutions examine and systematically learn from their past experiences, and leverage this learning to inform future decision-making.
- **Regional Resilience:** the capacity of regional communities and organizations to prepare, avoid, absorb, recover and adapt to the effects of shocks and stresses in an efficient manner through the preservation, restoration, and adaptation of essential services and functions, while learning from shocks and stresses to build back better.
- **Resourcefulness**: the capacity to identify problems, establish priorities, and mobilize resources when conditions exist that threaten to disrupt some element, system, or other unit of analysis; resourcefulness can be further conceptualized as consisting of the ability to apply material (i.e., monetary, physical, technological, and informational) and human resources to meet established priorities and achieve goals.
- **Response**: The provision of emergency services and public assistance during or immediately after a disaster in order to save lives, reduce health impacts, ensure public safety and meet the basic subsistence needs of the people affected.
- **Restorative Capacity**: The ability of the system to recover quickly after a shock or stress to normal functioning. This capacity can be increased by establishing disaster response plans and quick-response capabilities.
- **Risk**: The combination of the probability of the stress/shock, and its negative consequences.
- **Robustness**: strength, or the ability of elements, systems, and other units of analysis to withstand a given level of stress or demand without suffering degradation or loss of function.
- **Safe to Fail Infrastructure**: theory that anticipates failure of infrastructure and strategically designs a system to minimize and contain the failure.
- **Shock:** Shocks are sudden events such as earthquakes, floods, or cyber attacks.
- **State of Repair:** The physical condition of infrastructure or an asset.
- **Stress**: Stresses are chronic conditions that weaken a system on an ongoing or recurring basis, such as social inequity, and affordability.
- **System**: Essential services, infrastructure, and operations working together to support societal functions.
- **Vulnerability:** The characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a stress/shock.

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SERVICES AND SOLUTIONS FOR A LIVABLE REGION

To: Regional Planning Committee

From: Heather, McNell, General Manager, Regional Planning and Housing Services

Date: April 27, 2021 Meeting Date: May 7, 2021

Subject: **Manager's Report**

RECOMMENDATION

That the Regional Planning Committee receive for information the report dated April 27, 2021, titled "Manager's Report".

REGIONAL PLANNING COMMITTEE 2021 WORK PLAN

The Regional Planning Committee's Work Plan for 2021 is attached to this report (Attachment). The status of work program elements is indicated as pending, in progress, ongoing or complete. The listing is updated as needed to include new issues that arise, items requested by the Committee, and changes to the schedule.

Attachment

Regional Planning Committee 2021 Work Plan

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Regional Planning Committee 2021 Work Plan

Report Date: April 27, 2021

Priorities

1st Quarter	**Status**
Metro 2050 Implementation Policy Recommendations	Complete
Metro 2050 Climate Change Policy Review Recommendations	Complete
Hey Neighbour Discussion Paper	Complete
Social Equity in Regional Planning – Phase II	Complete
Metro 2050 draft policies – Goal 1	Complete
Metro 2050 draft policies – Goal 2	Complete
Metro 2050 draft policies – Implementation Section	Complete
Housing and Transportation Cost Burden Study – Scope	Pending
Regional Agricultural Land Use Inventory - Scope	Pending
2nd Quarter	
Projections for Population, Housing and Employment (Data Projections)	In Progress
Metro 2050 draft policies – Goal 3 (Includes Climate Research and SEI)	Complete
Metro 2050 draft policies – Goal 4	In Progress
Metro 2050 draft policies – Goal 5	In Progress
Regional Industrial Lands 2020 Inventory	Complete
Regional Industrial Land Implementation Tools - Scope	Pending
Ecosystem Services from Agricultural Land – Scope	Pending
Regional Land Use Assessment – Implementation Tools – Scope	Pending
3rd Quarter	
Draft Metro 2050 Refer for Comment	Pending
Where Matters Phase II - Update	Pending
Land Use Model Preparation – Land Use Component – Report Out	Pending
Data/Projections Validation – Report Out	Pending
Land Use Model - Scope	Pending
Regional Agricultural Land Use Inventory – Update	Pending
4th Quarter	
Ecosystem Services from Agricultural Land – Report Out	Pending
Housing and Transportation Cost Burden Study - Report Out	Pending
Regional Land Use Assessment –Update	Pending
Regional Agricultural Land Use Inventory – Report Out	Pending
Land Use Model – Report Out	Pending
Regional Industrial Land Implementation Tools – Update and Report Out	Pending
Metro 2050 – Update on Comment Period	Pending

