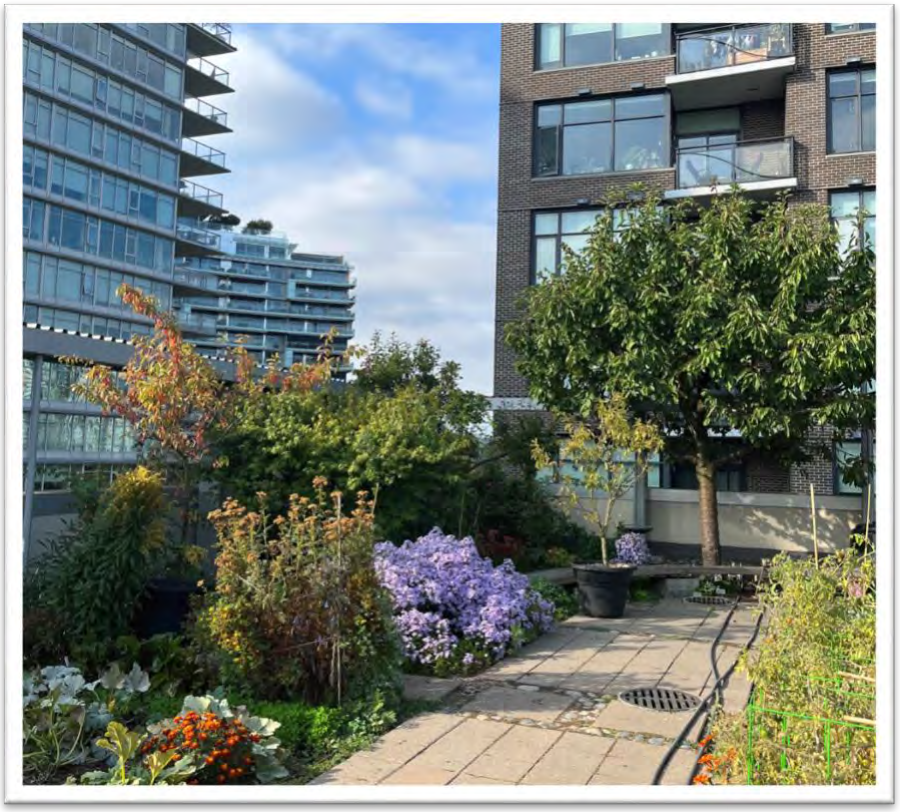
Workshop #2 Engagement Summary



Workshop #2a: Barriers and Solutions for Green Roofs

Engagement Summary

City of Vancouver, Green Rainwater Infrastructure (GRI) Pathways Study

Prepared by: MODUS Planning, Design & Engagement Inc.

Version: 2
Date: Nov 3, 2022 (revised February 23, 2024)

MODUS

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1 About the Project

The City of Vancouver and surrounding region was once covered by a temperate rainforest, which allowed for water to be managed naturally and the water cycle to function normally. Over time, the natural watersheds have been altered. As development of the region increased, trees were cleared, impervious surfaces were expanded, streams were filled in and the natural water cycle was altered. Sanitary and stormwater systems were also developed, contributing to community health but leading to other challenges.

The City of Vancouver is facing many challenges with respect to rainwater management, including sewer capacity and water quality impacts. In response, the City is advancing implementation of the Rain City Strategy (RCS) across private, public, and park spaces. The RCS treats rainwater as a valuable resource and encourages designers and developers to mimic the natural hydrologic cycle by capturing and treating rainwater where it lands using green rainwater infrastructure (GRI). The RCS identifies the following target and performance standards:

- Target: Capture and clean 90% of average annual rainwater in the city
- Performance standard: Capture and clean rainwater from a minimum of 48 mm per day

As part of the work related to private property, the City has retained a consultant team to better understand what GRI tool combinations ("compliance pathways") can be used to meet the City's rainwater management design standards and performance targets (capture, clean, discharge) for new development across a range of representative building-site "typologies;" from single family homes to large, dense developments.

As part of this work, the City is also seeking to better understand the cost of these GRI "compliance pathways," the co-benefits that they offer, and the barriers and corresponding solutions to implementation. This work will produce a preferred set of GRI tool "pathways" for each building-site typology. The work will also provide commentary/ recommendations that will inform the development of new and/or improved rainwater management policies for the City that will achieve the goals of the Rain City Strategy in a fair and consistent manner.

The GRI Pathways Study has four sections each with its own focused workshop. Workshop #1, which addressed building typologies, GRI tools, and GRI implementation barriers, was held in October 2021. Workshop #2a, which focused on the solutions to implementation barriers for a particular GRI (green roofs), was held in July 2022. Workshops #2b and #3 are anticipated to be held in January and February, 2023 respectively, to explore and address the remaining sections of the Study.

2 About Workshop #2a

2.1 Workshop Objectives

Overall, Workshop 2a was intended to engage with stakeholders to better understand their perspectives on barriers and solutions to green roof implementation and, as such, it represents an important step in this project to advance implementation of the RCS on private property in a fair and consistent manner.

The workshop had the following objectives:

- Advance implementation of the Rain City Strategy (RCS) on private property in a fair and consistent manner as it relates to green roofs;
- Hear from subject matter experts, industry leaders, advocates, and stakeholders about implementation barriers and, particularly, implementation solutions related to green roof installation in CoV. As example, barriers may be categorized into issues pertaining to Insurance and liability, Quality assurance and control, Design responses, and Costs, risks, and benefits; and,
- Learn from and understand the perspective of different actors involved in green roof policy, design, installation, maintenance, and regulation.

2.2 Workshop Methodology and Format

To address the workshop objectives, the Project Team planned for and organized the following workshop activities:

- An introduction and overview of the project from the City's Project Manager
- An introduction to the Project Methodology, Approach and Information about Green Roofs from the Consulting Team to enable participants to better understand the objectives of this particular workshop within the context of the overall study
- Presentations from four guest presenters to provide expert insights into specific barriers and solutions for the implementation of green roofs
- Facilitated small group discussions on each of the key workshop themes to provide participants with the opportunity to ask questions and provide their ideas and insights about barriers and solutions to green roof implementation
- A plenary report back from each of the small group discussion to allow all participants to hear s summary of what was discussed about each of them
- Following the workshop, a survey was distributed to allow invitees (including those who didn't attend the workshop) to add their ideas and perspectives
- This summary report was written to combine the results of the workshop and the survey

2.2.1 Workshop format

The virtual workshop was held on Zoom on July 14, 2022 from 9am – noon. The consultant team took notes and facilitated discussion in breakout and plenary groups.

2.2.2 Agenda

Time	Description
10 min	Welcome, Introductions and Agenda
30 min	Pathway Study and Green Roof Context
45 min	Guest Presentations
10 min	Break
30 min	Panel Q&A
45 min	Small Group Discussions and Report Back
5 min	Closing, Next Steps
180 min	***Total***

2.2.3 Attendees

The workshop had 88 invitees (plus 22 City staff invitees) and 64 registrants. External participants were identified by City staff and the consultant team, based on their relevant experience and area of expertise. The City desired representation from all major sectors in the green roof industry. Invitations were sent by email a few weeks prior to the workshop and reminders sent the week before. The invitation is included in Appendix B.

Discussions amongst City Staff, consulting team and Green Roof Experts resulted in four workshop themes and a list of potential attendees that could speak to each theme. It was determined that we needed approximately 6 to 10 attendees for each theme breakout group to have a good discussion and hear from multiple perspectives.

Attendees were selected from the following industries and organizations:

Area of expertise	Organization
Project team	City of Vancouver Staff Consultant team
Builders and Roof Contractors	Roofing Contractors Association of BC (attended) Architek (attended) Next Level Stormwater Management (attended) Soprema Canada (attended) Structure Monitoring Technology (attended) Columbia Green (attended) NAATS Nursery Ltd. (attended)
Developers	Urban Development Institute (attended) BOMA (attended)

Area of expertise	Organization
	Wesgroup (attended) Darwin (attended) Concert Properties
Insurance Industry	BC Housing / Homeowner Protection Office (attended) Insurance Bureau of Canada (attended) Travelers Canada (attended)
Civil Engineering	Aplin Martin Consultants (attended) Creus Engineering (attended) InterCAD (attended) RF Binnie & Associates (attended) Vector (attended)
Mechanical Engineering	AME Consulting Group (attended) Integral (attended)
Landscape Architects	Sharp + Diamond Landscape Architecture Ginkgo Sustainability BC (attended) Groundswell Landscape Architecture (attended)
Government Agencies	BC Housing (attended) Vancouver Coastal Health City of Toronto (attended) City of San Francisco (attended)
Academia and Green Roof Groups	UBC Land and Food Systems (attended) BCIT (attended) Green Roofs for Healthy Cities (attended) Green Up Roofing (attended)

2.3 Information Presented

The workshop began with an introduction by the City's project manager (Gord Tycho). This was followed with an overview of the project from the lead consultant (Lotus Engineering) that included the project purpose, process and approach to the work. The consultant team presented an overview of the project with reference to work completed to date, including the building typologies, rainwater management tools, performance modeling objectives, and implementation barriers identified to date.

Four guest experts presented and shared their perspectives on green roof barriers and solutions:

- **Wilma Leung** (Senior Manager, Technical Research and Education, BC Housing) provided an overview of work of BC Housing and some of the history and challenges of managing rainwater for buildings in a changing climate. Wilma provided an overview of the Homeowner Protection Act and the role of Home Warranty Insurance companies. She completed her presentation with information about BC Housing MBAR (Mobilizing Building Adaptation & Resilience) program.
- **Christine Thuring** (Green Roof info Think Tank) provided an overview of her organization and its perspective on the benefits of Green Roofs. Christine provided a broad overview of Green Roof barriers and key approaches and solutions for the Vancouver context.
- **James Klassen** (Roofing Contractors Association of BC) provided insights into the technical aspects of properly installing and maintaining green roofs. His presentation covered the elements of a green roof, myths and misconceptions, common failings and green roof success factors.
- **Shayna Scott** (City of Toronto) provided the perspective from the City of Toronto that has been implementing a green roof bylaw for over 12 years. The City has had considerable success encouraging green roofs with over 950 green roofs representing 900,00sq. m of space. Shayna presented on the history of the developing the bylaw, how it is structured/applied and key lessons learned.

The guest presenters along with Elizabeth Morris (Green Up Roofing) then formed an expert panel to respond to questions from participants. To see the information that was presented during the workshop, see Appendix B.

2.4 Follow-up Survey

Following the workshop, Modus distributed a follow-up survey to all attendees. Participants were given two weeks to provide further comment about the topics covered in the workshop. Twelve participants provided feedback. The survey feedback is attached in Appendix C.

3 What We Heard

The following section summarizes what we heard during the workshop and from the follow up survey. These comments do not reflect a consensus from participants. Rather, this qualitative summary reflects individual comments from participants.

3.1 Panel Q&A

Five panelists answered questions from the group. The panelists were Shayna Stott (City of Toronto); Elizabeth Morris (Green Up Roofing); Wilma Leung (BC Housing); James Klassen (Roofing Contractors Association of BC); and Christine Thuring (Green Roof Information Think Tank).

- **Question:** How can we help the COV communicate to the development and insurance industries that the professionally certified green roof industry has the solutions in hand and is more than willing to participate?
    - **Answer:** This is part of the scope of work of the Pathways Study, as also demonstrated by the range of invited participants and objectives of this workshop: to identify implementation barriers, and solutions to barriers. It is anticipated that the consultant will assess how the green roof industry can help provide solutions, where appropriate to do so.

- **Question:** In Toronto, how did you work to build trust in knowing that green roofs are part of the solution?
    - **Answer:** Toronto utilized green roofs on their own buildings first; provide incentives; provide a reliable source of information (website); broad stakeholder consultation when developing the bylaw; identify green roof development leaders; construction standards are critical to avoid green-washing or tokenizing green roofs.

- **Question:** How long do green roofs last relative to the regular roofs?
    - **Answer:** Exposed single-ply roof will typically need patching and repairing in 7-15 years, whereas a green roof will last 20-25 years (or could last even longer). When a roof is protected by vegetation, it may double or triple the life expectancy of your membrane because the membrane has reduced exposure to constant thermal cycling (and associated expansion/ contraction of membrane material).

- **Question:** Can you go into some detail on how the Toronto Green Roof Bylaw is expected to change green roof performance?
    - **Answer:** Toronto has both a Green Building Standard (applied through the planning process) and a Green Roof bylaw (that sets requirements for green roofs):
        - The Green Roof Bylaw requires that a green roof be installed for all new buildings greater than 2,000 m2 GFA. The larger the building the higher the % of

green roof coverage required. It includes a construction standard for green roofs.
    - The Green Building Standard includes a requirement to address rainwater management. Developer must meet the stormwater requirements but can choose whether or not to use the green roof to contribute toward satisfying rainwater management requirements.
    - As the Toronto Green Building Standard relates to the Green Roof Bylaw, we are working out how to use (layer) these regulatory tools together. In recent updates to Toronto Green Building Standard, new development must include high performance green infrastructure (choosing from a list of options). Through the Green Roof bylaw, Toronto is not requiring higher performance green roofs, but in the Green Building Standard, we're allowing the developer to select some options – biodiverse, intensive, larger coverage green roofs.

- **Question:** How would the City of Vancouver or others ensure that performance (i.e. stormwater management performance) continues over the lifespan of the green roofs?
    - **Answer:** Regulatory mechanisms can ensure that green roofs are functioning properly (e.g. Washington DC provides financial incentives for stormwater management; Portland has a robust monitoring system too). Embedding performance requirements at the onset of any regulatory approach is critical. There are many opportunities for green jobs and training in this area too. There is a need for flexible mechanisms – cash in lieu program could be a good source of resources for maintenance.

- **Question:** We have heard from other jurisdictions that one of the foundations of successful GRI programs is a robust tracking system. Such systems allow for data and spatial analysis of GRI over time and provide the information necessary for effective adaptive management and policy refinement. Does Toronto have a GIS tracker for green rainwater infrastructure, including green roofs?
    - **Answer:** Toronto has a green streets program, some GIS analysis in place in Toronto. But due to timing of regulation, there is not yet a sophisticated GIS tracker or associated analysis.

- **Question:** I understand that Toronto has a twofold program - rainwater management and green roofs. In circumstances where green roofs are designed to take on a rainwater management role, how does the city ensure ongoing performance (i.e. ensuring maintenance, but also delivering expected rainwater management function)?
    - **Answer:** There are regulatory mechanisms in place in many jurisdictions to ensure that green roofs are functioning as intended. Washington, DC provides developers a financial incentive for managing stormwater on properties above a certain regulatory threshold. In NYC, there is a requirement for green roofs on all new buildings – financial incentives will pay for costs, mechanisms in place to visit roofs periodically. Portland, OR has a robust monitoring system that starts in design phase (feasibility studies, design guidance). It is effective to require a third-party certification and inspection. Toronto requires a maintenance plan – embedding those requirements throughout a regulatory approach is critical.

