Sea2City DESIGN CHALLENGE

North Creek Collective

Design, Planning and Costing Brief

December 2022

Acknowledgements

Flanked to the north by Burrard Inlet, to the west by the Salish Sea, and to the south by the north arm of the Fraser River, Vancouver has always been a coastal community defined by its proximity to the ocean, river and mountains. Vancouver is situated on the unceded traditional homelands of xwmə kwəy'əm (Musqueam), Skwxwú7mesh (Squamish), and səlilwətaɬ (Tsleil-Waututh). The area currently known as False Creek is of significant meaning to the local First Nations who stewarded the land since time immemorial.

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Indigenous Knowledge Keeper

Charlene Aleck — Tsleil Waututh Knowledge Keeper

The City Advisory Team:

Amir Taleghani, P.Eng — Engineering

Angela Danyluk, RPBio — Project Manager

Brad Badelt, P.Eng — Sustainability Group

Brian Sears — Real Estate and Facilities Management

Claire Lee — CMHC-Granville Island

Cory Dobson — Planning, Urban Development & Sustainability

Debra Barnes — Park Board

Dora Li — Planning, Urban Development & Sustainability

Ginger Gosnell-Myers — Squamish Nation

Hayley Hoikka — Planning, Urban Development & Sustainability

Holly Schmidt — Engineering Artist-in-Residence

Jeannie Lee, P.Eng — Engineering

Jeremie Stephenson — Finance

Jordan McAuley — Park Board

Justin Li, P.Eng — Engineering

Kathleen Edwards — Squamish Nation

Kelly Carswell — Environmental Services

Marga Pacis — Assistant Project Manager

Natalia Myles, P.Eng — Engineering

Natasha McPherson — Engineering

Oswal Fuentes — Real Estate and Facilities Management

Rachel Telling — Assistant Project Manager

Sanya Pleshakov — Tsleil-Waututh Nation

Sarah Sutton — Real Estate and Facilities Management

Sarah Dal Santo — Tsleil-Waututh Nation

Sebastian Lippa — CMHC-Granville Island

Tugce Conger, Ph.D — Engineering

The Technical Advisory Group:

Andreanne Doyon — Simon Fraser University

Brent Burton, P. Eng. — Metro Vancouver

Danilo Caron — University of British Columbia

DG Blair, M.Sc. — Stewardship Centre for BC

Grant Lamont, P.Eng — Northwest Hydraulic Consultants

Isabel Kunigk — space2place

Jantsje van Loon — Wageningen University and Research

Jeff Cutler — space2place

Jessica Wilson, P. Eng — Northwest Hydraulic Consultants

Jim Papadoulis, P. Eng — BC Hydro

Kees Lokman — University of British Columbia

Khidhir Jorj, M.Sc., P.Eng — EXP Services

Mark Potyrala, RPBio — Department of Fisheries and Oceans

Mathilde Jung — Living with Water-UBC

Mujib Rahman, P.Eng — Fortis BC

Patrick Lilley, RPBio — Kerr Wood Leidel

Rebecca Seifert — Department of Fisheries and Oceans

Sara Jossul, RPBio — Department of Fisheries and Oceans

Tamsin Lyle, P. Eng — Ebbwater Consulting

Tira Okamoto — Living with Water-UBC

Tsjerk Vandoornik — Living with Water-UBC

The Community Advisory Group:

Andrea McDonald, April Treakle, Clare Wilkening, Evan Gal, Helen Lui, Imogene Broberg-Hull, Katherine Lauriente, Liz Dong, Maura Brown, Nati Herron, Patricia Schavarosk, Raphael Dipasupil, Sharman King, Steve Ellis, Warren Walker, Yael Stav, Zaida Schneider

The Youth Adaptation Lab:

Trisha Barbarona, Nabila Basri, Natasha Birdi, Pierce Burns, Shalen Chen, Emma Griggs, Gary Ip, Lisa Iqbal, Alex Mc Hugh, David Minic, Sayemin Azam Naheen, Jasmin Ogilvie, Adjoa Quainoo, Lia Laureen Schulz, Corrina Tang

North False Creek Collective Core Consultant Team

Derek Lee — PWL Partnership

Sophie MacNeill — PWL Partnership

D'Arcy Hutton — PWL Partnership

Meredith Wilson — PWL Partnership

Beau Wuthrich — PWL Partnership

Cory Douglas — Modern Formline Design

Nathalie de Vries — MVRDV

Kristina Knauff — MVRDV

Stijn Lanters — MVRDV

Enno Zuidema — MVRDV

Begonia Arellano Jaimerena — Deltares

Mark Niesten — Deltares

Floris Boogaard — Deltares

Henriette Otter — Deltares

North False Creek Collective Resource Team

Mitchell Reardon — Happy Cities

Daniel Leonard — Westmar Advisors

Gary Williams — GW Williams Associates Ltd.

Lucas van der Linde — Goudappel

Thomas Straatemeier — Goudappel

Edward Porter — Modus

Rob Barrs — Modus

Table of Contents

1 Planning & Design Brief

Executive Summary

The Sea2City project took place over the course of a year, and included multiple workshops, community events and associated deliverables. The process was collaborative, iterative, and cumulative, and focused on exploring visions and possibilities for our beloved urban waterfront, eminently vulnerable to sea level rise and coastal flooding. The result is not a final solution for False Creek. Rather, it is a renewed approach and deeper understanding of the relationships and connections that sustain us—and how this knowledge might be applied to help tackle the complex challenges we're facing.

Similarly, this report is not an exhaustive collection of work produced during this process. Rather, it is a summary of key outcomes and recommendations, intended to guide future work and approaches to sea level rise in False Creek. It is assumed this report will be read as part of a broader submission that includes the *Sea2City Design Challenge Project Story* and *Project Report*.

A detailed summary of work produced and referenced throughout this document is listed in Appendix 1.

THE PLANNING AND DESIGN BRIEF

1.0 Concept Designs

The document begins with Section 1.0 - a brief summary of the Concept Designs for both sites, which were developed for the final Collaboratorium and public engagement events. These conceptual designs demonstrated how each site may transform between now and the year 2100, prioritizing community values and decolonization to imagine a resilient and vibrant future. Feedback from the Collaboratorium and engagement events further informed the project's Approach (1.1) and identified the Key Considerations (1.2) that required additional clarification and study.

1.1 Approach

Section 1.1 explains the approaches that were integral to our team's process and fundamental in steering the project in a direction that reflected important values and priorities, including:

- Decolonization and Climate Justice
- Language
- (Urban) Integration
- Designing with Nature for Resilience
- Scalability and Phasing

1.2 Key Considerations

The following themes were considerations and concerns that were routinely voiced through various engagement sessions: (1) Flood Management - and understanding how it worked at a site scale (2) Water Quality and Habitat (3) Floating structures and (4) Accessibility and Mobility.

Section 1.2 delves deeper into each of these topics in the following ways:

- Defining the Problem: Outlines the main challenges and issues that the concept designs are seeking to address
- Concept Design Considerations & Constraints: Details how specific conditions and design responses of each site address each theme.
- Additional Consideration for Further Study: Areas identified for additional study, coordination, or exploration
- General Recommendations: A summary of brief and broad recommendations that are specific to the theme and sites.

1.3 Future Design Recommendations

Section 1.3 outlines future design recommendations for the City on how to continue planning for sea level rise in a way that achieves the vision of the Sea2City Design Challenge. These recommendations are broad in scope and focus on key actions that can help to ensure that the valuable lessons learned from this project are carried forward to help guide future decision-making around sea level rise and False Creek.

INTEGRATED FLOOD MANAGEMENT

2.0 General Flood Management Approach

Section 2.0 introduces the project's general flood management approach, which is summarized by basin-scale thinking and nature-based solutions bolstered by protective "hard" measures where necessary, and in response to specific site conditions. It emphasizes "all/and" rather than "either/or." The result is a layered, strategic, permeable approach to flood protection and management that is organized by shoreline zones representative of a natural and resilient shoreline.

2.1 Integrated Flood Management Strategies

Section 2.1 illustrates how this integrated approach can be applied on various sites, using the two project sites (Between Bridges and Coopers Park) as representative of the diverse shoreline conditions found in False Creek. It details specific strategies, providing descriptions of how they function either as flood management elements or adaptive features, and includes ways they may offer layered benefits.

2.2 Flood Management Ribbon

Section 2.2 applies the approach and strategies established in the previous two sections to the stretch of shoreline between Coopers Park and Between Bridges, on the north shore of False Creek. Using layered and diagrammatic site plans, it illustrates how the waterfront may change over time as the sea levels continue to gradually rise.

ADAPTIVE DESIGN BRIEF

The Adaptive Design Brief is considered a high-level document that elaborates on the adaptability of the approach pathway for the two Challenge Sites for sea level rise scenarios of 2.0+ m sea level rise. The section details a value-driven Adaptation Pathways approach, decision-making in times of uncertainty, and the importance of avoiding maladaptation.

"FIRST STEPS" COSTING BRIEF

The "First Steps" Costing Brief explores a series of pilot projects. These projects range from bold ideas for testing and developing innovation to nature-based "quick-starts" to boost biodiversity and other values threatened by sea level rise. High level costing considerations are included to support the implementation process.

APPENDICES

The appendices include precedent projects and important references that are applicable to the content in the report.

1.0 Concept Designs

BETWEEN BRIDGES OVERVIEW

Despite its central location, Between Bridges is currently largely disconnected from the city network,natural processes of its waterfront and urban life. Intertidal and backshore zone are minimal, narrowed by buildings and navigation channel. This future vision for Between Bridges proposes transforming it into a place where urban and aquatic life overlap and thrive - a creative, uplifted land-water community with green-blue connections to the rest of the city. It demonstrates that innovative nature-based solutions along with floating- and adaptive building structures have the potential to support ecological and cultural abundance, even on constrained urban sites. In the future, the city and nature will have a renewed relationship based on a reciprocity of care.

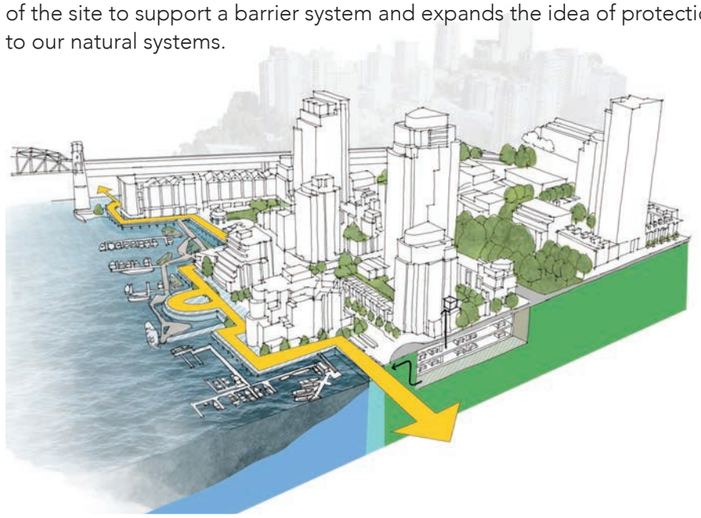
Refer to Appendix 1 for summary of related work.

Right: 2100 Vision for Between Bridges

ADAPTATION TIMELINE

Tomorrow 2030-2050

This approach prioritizes the protection of critical infrastructure while recognizing the necessity of initiating nature-based solutions and systemic mobility upgrades today to ensure resiliency tomorrow. While the traditional response of resistance focuses solely on the protection of property using rigid and ever-raising dykes, this approach recognizes the constraints of the site to support a barrier system and expands the idea of protection to our natural systems.

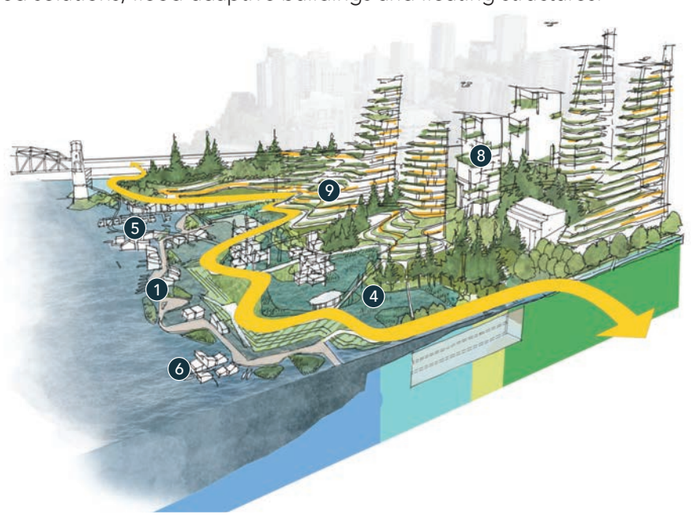


Mid-Term 2050-2100

This approach explores how we can transform the built environment into a resilient and adaptive system that provides the room and support for natural systems to thrive - even in dense and urban sites like Between Bridges. Instead of simply accommodating flooding waters, this approach asks how we can welcome, support, and steward our natural systems — and by doing so, create resilient responses to rising sea levels that are integrated into our urban fabric.

Long-Term 2100+

The approach illustrates a cultural shift and imagines a future where the city has reconnected with nature and recognizes a relationship of reciprocity and respect with the water. It assumes False Creek has been restored to a healthy, biodiverse, inclusive and productive part of the urban environment and is able to provide flood protection through nature-based solutions, flood-adaptive buildings and floating structures.



Between Bridges: 2100 Vision

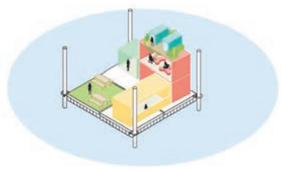
1 Floating Walkway

2 Elevated Walkway

3 Floating Habitat Island

4 Tidal Terraces

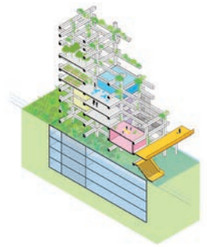
5 The Marina Community



6 The Circular Start-up Studios

7 Paddler's Pavilion

8 The Adaptive Cluster



9 The Adaptive Skeleton

10 The Community Garden Tower

COOPERS PARK OVERVIEW

Coopers Park today is a vulnerable park with an almost non-existent back-shore or intertidal zone. This vision transforms it into tidal gardens with adaptive building clusters and pavilions that can host a broad community of species and circular initiatives while inviting people to reconnect with the water.

In the future, Coopers Park will demonstrate that our natural spaces can be protected and restored into dynamic and ecologically rich community spaces - for humans and non-humans alike.

Refer to Appendix 1 for summary of related work.

Right: 2100 Vision for Coopers Park

ADAPTATION TIMELINE

Tomorrow 2030-2050

This approach prioritizes the protection of critical infrastructure while recognizing the necessity of initiating nature-based solutions today to ensure resiliency tomorrow. While the traditional response of resistance focuses on the protection of property using rigid and ever-raising dykes, this approach utilizes the public waterfront to expands the idea of protection to our natural systems.

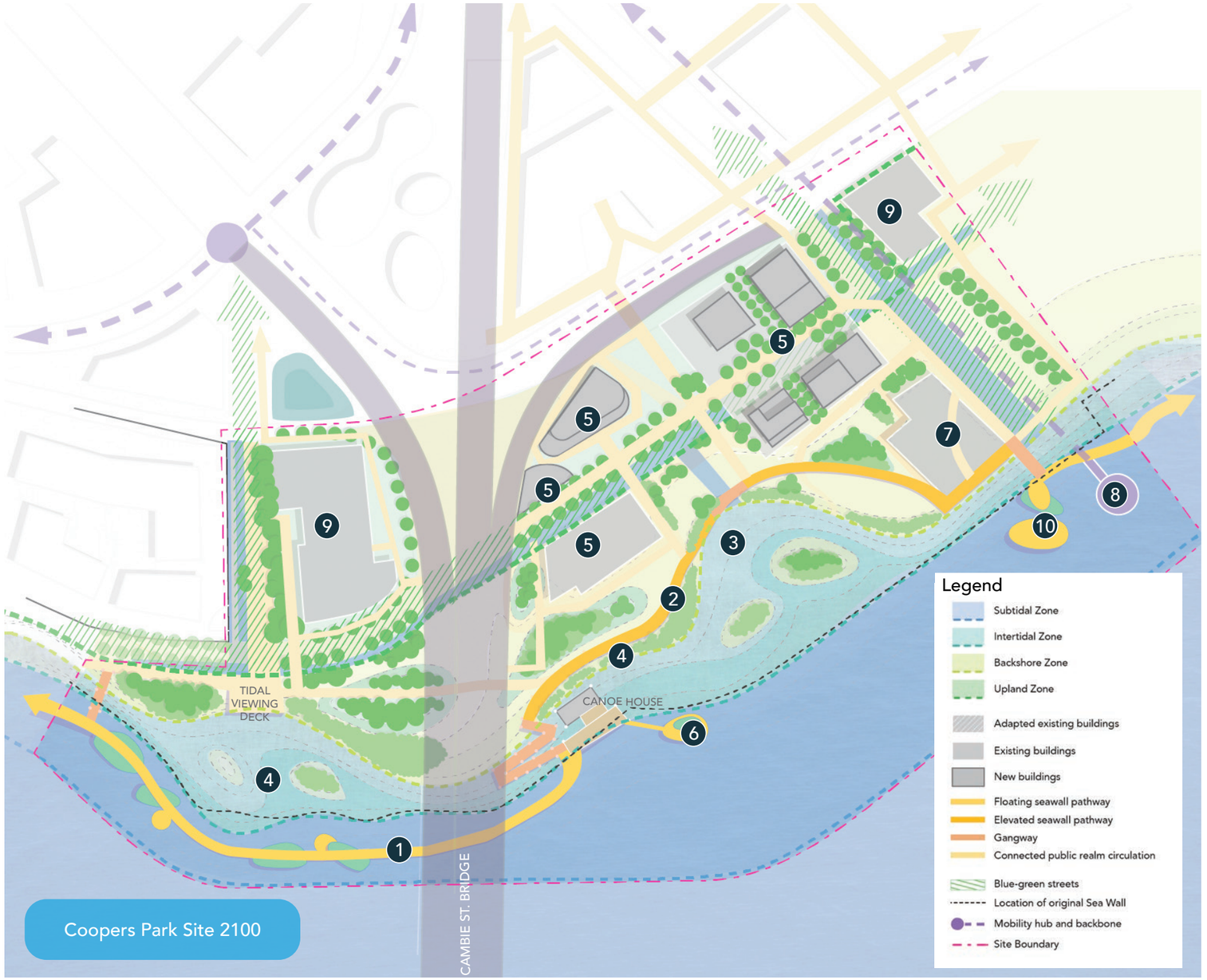
Mid-Term 2050-2100

This approach explores how we can transform the built environment into a resilient and adaptive system that provides the room and support for natural systems to thrive - while providing recreational, cultural and community services. Instead of simply accommodating flooding waters, this approach asks how we can welcome, support, and steward our natural systems - and by doing so, create resilient responses to rising sea levels that are integrated into our urban fabric.