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SERVICES AND SOLUTIONS FOR A LIVABLE REGION

To: Climate Action Committee

From: Laurie Bates-Frymel, Senior Planner, Regional Planning and Housing Services Department

Date: March 22, 2021 Meeting Date: April 16, 2021

Subject: **Best Management Practices for Invasive Species: Hedge Bindweed and American Bullfrog**

RECOMMENDATION

That the MVRD Board:

a) receive for information the report dated March 22, 2021, titled "Best Management Practices for Invasive Species: Hedge Bindweed and American Bullfrog"; and
b) direct staff to forward the Best Management Practices and suite of seventeen invasive species fact sheets to member jurisdictions for information.

EXECUTIVE SUMMARY

Building on an existing library of technical guidance for fifteen priority invasive species, Metro Vancouver has again worked with the Invasive Species Council of Metro Vancouver, member jurisdictions and other local experts to produce a new set of best management practices – this time for hedge bindweed (also known as morning glory) and American bullfrog. These documents provide information for practitioners about how to identify, track, report, dispose, prevent further spread, and effectively control these species, as well as regulatory requirements, monitoring and restoration tips, references and additional resources. Each guide also describes how these invasive species may adapt as our climate changes.

In addition, seventeen new fact sheets (one for each priority invasive species) have been created in collaboration with staff from the Invasive Species Council of Metro Vancouver, UBC Botanical Garden, and member jurisdictions. These public-friendly fact sheets provide general information on each species.

PURPOSE

To provide the Climate Action Committee and the MVRD Board with two new invasive species best management practices documents and a suite of seventeen new fact sheets for information.

BACKGROUND

In 2018, 2019, and 2020, the Climate Action Committee received reports regarding best management practices for 15 invasive species: knotweed species, giant hogweed, European fire ant, European chafer beetle, Himalayan blackberry, Scotch broom, English holly, English and Irish ivies, yellow archangel, Himalayan balsam, parrot's feather, purple loosestrife, reed canarygrass, wild chervil, and yellow flag iris. This report presents best management practices for two additional priority invasive species identified by the Regional Planning Advisory Committee (RPAC) – Invasive Species Subcommittee.

THE NEED FOR AND DEVELOPMENT OF REGIONAL BEST MANAGEMENT PRACTICES

Invasive species are non-native flora or fauna that out-compete native species and can be highly destructive and difficult to control. They can threaten property and recreational values, infrastructure, agriculture, public health and safety, as well as ecological health.

In 2016, the RPAC-Invasive Species Subcommittee requested the development of regionally-appropriate best management practices for priority invasive species. In October 2018, the MVRD Board adopted the *Ecological Health Framework*, which illustrates Metro Vancouver's role in protecting and enhancing ecological health as it relates to its services and functions, and supporting regional efforts. The *Framework* commits Metro Vancouver to "develop and employ best practices in the management of invasive species on Metro Vancouver lands and promote their use region-wide".

Metro Vancouver retained the Invasive Species Council of Metro Vancouver (ISCMV) to create the best management practice documents. The target audiences are local government staff, crews, project managers, contractors, consultants, developers, stewardship groups, and others who have a role in invasive species management. The best management practices include technical guidance about identification, tracking, reporting, effective prevention and control strategies, regulatory requirements, disposal, monitoring and restoration, as well as references and additional resources. The recommendations were informed by the best available scientific expertise and local experience.

OVERVIEW OF LATEST BEST MANAGEMENT PRACTICES

The best management practices for hedge bindweed (Reference 1) and American bullfrog (Reference 2) have been reviewed by members of the RPAC-Invasive Species Subcommittee and additional local experts. An overview of each document is provided below.

Hedge Bindweed

Also known as morning glory, hedge bindweed is a persistent plant that spreads by underground stems and roots that can re-sprout from fragments left in the soil. It can twist around other plants and structures, often forming a tangled mass that overwhelms gardens, weighing down branches or stems of other plants, and sometimes causing breakage.