3.2 Breakout Rooms & Survey Results

Implementation barriers to designing, installing, and maintaining GRI (including green roofs) were identified and presented as preliminary findings in Workshop #1. During Workshop #2a, participants were organized into four small breakout groups to discuss barriers and solutions to designing, installing and maintaining green roofs. Each breakout group focused on one of the following themes:

- Insurance and liability
- Quality assurance and control
- Design responses
- Costs, risks, benefits

The following section summarizes, under each key theme, the various barriers and potential solutions that were discussed during the breakout rooms discussions, plenary and in the follow up survey.

GROUP 1: INSURANCE AND LIABILITY

Barriers or challenges

- Insurance
    - Insurance industry needs to better understand green roofs and develop a specific product for them;
    - The Green Roof insurance market is still relatively small. Therefore, there is no driver to develop the product if the market is small, insurance is then a barrier because it is not a streamlined process. There is also little reason for a company to enter the market if they aren't "missing out";
    - The 2-5-10 warranty can be "easily" met but most owners and investors want the buildings to last much longer with minimal maintenance requirements;
    - Some insurers have forms that ask if your building has a green roof, if checked then coverage is denied (assumed reason);
    - Working with Canadian (BC) roof insurance can be tricky. There is typically no problem with Part 3 buildings but Part 9 buildings can be difficult;
    - Probably not many specific insurance issues with wood frame buildings but insurers want to see professional sign-off.
- Cultural / Insurance
    - The leaky condo crisis is relatively fresh in the minds of the public and industry in BC. This increases the perceived risk of green roofs, the desire for insurance and the potential risk for insurers.
- Retrofitting buildings
    - Existing roofs often don't have the needed structural support necessary for a green roof, so retrofit is difficult and expensive;
    - The City (Gord Tycho) noted that the Pathways Study, which is part of the first phase of Rain City Strategy implementation, is mostly focusing on ascertaining the feasibilities of new development achieving RCS targets. That said, the City is aware that achieving the RCS 'impervious surface managed' target will require some retrofitting of existing stock, and this is envisioned to be addressed in a subsequent implementation phase.

- Maintenance
    - Depends heavily on owner and operations staff: are they reliably performing maintenance, is there dedicated maintenance staff? Existing maintenance staff likely don't have the capacity for the additional tasks needed to maintain green roofs properly.

Potential solutions

- Establish green roof standards
    - as the industry matures most issues will get resolved but need to get the ball rolling and prove the reliability of green roofs;
    - If the City government established a requirement and standard for green roofs (including green roof design, construction (installation) and maintenance standards and a permitting process to go along with these requirements), then the insurance industry might feel more comfortable to insure green roofs. This is because the industry would be confident that the roof would meet structural, drainage, etc. requirements. This seems to be what has happened in Toronto where green roofs are now the norm on most new buildings.

GROUP 2: QUALITY ASSURANCE AND CONTROL

Barriers or challenges

- Lack of communication between all parties;
- Challenge ensuring that contractors properly build / install what is designed;
- Assurance for quality, insurance liability, feedback loop challenges – needs solid communication and documentation on what's being built;
- Resistance from developers who don't trust products;
- Stamping engineers don't have much control over other professionals working on the project (green roofs can be impacted by many different contractors);
- Perception about maintenance being prohibitively expensive and/or challenging for unskilled maintenance staff;
- Need an integrated design process to coordinate disciplines;
- Lack of clear specifications.

Potential solutions

- Green Roof Training and Certificate for installers;
- Training for roofers – builds trust in the industry (look to RCABC);
- Integrated design process – move from design approach to integrated approach.

GROUP 3: COMPETITION FOR ROOFTOP SPACE AND CREATIVE DESIGN RESPONSES

Key ideas shared

- Architects often need help from green roof experts;
- Civil engineers need to be involved earlier in the project;
- Regulations need to consider more than the percentage of rooftop covered by a green roof. Green roof regulations should also consider soil porosity, soil depth, plant types etc. depending the specific use/function that is desired for the green roof. This could take the form of plant lists , minimum requirements for soil depths and guidance for soil types.

- Discussion about the Toronto model of a green roof policy separate from a stormwater policy would lead to a higher amount of green roofs installed (but not necessarily more stormwater managed);
- Project team should investigate "smart" systems that release water from systems depending on rainfall amount;
- Consider co-locating urban agriculture with green roof systems.

GROUP 4: COSTS, RISKS, BENEFITS

Barriers or challenges

- Governance of these buildings with green roofs, particularly in regard to strata corporations;
- Trust concerns - the insurance industry, the City, and the Public are worried about how to deal with issues like lack of maintenance when the building might not necessarily be managed well. How are design, construction, and maintenance people for green roofs qualified?
- Recommendation to look into public health impacts of green roofs – i.e. type of vegetation, methods of irrigation (legionella, etc.), how are pests controlled, other vectors (i.e. mosquito breeding), etc.

Potential solutions

- Multiple, overlapping regulatory drivers lead to more green roofs besides just the stormwater requirement;
    - DC and Seattle: Both have successful green roof applications without a mandate. Both have a stormwater/green coverage requirement. When stormwater is the only driver, bioretention/etc. are often chosen instead;
    - San Francisco: cost of green roofs isn't a barrier for developers. Rather, green roofs have a lower performance per square foot. San Francisco allows for developers to choose multiple tools. Green roofs often don't meet the stormwater criteria as well as other tools;
- Proper operations and maintenance will be key to building community trust in green roofs.

4 Appendix A: Workshop Invitation

City of Vancouver GRI Pathways Study – Workshop #2a: Green Roof Barriers and Solutions – July 14 9am-12pm

Hello,

On behalf of the City of Vancouver and its project consultant team, I would like to invite you to an online workshop on July 14, 2022 to help advance implementation of the Rain City Strategy (RCS) on private property in a fair and consistent manner. The workshop will include an update on the City of Vancouver Green Rainwater Infrastructure (GRI) Pathways Study, presentations from experts in the field of Green Roofs, an expert panel discussion, and an opportunity to hear from all participants.

Workshop Purpose: To discuss the contribution that Green Roofs can make to on-site rainwater management, review implementation barriers and challenges to Green Roofs identified in Workshop 1, and *better understand from you* the potential solutions to address these barriers, thereby optimizing the appropriate use of Green Roofs in Vancouver.

Workshop Objectives:

- Explore the role of green roofs as multifunctional tools to meet stormwater management policies in addition to advancing broader energy, climate, and sustainable building policy in Vancouver.
- Hear from subject matter experts (SME's), industry leaders, advocates, and stakeholders about concerns (barriers), opportunities, and innovative ideas (solutions) related to green roof utilization as part of development in Vancouver.
- Learn from and understand the perspectives of different stakeholders involved in green roof policy, design, installation, and maintenance.

About the project

The City of Vancouver is facing a number of challenges with respect to rainwater management, including sewer capacity and water quality impacts. In response, the City is advancing implementation of the RCS across private, public, and park spaces. The RCS treats rainwater as a valuable resource and mimics the natural hydrologic cycle by capturing and treating rainwater where it lands using GRI.

As part of the work on private property, the City of Vancouver has retained a consultant team to better understand what GRI tool combinations ("compliance pathways") can be used to meet the City's rainwater management design standards (capture, clean, discharge) for new development across a range of representative building-site 'typologies' from single family homes to large, dense developments.

As part of this work, the City is also seeking to better understand the cost of these GRI "compliance pathways", the co-benefits that they offer, and the barriers and solutions to implementation. This work will produce a preferred set of GRI tool 'pathways' for each building-site typology. The work will also provide commentary/ recommendations that will inform the development of new and/or improved rainwater management policies for the City that will achieve the goals of the Rain City Strategy in a fair and consistent manner.

The GRI Pathways Study has four sections with four workshops.

Please join us:

- Date: Thursday, July 14, 9 AM-12 PM
- Platform: Zoom, register here: https://us02web.zoom.us/meeting/register/tZ0lcuGqqjwrGt2zgoqaaHIoOr1wGuKU9jDS

Attendees: For this workshop, we have invited green roof subject matter experts, policy makers, representatives from the green roof industry, development community, design community, academia, insurance industry, and City of Vancouver staff.

Agenda

Time	Description
10 min	Welcome and introductions
30 min	Pathway study and green roof context
45 min	Presentations about barriers and solutions
10 min	Break
30 min	Panel Q&A
35 min	Small group discussions
15 min	Report back
5 min	Wrap up and next steps
3 hours	*Total time*

Questions & Contact
For any questions about the event, please email Jean Roe, the workshop coordinator, at jean@thinkmodus.ca. Additionally, if you cannot attend this event but have a delegate who could attend, please send the delegate's name and email address to Jean Roe.

For any other City-related questions, please email Gord Tycho, the Project Manager for the GRI Pathways Project, at Gord.Tycho@vancouver.ca

We look forward to seeing you on July 14

Best regards,

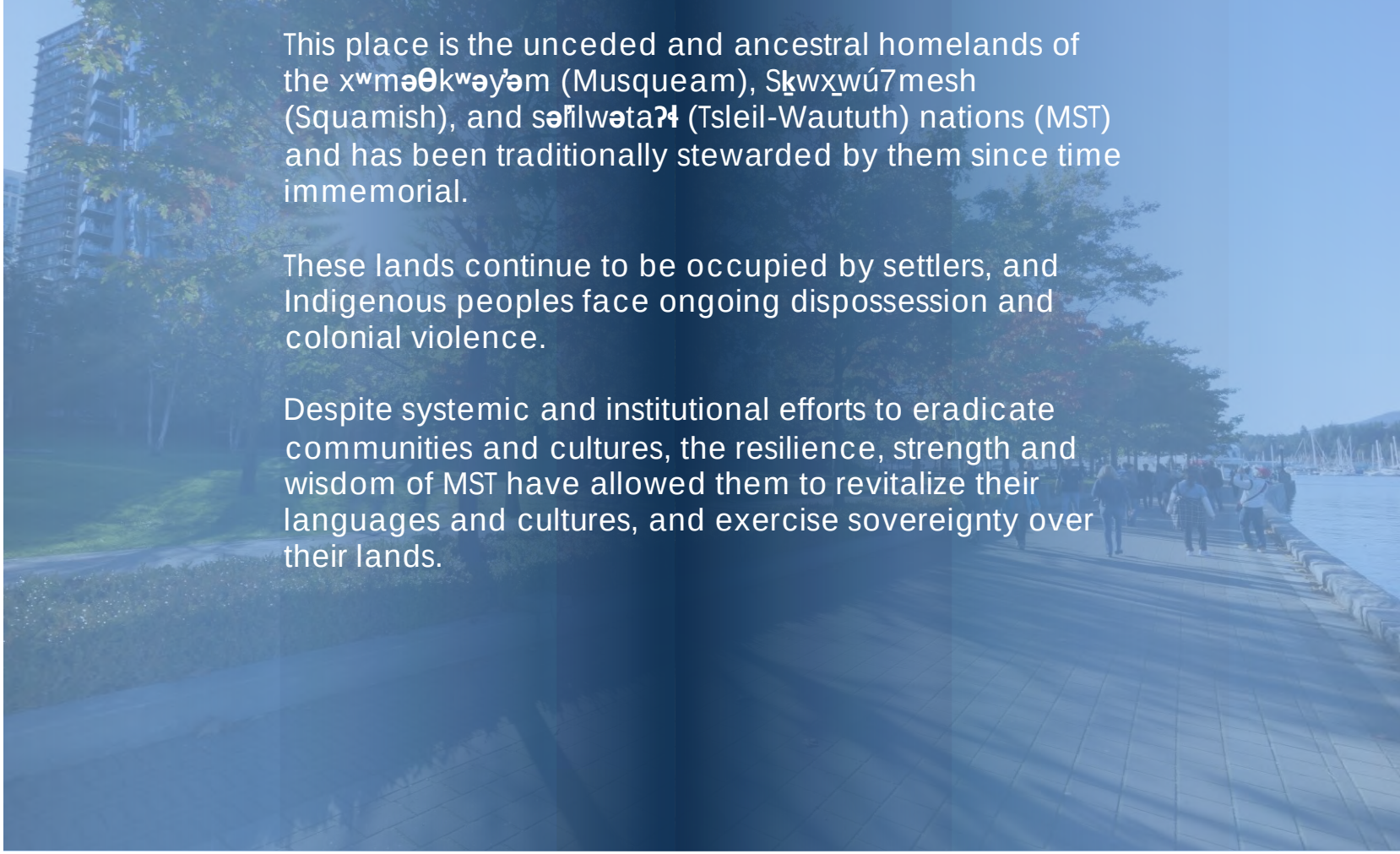
Jean Roe, MODUS Planning Design & Engagement Inc.
On behalf of the project team

5 Appendix B: Workshop Presentation

RCS Green Rainwater Infrastructure Pathways Study

Workshop #2A: Green Roof Barriers & Solutions – July 14 2022

Sustainability Group | Planning, Urban Design & Sustainability | City of Vancouver



This place is the unceded and ancestral homelands of the xʷməθkʷəy̓əm (Musqueam), Sḵwx̱wú7mesh (Squamish), and səl̓ilwətaʔɬ (Tsleil-Waututh) nations (MST) and has been traditionally stewarded by them since time immemorial.

These lands continue to be occupied by settlers, and Indigenous peoples face ongoing dispossession and colonial violence.

Despite systemic and institutional efforts to eradicate communities and cultures, the resilience, strength and wisdom of MST have allowed them to revitalize their languages and cultures, and exercise sovereignty over their lands.