Long-Term 2100+

The approach illustrates a cultural shift and imagines a future where the city has reconnected with nature and recognizes a relationship of reciprocity and respect with the water. It assumes False Creek has been restored to a healthy, diverse, and productive part of the urban environment and is able to provide flood protection, recreation, and cultural resources through nature-based solutions.

Coopers Park 2100 Vision



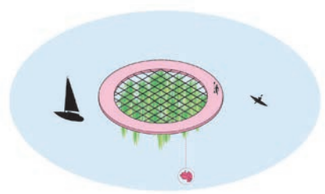

1 Floating Walkway

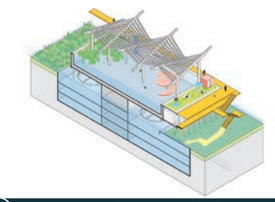

2 Elevated Walkway


3 Intertidal Exploration Area


4 Intertidal Restoration Area

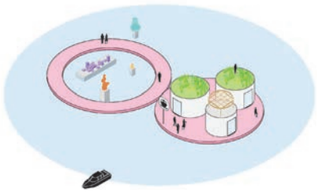

5 The Adaptive Cluster


6 The Oyster Island


7 The Longhouse Platform


8 The Water Mobility Hub


9 The Mobility Connector


10 The First Nations Restaurant

1.1 Approach

Over the past 250 years, False Creek has undergone rapid, profound, and repeated transformation. From an ecologically rich shoreline with expansive tidal mudflats that nourished and was tended to by Coast Salish communities since time immemorial, to a barren and contaminated industrial waterfront that drove Vancouver's early economy, to the recreational artery of the seawall and its neighbouring residential and commercial spaces of today. In the coming decades, False Creek will once again transform, along with the ways that human and more-than-human communities live along its shorelines.

Sea level rise in BC is expected to proceed at a rate of about a metre per century, with two metres of sea level rise expected by the year 2200. This newest transformation of False Creek will affect over 38,000 residents; major utilities and critical infrastructure like energy, sewers, and emergency routes; schools, medical, and emergency facilities; social and recreational amenities like parks and community centres; Granville Island; industrial properties; and over $19 billion in assessed property value (2019 assessment).

Recognizing the urgency, severity and causes of sea level rise informed every aspect of the project. Building on this understanding are the following approaches which were fundamental in steering the project in a direction that reflected both established and emerging values.

DECOLONIZATION AND CLIMATE JUSTICE

Climate change and environmental destruction is underpinned by the historical and contemporary structures of colonization, both globally and locally. Conversely, decolonization is inherently tied to the concept of climate justice. The topics are complex, entangled and require deep reflection and commitment to act as individuals and as professionals who have benefited from settler colonialism and capitalism. The success of this project relies on the continued recognition of our City's colonial roots and demands reflection and commitment by any proponent who benefit from work on unceded land.

Our approach to this project is rooted in the belief that decolonization and climate action both represent a return to nature and a re-acquaintance with what it means to be a part of an interconnected community of living things. This approach rejects the notion that decolonization and climate action are zero-sum propositions but instead seeks outcomes that are of benefit to all; as Art Manuel wrote, "there is no downside to justice."

LANGUAGE

The concept designs were greatly influenced by conversations with Charlene Aleck, the project's Knowledge Keeper, who helped us recognize that the typical language of Adaptation was seeped in colonial connotations. The terms "resist", "accommodate" and "retreat" informed the way we understand our relationship with the water and positioned water (and nature) in an adversarial position. By rewording these approaches to better reflect Indigenous values, the project team was compelled to completely re-think how the designs responded to them. These realizations were not only enriching for us personally, but also wholly informed the draft designs that emerged.

Acknowledge

Acknowledge means to admit to be real or true; recognize the existence, truth, or fact of. We acknowledge **what was** (the actions, beliefs, and blind spots that have produced the trajectory of colonization and climate change); **what is** (the distance between where we are and where we would like to be, and the urgency to act); and **what could be** (both the challenges and possibilities that lie ahead). As an adaptation approach, *Acknowledging* means:

- Recognizing the urgency to protect critical infrastructure now, while simultaneously recognizing the necessity to protect the health and function of natural systems
- Addressing the root causes of current issues rather than band-aid approaches
- Accepting that change is inevitable and preparing for an uncertain future

Host

Instead of simply accommodating sea level rise by adapting current infrastructure, this approach strives for a response rooted in the idea of stewardship and care. This means shifting language away from a tone of tolerance to one of reciprocity. As an adaptation approach, *Hosting* means:

- Honouring the inherent value of non-human life by providing space and conditions that support and nurture ecological systems.
- Prioritizing space for Musqueam, Squamish, and Tsleil-Waututh members to practice, celebrate, and share their culture and territory as Host Nations.

Restore

Rather than erecting barriers, our connection to the land, waters, and one another is restored by a focus on repairing relationships and systems. As an adaptation approach, *Restoring* means:

- Integrating natural systems into city environments so that "urban" is no longer considered an antonym to "natural"
- Restoring watershed and systems connectivity, thinking beyond the site-scale
- Providing room for natural systems to function, in turn creating nature-based protection for our cities that also provide valuable opportunities for recreation, culture, economy and community.

(URBAN) INTEGRATION

Our cities are facing many important future urban challenges concerning not only Sea Level Rise but also other climate-related issues such as urban heat, drought, storms, and the loss of biodiversity. Over the coming decades, cities must enable the transition to sustainable mobility, circular and resource-saving economic models, and cleaner, safer, healthier urban environments. As populations continue to concentrate in cities, the pursuit of inclusive, culturally diverse and affordable urban development that improves the livability of urban environments becomes ever more crucial.

The need to adapt to rising sea levels, and the extent of the changes to the urban landscape it entails, should be leveraged as an opportunity to develop and implement solutions for other urban challenges. Adapting to Sea Level Rise is not a narrow technical problem that can be addressed on a micro scale, but must be approached in a broad, foundational way on a multi-systemic urban scale. Adaptation strategies must be combined to create win-win situations that include upgrades to landscapes and buildings, programming and land use, and mobility strategies. Only by combining these urban challenges can we re-define our idea of urbanity and foster a reciprocal relationship with water and nature in the future. The places where the built environment touches natural systems are the places of endless possibilities and potential.

Upland locations must also be considered essential sites for adaptation. These upstream sites and hydrological systems have the potential to mitigate shocks and stresses that would otherwise impact downstream infrastructure. These sites offer more space to implement adaptation strategies on higher ground and should be recognized as integral part of any sea level rise approach.

Nature-based solutions and re-wilding of the landscape play an important role in adapting urban environments. They must go hand-in-hand with building adaptation and mobility transitions to ensure safe, accessible urban life in our future cities.

DESIGNING WITH NATURE FOR RESILIENCE

"Designing with nature" means prioritizing the ecology, character and spirit of a site, and taking lessons from natural systems and the Indigenous cultures that have been stewarding them since time immemorial. The typical inclination for urban developments to contain and conceal natural systems has created "tough" but vulnerable cities. The backbone of our approach is focused on nature-based and eco-engineered solutions that are in line with the ambitions of the City and grounded in the values of the Musqueam, Squamish, and Tsleil-Waututh Nations.

This approach has informed the concept design in the following ways:

- Prioritization of restored ecological function as a flood management strategy, recognizing the inherent capacity of natural systems to respond with resiliency to shocks and stressors
- Conditions required to support specific habitat zones are used as a driving spatial framework to guide site planning
- The needs of the human and more-than-human world are balanced by co-locating and integrating human needs for services like mobility, flood management, and recreation with habitat restoration

The North Creek Collective project team exploring the waterfront (February 2022).

SCALABILITY AND PHASING

The project describes a model of foreshore adaptation and re-development that is phased and scalable in order to minimize initial capital costs, maximize social and ecological benefits, and ensure the lowest possible carbon inputs over time. The long-term viability of this project is contingent on this phased approach that avoids continual rebuilding of elements as conditions change over time.

Refer to Section 3.2 Adaptation Pathways.

This approach has informed the concept design in the following ways:

- **Modular Designs:** The concept takes a modular design approach to floating infrastructure that can be added to over time as capital and operating budgets, and property ownership arrangements allow. Modular, floating components rise with future changes in sea levels, eliminating the need for costly adaptive reconstruction.
- **Shifting Landscapes:** Naturalization of the foreshore starts from the water's edge and works inland, anticipating eventual flooding and the upward migration of shoreline habitats. This approach allows the landscape to accommodate water in the form of sea level rise and intensifying pluvial events without constant reconstruction.
- **Building Life**: The adaptation and replacement of aging buildings will correspond to the estimated lifespan of buildings, culminating by about 2100. Buildings closest to the foreshore that are the most vulnerable will see the first adaptation measures, including adaptation of parking structures and underground servicing as the water table rises. As buildings near the end of the natural life, their core structures could be retrofitted with raised ground floors and more climate adaptive upper floors; or they could be replaced entirely with naturalized open space.
- **Mobility**: Future mobility needs will change over the next several decades, and this project assumes a gradual reduction in dependency on private automobiles as our primary source of mobility. This will be the result of concerted efforts to prioritize alternative modes of transportation and the reconfiguration of our street network to better support blue-green infrastructure. Roads will transition from corridors for walking, cycling, rolling and transit

1.2 Key Considerations

I. Flood Management: Site Scale

DEFINING THE PROBLEM

The concepts' flood management strategy is based on the recognition that the threat of sea level rise is compounded by the increasing threat of storm events and significant run-off making the False Creek shoreline especially vulnerable and in need of an Integrated Flood Management approach. *Refer to Section 2: Integrated Flood Management.*

This approach to flood management emphasizes systems-thinking and nature-based solutions that are integrated into the urban fabric and provide enhanced open space amenity and ecological benefits in addition to flood management. The concept design for both sites broadly focuses on expanding and restoring the extents, ecological function, and flood management capacity of the intertidal and backshore zones.

The distinct conditions of Coopers' Park and Between Bridges sites also require site-specific design responses within the regime of Integrated Flood Management. These sites are examples of how a menu of Integrated Flood Management strategies can be applied to a variety of sites within False Creek, and beyond.

CONCEPT DESIGN CONSIDERATIONS & CONSTRAINTS

Between Bridges

Despite being a central waterfront site, Between Bridges is defined by its disconnection from the broader city network and the natural processes of its shoreline. The seawall in this location is hard edged and elevated, making it less vulnerable to immediate coastal flooding but also less resilient to the compounding threats of storm surge and major rainfall events.

<u>The concept design for Between Bridges includes the following strategies to address flooding:</u>

- The incremental replacement of the seawall with terraced subtidal, intertidal and backshore zones, providing greater buffering capacity for storm surge and wave run-up by dissipating wave energy, as opposed to vertical structures that can deflect and amplify wave energy.
- Constructed wetlands, raingardens, bioswales, and other areas of permeable landscape in backshore and upland zones to replenish the water table and absorb excessive water during storm/rainfall events.
- The creation of floating or elevated walkways that are flood-adapted and allow for continuous connectivity without interrupting tidal or flooding processes.
- Establishment of a Shoreline Resilience Zone along Seabreeze Walk with the adaptive reuse or demolition of buildings inboard of this zone and the eventual redevelopment of buildings outboard of this zone in response to rising water tables and projected building life.

Coopers Park

Coopers Park is largely defined by its public realm: a relatively low-lying, highly valued park space surrounded by residential towers that spans the waterfront and is vulnerable to sea level rise and pluvial flooding. Its shoreline is a combination of rip rap revetments and sea walls, and includes a small area of backshore to the west of the Cambie Street bridge.

<u>The concept design for Coopers Park includes the following strategies to address flooding:</u>

- The incremental replacement of the seawall with expanded subtidal, intertidal and backshore areas, as well as setback earthen berms, elevated transportation corridors and generous infiltration areas.
- The strategic elevation of roadways at key locations (ie. Cooperage Way and Pacific Boulevard) when their current conditions reach end-of-life.
- Taking advantage of the site's large open space areas by integrating flood management into the design of park space that supports ecological processes as well as recreational and cultural use (ie. the intertidal restoration zone)
- The creation of floating or elevated walkways that are flood-adapted and allow for connectivity without interrupting tidal or flooding processes.
- Establishment of the Shoreline Resilience Zone along Cooperage Way with the adaptive reuse or demolition of buildings inboard of this zone and the eventual redevelopment of buildings outboard of this zone in response to rising water tables and projected building life.

ADDITIONAL CONSIDERATION FOR FURTHER STUDY

The following considerations were identified as areas for additional study, coordination, or exploration, with regards to flood management, specifically along the North Shore of False Creek.

PLANNING

Insurance

Costs of insuring properties (inclusive of Building, Strata, Homeowners and Tenant's Insurance) is likely to rise in response to increased flood risk. Cost to property owners related to major building improvements to address flood risk is also likely to increase over time. Given the gradual nature of sea level rise over several decades, these costs may become unmanageable, with the increased frequency of repairs that may limit the valuation of properties over time.

Property Valuation

The cost of insuring properties combined with uninsurable threats to buildings and the cost of repair may lower the value of waterfront properties over time. As well, untested adaptation solutions will introduce some degree of unpredictability in building lifespan, anticipated repairs, and material performance. All of this will affect the value of properties in areas exposed to flood risk.

Development in Flood Zones

Sea level rise in False Creek risks reducing housing stock and available land in one of Vancouver's few high density residential neighbourhoods, further exacerbating an existing housing crisis. In the absence of tailored City policy, flood designated zones could have the effect of restricting future development. Alternatively, this new zoning type could be leveraged to create opportunities for innovative flood adaptive development to avoid loss of density. Economic incentivization may be required to make the replacement cost of buildings desirable for future developers. In these instances, Council or the development permit board may allow the developer to transfer the bonus density to a separate site, where there is more opportunity for development.

Land Acquisition

There are several private properties that will need to be considered for land acquisition or another form of density transfer care of government or private sector or a combination of the two actors. Typically, these properties fall into two categories:

- Properties that are vulnerable to flooding and where no adaptation solution can be reasonably implemented
- Properties that are required to support broader integrated flood management strategies

Flood Risk and Community Engagement

Concerns around sea level rise and flooding are multifaceted. They include the impact that flooding risks have on waterfront properties as well as the implications on home and strata insurance. Related to this, there is limited clarity about how stratas managing multi-family buildings can prepare for consistently higher water levels and the costs of these preventative measures, or the cost of not taking these preventative measures. There are also concerns about the impact that physical measures (such as coastal infrastructure) to address sea level rise may have on views, access to the water, and property values.

Added to these concerns are competing senses of helplessness about how individuals can address a global concern like climate change, and a sense that adequate progress will not be made. To avoid paralysis that will lead to inaction, the City must engage strategically with residents and other affected groups to raise awareness about the implications of sea level rise and provide informational resources, clear guidelines, and options for individuals as well as property management bodies.

DESIGN

Flood Adaptive Elements

Further study on best practices for the construction and maintenance of flood adaptive elements -- especially floating structures -- will be needed. Canada does not have any codes to guide the design of nearshore floating structures. Instead, British standards are often used. Pilot projects that explore approaches to floating and flood adaptive construction should be deployed and monitored to gather data on performance, maintenance, materials, and lifespan of these elements towards the development of building codes. *See Section 4 for more details.*

Designing for Change

Designing foreshore landscapes that can adapt to sea level rise without having to be continuously redesigned or reconstructed (ie freshwater ecologies that can slowly transition into estuarine and saltwater ecologies with sea level rise) will require further study, testing and expertise from various professionals, across jurisdictions.

TECHNICAL

Phasing

Risk of increased damage to structures (seawalls) and shoreline due to more frequent storm events can result in greater discontinuity of use. The timeline and phasing for the implementation of an alternative dedicated pedestrian and cycle route inboard of the flood zone that can provide a safe route during flood events, as well as a permanent new alignment once the seawall pathway is removed, will need to be carefully considered and planned.

Infrastructure

Because sea level rise will raise the elevation of the ocean surface, inundating the outlets of sewers and creating less opportunity for gravity drainage to relieve loads from the system during periods high intensity runoff. The effect of this could include localized flooding at higher elevations when storm and combined sewers are unable to drain. This will require study into the timelines of IRMP measures combined with potential additions of pumps/lift stations to mitigate flooding due to elevated coastal waters.