Manual control is recommended, carefully removing new seedlings by hand from other plants and structures, while also digging up all underground stems and roots. Effective hedge bindweed control will likely involve several years of ongoing monitoring and removal.

American Bullfrog

Native to eastern North America, the robust American bullfrog was first introduced as a delicacy for human consumption, but they escaped or were released, and subsequently spread, including into several wetlands across Metro Vancouver. Bullfrogs are voracious predators that consume a variety of prey, including smaller native and some endangered frog species. They can also spread deadly viruses and funguses to other amphibians, and damage wetland habitats and water supply infrastructure.

Control methods include egg mass removal (late May to early September), or capturing tadpoles or adults with dip nets or by hand with subsequent humane euthanasia. The elimination of American

bullfrogs from this region is likely impossible, so efforts should be focused on preventing further spread and improving habitat for native species.

Climate Adaptation
This set of best management practice documents features a section on 'Climate Adaptation' that describes how these species may adapt as our climate changes based on their ability to withstand warmer temperatures, summer drought, warmer wetter winters, and an extended growing season. All of the existing best management practices will be updated to include a Climate Adaptation section over the coming months.

FACT SHEETS AND NEXT STEPS
In 2020, the RPAC-Invasive Species Subcommittee requested the creation of one-page plain language fact sheets to help share the best practice guidance beyond practitioners. Seventeen fact sheets - featuring information on impacts, identification, prevention, recommended control options, and tips for how residents can help - have been produced, one for each of the 15 previous priority species (References 5-19), as well as the two latest that are the subject of this report (References 3 and 4). These resources have been posted on Metro Vancouver's Invasive Species webpage. To increase awareness of the new best practices and suite of fact sheets, staff recommends circulation to member jurisdictions, as per Alternative 1.

ALTERNATIVES
1. That the MVRD Board:
   a) receive for information the report dated March 22, 2021, titled "Best Management Practices for Invasive Species: Hedge Bindweed and American Bullfrog"; and
   b) direct staff to forward the Best Management Practices and suite of seventeen invasive species fact sheets to member jurisdictions for information.

2. That the Climate Action Committee receive for information the report dated March 22, 2021, titled "Best Management Practices for Invasive Species: Hedge Bindweed and American Bullfrog", and provide alternate direction to staff.

FINANCIAL IMPLICATIONS
The 2020 MVRD Board-approved Regional Planning budget included $10,000 for best management practices presented in this report.

CONCLUSION
Best management practices have been compiled for two additional invasive species found within the Metro Vancouver region: Hedge bindweed and American bullfrog. These documents provide locally-tested technical guidance about identification, tracking, reporting, climate adaptation, effective prevention and control strategies, regulatory requirements, disposal, monitoring and restoration, as well as references and additional resources. A set of one-page fact sheets has also been created to increase public awareness of the seventeen priority invasive species. Staff recommend Alternative 1, that the Board receive these documents for information, and direct staff to forward them to member jurisdictions.

References

1. Best Management Practices for American Bullfrog in the Metro Vancouver Region - March 2021
2. Best Management Practices for Hedge Bindweed in the Metro Vancouver Region - March 2021
3. American Bullfrog Fact Sheet - March 2021
4. Hedge Bindweed Fact Sheet - March 2021
5. English and Irish Ivies Fact Sheet - December 2020
6. English Holly Fact Sheet - December 2020
7. European Chafer Beetle Fact Sheet - December 2020
8. European Fire Ants Fact Sheet - December 2020
9. Giant Hogweed Fact Sheet - December 2020
10. Himalayan Balsam Fact Sheet - December 2020
11. Himalayan Blackberry Fact Sheet - December 2020
12. Knotweeds Fact Sheet - December 2020
13. Parrots Feather Fact Sheet - December 2020
14. Purple Loosestrife Fact Sheet - December 2020
15. Reed Canarygrass Fact Sheet - December 2020
16. Scotch Broom Fact Sheet - December 2020
17. Wild Chervil Fact Sheet - December 2020
18. Yellow Archangel - December 2020
19. Yellow Flag Iris Fact Sheet - December 2020

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