Meeting Preamble

1. Welcome & Context: the Rain City Strategy
2. Pathways Study – Purpose
3. Which City departments are involved in the Study?
4. Who is in the room today? – partners and stakeholders

Context

The city was once a **temperate rainforest.**

Image: Capilano River Regional Park, North Vancouver
Photo Credit: Robert Pennings

Over time, we have changed the **natural watersheds…**

(sanitary & stormwater are collected, combined, concentrated, and conveyed away from where they originate)

Image: View of Yaletown from Charleson Park in 1893, Vancouver
Photo Credit: www.onthisspot.ca, 10/25/2015

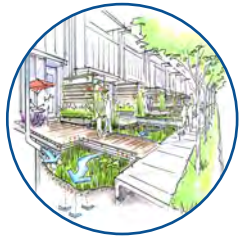
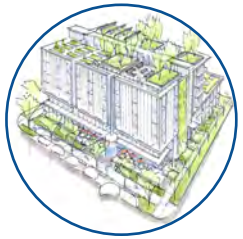
…to service today's **Vancouver.**

…to service today's **Vancouver.**

- Combined system near capacity
- CSO's, aquatic pollution
- Climate change, future growth

Response: Rain City Strategy

RCS & GRI Pathways Study

	Single Family	Mid-Rise	High-Rise
 Capture and Re-use		✓	✓
 Infiltration	✓	✓	
 Resilient Roofs		✓	✓

GRI Pathways Study

3a. Model/ rank GRI tool 'pathways' that meet Bulletin – site, policy, and form & massing assumptions

3b.Broadway zero discharge

2. GRI Tools - infiltration, blue/green roofs, water reuse

Design methodologies

24mm/day & 48mm/day

4. Understand Pathway Costs and rank Co-benefits of GRI tool combinations

Develop Policy considerations – recommended pathways, prescriptive or performance, policy barriers, targets not achieved, risk mitigation, Policy Implementation, Standards, Toolkits, Capacity building

1. 8-10 'Building-Site' Typologies that represent CoV building stock

5. Understand Barriers and Solutions to GRI implementation

Image: Vancouver skyline
Photo Credit: Wendy de Hoog

Which departments are involved?

Which partners & stakeholders are involved?

Green Rainwater Infrastructure (GRI)
PATHWAYS STUDY

Workshop #2a
Green Roof Barriers & Solutions

Vancouver Marina (JMR Julian)

CITY OF VANCOUVER | GREENEST CITY

Agenda

- Introduction (10 minutes)
- Pathway Study and Green Roof Context (30 minutes)
- Presentations (45 minutes)
- Break (10 minutes)
- Panel Q&A (30 minutes)
- Small Group Discussions & Report Back (45 minutes)
- Closing, Next Steps (5 minutes)

Workshop Objectives

- Advance implementation of the Rain City Strategy (RCS) on private property in a fair and consistent manner as it relates to green roofs
- Hear from subject matter experts, industry leaders, advocates, and stakeholders about barriers and solutions related to green roof installation in CoV.
- Learn from and understand the perspective of different actors involved in green roof policy, design, installation, and regulation.

PROJECT OVERVIEW

Bioretention in interior courtyard of Bridges @11th development, Seattle (GGLO)

CITY OF VANCOUVER | GREENEST CITY

STUDY OVERVIEW

WE ARE HERE

July - Dec. 2021	January - October 2022		Sept. '22 - Jan. '23
SECTION 1 Typologies, Tools, & Barriers	**SECTION 2** Design Standards, Modeling, Costs	**SECTION 3** Benefits & Solutions	**SECTION 4** Policy Implications & Implementation
• Representative Building-Site Typologies • Rainwater Management Tools • Implementation Barriers	• GRI Design Methodology • Performance Modeling • Preliminary Pathway Development • Cost Estimates	• Rainwater Management Co-benefits • Solutions to Barriers	• Recommended Pathways • Policy Options • Implementation Recommendations
Workshop #1 (Oct. 2021)	**Workshop #2a (July 2022)** **Workshop #2b (Oct. 2022)**		**Workshop #3 (Dec. 2022)**

CITY OF VANCOUVER | GREENEST CITY

STUDY OVERVIEW

COMPLETE

July - Dec. 2021

January - October 2022

Sept. '22 - Jan. '23

SECTION 1
Typologies, Tools, & Barriers

- Representative Building-Site Typologies
- Rainwater Management Tools
- Implementation Barriers

Workshop #1 (Oct. 2021)

SECTION 2
Design Standards, Modeling, Costs

- GRI Design Methodology
- Performance Modeling
- Preliminary Pathway Development
- Cost Estimates

Workshop #2a (July 2022)

Workshop #2b (Oct. 2022)

SECTION 3
Benefits & Solutions

- Rainwater Management Co-benefits
- Solutions to Barriers

SECTION 4
Policy Implications & Implementation

- Recommended Pathways
- Policy Options
- Implementation Recommendations

Workshop #3 (Dec. 2022)

CITY OF VANCOUVER | GREENEST CITY

STUDY OVERVIEW

WE ARE HERE

July - Dec. 2021	January - October 2022		Sept. '22 - Jan. '23
SECTION 1 Typologies, Tools, & Barriers	**SECTION 2** Design Standards, Modeling, Costs	**SECTION 3** Benefits & Solutions	**SECTION 4** Policy Implications & Implementation
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CITY OF VANCOUVER | GREENEST CITY

STUDY OVERVIEW

UPCOMING

July - Dec. 2021	January - October 2022		Sept. '22 - Jan. '23
SECTION 1 Typologies, Tools, & Barriers	**SECTION 2** Design Standards, Modeling, Costs	**SECTION 3** Benefits & Solutions	**SECTION 4** Policy Implications & Implementation
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Workshop #1 (Oct. 2021)	Workshop #2a (July 2022) Workshop #2b (Oct. 2022)		Workshop #3 (Dec. 2022)

CITY OF VANCOUVER | GREENEST CITY

UPCOMING WORKSHOPS

Workshop #2b: Costs, Benefits, & Preliminary Solutions

Anticipated October 2022

- Preliminary compliance pathway findings, costs, and benefits
- Potential solutions to key barriers
- Covering all rainwater management tools and pathways

Workshop #3: Revised Solutions & Policy Recommendations

Anticipated December 2022

- Ranked and prioritized pathway tool set for each building typology
- Policy recommendations to support pathways and implementation

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Rainwater Infrastructure Building Typologies Pathways Study:

Green Roofs in Context of the Pathway Study

HERRERA

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Pathway Study Context

Rainwater Management Tools

1 **Identify Tools**

Green or resilient roofs are one type of tool considered for managing rainwater

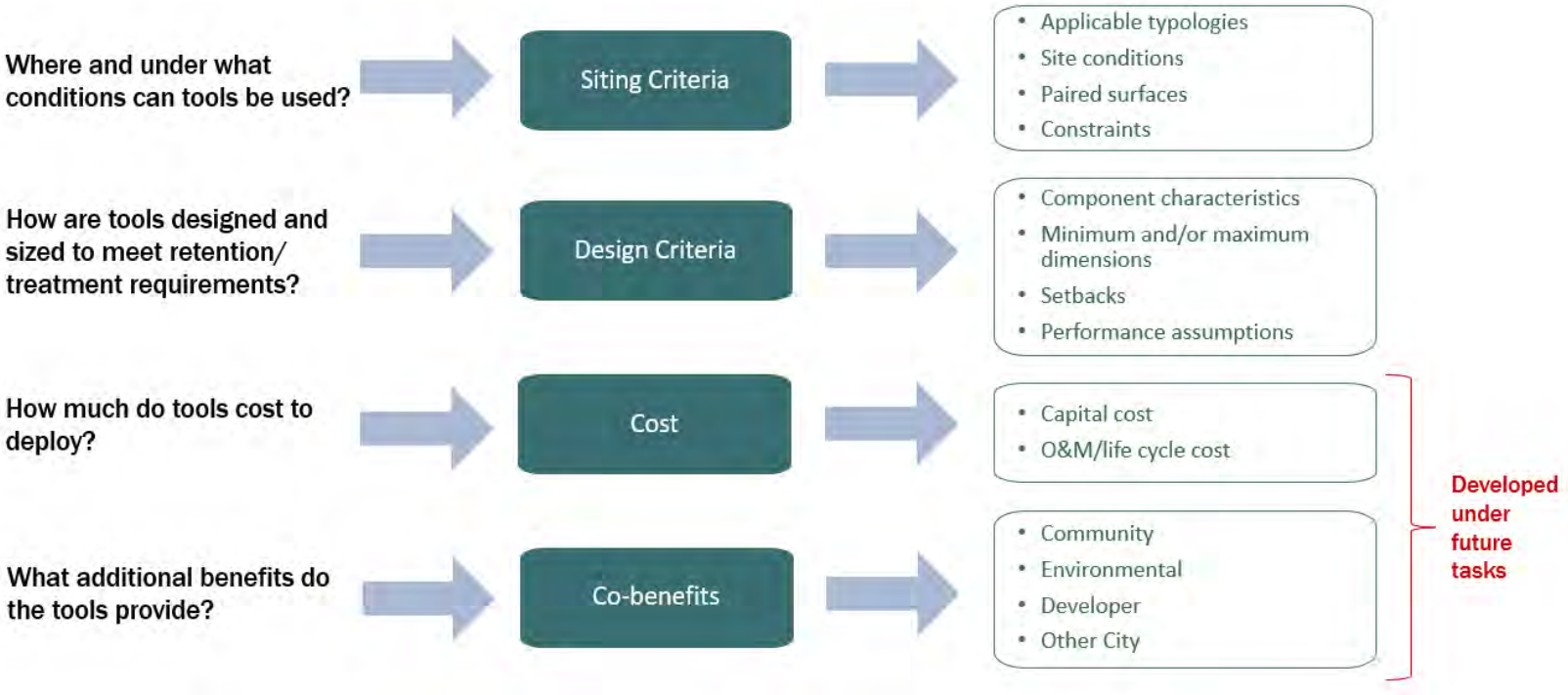
Tool Type	Tool Sub-type
Tier 1 Tools	
Resilient roofs	Extensive (<150 mm soil depth) green roofs Intensive (≥150 mm soil depth) green roofs Blue-green roofs
Bioretention	Sloped-side bioretention (unlined wo/ underdrains) Full-walled bioretention (planter) (unlined wo/ underdrains) Partial-walled bioretention (unlined wo/ underdrains)
Absorbent landscapes	Over native soils
Tree trenches	Structural soils Soil cells
Permeable pavement	Permeable pavers Pervious concrete Pervious asphalt
Subsurface infiltration	Small-scale near-surface infiltration (e.g., drywells) Large-scale near-surface infiltration (e.g., infiltration chambers) Deep infiltration (e.g., drill drains)
Non-potable water systems	Rainwater harvesting systems (rooftop runoff) Groundwater + rooftop rainwater harvesting systems (rooftop runoff) Rainwater harvesting systems (all impervious runoff)
Tier 2 Tools	
Bioretention	Sloped-side bioretention (lined w/ underdrains) Full-walled bioretention (planter) (lined w/ underdrains) Partial-walled bioretention (lined w/ underdrains)
Absorbent landscapes	Over slab
Permeable pavement	Permeable pavers (lined w/ underdrains) Pervious concrete (lined w/ underdrains) Pervious asphalt (lined w/ underdrains)
Tier 3 Tools	
Detention tanks (without reuse)	Surface detention tanks Subsurface detention tanks/vaults Blue roofs
Proprietary water quality devices	Pre-treatment devices Basic treatment (50-80% Total Suspended Solids (TSS) removal)
Offsite Tools	
Offsite green facilities	Centralized green facilities Localized green facilities (e.g., green street)

Pathway Study Context

Rainwater Management Tools

2 Define Tools

General criteria for siting, design, cost, and benefit are established for each tool type



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Pathway Study Context

Rainwater Management Tools

2 Define Tools

Siting and design parameters for green roofs aid in subsequent modeling and analysis

Parameter/Criteria	Values		
	Extensive Green Roof	Intensive Green Roof	Blue-Green Roof
Siting			
Applicable Building-Site Typologies	All typologies considered		
Maximum Contributing Drainage Area	Self-mitigating		
Design			
Ponding Depth	NA	NA	100 mm
Media Depth	450 mm	150 mm	450 mm
Media Porosity	25%		
Media Conductivity	70 mm/hr		

Data Sources

- 2019 Vancouver Building Bylaw
- Metro Vancouver Stormwater Source Control Design Guidelines
- City of Vancouver Integrated Resource Management Plan - Volume II
- King County, Washington
- Seattle, Washington
- San Francisco, California
- Best Professional Judgement

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Pathway Study Context

Performance Modeling

3 Developing Scenarios

Scenarios represent different combinations of variables to be tested. Only some variable are relevant to green roofs

Scenario Variable	Typology	Design Standards	Rainwater Management Tools	Site		Development/Policy		
				Pre-Development Conditions	Soil Conditions	Roof Area Available (Unoccupied)	Infiltration Area Available	Reuse Policy
Variable Values	• Small Lot Residential – Low Massing • Small Lot Residential – High Massing • Low-Rise Residential & Mixed-Use • Mid-Rise Residential & Mixed-Use • High-Rise Residential & Mixed-Use • Low/Mid-Rise Non-Residential • High-Rise Non-Residential	• Existing Standard - 24-mm retention OR treatment/ detention with pre/post-construction peak flow matching + additional 24-mm treatment for PGIS • Rain City Strategy Standard - 48-mm retention OR treatment/detention with pre/post-construction peak flow matching	• Various combinations that differ based on typology and standard being tested	• No pre-development (0% impervious) • Less than post-development (50% of post-construction impervious) • Equivalent to post-development (100% of post-construction impervious)	• High Infiltration (50 mm/hr) • Medium Infiltration (20 mm/hr) • Low Infiltration (5 mm/hr) • No infiltration (0 mm/hr)	• Low (25%) • Medium (50%) • High (75%)	• 100% of area available with existing policies (infiltration setback, parking requirements, building massing, • 110% of area available • 120% of area available	• Existing permitted non-potable uses • Alternative policy for non-potable uses