Additionally, saltwater intrusion in built-up areas affecting the longevity of underground infrastructure and pump stations will require further study into the depreciation timelines of existing buildings that will inform long range planning for building adaptation, demolition and/or relocation.

Seismic

Vancouver is at increasingly higher seismic risk each year. When planning for future sea levels that may not materialize for another 50 years, it needs to be recognized that any new flood prevention infrastructure may sustain significant damage from a large seismic event before the flood scenario is expected to occur, requiring the infrastructure to be rebuilt.

General Recommendations:

For key recommendations, see Section 1.3

- Plan and Design for Incremental Transitions
- Initiate Pilot Projects that explore flood-adaptive construction for multi-residential buildings
- Advance (with urgency) Green Rainwater Infrastructure per the Rain City Strategy's three Action Plans
- Explore the creation of legal mechanisms, capacity, and budget to perform ongoing monitoring / inspection of building foundations and mechanical systems as impacted by saltwater intrusion
- Ensure that any replacements for aging or damaged park infrastructure (walkways, paving, furnishing, vegetation, etc.) within the floodplain considers adaptive design
- Study feasibility of raising elevations of select roadways at key locations (ie. Cooperage Way and Pacific Boulevard) when their current conditions reach end-of-life

II. Water Quality and Habitat

DEFINING THE PROBLEM

False Creek existed as a dynamic and vibrant mudflat for millennia, supporting (and supported by) the Indigenous caretakers who lived within its reach. As an intact ecosystem, the area served as an ecological corridor and salmon habitat, with a floodplain that provided cleansing, filtering and water storage services. Yet, in little over a century, the form and function of this natural system was extracted and transformed into a dense and armoured industrial waterway that neglected the complex web of life that its shores had supported.

Over the last few decades the False Creek basin has grappled with balancing further urbanization with the increasing recognition of the immense value of an intact and healthy ecosystem. Some recent improvements have included the restoration of riparian and marine habitat as well as some selective capping of contaminated fill material. These improvements have demonstrated the powerful impact of nature-based solutions and thoughtful planning. The return of spawning herring for the first time in over a century along with other marine flora and fauna is evidence that restoration is possible.

However, while some progress has been made, water quality issues persist and are deeply entangled with issues of habitat, biodiversity and recreation. While heavy industrial uses have waned, there are still many areas of concern. Poor water quality within False Creek can be summarized by three main issues:

1. The seabed within False Creek contains unmapped industrial contaminants.
2. The water deposited from surface runoff, CSOs, and boats have contaminants.
3. The long tank shape of False Creek does not allow for flushing of the water at the east end of the creek during tidal cycles, yielding higher water temperatures and reduced dissolved oxygen content of the water. Both conditions contribute to higher E. coli counts.

Similarly, poor habitat quality is the result of three main concerns:

- Poor water quality
- Unsuitable foreshore structure and diversity
- Incompatible uses

These issues may also have impacts on groundwater quality.

CONCEPT DESIGN CONSIDERATIONS & CONSTRAINTS

The future concept design for Between Bridges demonstrates that innovative nature-based solutions have the potential to support ecological and cultural abundance, even on constrained urban sites. Floating habitat islands provide the opportunity to test marine and wetland habitats as conditions in False Creek change. Intertidal terraces can provide low-gradient pockets of intertidal habitats where space is limited, and blue-green corridors in the upland zone provide both perennially wetted and intermittently wetted habitats. These solutions, while subject to the spatial and environmental constraints of a dense urban area, support valuable ecological processes and provide a meaningful degree of habitat connectivity.

Constructed armatures for marine and intertidal habitats can be deployment in urban environments like Between Bridges where there is limited space on the foreshore. These floating elements accommodate marine and terrestrial flora and fauna, minimize highly invasive and expensive filling of the False Creek basin, and can be anchored to existing or proposed structures within False Creek.

Coopers Park, on the other hand, takes advantage of existing vulnerable (but valuable) open spaces by reintroducing re-wilded areas that support continuous habitat corridors while still offering an abundance of recreational and cultural services. The focus in Coopers Park is the restoration of an ecologically rich rocky intertidal and backshore zone, including an area of protected habitat with restricted access. These areas protect water quality by intercepting runoff before it reaches False Creek.

Beyond the challenge sites, the amelioration of water quality and remediation of soil quality and contaminants in False Creek will improve the quality of marine habitat throughout.

<u>The concept design for the North Shore of False Creek includes the following strategies to address water quality and habitat:</u>

- Incorporating both phytoremediation (plant-based contaminant management) and engineered filtration systems, as well as visible monitoring features that track and share water quality in real time, into all applicable work (ie. The Paddler's Pavilion Pilot Project).
- Natural creek restoration through the conversion of street right of ways into day-lit streams that will ameliorate the quality of flows into False Creek, thereby improving water quality. [Long-term].
- Regrading of the foreshore through the replacement of the seawall with sloped or terraced marine and foreshore habitat that will slow down the flow of water and increase space for natural ecologies where full shoreline restoration is not feasible, especially the intertidal zone.

ADDITIONAL CONSIDERATION FOR FURTHER STUDY

The following considerations were identified as areas for additional study, coordination, or exploration, with regards to water quality and habitat, specifically along the North Shore of False Creek.

PLANNING

Urban Runoff and Outfalls

Urban runoff and outfalls require careful planning to maximize beneficial results. Current issues with outfalls include degradation of water quality by untreated urban runoff, and inconsistent flows that vary dramatically in intensity. Renewal of urban waterways through the restoration of urban streams, phytoremediation of urban runoff, engineered filtration, and detention / infiltration zones can strive to provide more stable flow rates and improved water quality. All of this contributes to improved habitat provision both upstream of False Creek, locally at outfall sites, and in False Creek at large. Significant increases in treated or untreated runoff and outfalls into False Creek may create localized estuarine conditions that impact the ecological composition of the site. Conversely, salinity is projected to increase in the intertidal and upland zones as sea levels rise, resulting in shifts from freshwater habitats to estuarine habitat. It is important that nature-based infrastructure can accommodate changing foreshore habitats in areas that will become increasingly exposed to saline and brackish waters. Monitoring these changes to the salinity gradient will be important in order to ensure the long-term health and resilience of these foreshore environments.

Public Awareness

Water quality is not a widely understood issue for many Vancouver residents and community groups. The technical aspects of pollution and water monitoring may make it a less accessible topic for many people. Furthermore, the factors impacting water quality are difficult to tie to our individual and daily actions. An important component of addressing water and habitat quality is information sharing and awareness raising. This encompasses past and current water quality, research, and mitigation efforts underway, and the individual and collective actions that we must take to care of our environment.

Regulatory

Regulatory agencies mandates ensure that any development does not cause detrimental impacts to habitat, biota, or receiving environment. Environmental and First Nation reviews can be lengthy and take several

months or more. With newer initiatives such as nature-based solutions and innovations to address climate change, regulatory agencies are becoming more flexible and open to non-traditional approaches to project implementation. However, it is up to the proponent to present a rationale supporting the proposed works. Some important statues and regulatory agencies include:

- Fisheries Act: administered by Fisheries and Oceans Canada (DFO) and Environment and Climate Change Canada (ECCC), prohibits death of fish, the harmful alteration, disruption, destruction of fish habitat, and the release of deleterious substances to waters frequented by fish.
- Navigation Protection Act: Navigation Protection Program (NPP), administered by Transport Canada protects public navigation in navigable waters.
- Migratory Bird Convention Act: administered by the Canadian Wildlife Service, protects migratory birds, including eggs, and nests.
- Wildlife Act: administered by the BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development, protects and manages wildlife as well as habitat lands.

Unauthorized Discharge

Unauthorized discharges in False Creek and difficulty to monitor and enforce marine vessel discharge will continue to impact water quality. See Public Awareness on preceding page.

Invasive Species

False Creek is particularly vulnerable to a host of invasive species vectors and pathways, as evident by it being the location where Japanese Beetle – a highly destructive and federally regulated pest – was first dedicated in Canada in 2017. There have also been a number of regionally invasive and noxious species identified in False Creek, including the following:

- Provincially Noxious: Saltmeadow cordgrass, Sporobolus patens
- Invasive species: Common Tansy, Tantacetum vulgare; Himalayan Blackberry, Rubus bifrons

The City of Vancouver has several initiatives that reference the management and control of priority species in parks and public property but there is no clear or comprehensive authority, strategy or regulation to manage this issue. False Creek, as a central urban area is vulnerable to multiple invasion vectors via waterways, transportation corridors, and flight paths. Prevention and early detection of invasive species is an essential part of restoring and protecting the area's marine and terrestrial ecology.

DESIGN

Planting in a Changing Climate

Diverse and healthy planting supports habitat and water quality, as well as offering flood protection, carbon sequestration and cultural services. However, climate change will impact growing seasons, landscape zones and the many conditions that specific plant communities need to thrive. All new planting will need to recognize these changes which may mean considering alternate species or cultivars that will thrive with little maintenance but that were not historically native to the region, while balancing the significance of Indigenous culturally important plants and the need to restore, protect and advocate for their survival. Indigenous management regimes and traditional ecological knowledge should be considered for application to the False Creek lands and waters.

TECHNICAL

Contaminated Soil and Seabed

Contaminated soil and seabed within False Creek has ongoing impacts on water quality, habitat quality, and ecosystem health. There has been no comprehensive mapping and analysis of contaminants within False Creek; this will pose an ongoing risk to the health of False Creek with any restoration or construction activity that disturbs the seabed.

Remediation of this contamination faces several hurdles. Typically, restoration of the seabed occurs with redevelopment and the significant costs are borne by the proponent. In many areas of False Creek, the contamination is historical and responsibility for the cost of remediation will need to be determined. Impacts on benthic habitat will depend on type and level of concentration of contaminant.

Ecological Disturbance

When construction and disassembly of seawall is undertaken, it will need to be implemented with a suite of mitigation measures and best management practices to reduce impacts. There will be impacts from redevelopment on existing habitat and biota, and new development will need to demonstrate that it will provide higher productivity and diversity to fit the new environmental conditions.

Logistics of Monitoring

Water in False is monitored by a variety of organizations (Metro Vancouver, Vancouver Coastal Health) as well as non-profit organizations (Fraser Riverkeepers, etc). The City of Vancouver monitors in-pipe water quality and may begin monitoring outfall water quality. The City should consider convening these groups to understand the status of monitoring efforts, their outputs, and opportunities for sharing this information with the public in a consolidated and accessible format.

General Recommendations:

For key recommendations, see Section 1.3

- Work closely with Indigenous partners toward restoration and stewardship of native plant and animal communities
- Incorporate habitat strategies that support Indigenous Food Sovereignty
- Build public awareness of water quality issues and impact
- Map areas of contaminated soil/seabed by levels and severity of pollutants
- Where seabed contamination is historical, undertake processes to determine the agency responsible for the cost of remediation
- Create inventory of existing water quality monitoring data and initiatives to develop a comprehensive water quality monitoring program to track remediation progress and ecosystem health
- Establish and enforce regulatory tools to support positive outcomes for water quality and habitat
- Ensure all agencies and government bodies with jurisdiction over False Creek are working cooperatively towards shared goals
- Incentivize electrification of marine vessels

III. Floating Elements

DEFINING THE PROBLEM

Most floating elements do not provide flood risk reduction, but rather provide adaptive strategies that recognize the inevitability of flooding and embrace the constant fluctuations of water levels.

Floating elements are best adapted to urban, land constrained conditions where in-water interventions provide a cost effective, and low impact approach. Their ability to be deployed quickly and their inherent portability make this a low barrier approach to managing the physical and financial cost uncertainties of sea level rise.

CONCEPT DESIGN CONSIDERATIONS & CONSTRAINTS

Floating elements include a range of possible design solutions that float on the surface of the water and visibly rise and fall with water level fluctuations. This strategy allows the water to flow unimpeded beneath and essentially provides a flood-proof and adaptive surface for a variety of uses. These elements can be temporarily or permanently attached to a specific place, depending on their form, function and location. In dense places like False Creek, these elements provide much-needed space as areas of developable land are reduced as sea levels continue to rise.

The concept designs for both sites consider multiple floating elements, each with distinct considerations and feasibility that largely depends on their location and ownership model. The catalogue of floating elements are intended to prompt discussions and questions about existing jurisdictional, technical and cultural barriers that will need to be seriously examined if False Creek is going to transform into an adaptive, resilient and inhabitable community.

Floating Habitat Islands

Floating Habitat Islands offer an opportunity to provide habitat, above and below the water, while improving water quality and providing important adaptation research opportunities. Habitat islands can function as ecological pilot projects as precursors to more comprehensive shoreline restoration projects, allowing the testing and monitoring of plant species and ecosystem types over a period of changing environmental conditions. They are also important areas of refuge for wildlife in a densely populated urban area. These islands are particularly important for introducing biodiversity to the area as restoration of the shoreline is underway, or for providing habitat in areas where more fulsome shoreline restoration is not possible.

As relatively low-cost, modular interventions, floating habitat islands can be deployed for the purposes of habitat creation, public education, and research purposes at any point in the adaptation process. Habitat islands can be installed in advance of longer-term shoreline restoration as part of a near term habitat enhancement strategy. They can remain in place as part of a permanent urban ecosystem and can be added to incrementally over time.

Floating Walkway

The existing pedestrian seawall serves as an active mobility corridor and beloved public open space. These valuable services must be protected and prioritized in adaptation planning. A floating walkway network, as part of an expanded active mobility network, will provide a more climate adaptive alternative to the existing pedestrian seawall while creating a more intimate connection to the water. The concept would achieve a long-term public asset that is inherently adapted sea level rise, thus eliminating the need for costly adaptive reconstruction.

In addition to providing pedestrian access, the underside will feature constructed habitats for marine life. The walkway will be positioned to avoid shading the shallower sections of foreshore which tend to be more ecologically productive. Other uses currently accommodated by the seawall pathway – such as bicycles and other higher speed uses -- would be located on a network of pathways along the shore of False Creek.

Floating walkway segments can be deployed incrementally allowing for a phased approach to expanding the floating walkway system. Their mobile components can be repositioned with relative ease as the walkway system expands or to accommodate changing marine activities.

The intimate connection to the water provided by a floating walkway would require careful study to determine best practices for safety and public access. Guidelines for access and maintenance in the case of extreme weather events, king tides, storm surge, ice formation and other hazardous conditions would need to be developed to ensure public safety.

Floating Buildings

Floating buildings or dwellings may be anchored or moored to piles. Floating dwellings are found in many areas around the world where building technology and construction is advanced in this field. Buildings include publicly accessible marine services such as a ‘kayak hotel’, cultural facilities and longboat storage; and private floating homes, artist studios and workspaces.

ADDITIONAL DESIGN CONSIDERATIONS

The following considerations were identified as areas for additional study, coordination, or exploration, with regards to floating elements, specifically along the North Shore of False Creek.

PLANNING

Water Lot Boundaries

Existing water lots within False Creek have shared jurisdiction between the City, Transport Canada, the Coast Guard and the Vancouver Board of Parks and Recreation. Often, the water lot boundary, ownership and current use is the constraining factor in determining the space available to establish a floating element. Depending on location and programming, coordination and negotiation with various agencies may be required. For a new water lot to be considered, an application would need to be made to the Province. The Province will not consider a water lot application until DFO agrees with the proposed usage and mitigations; and Transport Canada’s Navigation Protection Program agrees that the usage will not significantly affect navigation.

Permitting

Complex and overlapping jurisdictional structures present challenges for any project within coastal or marine areas. An assessment of all necessary permits, approvals and consultation will need to be considered as early as possible as these requirements will dictate the project schedule.

Engagement with Marina/Boating Community

Any future designs that impact marinas will need to recognize the vibrant community of boat owners (including many people living on their boats) and the potential impact on them. Many of the floating elements would need to take place in existing marinas, taking much needed/desired moorage space away from boats. It is recommended that the City conduct an overall assessment of the current use and availability of all public and private moorage spaces available in False Creek.

DESIGN

Accessibility

Accessibility will need to be considered to ensure equitable access and adequate maintenance and monitoring. For floating elements that are intended to be accessible from land, the tidal range of False Creek poses the greatest challenge. As a result, the fluctuating height difference

between the shore and the element must be compensated for with flexible construction (i.e., gangways). Restrictive water lot boundaries may pose a challenge to achieving accessible slopes on gangways during low tide. Other accessibility challenges posed by floating elements include the structure's movement on the water; ensuring non-slip surfaces in wet conditions while minimizing friction for wheeled mobility aids; eliminating tripping hazards; mitigating open drop-offs; and providing shade. For general design guidelines, refer to the Guidelines for Universal Access to New Public Docks in False Creek[2]. Additional study of accessibility on other kinds of floating structures, such as continuous walkways and programmed public space, will be required.

Marine Habitat

Floating elements can offer cover and habitat for fish and marine invertebrates, including refuge from predators, feeding areas, and resting habitat. However – floating elements may also block UV, contributing to potential water quality issues that will need to be further explored and balanced with benefits.

Hanging linear features from floating elements have the potential to provide artificial substrates for habitat creation. Potential to support filter feeders that could contribute to improved water quality should be explored. While hanging elements have the potential to support macroalgae (seaweed) or shellfish, many of these species require light so this may only be applicable along the perimeter or beneath elements that allow light penetration (i.e. metal grating).

Similarly, establishing appropriate plant species that can tolerate the unique conditions of a floating island, will need to further studied, as the only local precedent is installed in the freshwater of Trout Lake.