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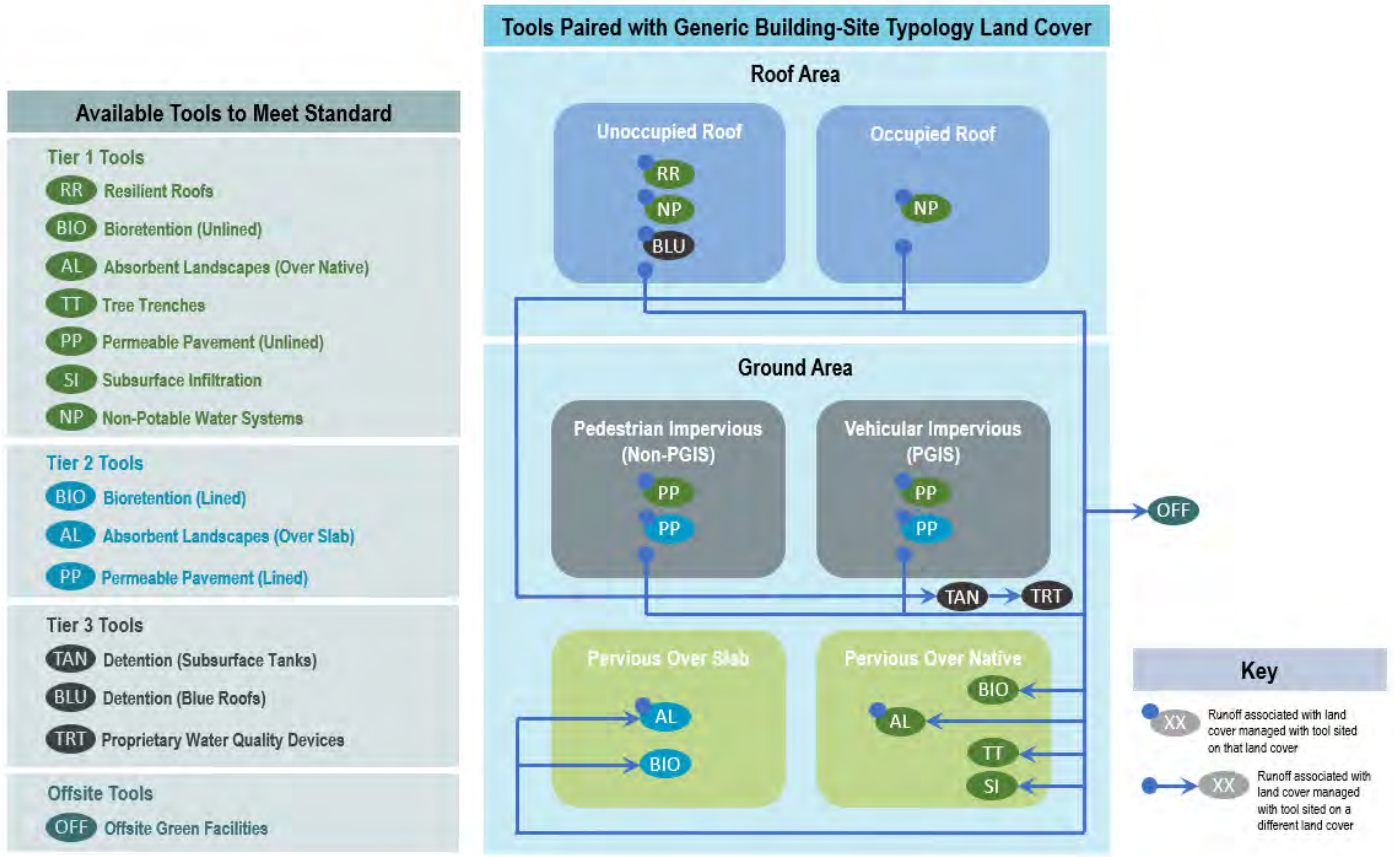
Pathway Study Context

Performance Modeling

4 Modeling Scenarios

Scenarios that apply to unoccupied roof area:

- Resilient roofs
  - Extensive
  - Intensive
  - Blue-green
- Non-potable reuse
- Blue roofs
- All ground area tools



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Pathway Study Context

Performance Modeling

Initial Results

- Green roofs are viable pathways for all building-site typologies being considered
- Green roofs are critically important tools for use with *denser* building-site typologies

Future Work

- Complete modeling
- Perform cost analysis
- Perform co-benefit analysis

Analysis of Continuum of Compliance Pathways

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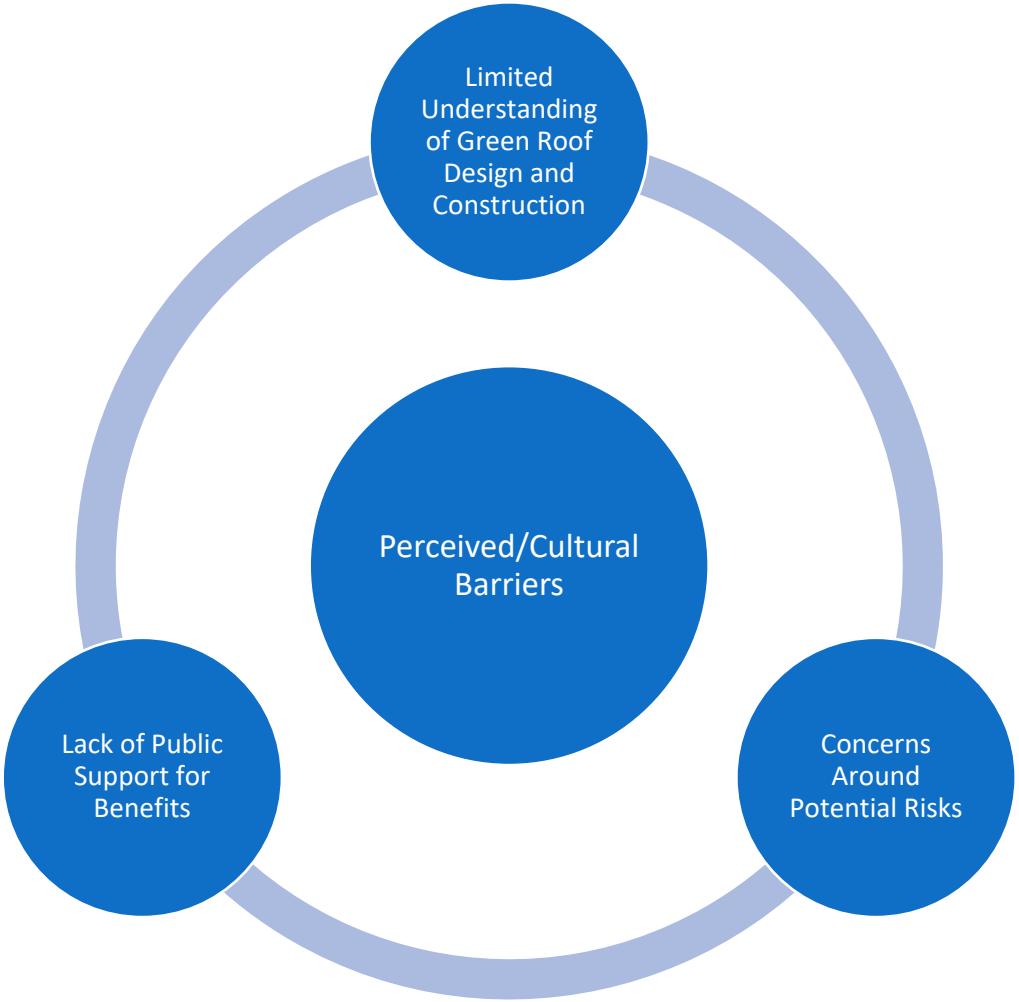
BARRIERS OVERVIEW



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BARRIERS OVERVIEW

Rooftop Space Constraints & Competitions for Use (Physical Barriers)

- Rooftops are used for a variety of reasons:
  - Mechanical Equipment
    - HVAC Systems
    - Solar Panels
  - Elevator Overruns
  - Private Balconies
  - Amenity Spaces
  - Daycare Spaces
  - Urban Agriculture
  - Child Friendly Amenity

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BARRIERS OVERVIEW

Quality Control / Maintenance (Regulatory / Procedural Barriers)

- Some green roof designs may require regular inspections and maintenance to continue working properly.
- Currently an *"Operation and Management Plan"* is required for RWMPs but limited guidelines are provided.
- Minimal existing City of Vancouver green roof standards/requirements to guide design and development.
- No City of Vancouver mechanisms for enforcement of quality and/or maintenance.

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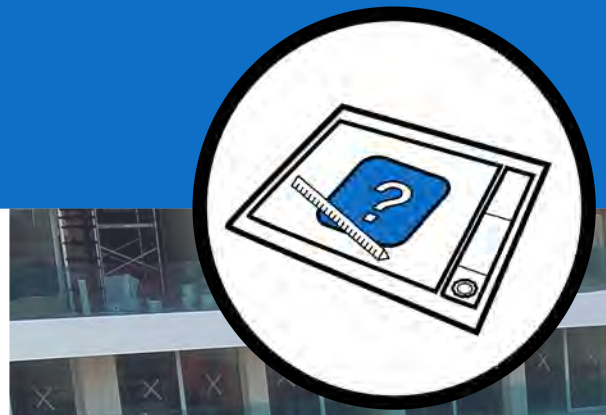
BARRIERS OVERVIEW

Industry Capacity (Cultural Barriers)

- Lack of local industry experience and expertise in:
  - **Design**
    - Structural consultants often provide concerns about structural costs when asked for a justification to eliminate green roofs from a proposed development.
  - **Construction**
    - Proper installation and maintenance of green roofs is not commonplace in the market.
  - **Monitoring + Maintenance**



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BARRIERS OVERVIEW

Insurance / Liability / Warranty Concerns (Economic Barriers)

- Current concerns regarding building insurance and roof warranty
- Knowledge regarding potential impacts to the insurance industry is currently limited
- Standard guidelines for green roof warranties and insurance are not readily available

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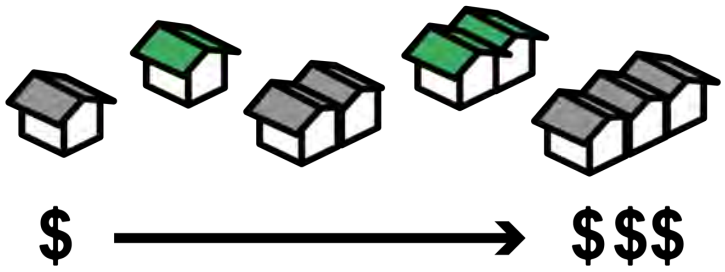
BARRIERS OVERVIEW

Cost

- Initial costs of green roofs is higher than traditional stormwater solutions. This can lead to value engineering.
- Requires more engineering and design costs then would typically be required for low density housing.
- Potential impacts to construction costs for temporary or low income housing.



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EXPERT PRESENTATIONS

Living roof + cistern, Australia (Fytogreen)

EXPERT PRESENTERS

- Wilma Leung
  BC Housing
- Christine Thuring
  Green Roof info Think Tank
- James Klassen
  Roofing Contractors Association of British Columbia
- Shayna Stott
  City of Toronto

CoV Green Rainwater Infrastructure Pathways Study – Green Roof Workshop

July 14, 2022

Wilma Leung
Senior Manager, Technical Research & Education

BC HOUSING RESEARCH CENTRE

MBAR
MOBILIZING BUILDING ADAPTATION AND RESILIENCE

In the spirit of honouring the truth, I acknowledge that I live and work on the shared, ancestral and unceded homelands of the hən̓q̓əmin̓əm and Sḵwxwú7mesh-speaking people. I thank the Coast Salish peoples who continue to live on these lands and care for them, along with the waters and all that is above and below. I hope to reciprocate by participating in opportunities to reconcile with all our relations.

BC HOUSING
RESEARCH CENTRE

MBAR
MOBILIZING
BUILDING ADAPTATION
AND RESILIENCE

Some history, but we can do better

- Crisis response vs. crisis prevention
- Capacity building takes years – since 1980s for energy efficiency
- Adding rain screens, insulation, exterior shading, seismic resilience – costs less when integrated
  - all involve working on the exterior walls
  - windows and roofs are replaced only once in a few decades
- Designing for the past vs. the future
  - sites and buildings are still designed using “historical” climate data
  - not reflecting the future climate we are moving into

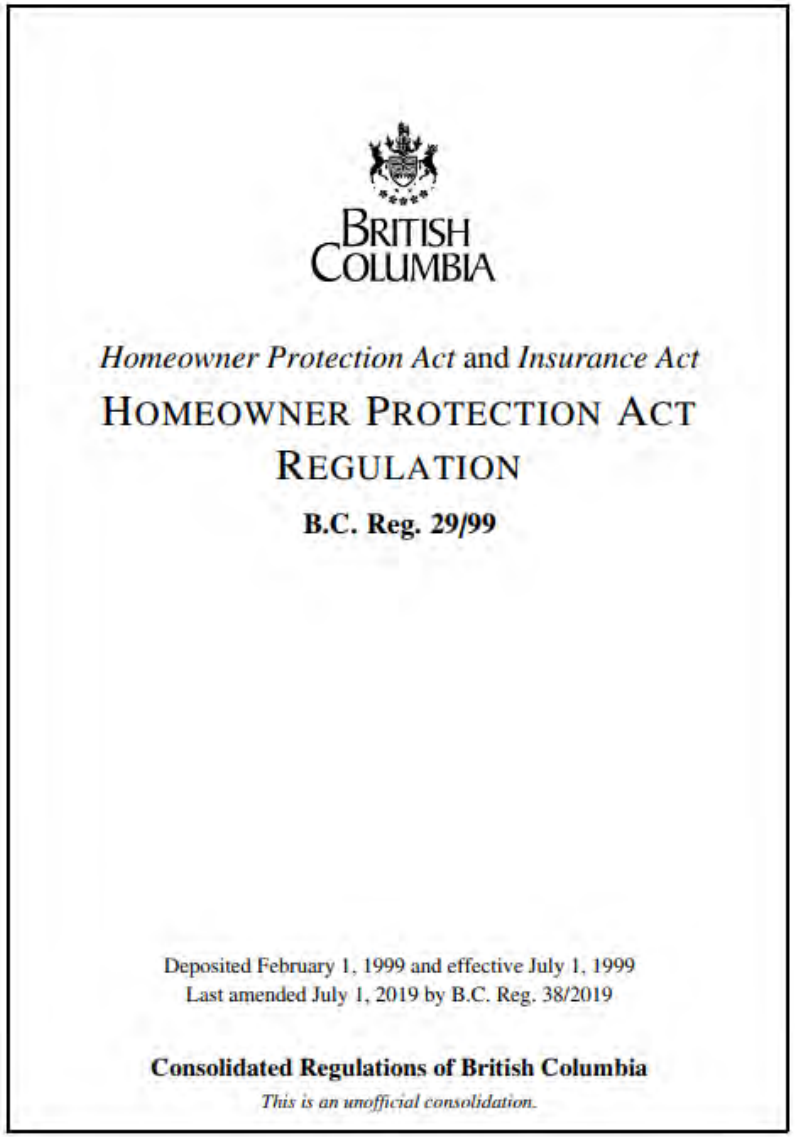
Image source: Wikipedia

BRITISH COLUMBIA

BC HOUSING RESEARCH CENTRE

MBAR MOBILIZING BUILDING ADAPTATION AND RESILIENCE

Homeowner Protection Act and Regulations



BRITISH COLUMBIA

Homeowner Protection Act and *Insurance Act*

HOMEOWNER PROTECTION ACT REGULATION

B.C. Reg. 29/99

Deposited February 1, 1999 and effective July 1, 1999
Last amended July 1, 2019 by B.C. Reg. 38/2019

Consolidated Regulations of British Columbia

This is an unofficial consolidation.