Stability

Experience with floating structures in BC shows that the tolerance for motions from waves generated by wind and vessels on public access floating facilities is different than the tolerance in marinas. Several floating facilities have been decommissioned or modified because the motions were deemed too great for the general public to tolerate. Any floats supporting the public will need to be robust to limit motions.

TECHNICAL

Securement (Anchorage, Piles, Attachments)

How each element is secured in place will depend largely on their scale, programming, location, design and the various other considerations mentioned. Each type of securement comes with its own specific set of considerations and will need to thoroughly studied to confirm the safest and least invasive way ensuring these elements stay in place.

Anchoring systems can be advantage for elements that will need to be relocated in the future – but anchors can damage valuable benthic organisms or habitats if not adequately weighted, and provide limited stability when face with wave action. Piles that are fixed in place offer a more permanent and stable support and come in a range of materials and foundations. However, installation of any piles would require --- add details about permitting, treatment, maintenance, habitat disturbance, etc.

Coastal Characteristics

These floating elements are directly exposed to water fluctuations, waves from wind and passing vessels, and currents, so adequate moorage and thorough knowledge of the area's coastal characteristics and vessel navigation are critical to ensuring a safe and stable design.

Construction Material and Methods

Construction methodologies will need to align with desired lifespans, operations, and maintenance budgets. Innovative modular construction methods to allow for easy repositioning/relocation should be explored but will require additional design and construction time and budget to allow for potential piloting. Some key areas that will require additional study include:

- Lifespan and structural stability will be largely determined by material selection. Understanding benefits and limitation of various material for specific features will need further consideration
- The carbon footprint, disassembly
- Use of prefabricated modular floating habitat modules such as Biomatrix (Appendix A2), floating concrete, self-watering floating planters, etc.
- Sustainable building construction methodologies that are suitable for saltwater environments and adherence to sustainable building certifications, building codes and municipal requirements

Operations and Maintenance

Floating structures are exposed to harsh elements, fluctuating water levels and limited access, resulting in specific operational and maintenance considerations to ensure lengthy life spans and public safety. These include the following:

- Development of capacity on the part of the City to conduct regular monitoring and maintenance of shoreline and floating elements, including relevant expertise and physical resources like boats.
- For floating habitat islands, further consideration of stewardship opportunities with Host Nations/citizens/organizations along with commensurate funding sources should be explored to ensure the features are monitored and managed sufficiently. *Refer to Section 4.2*
- Logistics of cost sharing opportunities for gangways and walkway sections that jointly service facilities (ie. Private marinas and water taxis)
- Further study is needed to determine appropriate leasing arrangements with private operators and to identify potential funding sources for sustainable operations and maintenance.

Safety and Liability

Further study is needed to Identify necessary safety requirements for in-water public access (ie adherence to the building code, ADA, risk management strategies, any specific marine-based building codes) as well as public guidelines regulating public access to floating structures in the event of extreme weather, storm surges, and other hazardous conditions. See above note on Stability.

Additionally, further study is needed to determine risk tolerance for publicly accessible floating structures, and guidelines regulating public access to these amenities in relation to environmental hazards such as

General Recommendations:

For key recommendations, see Section 1.3

- Initiate Pilot Projects that explore floating structures. *Refer to Section 4.*
- Engage public regarding the future of the seawall and gather input where appropriate
- Development of guidelines and regulations governing safety and access to floating elements.
- Design walkway and planter structures to be modular and movable so they can be easily added to over time as budgets allow
- Identify and build relationships with key organizations and companies that are experienced in floating elements

IV. Accessibility and Multi-Modal Mobility

DEFINING THE PROBLEM

The seawall multi-modal pathway is a key connector for active transportation, a crucial public service that supports Vancouver's adaptation to climate change. Active transportation is typically defined as using your own power to get from one place to another. The imperative to prioritize this form mobility is supported by the targets outlined in Vancouver's Climate Emergency Action Plan: How We Move which aims to ensure two thirds of trips within Vancouver will be by active transportation and transit by 2030. Car-free routes, like the current 28km seawall pathway, are essential for increasing participation in active transportation (Transportation 2040 Plan).

Ensuring continued access to this resource will require prioritization as climate change progresses and a sharp increase in the aging population/ disabilities is expected to compound accessibility issues, especially in waterfront, recreational and marine facilities. Large stretches of the seawall are vulnerable to existing seasonal and more extreme future flooding, gravely compromising accessibility and continuity. With every passing year, higher temperatures and air quality issues from more frequent wildfires will result in challenging, and periodically unsafe, conditions for walking, rolling, and cycling. Much of the shoreline of False Creek is buffered from extreme heat, making this location even more valuable as an active transportation artery.

CONCEPT DESIGN CONSIDERATIONS & CONSTRAINTS

The concept designs are focused on two key elements for mobility: providing redundant backbone infrastructure with resilient and accessible waterfront corridors.

Currently, the seawall functions as both public open space and mobility corridor, and these uses are sometimes in conflict due to limited space. Many sections of the existing seawall pathway are vulnerable to sea level rise, but public access to the waterfront and connection to False Creek are valued features of this public space.

Between Bridges

Despite its central location, Between Bridges is disconnected from the city network due to its form of development and the natural processes of its waterfront due to the pile-supported deck that supports the seawall pathway. The elevation of the deck surface means that this section of the pathway is less vulnerable to flooding due to sea level rise than other sites around False Creek. However, steep grades on the landward side of the seawall and the underground structures associated with existing residential buildings offer little opportunity to restore a functioning floodplain.

Cooper's Park

Mobility in and around Cooper's Park is vulnerable to sea level rise due to its low elevation. Seasonal flooding currently occurs in Cooper's Park, and over time this will become more frequent. To guarantee continuous circulation through and around the site, raised, floating, and seasonally flooded pathways will be required, in addition to "safe line" active transportation routes that offer uninterrupted year-round access.

As a municipally owned green space, Cooper's Park provides an opportunity for the restoration of shoreline ecology. As outlined in the City of Vancouver's Marine Rocky Intertidal Design Guidelines, a critical element of shoreline restoration is ensuring some habitat areas are inaccessible to the public. Though this principle restricts mobility through the site, it also provides an opportunity for an enrichment of the public's experience given appropriate infrastructure.

The concept design for the North Shore of False Creek includes the following strategies to address multi-modal mobility and accessibility:

- Expansion of car-free transportation routes
- Separation of cyclists and micro-mobility users from pedestrians where appropriate
- Providing multiple, redundant routes for active transportation using a typology of design solutions that accommodate flooding: raised, floating, and seasonally flooded pathways
- Provision of raised walkways to ensure 'habitat reserve' areas are undisturbed, but overlook is possible.
- Accessibility is maximized through the provision of alternative routes that avoid significant grade changes (for example, gangways from the shoreline to floating elements) to provide an uninterrupted experience for all.
- Providing universally accessible "safe line" active transportation routes away from motorized vehicle traffic that are usable year-round.
- Integration of mass transit with active and micro-mobility transportation
- Expansion of water-based transit in False Creek including motorized mass transit and infrastructure for non-motorized watercraft like canoes and kayaks

ADDITIONAL DESIGN CONSIDERATIONS

The following considerations were identified as areas for additional study, coordination, or exploration, with regards to multi-modal mobility and accessibility in and around False Creek.

PLANNING

Integrated Water-based Transportation

Current Aquabus service is privately-operated and not fully integrated into the existing public transportation network. While the fleet includes "cyquabuses" - boats able to transport bicycles, strollers and wheelchairs, much of the connected infrastructure is not universally accessible. Further study will be required to understand the feasibility of mobility hubs that support multi-modal transportation across False Creek, including integration with existing TransLink infrastructure/payment methodologies.

Adding mobility hubs/water-based recreation and transportation may increase traffic in this already busy waterway. Further study on the "carrying capacity" of False Creek and the pros/cons of water-based transportation in relation to other spatial priorities such as habitat provision and non-motorized watercraft.

Pedestrian Realm

Pedestrian mobility is the City of Vancouver's number one transportation priority[3].

- The current seawall pathway is multi-modal and at peak times can be overcrowded, which can lead to unsafe and frustrating experiences for both cyclists and pedestrians.
- The street network around False Creek deviates from the surrounding grid network, which impacts the area's walkability. Pathways through residential development can be difficult to navigate or private. Further study on pedestrian traffic and patterns will be essential to ensure adequate, accessible and safe connections through False Creek.

Cycling Network and Supporting Infrastructure

- Per Vancouver's 2040 Plan, expand and maintain wayfinding within and between the cycling route and pedestrian network, and the transit network through multiple approaches: mobile applications, trip planners, signage and wayfinding strategy.
- Secure bike parking and bike-friendly mass transit is limited. Consideration for both should be integrated into all future projects.

- The existing cycling network includes both separated and unseparated bike lanes. Further study will be required to confirm how and where to integrate the appropriate cycling infrastructure into the changing waterfront.

DESIGN

Floating Elements

- The feasibility of including bicycles and micro-mobility devices on floating pathways is unknown and requires further study.
- The feasible extents of floating walkways within the existing jurisdictions in False Creek is unclear and requires further study.
- Gangways between existing seawall and floating elements are not universally accessible and faces major constraints, including available space within water lots to mitigate steep grades at low tide
- The existing seawall pathway is composed of a patchwork of materials, which poses an accessibility barrier.

TECHNICAL

Operations and Maintenance

Maintenance and inspection regimes must be promptly responsive to irregularly occurring flooding as well as expected seasonal flooding, and other hazards related to weather such as ice and snow, high winds, and extreme weather to ensure the safety of pathways.

Pacific Street in Vancouver : 7,000 cars/day

Binnerothin/Meent in Netherlands : 7,300 cars/day

General Recommendations:

For key recommendations, see Section 1.3

- Ensure all pathways and access points are planned and designed to welcome all ages and abilities (AAA) standards for accessibility
- Develop maintenance and inspections regimes for all pathways to ensure safety and accessibility
- Provide secure, covered bike parking at mobility hubs
- Assess "carrying capacity" of water-based mass transit in False Creek in relation to other priorities
- Update accessibility guidelines to include flood-adapted multi-mobility, including solutions to improve the accessibility of gangways, floating elements, and water-based transit.
- Investigate models for water-based transit expansion including public and private options
- Test feasibility of bike and micro-mobility traffic on floating devices

1.3 Future Design Recommendations

The recommendations below are general, often overlapping and largely affirm and expand on the Planning Principles developed as part of the False Creek Coastal Adaptation Plan (2021). It is assumed that the Recommendations and Considerations specified in that report will be carried forward to guide future work in False Creek.

I. CREATE SPECIFIC FALSE CREEK DESIGN GUIDELINES FOR FLOOD-ADAPTIVE WATERFRONTS AND BUILDINGS

The False Creek Coastal Adaptation Plan includes established Design Principles that represent foundational guidelines for coastal flood management approaches. These principles were developed in 2018 and represent the accumulated knowledge and experience of the City, consultant teams and public input. The Sea2City Design Challenge has used these principles to propose concept designs for specific sites along False Creek.

It is recommended that these collective efforts for flood-adaptive buildings and waterfronts serve as a basis for the development of building guidelines for retrofitting and constructing buildings, infrastructure and landscapes.

Specific typologies could be embedded into the four landscape zones, creating a system in which built structures respect, prioritize and support waterfront habitat. From finding new, flood-proof uses for underground structures, to the development of raised walkways, these principles are designed to ensure that building and infrastructure can coexist with water – whether that involves accommodating higher tides on a daily basis or being prepared for more frequent storm surges. Engineering guidelines for sewers, utilities and mobility should be included.

These design guidelines should demonstrate how water infiltration, green spaces, active transportation, livable neighbourhoods and flood-adaptive new constructions fit together and impact everyone. Balancing tangible design principles with dialogue about flexible waterfront zoning and legislation with various stakeholders will ease the process of implementation and contribute to public awareness-building and stewardship.

II. COMPLETE LOCAL SHORELINE ENVIRONMENTAL ASSESSMENT

Since 2018, there have been extensive changes to environmental legislation and requirements at the federal, provincial, and municipal levels. In general, there is increased level of environmental protection and a greater role for Indigenous Nations and other communities. The BC Environmental Assessment Act has also been updated and the thresholds for project activities that require an Environmental Assessment (EA) have changed:

- A new dike project [or modification] that protects an area greater than or equal to 10 km2.
- A new project [or modification] that (a) results in changes in or about a stream, marine coastline or estuary, and (b) entails dredging, filling or other direct physical disturbance of (i) ≥ 1 000 m of linear shoreline, or (ii) ≥ 2 ha of foreshore or submerged land, or a combination of foreshore and submerged land, below the natural boundary of a stream, marine coastline or estuary.
- There is discretion for the province to complete an EA if a project is within 20% of a threshold.

Due to the thresholds noted above, many municipalities have chosen to complete shoreline resilience projects in separate, short increments and to limit or eliminate impacts below the high-water level. Often, this approach leads to comprised outcomes related to seismic resilience and marine habitat restoration. **To provide the flexibility required to achieve the best outcomes for shoreline flooding resilience, seismic resilience, and marine habitat restoration, it is recommended that the City of Vancouver review the option of completing local or catchment scale environmental assessments.** The size of the region could vary following engagement with regulators, i.e. it could include all of False Creek or could extend beyond that.

The UK has completed Strategic Environmental Assessments (SEA) of regions in order to implement comprehensive erosion and flood protection projects.

III. CONSIDER A SHORELINE RESILIENCE LAND USAGE ZONE

Most of the existing shoreline conditions located in False Creek have steep slopes or are vertical walls. Many of these areas are also narrow City owned properties between provincial Crown seabed and private properties with dense zonings. However, restoring natural marine habitats is best achieved through natural shorelines with gradual slopes. Future sea level rise will move marine habitat upwards with sea levels, requiring even more space for shorelines.

The current ownership structure along the shoreline of False Creek will require the City of Vancouver to request land transfers from the province or reach agreements on multiple water lot leases if current shoreline footprints extend offshore.

It is recommended that the City of Vancouver engage with the province about the potential for a shoreline resilience land usage zone along the shoreline (extending across land and water). This could be used by the City to develop shoreline resilience solutions that balance best outcomes for flooding and seismic resilience, and marine habitat restoration.

It is also recommended that the City initiate a process that coordinates all relevant government bodies to manage this process and develop the integrated plan towards resiliency and climate adaptation in False Creek. This would provide the following benefits:

- facilitate open access to, and sharing of, relevant data and information,
- stimulate regional stakeholders to cooperate and develop adaptation pathways and strategies in line with the integrated plan
- potentially manage or support funding strategies

IV. PLAN AND DESIGN FOR INCREMENTAL CHANGES

The concept designs propose a steady and incremental approach to designing infrastructure that can meet the immediate and near term needs and can be added to over time (ie floating walkways + habitats, introduced terrestrial habitats, incremental building adaptations).

The challenges that False Creek faces cannot be tackled bottom-up or top-down alone. Large scale and long-term projects aimed at protecting people, ecologies and infrastructure are critical for adaptation. At the same time, there is a need to start implementing small solutions on local and street scales that contribute to reconciliation, climate adaptation, water management, flood-resilient and non-fossil transportation, livable flood-adaptive neighborhoods, and installing governance frameworks and financing models.

While it's important to have a collective, long-term adaptation vision from the start, it is just as important to revise the long-term strategy regularly based on updated knowledge. Instead of a linear process, the method of adaptive pathways helps to identify tipping points, crucial moments for action and revision to avoid mal-adaptation. *Refer to Section 3.2: Adaptation Pathways.*

It is recommended that the City balance long-term plans with a variety of pilot-projects that present 'no regrets' options and respond to climate change that deliver net economic benefits, and hence represent a low-risk, attractive strategy for governments, firms or households. These measures are sometimes referred to as 'win-win' actions, since they deliver multiple benefits simultaneously, namely economic growth as well as climate change objectives. *Refer to Section 4.1 Pilot Project Overview.*

The outcomes of these test-projects should be exchanged to allow for the

collection and sharing of data and information between the Host Nations, academics, government, the private sector and the public.

V. HARNESS AND COORDINATE LOCAL COMMUNITY, EXPERTISE, CITIZEN SCIENCE, ETC.

Leveraging local expertise and citizen science initiatives can increase public engagement and commitment to stewardship, and literacy of city and scientific processes. These processes can make use of existing expertise or build capacity.

Citizen science can require some investment in outreach and engagement but is especially appropriate for long term initiatives with stable funding that require ongoing data collection.

- Engaging local experts and citizens is an opportunity to include a multiplicity of perspectives, which can strengthen both the process and the outcomes.
- Collaboration with community can lead to the development of mutual trust between the public, scientists, city staff, and city government.
- Collaborative processes are well-suited to adaptive management approaches. In the context of climate change adaptation where conditions may change unpredictably, the iterative nature of adaptive management is a strength.

To maximize the advantages of citizen science, care must be taken in community outreach and in the design of data collection methods and study to ensure that participation is representative and does not reinforce existing inequities to public space and knowledge.

It is recommended that the City commits ongoing staff capacity to ensure continued momentum and coordination of efforts around sea level rise in False Creek.

VI. CREATE A STEWARDSHIP PLAN FOR FALSE CREEK

A Stewardship Plan provides a framework for planning, implementing and managing stewardship activities required to achieve the basic goals of caring for land, air and water and sustaining the natural processes on which life depends. The existing seawall is maintained by the City Engineering Department, but no capacity currently exists for inspecting and maintaining a naturalized shoreline. Obtaining adequate, stable, long-term funding, expertise, and coordinated support for the "operations and maintenance" - or stewardship - of the ecosystems that support adaptation pose a serious challenge, particularly when the potential impacts are not fully understood by all citizens or by all decision-makers.