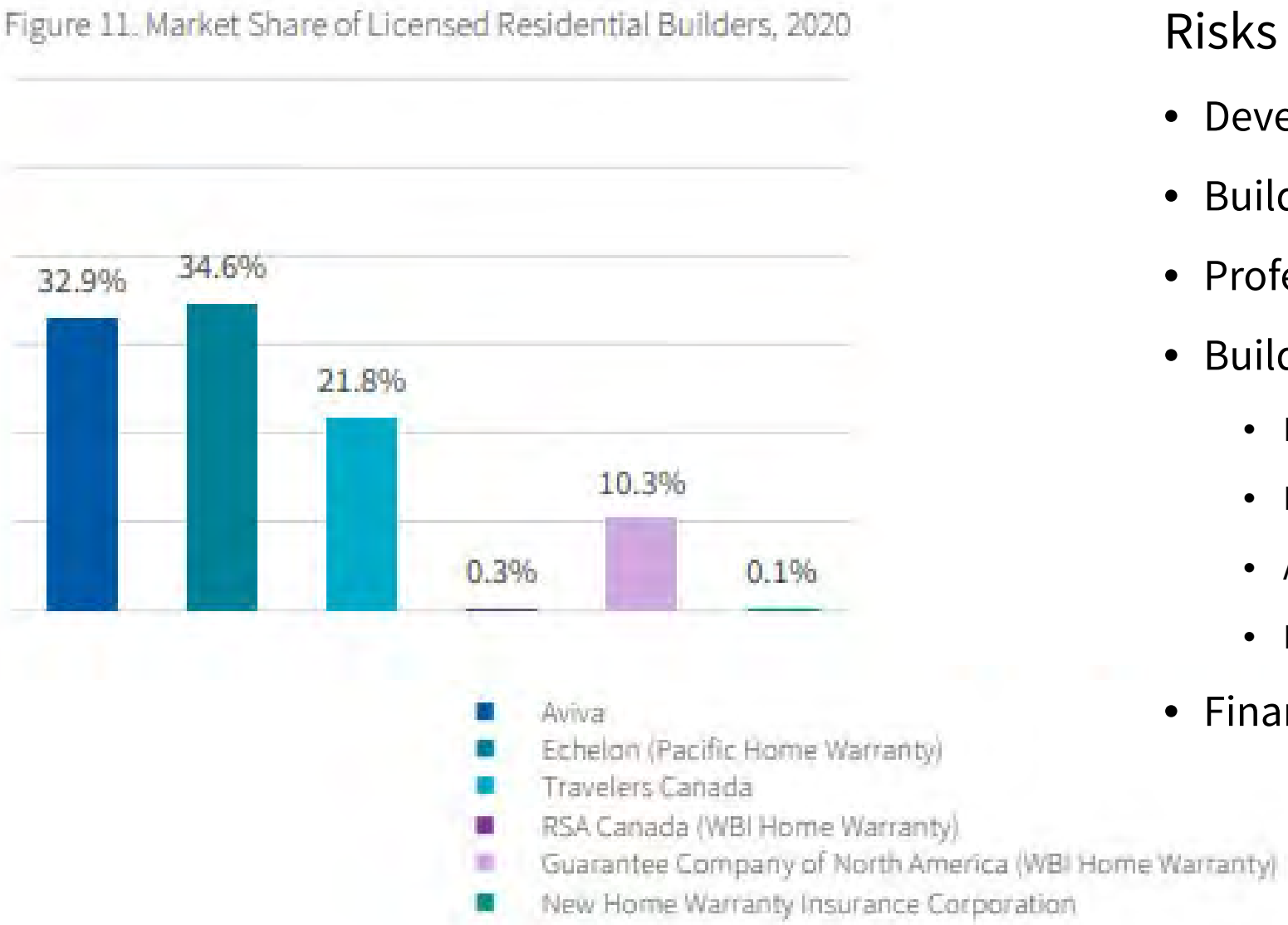
- Licensing of residential builders
- Mandatory, third-party home warranty insurance
  - 2-5-10 Year Home Warranty Insurance
- Research and education that benefits the residential construction industry and consumers

BRITISH COLUMBIA

BC HOUSING RESEARCH CENTRE

MBAR MOBILIZING BUILDING ADAPTATION AND RESILIENCE

BCFSA authorized home warranty insurance companies



Risks also shared and managed by

- Developers
- Builders
- Professionals on record
- Building/Homeowners
  - Maintenance
  - Repair
  - Access
  - Liabilities
- Financial institutions and Others

BC HOUSING RESEARCH CENTRE

MBAR MOBILIZING BUILDING ADAPTATION AND RESILIENCE

Gathering, Sharing, Implementing, Growing Knowledge

Opportunity: Grow a knowledge hub

MBAR Stakeholder Roundtables

Proactive Research

Digital Library Collection

- BC Housing MBAR research
- Partner materials
- Videos - YouTube, Vimeo
- Data sets
- Tools - spreadsheets, calculators
- Conference proceedings
- Specification writing tools

Published in June 2019 through research partnership of governments and industry

MBAR Pilots – Supportive Research & Lessons Learned

Works with pilot project owners to identify priorities, and provides **supportive research** to evaluate options, inform decisions and reduce barriers for pilot projects.

Supportive research generates **shared** knowledge that become **engaging content** for tools, guides, templates, videos and training curriculum.

Lessons Learned in the words of a pilot project developer (QuadReal):

- Resiliency strategy needs to be considered early in design
- Process led by Owner
- Codes and regulation can support the process
- Knowledge needs to be shared

BRITISH COLUMBIA

BC HOUSING

MBAR
MOBILIZING BUILDING ADAPTATION AND RESILIENCE

MBAR Pilots

QuadReal™

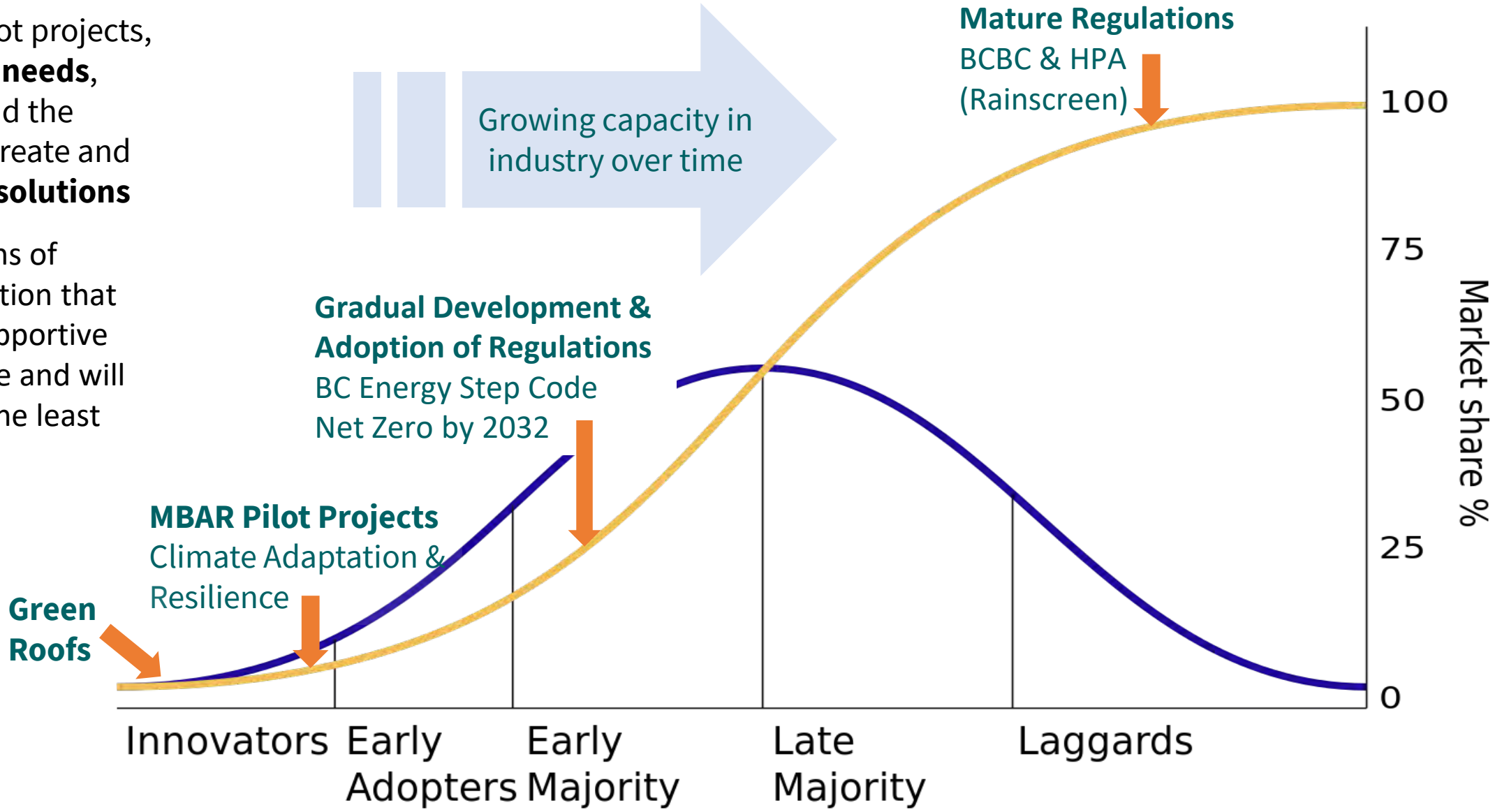
CONCERT™

BC HOUSING

Urban arts
Architecture Urban Design

Transforming Industry Practice

- Through pilot projects, understand **needs**, **barriers**, and the process to create and implement **solutions**
- Identify paths of implementation that are most supportive and effective and will encounter the least resistance.



MOBILIZING BUILDING ADAPTATION AND RESILIENCE

Image credit: Wikipedia

City of Vancouver GRI Pathways Study

Workshop #2a Green Roof Barriers & Solutions

Green Roof info Think-Tank

July 14, 2022

Representing Green Roof info Think-Tank:
Christine Thuring, B.Sc., M.Sc., Ph.D.

Who/ What is GRiTT Vancouver?

Affiliate of Portland-based Green Roof Info Think-Tank (GRIT), a registered 501c-3 non-profit in Oregon.

GRiTT Vancouver is a network of businesses, non-profits, researchers and community members united to advance the widespread implementation of green roofs in Metro Vancouver.

Outline

1) GRiTT Perspectives
2) Perceived Barriers and Solutions
3) Solutions for Vancouver

GR = green roofs

GRiTT Perspectives

1) GR are feasible on sloped & residential roofs, on timber frame constructions (commonplace in Europe!)
2) GR percentages for different building types can be higher than current suggestion (10-30%)

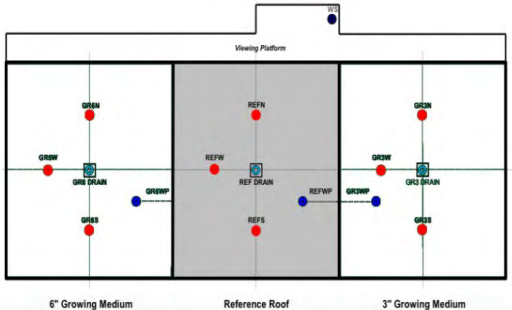
GR are good investments in the Pacific Northwest climate, overall, especially in the summer.

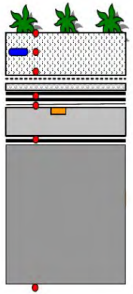
We have 20 years of research on GR performance via BCIT

Research Infrastructure	Stormwater	Energy	Acoustics	Maintenance	Primary Investigators
VPL Green Roof	O				Kerr Wood Liedal
Green Roof Research Centre Phase 1 Phase 2	O	O	O	O	Connelly M. et al, Rousseau, N. & Dunster, K.
Green Facades	O				Connelly, M. & Rousseau
Regional Infrastructure network					
Electronic Art	O				Acosta, K. et all
White Rock Operations	O				Acosta, K. et all
Capital Regional District	O				Acosta, K. et all
I_O sound transmission suite			O		Connelly, M. & Hodgson, M.
Roof Evaluation Modules	O	O	O		Snell, J. et all
Elevated Lab			O	O	Connelly, M., Nagano, M., Rousseau, N. Thuring, C.
Living Walls					Akbarnejad, M., Danesh Panah, S., Bartlett, K., Cheng, I.
Field: Vancouver Conference Centre			O		Nordic, S. & Connelly, M.
Field: Olympic Village			O		Connelly, M., Foroughi, M., Zhang, S.
Design applications			O		Kanjanakunchorn, K.
BS Envelope Huts		O			Tariku, F.,
Blue/Green modules	O				Mora, R., Chan, C.,

See the CMHC report:

M. Connelly et. al. 2006. "**BCIT Green Roof Research Program, Phase 1 Summary of Data Analysis**, Report to Canada Mortgage and Housing Corporation [PDF] by Centre for the Advancement of Green Roof Technology," BCIT.





We also have GR performance data from the Regional Infrastructure Network.

Electronic Arts 1760 m^2

Fall season 3 months
64% run-off reduction

Capital Region District 196 m^2

Aug to Jan
74.5% run-off reduction
Rainfall in time period 356 mm

White Rock operations 135 m^2
700 mm annual rain fall

Annual
52 % run-off reduction
Dry season 87 %
Wet season 40 %
Delay 17 hrs/ 2 hrs.....

This work is grounded in 20 years of collaboration.