Any stewardship plan should recognize that Indigenous science, caretaking and leadership sustained the lands and water for millennia. Early and meaningful collaboration with the Host Nations is essential. **It is recommended that the City create a network of Stewardship specialists from the City and organizations that can contribute ideas, approaches, and expert advice that will be used to develop and support messaging and training programs for officials, educators, professionals and the public.** The development and distribution of a guiding document for stewardship that includes consistent messaging, enhanced communication and education activities could help encourage engagement and disperse efforts across public, private and government bodies.

VII. DEMONSTRATE VALUE & FIND THE MONEY

It is clear that adaptation measures are expected to bring significant net benefits though avoided flood damage, yet despite their economic attractiveness, funding and implementation of integrated flood management and adaptation plans has been slow, poorly understood, and often inadequate.

An essential aspect of funding for sea level rise and adaptation is the necessity of highlighting the value of an integrated flood management plan by quantifying the costs of damages avoided - rather than focusing solely on the cost of adaptation planning and design projects. This requires modeling at a broad scale but can be done with the support of tools such as Hazus, which calculates the consequences of natural hazards and has been adopted by Natural Resources Canada. **It is recommended that the City initiate a detailed Cost-Avoided Analysis that highlights monetary and non-monetary values and trade-offs, and communicates these finding to the public in an accessible way.** Early reports can form the basis of these studies, but the focus of this analysis should be on understanding and communicating the economic costs of maladaptation in relation to alternative flood management solutions, which may appear cost-prohibitive if not understood within the context of the big picture.

Once the value of these solutions are broadly understood, sourcing funding becomes the primary challenge. Municipalities manage the majority of public infrastructure, and as climate change and associate pressures mount, cities are constantly required to do more with less. Finding reliable, alternative and innovative funding sources will be a critical tool for implementing a diversity of strategies that provide flood management. **It is recommended that the City undertakes a research effort to understand what sources of income/funds are available.** Given the constraints on public finance, the City should focus on adaptation projects that can leverage public finance while exploring alternative funding strategies. Below are some preliminary areas for further study and exploration.

Public funding

Provincial or Federal Grants: This may include funding from sources such as Infrastructure Natural Resources, Indigenous Services, Environment and Climate Change etc. While government grants can be important sources of funding, applications require significant effort and often depend on capital projects with financial commitment in place by the City.

Small Grants: A community small grant program can support educational initiatives and the sharing of community resources. These could support initiatives such as community events, workshops for strata councils and co-op boards, asset-mapping activities, resilience walks, or the development of new resources.

Alternative Sources/Considerations

Revenue: Revenue generating activities including equipment rentals, food and beverage, and admission or membership fees for educational and cultural programs could become a viable source of revenue earmarked for operating budgets of climate adaptive infrastructure.

Public-Private Partnerships: there are a variety of definitions, logistics, and pros/cons when considering a P3 source of delivery. Many programs in Canada have received notable criticisms around issues of accountability, privatization, performance, costs, etc. However, P3 models can be used to transfer some risk to the private sector and can provide a framework for accessing expertise and innovation within the private sector. P3 models do require a funding source, but some initiatives receive public funding.

New growth industries and markets for businesses and investors, such as flood risk modeling, adaptive building and nature-based solution services offer huge business opportunities as demand for these services is expected to grow. Incentivizing growth in these areas through partnerships with public projects and grants can result in improved quality of and wider implementation of climate adaptive infrastructure.

2 Integrated Flood Management

2.0 General Flood Management Approach

I. Flood Management

The flood management strategy outline in this report is based on two key recognitions:

1) That the threat of sea level rise is compounded by the increasing threat of storm events and significant run-off. As storms increase in frequency and severity, some vulnerable places within highly urbanized, impermeable areas will be increasingly prone to flood-related damage. This vulnerability only increases when considering the trend of aging infrastructure and increasing population density in these same areas.

2) That False Creek was built on a floodplain. Floodplains, if recognized for their inherent qualities, reduce flooding by providing an increased area for the storage and slow movement of water. However, when a floodplain's natural function is disrupted by human interventions (landfilling, diking, urbanization, etc.), ironically, new risks are introduced as water is positioned largely as a threat.

The typical armored approach to coastal flood management that has neglected these realities continues to present the following challenges:

- Instead of damping wave energy, it deflects it to adjacent areas.
- Traps surface runoff inboard of defense line, causing "bathtub" effect and urban flooding
- Disconnects people from natural rhythms and systems
- Concentrates and channelizes runoff and stormwater, including pollutants

False Creek needs an integrated flood management approach that recognizes the complexity of the problem and prioritizes nature-based solutions.

Integrated flood management is a basin-scale approach that deploys an array of strategically located flood management and adaptation solutions to restore, maintain, or augment the function and productivity of the natural floodplain. This approach emphasizes nature-based solutions bolstered by hard solutions according to local priorities and constraints in accordance with a holistic, pragmatic attitude that emphasizes and all/and rather than either/or. This will require cross-jurisdictional and interdisciplinary coordination, collaboration, and partnership.

The result is a layered, strategic, discontinuous approach to flood protection and management where conventional approaches rely upon continuous, linear protection. Instead, continuity of habitat and mobility are prioritized as an essential dimension of the overall strategy. Other priorities include the protection of infrastructure, social services, housing density, local economies, cultural expression, recreation, and the provision of urban green space. This holistic approach requires a thoughtful balancing of many priorities, constraints, and spatial demands, recognizing that diversity, multifunctionality, and redundancy provide more benefits than monolithic approaches.

Nature-based protection and restoration utilize native materials (gravel, sand, rocks, logs, root masses and vegetation) in designs that are dynamic and resilient. The restoration and/or mimicking of natural processes provide shoreline protection and restoration, ameliorates water quality and habitat, enhances upstream water infiltration and cleansing, protects critical infrastructure and services, and stewards the overall health of the False Creek ecosystem. This approach has the opportunity to reflect and enrich recreational, cultural, and social life of human and more-than-human communities.

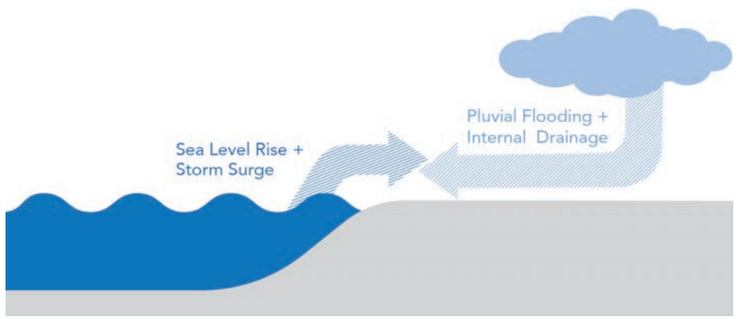
(URBAN) COASTAL SQUEEZE

Both sea level rise and flood risk reduction measures take up space in high-density urban areas where land is scarce and land use decisions have enormous impacts. Sea level rise itself eats up coastline. Flood risk reduction solutions lower the probability of flooding events in areas that are not designed to accommodate it, and will become critical infrastructure in the coming decades, but impose their own footprint in an already crowded space. Accompanying strategies to mitigate the loss of housing density, public green spaces, and transportation options are also necessary. Flood adaptation strategies replace lost spaces, habitats, and amenities, and propose new ones, and are designed to function alongside water. Without them, the negative impacts of sea level rise will be broader and deeper.

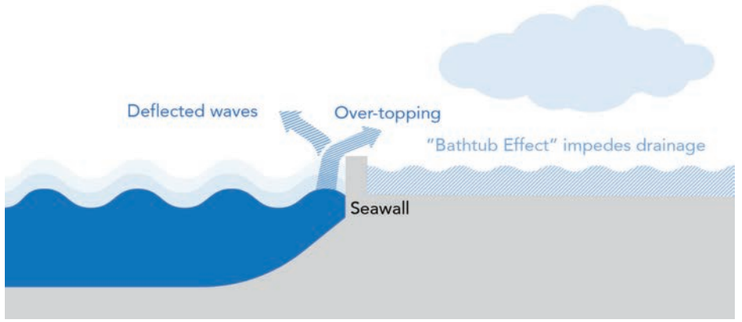
VALUING NATURE-BASED FLOOD MANAGEMENT

Research overwhelmingly shows that investing in adaptation and resilience is cheaper than the cost of restoring infrastructure after it has been damaged. The cost-savings and numerous co-benefits that result from nature-based community adaptation outweigh the cost of investment at a ratio of 6 to 15. Protecting and expanding natural assets is increasingly understood as a cost-effective response to aging "grey infrastructure" that comes with significant community benefits.

The following pages will detail this approach. Informed by the significant efforts of existing initiatives and policies such as the Rain City Strategy, the Climate Emergency Action Plan, and the Vancouver Plan, the approach outlined in this document draws from and builds upon existing work.



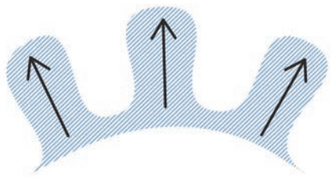
Compounding flood threats



Challenges of an Armoured Approach

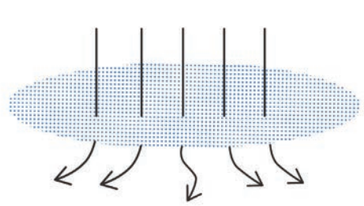
II. Integrated Flood Management Principles

The purpose of these draft Flood Management Principles is to help guide the planning, design and decision making processes in the flood-prone area of False Creek. These principles were defined through the course of the Sea2City Design Challenge and served as a tool for applying broad concepts onto specific sites. The most successful flood management practices are based on site conditions - the climate, soils, hydrology, degree of impervious material, and how the buildings and landscape work together. These principles recognize that every site will be different, requiring unified philosophies regarding flood management across scales and locations.



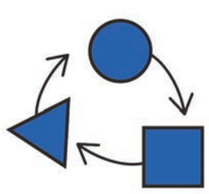
MAKE SPACE

Prioritize space for dynamic natural processes (tides, floods, drainage) and the ecologies that depend on them. This principle not only supports a reconnected and functioning floodplain, it also values the additional benefits that come with hosting the more-than-human world. It requires more than just accommodating water: making space requires a deep understanding of, respect for, and connection to natural processes.



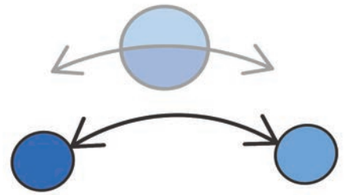
MAXIMIZE PERMEABILITY

Allow for flow of water by increasing urban water absorption capacity and strategic, rather than continuous, flood protection. In traditional flood management, permeability is considered a weakness and suggests a leaky or breached barrier. However, permeability is an important condition that supports slower flows of water, infiltration and storage.



DESIGN FOR ADAPTABILITY

Designing for uncertainty and flexibility means ensuring that every intervention has the ability to adapt, as needed, to a multitude of expected - and unexpected conditions. This may apply to specific elements or features on a site that have the ability to transform, or it may apply to site programming that is flexible.



CREATE CONNECTIONS NOT BARRIERS

Ensure adaptive, redundant, and continuous networks for mobility and ecology while promoting visual/ physical connection to water's edge. While sea walls and dykes can support continuous mobility, they are designed to be barriers that establish distinct boundaries and separation. Think beyond barriers to consider ways to improve connectivity without compromising connection.

LAYERED RESILIENCY

Ensure interplay between layers of flood protection, ecology and amenity by ensuring that interventions support multiple functions. Rather than a barrier approach that depends on a singular element that is continuous and linear, consider the benefits of a layered, discontinuous approach, that values redundancy rather than robustness.

III. Language

The language we use impacts the way we understand the world. Below are some important terms that help to communicate the integrated approach of this project.

Integrated Flood Management

An approach that deploys an array of strategically located solutions to restore, maintain, or augment the function and productivity of the natural floodplain in order to provide flood protection and management. Integrated Flood Management is a basin-scale approach with strategies that can be applied at a site scale.

Resiliency

The capacity of linked social-ecological systems to absorb recurrent disturbances such...floods so as to retain essential structures, processes, and feedbacks. Resilience reflects the degree to which a complex adaptive system is capable of self-organization (versus lack of organization or organization forced by external factors) and the degree to which the system can build capacity for learning and adaptation (Adger et al. 2005)

Nature-Based Solutions

Actions to protect, sustainably manage and restore natural and modified ecosystems in ways that address societal challenges effectively and adaptively, to provide both human well-being and biodiversity benefits. They target major challenges like climate change, disaster risk reduction, food and water

More-than-Human World

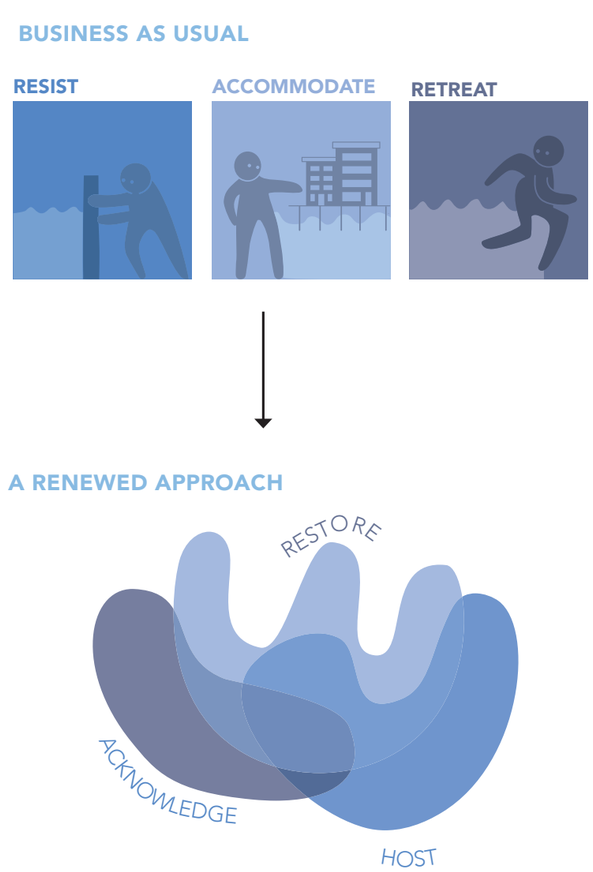
A term used critically to remind practitioners that the non-human world not only exists but has causal powers, capacities and intrinsic value of its own.

Watershed Approach

Watersheds are typically defined as areas of land draining into a common body of water. In urban settings in particular, the flow of water across various jurisdictions and surfaces present significant obstacles for water governance. Generally speaking, a "Watershed Approach" recognizes the importance of considering the many systems - hydrological, ecological, even cultural - that effect, or are effected by, the conditions of a particular site. It requires looking beyond arbitrary boundaries of ownership and jurisdiction, to understand interconnected and overlapping processes.

Floodplain

The City defines a floodplain as a lowland area that is susceptible to flooding from an adjoining watercourse, ocean, lake or other body of water.) Urban development has largely disrupted the natural extents of the floodplain, denying the reality that much of False Creek was built on these dynamic landscapes. Natural floodplains provide flood risk reduction benefits by slowing runoff and storing flood water. They also provide other benefits of considerable economic, social, and environmental value that are often overlooked when local land-use decisions are made.



How Language informed approach. Refer to Section 1.1 Approach

IV. Shoreline Zones

The False Creek shoreline area has been drastically urbanized, and original ecological conditions cannot be recreated. Shoreline interventions, such as the flood protection systems, can only create elements along the shoreline that enhance the capacity of the False Creek ecosystem, to provide ecological functions for marine life typical of the southwest coast of British Columbia.

- From NEFC Shoreline Flood Protection Performance Criteria

While the shoreline of False Creek cannot be returned to its "original" state, an integrated, nature-based flood management plan can restore ecological conditions and their inherent flood management qualities.

Categorizing these distinct shorelines zones based on habitat (a function of water levels) recognizes the complex relationships between multiple systems and prioritizes a "rewilding" approach.

Each zone plays an important role in supporting a healthy and resilient "more-than-human" world, that in turn provides incalculable ecosystems services, including flood mitigation and protection.

Shoreline Zones and Indicator Species. Adapted from "Figure 7 Ideogram representing an ideal shoreline section, interactive and complete with all shoreline zone" (NEFC Shoreline Flood Protection Criteria)

SUBTIDAL

Constant Flux: Below low tide - dynamic with currents/water level.

This zone is an aquatic environment - in constant motion and influenced by tidal fluctuations, marine vessels, and the various lifeforms that call it home.

Priorities:

- Improve water quality and marine habitat
- Resolve issue of seabed soil contamination
- Support water-based recreation and mobility
- Restore benthic habitat

INTERTIDAL

Daily Flux: Between low tide and high tide. Highly dynamic, valuable habitat.

This zone is the most temporally and spatially variable of all marine habitats, supporting a wide variety of plant and animal communities across distinct sub-zones. An intact and appropriately sloping tidal area provides flood protection through wave attenuation and erosion control.

Priorities:

- Restore and expand intertidal habitat
- Support food sovereignty and cultural practices
- Provide safe connection between land and water
- Celebrate and make visible dynamic natural processes

BACKSHORE

Seasonal Flux: Typically above high tide line but impacted by severe storms and tides.

The zone is still part of the floodplain but provides a more stable environment to establish vegetation and habitat for terrestrial and avian species.