BC Housing

Natural Sciences and Engineering Research Council of Canada

Pacific Economic Development Canada

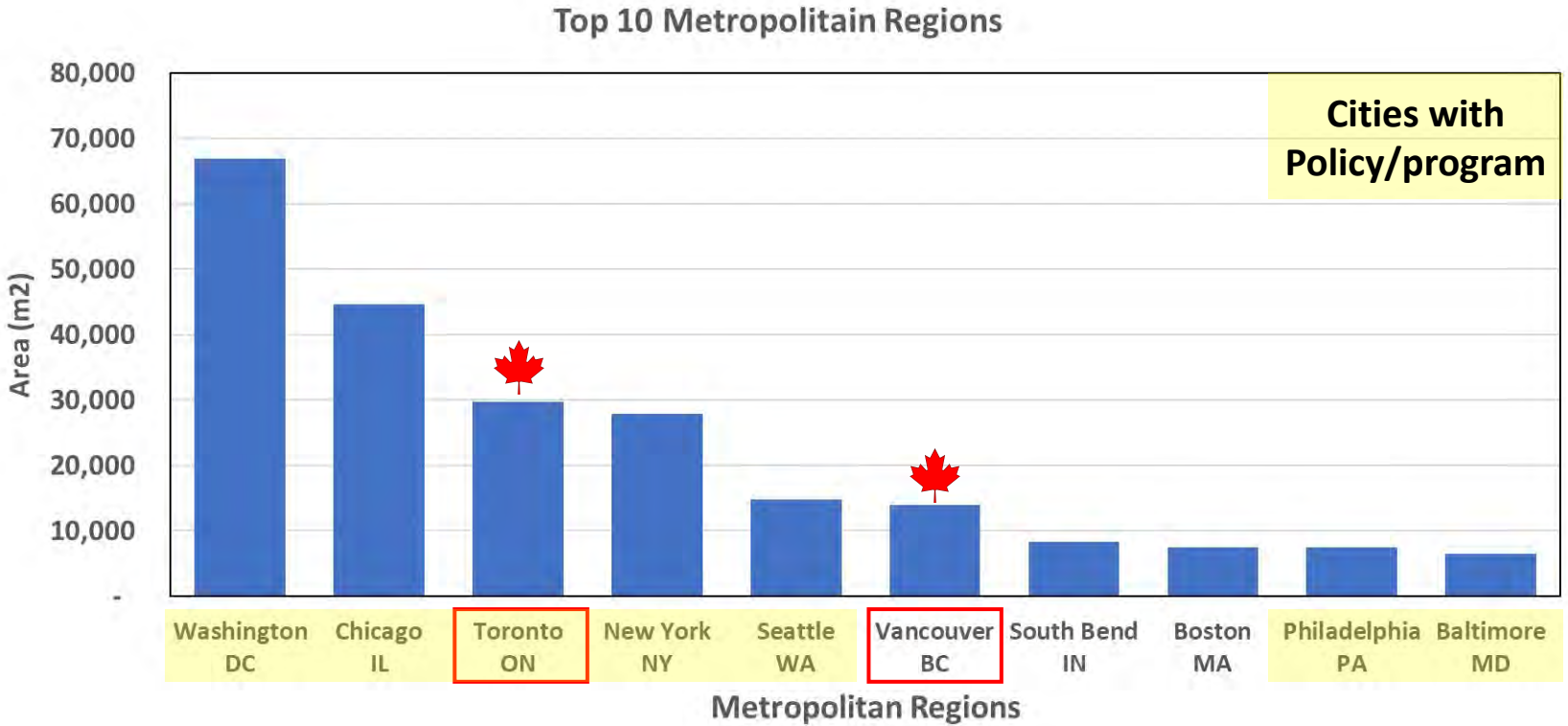
Roofing Contractors Association of BC

Environment Canada

Metro Vancouver

National Research Council Canada

Government policy is a key driver for GR adoption, as shown by the 2018 North American Industry survey:



SOURCE: Green Roofs for Healthy Cities

https://greenroofs.org/policy-resources

Numerous cities around the world have green roof programs. Political will and leadership are both essential.

Perceived Barriers and Solutions

“Adopted presumptions” that perpetuate myths

- Misunderstandings must be addressed
- Resolve questions with clarity
  - **GRiTT can offer “ask-me-anything” sessions**

Lacking/ poor communication between silos

- Integrated design teams are essential for success on inter-disciplinary matters

Perceived Barriers and Solutions

Long-term performance/ maintenance

- Suggest 5-yr renewable terms after hand-over
- Tie-in with operations manual of building
- Inspection & enforcement: annual, educational
- Consider 2-5-10 warranty structure, as in TO
  - 2 years on labour and materials
  - 5 years on building envelope
  - 10 years on structure

Home insurance issue..?

Perceived Barriers and Solutions

Higher upfront costs

- Costs of <u>not</u> greening our roofs?
- Financial incentives can offset initial costs, *e.g.*
  - *City of Toronto's EcoRoof incentive program*
  - *NYC's Green Roof Tax Abatement program*

Solutions for Vancouver

Climate emergency, biodiversity crisis, pollution

- "Impact" from Greenest City Action Plan
  → "use all our tools"
- Create fund for existing and aging housing stock
- Act like it's an emergency: work together

Aim for multi-functionality

- e.g., GRs that integrate solar panels and biodiversity ("biosolar", or "agri-voltaic roofs")

Solutions for Vancouver

Policy and funding

- Create fund or incentive to help green building stock, both existing and new

Update by-laws and policies

- e.g., Rainwater harvest and re-use on landscape
- Develop a Vancouver GR mandate

Collaborate and communicate better

- **GRITT members have heaps of local knowledge and scientific & practical expertise**

Let's work together! GRiTT can help:

- Collaborate on technical standards and guidelines (design, installation, maintenance)
- Provide "ask-me-anything" sessions
- Anything else? Get in touch: **gritt.vancouver@gmail.com**

Success for Green Roofs

as a Green Rainwater Infrastructure strategy

James Klassen, Technical Advisor (RCABC)

Success for Green Roofs

as a Green Rainwater Infrastructure strategy

Let's talk about

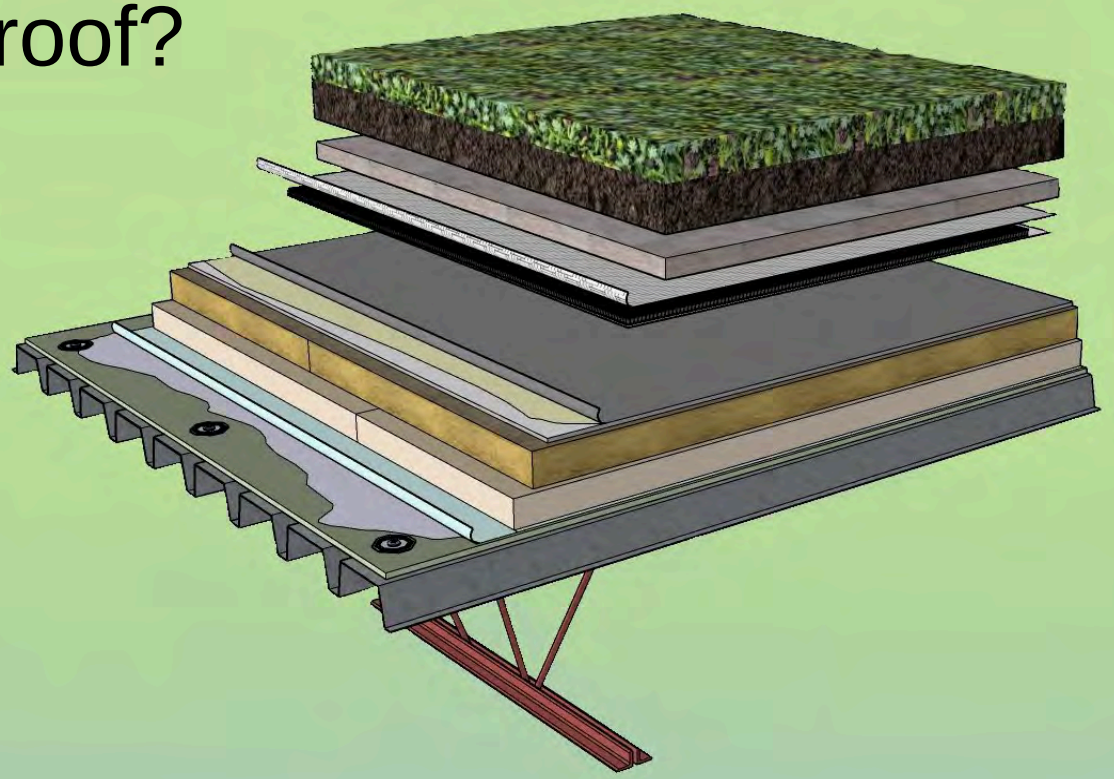
- ☆ what makes a green roof
- ☆ myths and misconceptions
- ☆ why green roofs underperform or fail, and
- ☆ how green roofs succeed

Brooklyn Grange, NYC
Photo credit: Brooklyn Grange

Success for Green Roofs

as a Green Rainwater Infrastructure strategy

What is a green roof?



Green Roof System

Roof Assembly

Success for Green Roofs

as a Green Rainwater Infrastructure strategy

What is a green roof?

- Vegetated systems (the green part) generally are comprised of
  - ✓ a root barrier (sheet material)
  - ✓ a drainage layer (to convey water toward roof drains)
  - ✓ Filter fabric (to prevent fine material from clogging up the drainage layer and drains)
  - ✓ a water-retention material (to store water for plants to draw from)
  - ✓ Growing media (engineered to be light-weight, hold air and water and yet drain adequately, and provide nutrients for the plants)

Success for Green Roofs

as a Green Rainwater Infrastructure strategy

What is a green roof?

- The waterproofing platform (the black or grey part) generally is comprised of
  - ✓ a roof deck (structural)
  - ✓ an air/vapour control membrane (this depends on the assembly type)
  - ✓ Insulation
  - ✓ an insulation overlay board (only when insulated below the roof membrane)
  - ✓ the roof membrane (the primary layer that waterproofs the roof and protects the building)

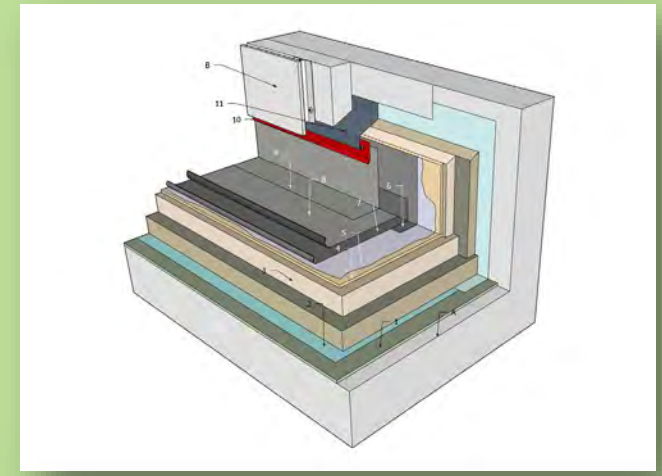
(cont.)

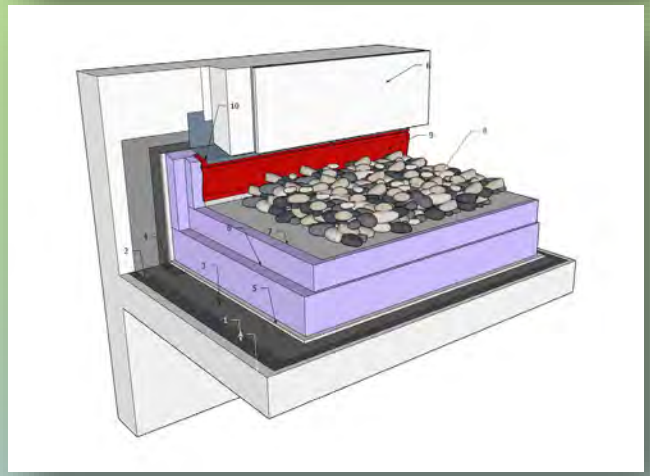
Success for Green Roofs

as a Green Rainwater Infrastructure strategy

What is a green roof?

- The roof platform is generally designed according to one of two assembly types:
  - ✓ Conventionally insulated (insulated below the roof membrane, which is exposed to the elements)
  - ✓ Protected (where the membrane lies below insulation, which affords it protection)





Images from RCABC Roofing Practices Manual
Construction Details (Division D)
Image credit: RCABC

Success for Green Roofs

as a Green Rainwater Infrastructure strategy

What is a green roof?

A green roof system, and the roof platform that supports it, each must

- ✓ be well designed
- ✓ use appropriate materials
- ✓ be professionally constructed (this means by knowledgeable, practiced installers)
- ✓ be maintained

Success for Green Roofs

as a Green Rainwater Infrastructure strategy

What is a green roof?

For green roofs to be truly successful, both the Green Roof System and the platform that supports it (Roof Assembly) also must be

- ✓ designed and constructed according to an accepted Standard
- ✓ independently reviewed during construction for quality assurance
- ✓ commissioned with a QA certificate

Success for Green Roofs

as a Green Rainwater Infrastructure strategy

Myths and misconceptions

- ✘ Green roofs are uninsurable

Success for Green Roofs

as a Green Rainwater Infrastructure strategy

Myths and misconceptions

- ~~Green roofs are uninsurable~~
  - ✓ Part 3 buildings generally are heavier in construction (concrete/steel) but some are constructed of “mass timber” (CLT, NLT, DLT, Glulam)
  - ✓ The former MEC office building on Great Northern Way (now Electronic Arts)
    - ✓ has a laminated wood deck
    - ✓ supported a green roof system
    - ✓ carried RCABC’s RoofStar Guarantee, and
    - ✓ was insured under MEC’s property assets policy

Former MEC headquarters, Vancouver

Photo credit: Green Roofs for Healthy Cities

Success for Green Roofs

as a Green Rainwater Infrastructure strategy

Myths and misconceptions

- ~~Green roofs are uninsurable~~
  - ✓ Part 9 buildings (wood-framed; up to 3 stories; limited footprint of 600 m^2, etc.)
  - ✓ BC Housing now manages the former Homeowners Protection Office (HPO)
  - ✓ Policies underwritten by 8+ widely recognized insurers, including Travelers and Aviva
  - ✓ Standard for underwriting is the “Residential Construction Performance Guide” (available online) which permits roofs designed to retain water (item 5.16, “Standing water on a flat roof”)

Photo credit: source unknown

Success for Green Roofs

as a Green Rainwater Infrastructure strategy

Myths and misconceptions

- ✘ Green roofs leak

Photo credit: Basilmomma

Success for Green Roofs

as a Green Rainwater Infrastructure strategy

Myths and misconceptions

- ~~Green roofs leak~~
  - ✓ Green roofs, per se, do not leak – only the waterproofing beneath them leaks
  - ✓ Waterproofing leaks occur because of
    - Poor design (sometimes)
    - Flawed execution (common)
    - Failed materials (rare)
    - Damage by others (occasionally)

VanDusen Gardens, Vancouver

Photo credit: Zinco

Success for Green Roofs

as a Green Rainwater Infrastructure strategy

Myths and misconceptions

- ✘ Green roofs are too expensive
- ✘ Green roofs offer no tangible benefits
- ✘ Green roofs are a fire hazard

and the list goes on…

Vancouver Convention Centre

Photo credit: RCABC

Success for Green Roofs

as a Green Rainwater Infrastructure strategy

But

every myth has a reason,

and the most likely reason behind all these myths is that…

Success for Green Roofs

as a Green Rainwater Infrastructure strategy

…green roofs can’t be trusted.

Success for Green Roofs

as a Green Rainwater Infrastructure strategy

Green roofs can't be trusted

because somewhere, in someone's experience, a green roof was a failure.

It didn't perform as promised.

It died.

It leaked (the green roof didn't leak, but perception is reality, so it's pointless to argue with what people fixate on)

Success for Green Roofs

as a Green Rainwater Infrastructure strategy

The failure bred suspicion.

Suspicion led to stories.

And the stories became the myths we trip over time and again.

Success for Green Roofs

as a Green Rainwater Infrastructure strategy

So, why should insurers, developers, general contractors, and the public trust a green roof?

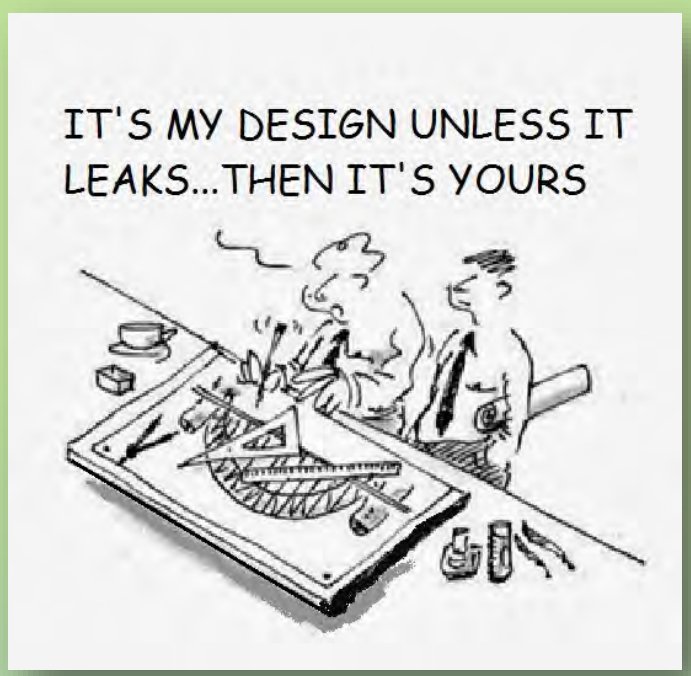
To answer that question, let's look at some of the reasons why folks *mistrust* them.

Success for Green Roofs

as a Green Rainwater Infrastructure strategy

Why green roofs underperform or fail

- Inadequate or uniformed design (architect)
  - Unsuitable plant profile for location
  - Poor drainage
  - Wrong growing media (no topsoil, please)
  - Tendered as part of the landscaping scope
  - Etc....

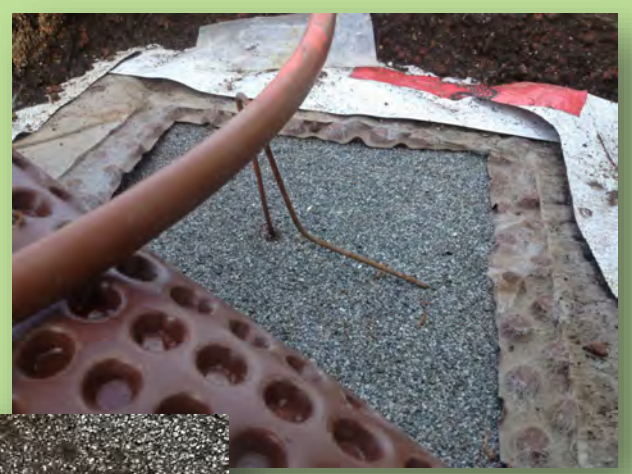


Success for Green Roofs

as a Green Rainwater Infrastructure strategy

Why green roofs underperform or fail

- Inadequate or uninformed design
- Poor installation (installer)
  - Materials installed incorrectly
  - Omitted materials (like a root barrier)
  - Materials installed by unqualified workers
  - Failure to follow best practices (i.e., omitting separation zones)



Irrigation support driven through roof waterproofing membrane
Photo credit: RCABC

Root damage to membrane (six years, no maintenance)
Photo credit: RCABC

Success for Green Roofs

as a Green Rainwater Infrastructure strategy

Why green roofs underperform or fail

- Inadequate or uninformed design
- Poor installation
- Little to no maintenance (owner)
  - ✖ No irrigation during plant establishment
  - ✖ Intrusive species allowed to persist
  - ✖ Culling and replanting overlooked

Burnaby sedum roof – left unmaintained for six years

Photo credit: RCABC

Success for Green Roofs

as a Green Rainwater Infrastructure strategy

Why green roofs underperform or fail

- Inadequate or uninformed design
- Poor installation
- Little to no maintenance
- Damage to or failure of the waterproofing (installer/maintenance/roofer)
  - Failed detailing executed by roofing trade
  - Materials unsuitable for green roofing
  - Damage to the waterproofing membrane (often by green roof installers who do not appreciate the nature of a roof)

EPDM (“rubber”) roof membrane damaged by landscaper’s tool
Photo credit: RCABC

Success for Green Roofs

as a Green Rainwater Infrastructure strategy

Why green roofs underperform or fail

- Inadequate or uninformed design
- Poor installation
- Little to no maintenance
- Damage to or failure of the waterproofing
- No objective Standard to guide design and installation
  - FLL (German standard) is a terrific starting point, but it lacks contextuality for the BC South Coast
  - A Standard must address the full scope of green roof design, from hydrology and plant profile to media composition and specified or recommended maintenance

Sedum mix
Photo credit: unknown

Success for Green Roofs

as a Green Rainwater Infrastructure strategy

Why green roofs underperform or fail

- Inadequate or uninformed design
- Poor installation
- Little to no maintenance
- Damage to or failure of the waterproofing
- No objective Standard to guide design and installation
- Absence of independent QA/QC reviews during construction to ensure conformity to a Standard
  - ✘Prudence says (to paraphrase Ronald Regan's favourite Russian proverb, "Trust but verify")

Example of separation zones around details and perimeters
Photo credit: Architek Sustainable Building Products Inc.

Success for Green Roofs

as a Green Rainwater Infrastructure strategy

Why green roofs underperform or fail

- Inadequate or uninformed design
- Poor installation
- Little to no maintenance
- Damage to or failure of the waterproofing
- No objective Standard to guide design and installation
- Absence of independent QA reviews during construction to ensure conformity to a Standard
- No review post-construction to ensure survivability and conformity to design profile
  - ✘A green roof that is dead or dying after 2 years (or 5 years) won't achieve the objective metrics required by city policy

A dead green roof
Photo credit: Unknown

Success for Green Roofs

as a Green Rainwater Infrastructure strategy

How green roofs succeed

- Success occurs when both the Roof Assembly (platform) and the Green Roof System are
  - ✓ Thoughtfully designed, following accepted Standards
  - ✓ Professionally installed by trained personnel (we're working on a training program for green roofing)
  - ✓ Built cooperatively (one depends upon the other)
  - ✓ Independently reviewed for quality assurance
  - ✓ Routinely maintained
  - ✓ Periodically reviewed for performance, and to verify maintenance

Vancouver House

Photo credit: Architek Sustainable Building Products Inc.

Success for Green Roofs

as a Green Rainwater Infrastructure strategy

RCABC ROOFING CONTRACTORS ASSOCIATION OF BRITISH COLUMBIA | RoofStar GUARANTEED. BETTER.

To really build trust, you need someone to make a financial commitment, to certify and guarantee

- ✓ that roofing and green roofing each conform to their respective Standards
- ✓ that the roof and green roof were built by qualified people
- ✓ that the green roof will survive to achieve the municipal or provincial goals for stormwater detention, biodiversity, etc.

Success for Green Roofs

as a Green Rainwater Infrastructure strategy

RCABC ROOFING CONTRACTORS ASSOCIATION OF BRITISH COLUMBIA | RoofStar GUARANTEED. BETTER.

RoofStar Guarantee certification program – a model for building trust that works!

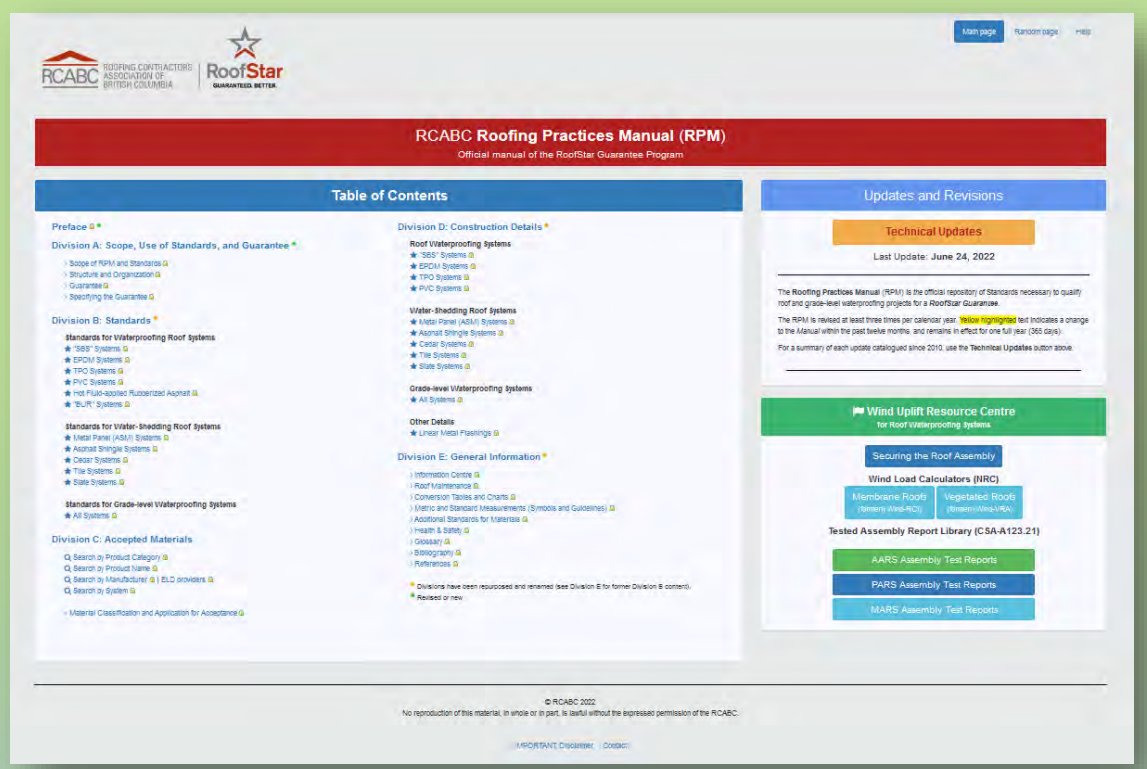
- ✓ Objective, rational, clear Standards
- ✓ Member-driven with enforceable bonds
- ✓ Accepted materials (material bonds supplied by manufacturers)
- ✓ Training, TQ certification, and mandatory TQ crew ratios
- ✓ Independent observations
- ✓ Maintenance reviews throughout certificate period
- ✓ Required maintenance (failure to maintain a roof can void the Guarantee)

Success for Green Roofs

as a Green Rainwater Infrastructure strategy

RCABC

- ✓ https://www.rcabc.org/
- ✓ https://rpm.rcabc.org/



Success for Green Roofs

as a Green Rainwater Infrastructure strategy

Codes are a good place to ground the framework

- The VBBL (like the BC Building Code) is driven by objectives
- Green roofing, partnered with sound waterproofing (roofing), can help achieve those objectives (Division B, Part 5):
  - ✓ Wind resistance
  - ✓ Heat resistance
  - ✓ Dissipation of heat
  - ✓ Accumulation/detention and disposal of rainwater
  - ✓ Sound attenuation
  - ✓ Waterproofing…

Success for Green Roofs

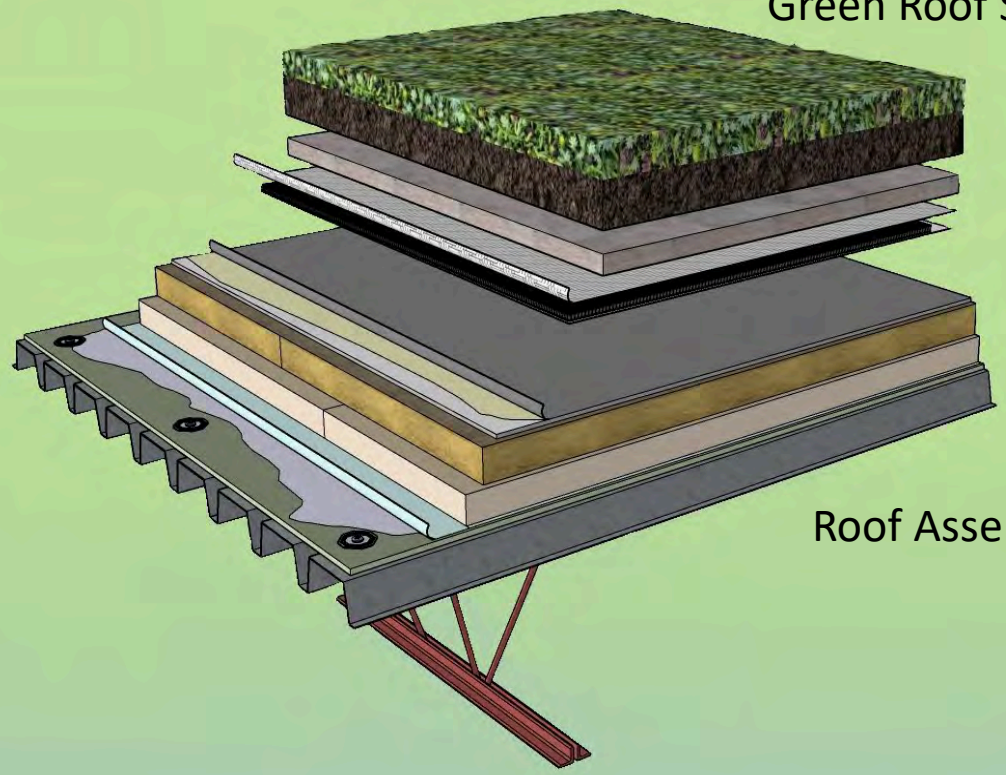
as a Green Rainwater Infrastructure strategy

Thriving, functional Green Roof System

- Designed and constructed to a Standard
- Installed and maintained professionally
- Certified as QA-compliant

Durable Roof Assembly (Platform)

- Designed and constructed to a Standard
- Built professionally with accepted materials
- Independently reviewed for QA
- Certified as QA-compliant



City of Toronto Green Roof Bylaw

City of Vancouver Green Roof
Workshop 7/14/2022

Shayna Stott, City of Toronto
City Planning Division

TORONTO

City of Toronto Green Roof Bylaw
12 years and counting !