Priorities:

- Restore and expand the backshore zone
- Restore salt-tolerant and adaptive vegetation to support erosion control and habitat
- Create landscapes (and related programming) that are adaptive and resilient to periodic flooding
- Ensure buildings are all flood-adapted and accessible in storm events

UPLAND

Watersheding: Above the dynamic processes of floodplain but still vulnerable to pluvial flooding

Surface runoff and localized flooding is an ongoing concern, even at elevations above the storm surge. The upland zone has a critical role to play in managing stormwater and reducing pollutants before it reaches the waters of False Creek.

Priorities:

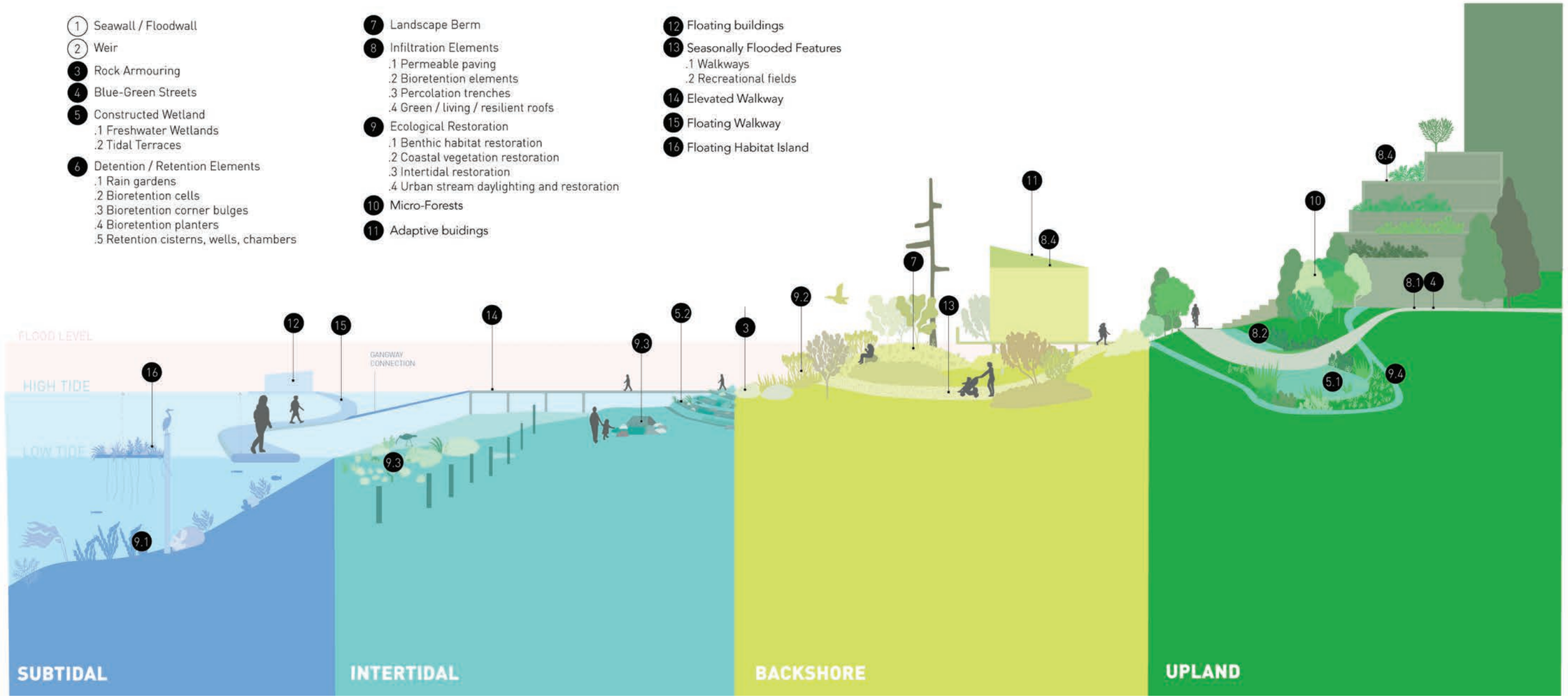
- Increase infiltration and filtration through green infrastructure
- Expand tree canopy by establishing pocket forests
- Support multi-modal transportation
- Support higher density buildings

2.1 Integrated Flood Management Strategies

I. Flood Management Strategies

The graphic below demonstrates how specific strategies (detailed on the following page), might be applied on a range of shorelines. It is not meant to illustrate a specific shoreline or site - but rather a diversity of conditions and combination of strategies. Integrated flood management does not mean that all sites will include all strategies, but rather, every site will need to utilize specific elements layered together to create a resilient waterfront.

1. Seawall / Floodwall
2. Weir
3. Rock Armouring
4. Blue-Green Streets
5. Constructed Wetland
   - .1 Freshwater Wetlands
   - .2 Tidal Terraces
6. Detention / Retention Elements
   - .1 Rain gardens
   - .2 Bioretention cells
   - .3 Bioretention corner bulges
   - .4 Bioretention planters
   - .5 Retention cisterns, wells, chambers
7. Landscape Berm
8. Infiltration Elements
   - .1 Permeable paving
   - .2 Bioretention elements
   - .3 Percolation trenches
   - .4 Green / living / resilient roofs
9. Ecological Restoration
   - .1 Benthic habitat restoration
   - .2 Coastal vegetation restoration
   - .3 Intertidal restoration
   - .4 Urban stream daylighting and restoration
10. Micro-Forests
11. Adaptive buidings
12. Floating buildings
13. Seasonally Flooded Features
    - .1 Walkways
    - .2 Recreational fields
14. Elevated Walkway
15. Floating Walkway
16. Floating Habitat Island

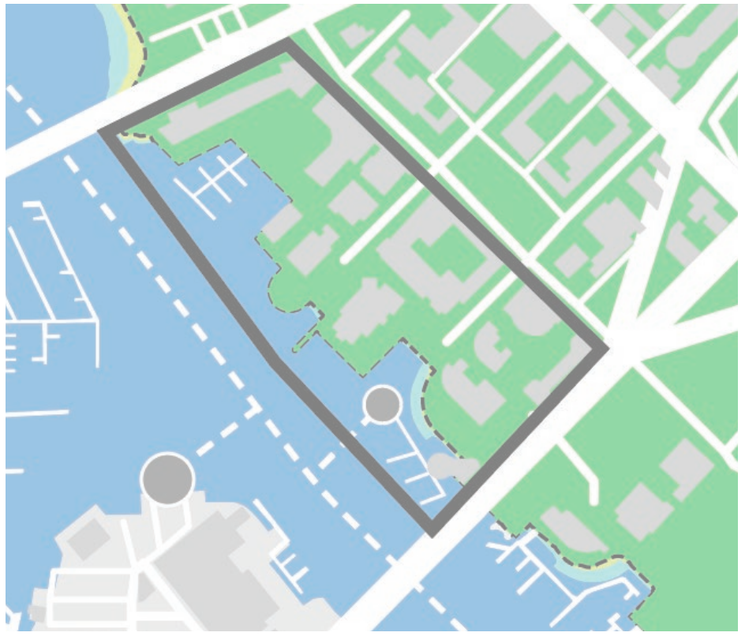


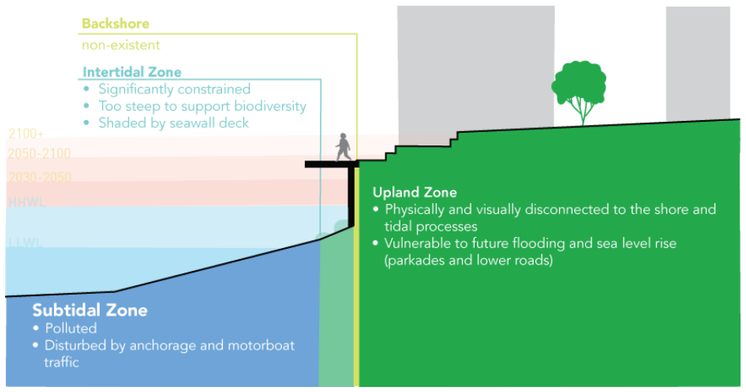
II. Flood Management Strategies: Functions and Benefits

KEY	STRATEGY	DESCRIPTION	FLOOD MANAGEMENT / ADAPTATION FUNCTION	LAYERED BENEFITS
1	Seawall / Floodwall	Vertical constructed barrier.	Prevents inundation by containing water.	• Coastal flood management • Transportation / mobility
2	Weir	Vertical constructed partial barrier	Slows and restricts the flow of water through partial containment. Intended to mitigate scouring and overloading of the waterway during a storm event.	• Pluvial flood management • Habitat connectivity • Transportation / mobility
3	Rock Armouring	Interlocking boulders forming revetments within the intertidal and backshore zones.	Protects the coastline or coastal structures from erosion and dissipates or redirects wave energy.	• Coastal flood adaptation
4	Blue-Green Streets	Networks of park-like green infrastructure corridors that manage water, contribute to the urban forest, and provide transportation routes *(Adapted from Vancouver's Rain City Strategy)*	Rainwater management: retention, infiltration, cleaning, volume and velocity management.	• Pluvial flood management • Habitat connectivity • Transportation / mobility • Recreation / public green space • Connection to nature
5	Constructed Ecologies	Designed wetlands that mimic the structure and physical, biological, and chemical functioning of natural wetlands. i. Freshwater wetlands ii. Tidal terraces	Provides detention, retention, habitat, and filtration of stormwater runoff. Manages volume and velocity of water entering downstream systems. Provides infiltration.	• Pluvial flood management • Habitat connectivity • Recreation / public green space • Connection to nature
6	Detention/Retention Elements	Green or grey element to capture urban rainwater runoff to mitigate the stress of storm events. Can also provide cleaning. Retention elements redirect water away from sewer system through infiltration or reuse. 1. Rain gardens 2. Bioretention cells 3. Bioretention corner bulges 4. Bioretention planters 5. Retention cisterns, wells, chambers	Reduces the risk of flooding by collecting and storing runoff during storms, and then releasing it at a lower volume and velocity into downstream systems.	• Pluvial flood management • Connection to nature • Habitat connectivity
7	Landscape Berm	Engineered terraformed linear embankment. Can be designed with a variety of slopes and sizes.	Protects against storm surges and onshore winds. Provides high diversity of habitat gradients.	• Habitat connectivity • Connection to nature • Public green space

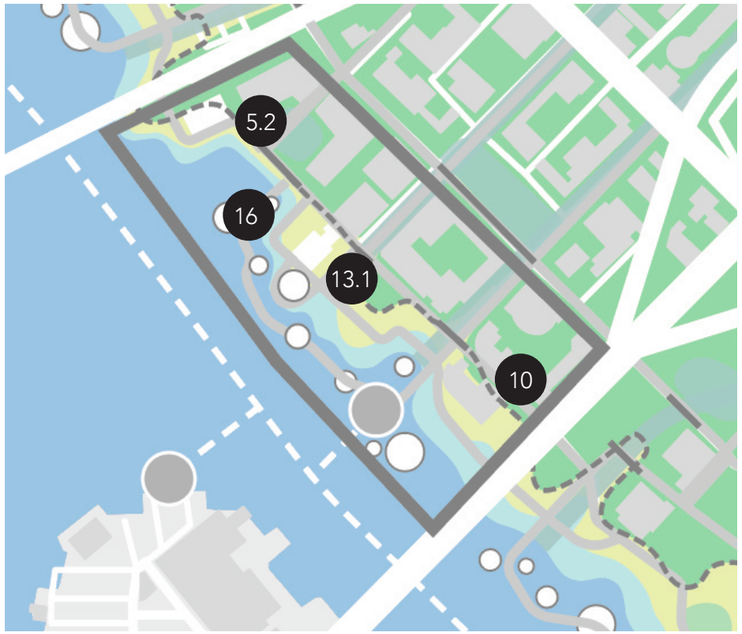
KEY	STRATEGY	DESCRIPTION	FLOOD MANAGEMENT / ADAPTATION FUNCTION	LAYERED BENEFITS
8	Infiltration Elements	1. Permeable paving 2. Bioretention elements 3. Green / living / resilient roofs	Reduce volume of stormwater runoff by intercepting and infiltrating water.	• Pluvial flood management • Recreation / public green space • Connection to nature • Habitat connectivity
9	Ecological Restoration	The acceleration or initiation of repair of degraded ecosystems, including restoration of ecosystem services and habitat value. 1. Benthic habitat restoration 2. Coastal vegetation restoration 3. Intertidal restoration 4. Urban stream daylighting and restoration	Upland restoration assists with the infiltration, retention, and transpiration of pluvial runoff. Floodplain restoration makes space for coastal waters and absorbs and dissipates wave energy.	• Pluvial flood management • Coastal flood management • Recreation / public green space • Connection to nature • Habitat connectivity
10	Micro-Forests	A densely planted forest of native species in a constrained area. Species to include a complete palette of groundcover, understorey, and canopy species as well as prepared soil. Micro forests can grow into mature ecosystems in as little as 20 years.	Soil volume retains pluvial runoff and provides filtration, while the tree canopy intercepts, stores, and diverts water through transpiration.	• Pluvial flood management • Urban heat island mitigation • Habitat connectivity • Connection to nature
11	Adaptive Buildings	Adaptive buildings are designed to withstand and embrace periodic flooding.	Mitigates the loss of housing, amenities, and services through sea level rise.	• Coastal flood adaptation • Provides built infrastructure for housing, services, recreation, commerce
12	Floating Buildings	Floating structures are designed to embrace the fluctuation of water levels.	Mitigates the loss of housing, amenities, and services through sea level rise.	• Coastal flood adaptation • Provides built infrastructure for housing, services, recreation, commerce
13	Seasonally-Flooded Walkway	Active transportation corridor along the waterfront designed to withstand periodic flooding.	Mitigates the loss of the existing sea wall, its pedestrian connectivity and connection to the waterfront	• Coastal flood adaptation • Public green space • Transportation / mobility
14	Elevated Walkway	Active transportation corridor elevated above sensitive restored habitats.	Mitigates the loss of the existing sea wall, its pedestrian connectivity and connection to the waterfront, and provides a connection to fragile habitats with restricted access.	• Coastal flood adaptation • Public green space • Connection to nature
15	Floating Walkway	Floating active transportation corridor along coastline.	Mitigates the loss of the existing sea wall, its pedestrian connectivity and connection to the waterfront.	• Coastal flood adaptation • Public green space • Connection to nature
16	Floating Habitat Island	Floating marine or intertidal habitats on constructed modular armatures. Can be suspended or anchored to existing coastal structures.	Mitigates the loss of existing habitats and provides habitat connectivity where full restoration is not possible.	• Coastal flood adaptation • Connection to nature • Habitat connectivity

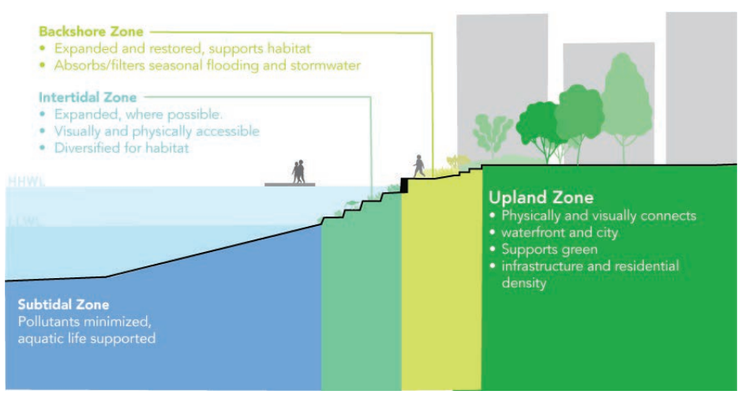
BETWEEN BRIDGES SITE — TODAY

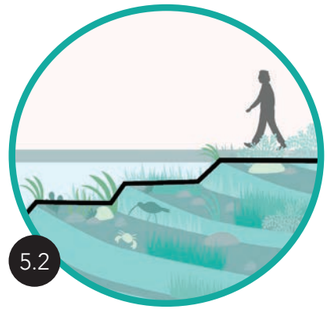




BETWEEN BRIDGES SITE — 2100 VISION







Tidal Terraces

Intertidal habitat benches - or tidal terraces - are valuable alternatives on constrained sites where steep slopes and available area are limited. *Refer to Appendix 2.1*

Seasonally Flooded Walkway

Multi-modal corridors designed to withstand periodic flooding, allow for more meaningful connections with the water, year-round.

Habitat Islands

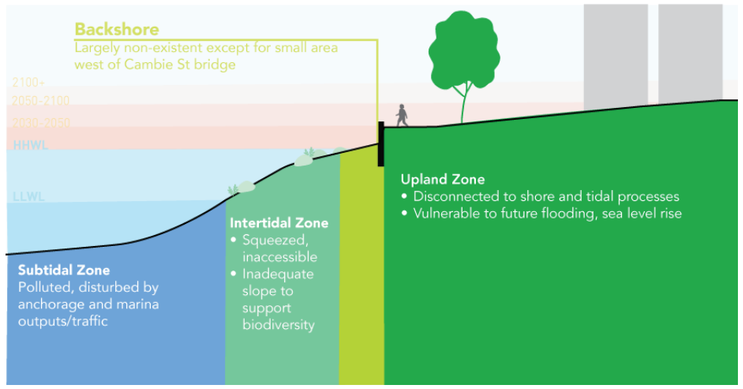
Where appropriate space on land is limited, floating habitat islands offer alternative sources of ecological services. *Refer to Appendix 2.2*

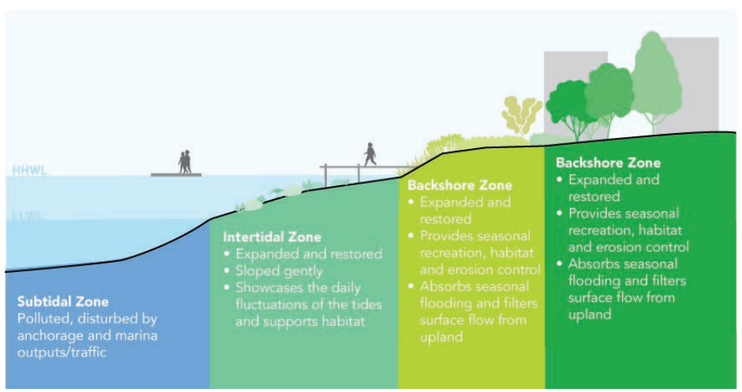
Micro-Forests

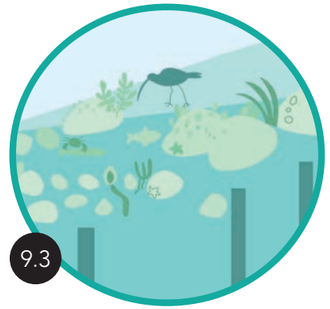
Trees play an important role in pluvial and coastal flood management but the Between Bridges site has a current tree canopy cover of less than 10%. Micro-forests allow for rapid creation of native forest in small urban areas.

COOPER'S PARK SITE — TODAY

COOPER'S PARK SITE — FUTURE







Intertidal Restoration

On sites where expansion is possible, intertidal habitats should be prioritized for their ecological and flood management value.

Landscape Berm

On low-lying sites, such as Coopers Park, landscape berms can provide protection against storm surges and onshore wind, while supporting a range of habitat.

Floating Walkways

The sea wall along Coopers Park is already experiencing the effects of sea level rise. Creating floating public walkways along the waterfront is an adaptive solution that ensures low-impact connectivity.

Constructed Wetland

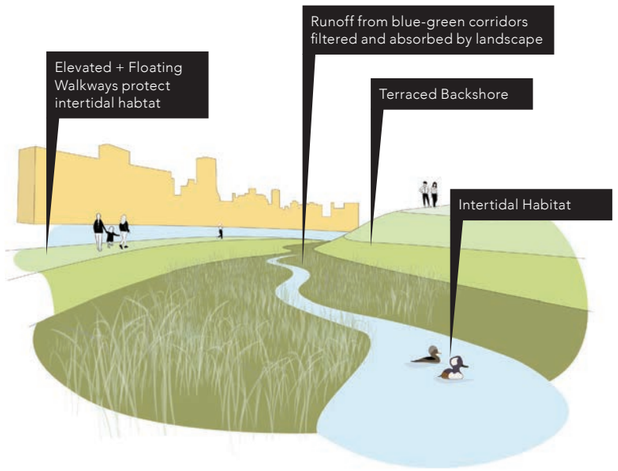
Integrated constructed wetlands into the upland zones can provide significant detention, retention, habitat, and filtration of stormwater runoff, reducing pressure on lower zones. *Refer to Appendix 2.1*

2.1 North Creek Flood Management Ribbon

I. Beyond the Site Scale

The following section applies the approach and strategies established in the previous two sections to the stretch of shoreline between Coopers Park and Between Bridges, on the north shore of False Creek. Using layered and diagrammatic site plans, it illustrates how the waterfront may change over time as the sea levels continue to gradually rise. This overview is intended primarily for internal use to support future planning and design discussions.

This area that we are referring to as the North Creek Ribbon is limited in scope to the zone defined by False Creek to the south, Burrard bridge to the west and Plaza of Nations of the east. Despite only spanning approximately 2.5 km, this stretch of shoreline has a diversity of conditions, ranging from low and semi-natural, to steep and urbanized. This diversity provides a meaningful test of the flood management approach and strategies by demonstrating how they can be applied at a larger scale, incorporating broader watershed, habitat and mobility connections.



Tidal Terraces connect water, habitat and people along the waterfront

II. The North Creek Ribbon: How to Read

This section is intended to provide supporting information on how to interpret the diagrammatic Flood Ribbon graphics on the subsequent pages.

ASSUMPTIONS:

The graphics shown on the following pages required a series of assumptions as described below.

General

- Though the progression of sea level rise is fundamentally unpredictable, the rough time interval of 50 years between half metre increments is used.
- The principles outlined in Section 2.1ii Integrated Flood Management Principles were used as a guide to prioritize decision-making

Buildings:

- Reference to Flood Construction Levels (FCL's) apply specifically to the protection of habitable spaces of buildings
- Average lifespan of all buildings is assumed to be 80 years from the time of construction
- This work is not intended to provide recommendations for specific buildings, but rather a general reference that uses the current anticipated lifespans of existing buildings as a tool to demonstrate potential long term adaptation strategies
- The cost of SLR adaption/retrofitting will be assumed to be amortized over a period of 30 years. Therefore, unprotected and non-adapted buildings with fewer than 30 years of remaining lifespan will be designated for replacement in the illustrated scenarios. It is assumed that equitable building replacement strategies would be considered for those whose remaining lifespans are not economically viable for adaptive retrofit measures
- It is assumed that any housing or commercial space lost will be compensated for at higher elevations.
- Most buildings that end up in the intertidal zone as a result of SLR will be removed and compensated for in the upland zone.

Transportation

- It is assumed that transportation will trend away from private cars in the future, which will allow for more space in street corridors for blue-green infrastructure (Transportation 2040 Plan, COV).

Infrastructure

- Vulnerable sections of storm/sewer lines are shown cumulatively across sea level rise intervals to indicate how existing infrastructure will be impacted overtime. However, proposed locations of upgrades are beyond the scope of this project and were not included in the subsequent intervals.

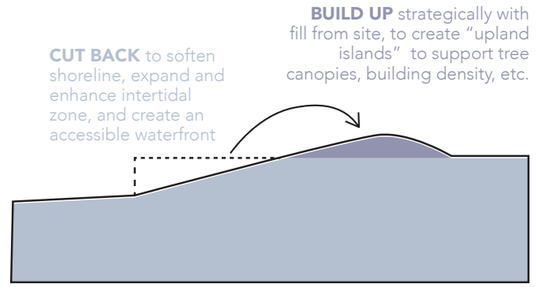
Ownership and Zoning

- It is assumed that current zoning along vulnerable foreshore areas that would be applicable to existing development and ownership would be amended to support zoning that would incorporate resilient shoreline requirements. *Refer to Recommendation #III. Consider a Shoreline Resilience Land Usage Zone in Section 1.3*

Shoreline Zones

The extents of the shoreline zones as shown on the plans were guided by the following assumptions:

- Projected extent of SLR combined with a coarse assessment of existing contours and sea wall condition
- Conditions associated with these zones correspond directly with sea level. The backshore and intertidal zones are prioritized for expansion to support habitat and floodplain function wherever possible. *Refer to Section 2.0 iii. Shoreline Zones*
- With the exception of low-impact, adaptive buildings and structures, the Intertidal zone will be prioritized for ecological restoration



Cutting back and building up to balance earthworks and minimize vulnerabilty.

LEFT SPREAD: ESTABLISHING PRIORITIES

This spread illustrates four key "layers" that establish the basis for planning for sea level rise protection and adaption. The following diagrams provide an organizing structure for focusing efforts on the various elements of protection and adaptation. They illustrate how vulnerabilities and priorities evolve over time.

Threat and Vulnerability

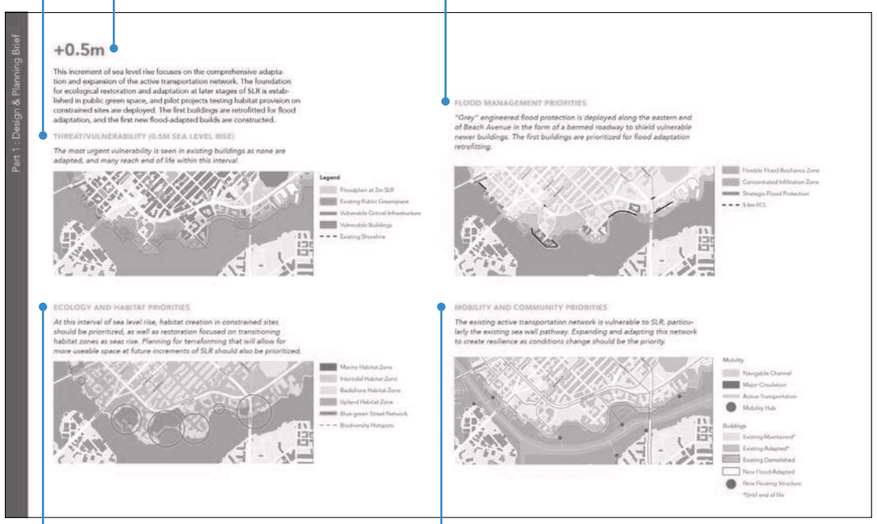
Where are we most vulnerable? This diagram highlights buildings and infrastructure that are vulnerable to the next 0.5m of SLR.

Projected Increase in Sea Level

Estimated in 0.5m increments to demonstrate changing risk and opportunities over time.

Flood Management Priorities

Where is immediate action needed? A direct result of the Threat/Vulnerability analysis, this diagram Illustrates areas that require consideration for immediate protection and flood adaptation.



Ecology and Habitat Priorities

Where are opportunities for ecological restoration on this changing shoreline? Areas that are ideal for restoration often overlap with vulnerable sites unsuitable for traditional development. Identifying these areas early in the design process ensure they are integrated into the basin-scale management planning and prioritized accordingly.

Mobility and Community Priorities

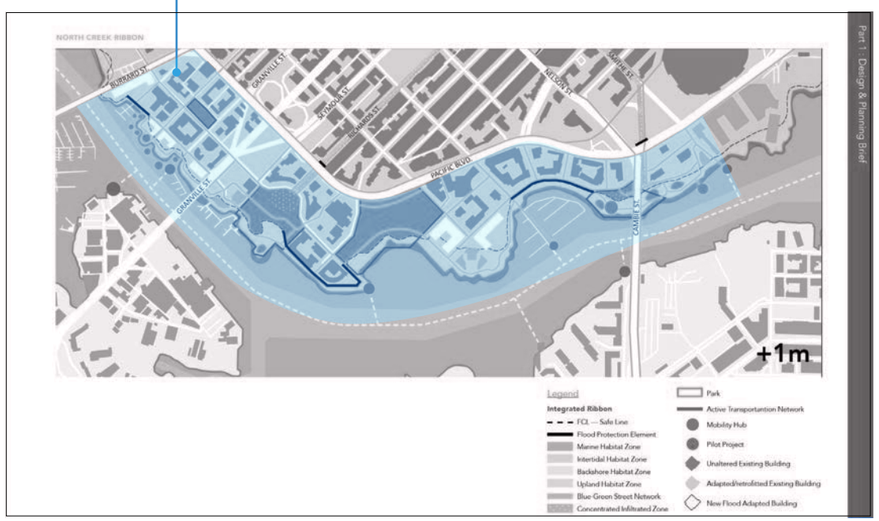
How will SLR impact accessibility and the ability to move around the community? This diagram illustrates how connectivity is impacted by SLR and highlights areas and corridors that should be prioritized. Planning for, and investing in, alternative routes should be done when vulnerability is still low.

RIGHT SPREAD: AN INTEGRATED RIBBON

This spread illustrates a comprehensive and layered vision for the northern shore of False Creek. Its purpose is to demonstrate how an adaptive and integrated flood management approach could inform the near and long-term transformation of this area, and how comprehensive transformation can unfold over the course of decades. It is not meant to be a plan but rather a possibility: visualizing how strategic and incremental change can ensure a resilient, connected and thriving urban waterfront, despite the challenges associated with sea level rise.

Area of Focus

The area of focus is the north shore of False Creek, between the Between Bridges and Coopers Park Project Sites.



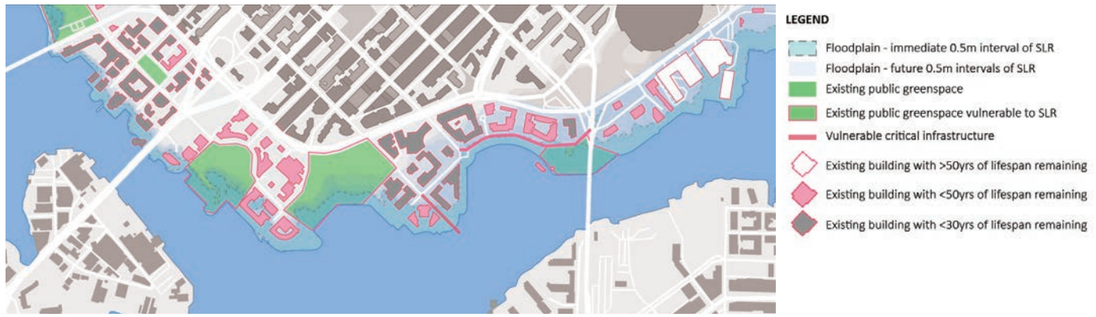
III. The North Creek Ribbon

+0.5m

This increment of sea level rise focuses on the comprehensive adaptation and expansion of the active transportation network. The foundation for ecological restoration and adaptation at later stages of SLR is established in public green space, and pilot projects testing habitat provision on constrained sites are deployed. The first buildings are retrofitted for flood adaptation, and the first new flood-adapted builds are constructed.

THREAT/VULNERABILITY (0.5M SEA LEVEL RISE)

The most urgent vulnerability is seen in existing buildings as none are adapted, and many reach end of life within this interval.

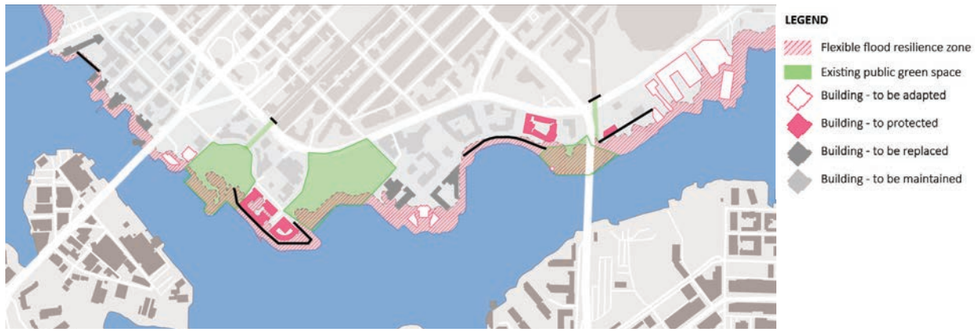


ECOLOGY AND HABITAT PRIORITIES

At this interval of sea level rise, habitat creation in constrained sites should be prioritized, as well as restoration focused on transitioning habitat zones as seas rise. Planning for terraforming that will allow for more useable space at future increments of SLR should also be prioritized.

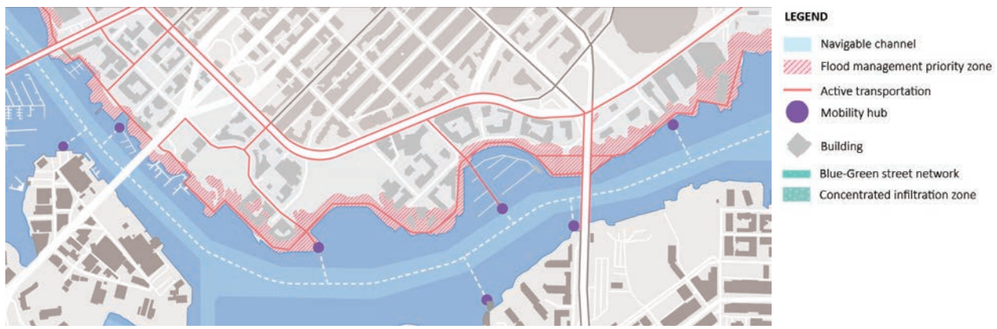
FLOOD MANAGEMENT PRIORITIES

"Grey" engineered flood protection is deployed to shield vulnerable newer buildings. The first buildings are prioritized for flood adaptation retrofitting.



MOBILITY AND COMMUNITY PRIORITIES

The existing active transportation network is highly vulnerable to SLR, particularly the existing sea wall pathway. Expanding and adapting this network to create resilience as conditions change is the priority.



LEGEND

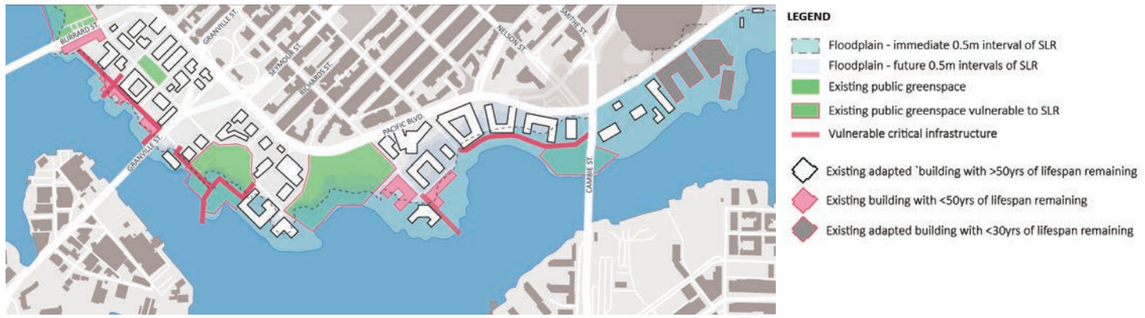
- FCL - safe line
- Flood protection element
- Marine habitat zone
- Intertidal habitat zone
- Backshore habitat zone
- Upland habitat zone
- Blue-Green street network
- Concentrated infiltration zone
- Park
- Active transportation network
- Mobility hub
- Pilot project
- Unaltered existing building
- New flood adapted building
- Navigable channel

+1.0m

This increment of sea level rise focuses on adapting or replacing the majority of remaining vulnerable buildings. Pluvial flood management continues to expand through infiltration sites and the blue-green street network. Ecology focuses on restoring sites that have undergone habitat zone transformation, and whose human land use regimes have changed.