950 green roofs

900,000 sq.m

140 World Cup soccer fields

History

Green Roof Cost Benefit Study, Green Roof Strategy, Incentive program

2006

City of Toronto Act, Authority to require and govern construction of green roofs

2006

City of Toronto Green Roof Policy For City Owned Buildings

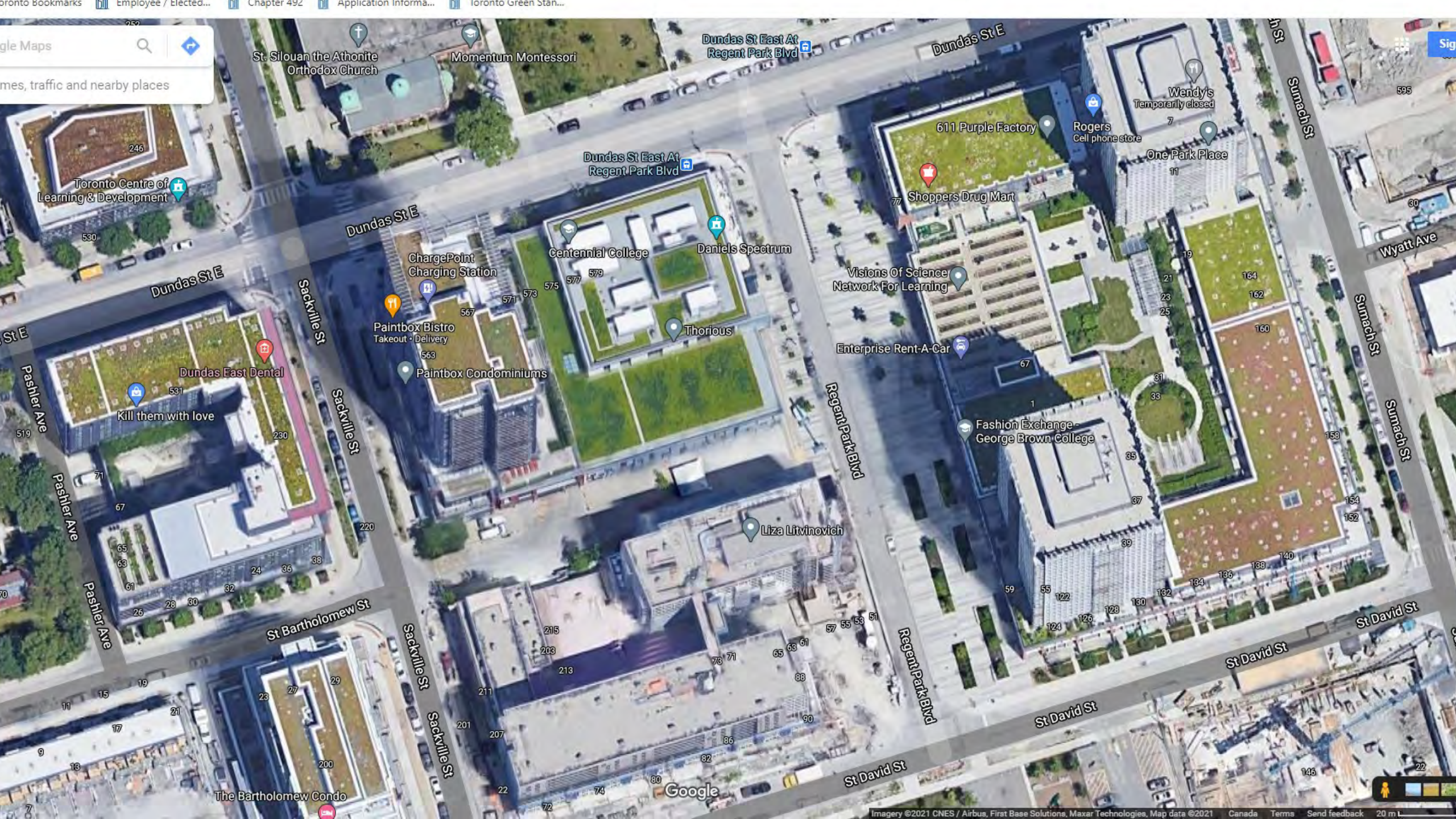
2008

Green Roof Bylaw Adopted by Council, OBC applicable law

2009

Green Roof Bylaw In effect

2010


St. Silouan the Athonite Orthodox Church
Momentum Montessori
Dundas St East At Regent Park Blvd
Dundas St E
Wendy's
Temporarily closed
Sumach St
Toronto Centre of Learning & Development
611 Purple Factory
Rogers
Cell phone store
One Park Place
Shoppers Drug Mart
Dundas St East At Regent Park Blvd
Centennial College
Daniels Spectrum
ChargePoint Charging Station
Wyatt Ave
Visions Of Science Network For Learning
Paintbox Bistro
Takeout · Delivery
Thorious
Paintbox Condominiums
Enterprise Rent-A-Car
Dundas East Dental
Kill them with love
Sackville St
Pashler Ave
Regent Park Blvd
Fashion Exchange - George Brown College
Liza Litvinovich
St Bartholomew St
St David St
The Bartholomew Condo
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Terms
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20 m

Bylaw Structure

Policy

- All New Buildings greater than 2,000 m^2 GFA
- Mid-rise and Industrial provisions
- Technical Amendments/ Transit network amendment

Gross Floor Area (Size of Building)	Coverage of Available Roof Space (Size of Green Roof)
2,000 – 4,999 m^2	20%
5,000-9,999 m^2	30%
10,000-14,999 m^2	40%
15,000-19,999 m^2	50%
20,000 m^2 or greater	60%

Bylaw Structure

Available Roof Space

Available Roof Space is the total roof area excluding:

- areas devoted to renewable energy
- private terraces
- required outdoor amenity areas
- Tower roof area (<750 sq.m floorplate)

TORONTO City Planning Division

Green Roof Statistics

The Green Roof Statistics Template is required to be submitted for Site Plan Control Applications where a green roof is required under the Toronto Municipal Code Chapter 492, Green Roofs. Complete the table below and **copy it directly onto the Roof Plan** submitted as part of any Site Plan Control Application requiring a green roof in accordance with the Bylaw. Refer to Section § 492-1 of the Municipal Code for a complete list of defined terms, and greater clarity and certainty regarding the intent and application of the terms included in the template. The Toronto Municipal Code Chapter 492, Green Roofs can be found online at: http://www.toronto.ca/legdocs/municode/1184_492.pdf

Green Roof Statistics

		Proposed
Gross Floor Area, *as defined in Green Roof Bylaw* (m^2)		
Total Roof Area (m^2)		
Area of Residential Private Terraces (m^2)		
Rooftop Outdoor Amenity Space, *if in a Residential Building* (m^2)		
Area of Renewable Energy Devices (m^2)		
Tower (s)Roof Area with floor plate less than 750 m^2		
Total Available Roof Space (m^2)		
Green Roof Coverage	Required	Proposed
Coverage of Available Roof Space (m^2)		
Coverage of Available Roof Space (%)		

TORONTO

Bylaw Structure

Green Roof Construction Standard

- Green Roof Assembly
- Gravity Loads Waterproofing
- Drainage
- Water Retention
- Vegetation Performance
- Plant Selection
- Occupancy and Safety
- Irrigation
- Maintenance
- Slope Stability
- Parapet Height and /or Overflow Scupper Locations
- Wind Uplift
- Fire Safety

Bylaw Structure
Cash-in-lieu

- Cash in lieu compliance option
- $200/m^2 (20/ft^2)
- 7.5 % of green roof permits (116 permits) requested cash-in-lieu
- Funds dedicated to the Eco-Roof Incentive Program

TORONTO

Lessons Learned

- Consultation with industry
- Flexibility mechanisms
- Value of regulation in market development
- Connections to stormwater approvals
- Maintenance/inspections
- Monitoring
- Climate Resilience

Questions?

Shayna Stott
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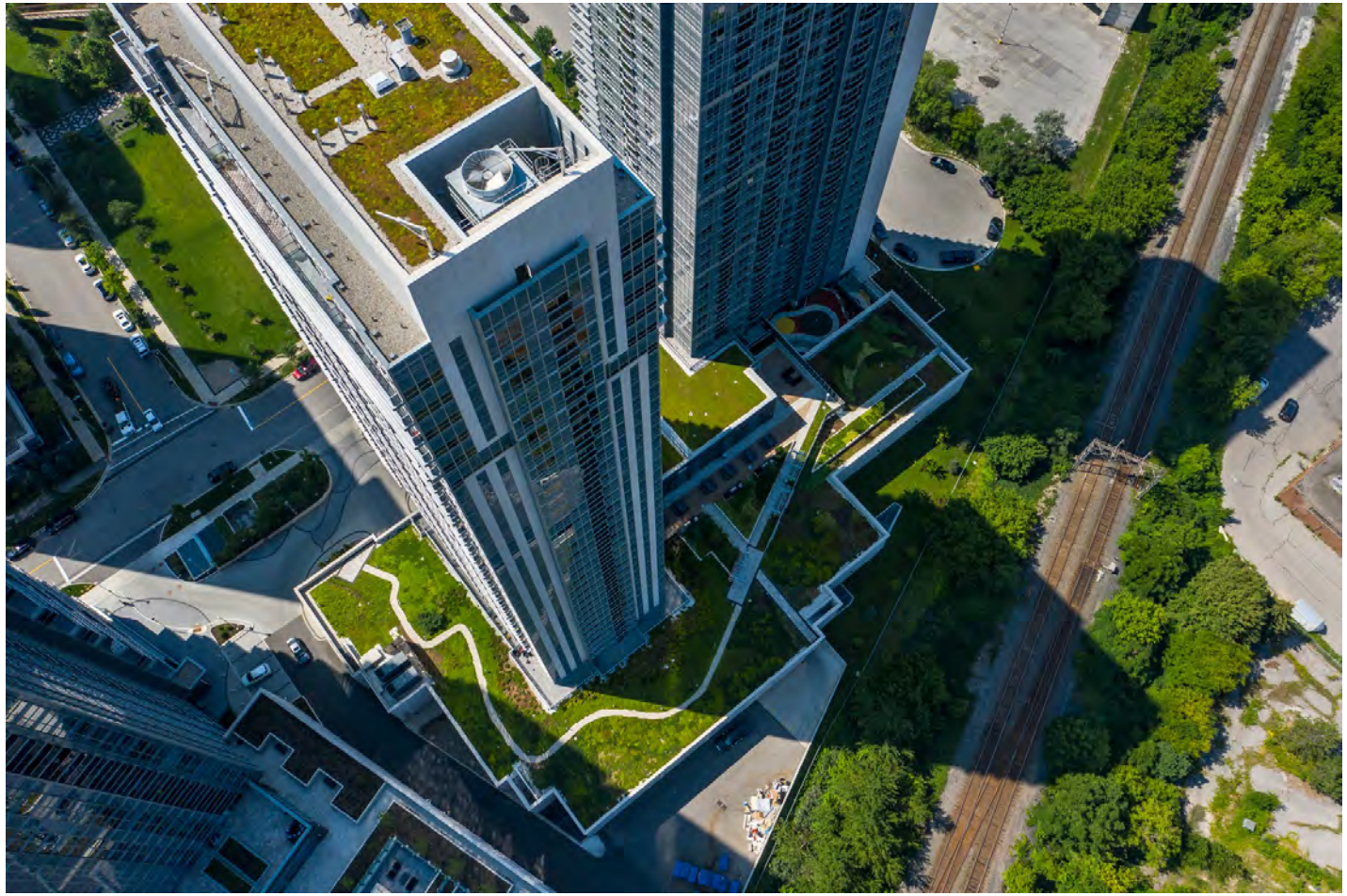
City Planning Division
Shayna.Stott@Toronto.ca
416-392-0171



TORONTO

BREAK

Bioretention in interior courtyard of residential development, San Francisco (Bruce Damonte)

CITY OF VANCOUVER | GREENEST CITY

PANEL Q&A

Scupper drains into terraced biofiltration planter at Santa Catalina School, Monterey (BFS Landscape Architects)

BREAKOUT ROOMS

Bioretention in interior courtyard of residential development, San Francisco (Bruce Damonte)

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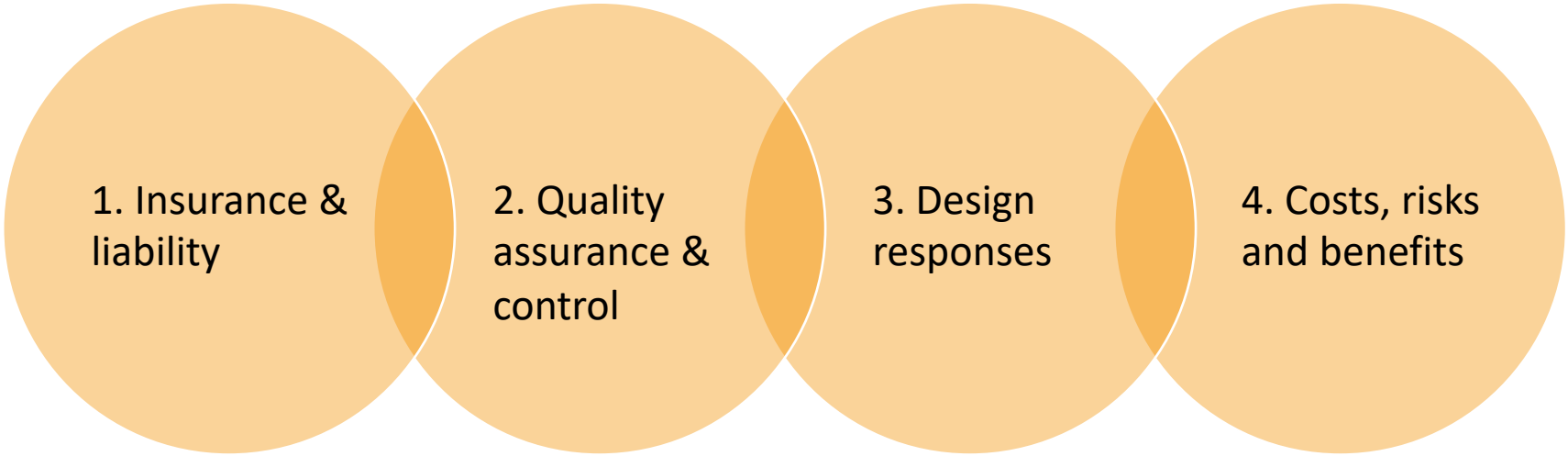

BREAKOUT THEMES

NEXT STEPS

WE ARE HERE

July - Dec. 2021	January - October 2022		Sept. '22 - Jan. '23
SECTION 1 Typologies, Tools, & Barriers	**SECTION 2** Design Standards, Modeling, Costs	**SECTION 3** Benefits & Solutions	**SECTION 4** Policy Implications & Implementation
• Representative Building-Site Typologies • Rainwater Management Tools • Implementation Barriers	• GRI Design Methodology • Performance Modeling • Preliminary Pathway Development • Cost Estimates	• Rainwater Management Co-benefits • Solutions to Barriers	• Recommended Pathways • Policy Options • Implementation Recommendations
Workshop #1 (Oct. 2021)	**Workshop #2a (July 2022)** **Workshop #2b (Oct. 2022)**		**Workshop #3 (Dec. 2022)**

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THANK YOU!

Vancouver Marina (JMR Julian)