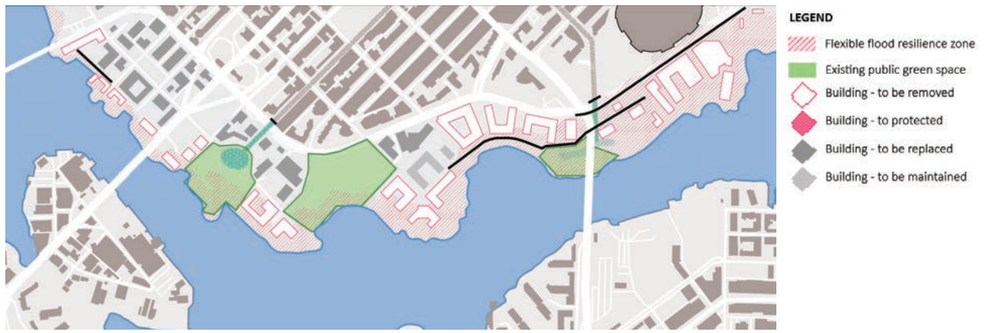
THREAT/VULNERABILITY (1M SEA LEVEL RISE)

At 1 metre of SLR, Pacific Blvd begins to be impacted and buildings that were previously above the FCL, are considered vulnerable.



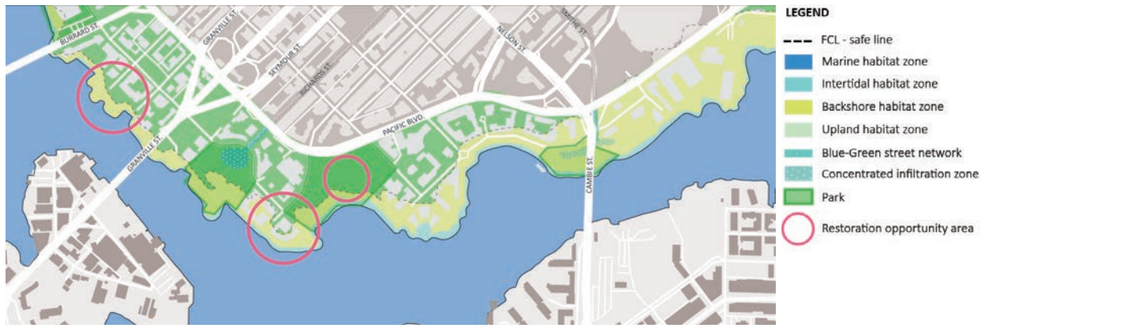
FLOOD MANAGEMENT PRIORITIES

Pacific Boulevard is strategically elevated to protect critical infrastructure while new adapted buildings and shoreline restoration is prioritized.



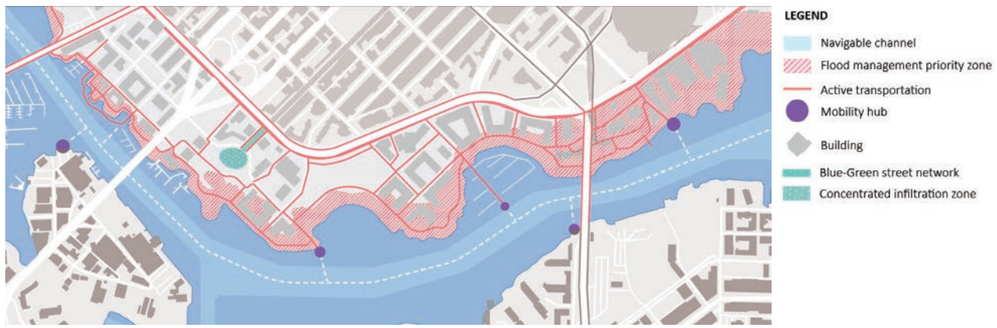
ECOLOGY AND HABITAT PRIORITIES

Infiltration sites / constructed wetlands should be prioritized as the demands on stormwater management continue to grow. Sites around adapted buildings that have shifted from upland to backshore habitat should be the focus of restoration that allows for human uses.



MOBILITY AND COMMUNITY PRIORITIES

The adaptation of active transportation already undertaken continues to be resilient. As ecological restoration unfolds, circulation routes through sensitive habitats and floating walkways should be prioritized.



LEGEND

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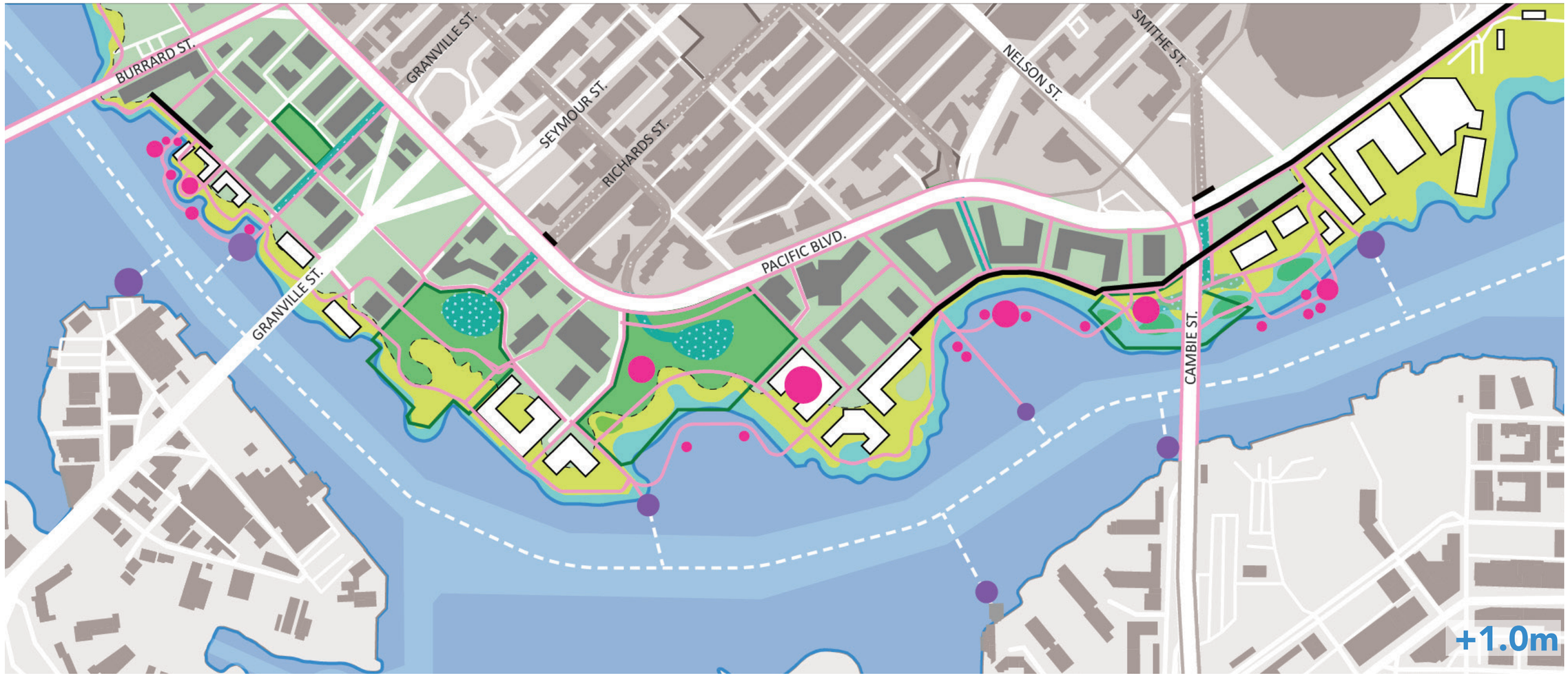
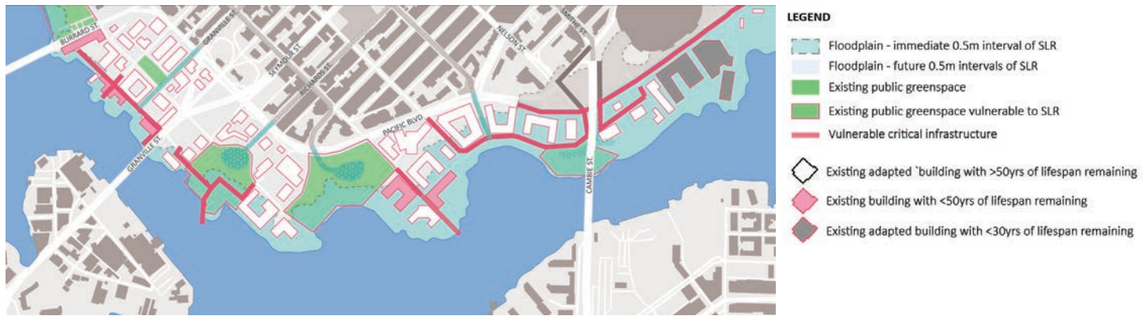


+1.5m

This increment of sea level rise focuses on the comprehensive expansion of green infrastructure to manage pluvial runoff. The restoration of back-shore sites surrounding adapted buildings continues. The first adapted buildings reach end of life and more space is dedicated to ecological restoration and public green space to provide integrated flood management benefits.

THREAT/VULNERABILITY (1.5M SEA LEVEL RISE)

Pacific Blvd is increasingly vulnerable. Sewer and storm lines are progressively more compromised. Early flood-adapted buildings are beginning to reach end of life.



ECOLOGY AND HABITAT PRIORITIES

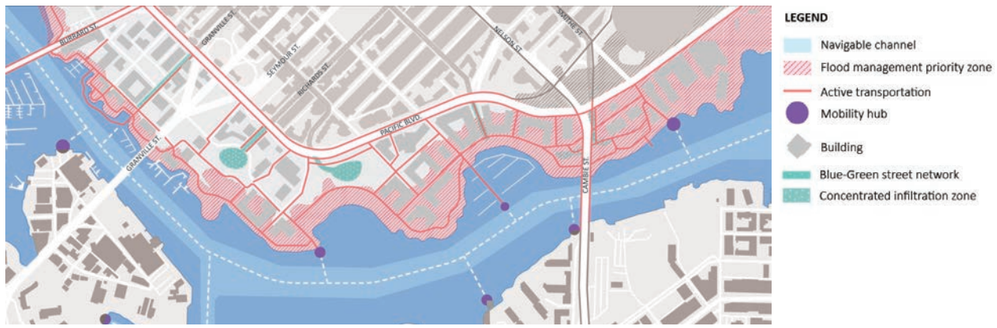
Shoreline restoration on sites of removed buildings can begin. As buildings are removed, public green space and ecological restoration efforts are expanded to compensate for space already lost to SLR. Intertidal restoration outside of public green space begins.

FLOOD MANAGEMENT PRIORITIES

Pacific Blvd is a priority. Buildings below the FCL that are at end of life should be removed in favour of ecological restoration and adapted structures and amenities.

MOBILITY AND COMMUNITY PRIORITIES

The implementation of floating walkways are prioritized. Operations and management for periodically flooded pathways becomes critical. Waterborne public transit is expanded.



LEGEND

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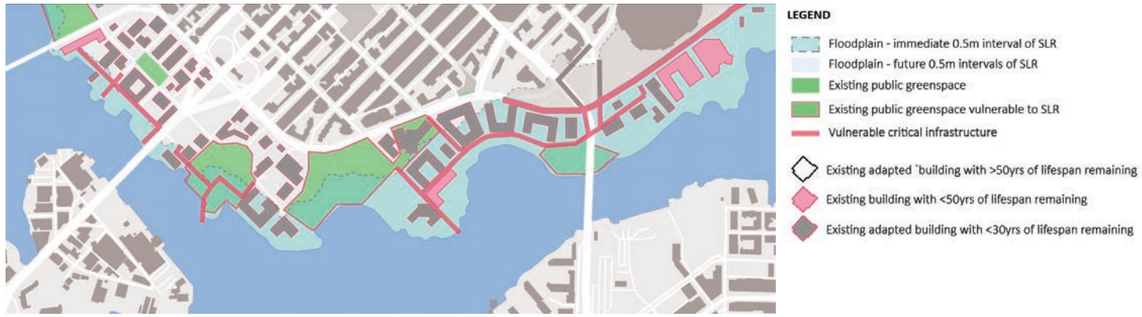
- Concentrated infiltration zone
- Park
- Active transportation network
- Mobility hub
- Pilot project
- Unaltered existing building
- New flood adapted building
- Navigable channel

+2.0m

This increment of sea level rise focuses on comprehensive ecological restoration, including on sites of demolished buildings. The gradual removal of buildings from the intertidal and backshore zones allows for comprehensive habitat connectivity across an expanded intertidal zone. Loss of housing is mitigated through increased density in the upland zone. The establishment of the Pacific Boulevard berm is completed.

THREAT/VULNERABILITY (2M SEA LEVEL RISE)

Pacific Blvd continues to be a priority. Flood-adapted buildings are increasingly reaching end of life.



FLOOD MANAGEMENT PRIORITIES

Strategically raising/protecting Pacific Boulevard is a priority. Integrated flood management strategies are prioritized for all development and restoration.

ECOLOGY AND HABITAT PRIORITIES

The sites of removed buildings are undergoing ecological restoration. Comprehensive intertidal restoration and habitat connectivity across False Creek should be the focus.

MOBILITY AND COMMUNITY PRIORITIES

The adaptation of active transportation already undertaken continues to be resilient. The expansion of floating walkways continues.

LEGEND

- FCL - safe line
- Flood protection element
- Marine habitat zone
- Intertidal habitat zone
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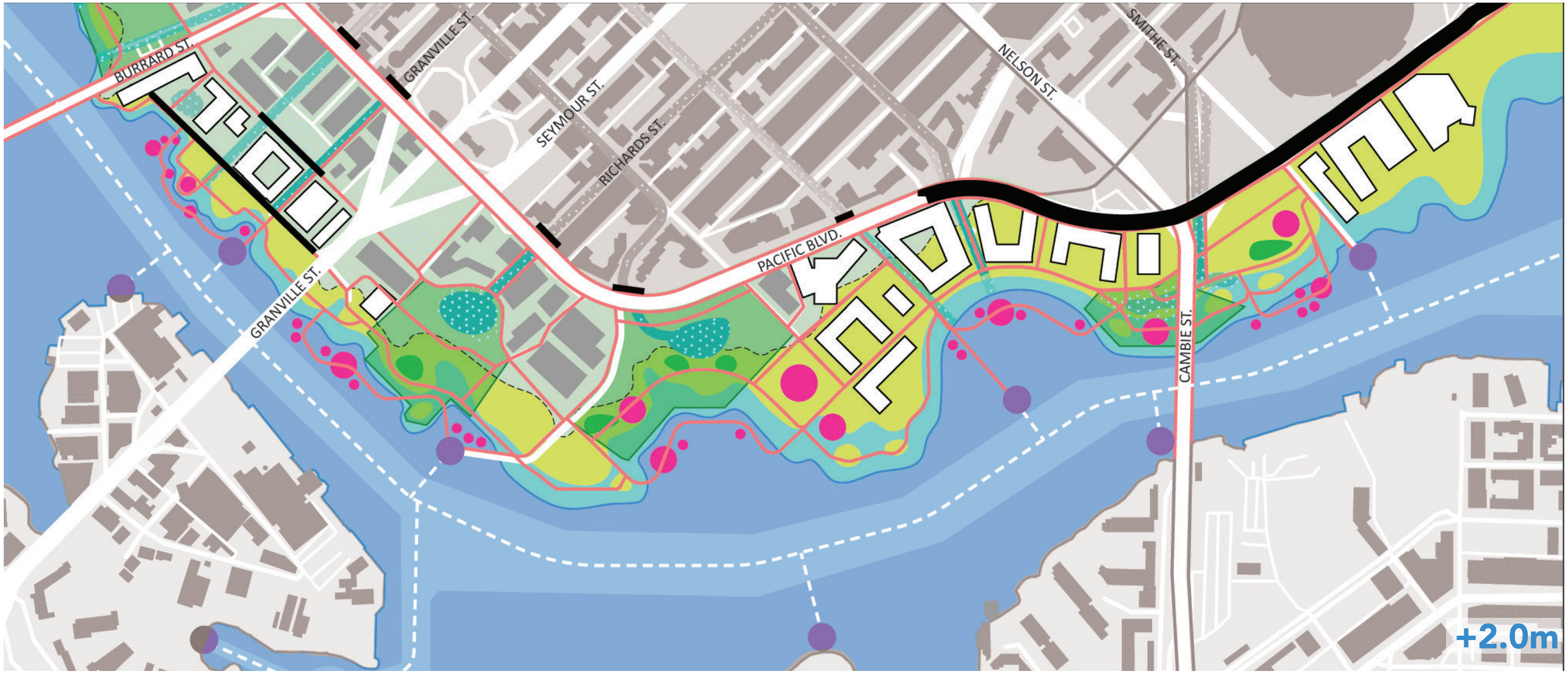


3 Adaptive Design Brief

3.0 Introduction

Inhabiting a climate-changed world requires an ongoing process of adjusting to uncertainty. This continual adjustment is defined as Climate Adaptation. Although several predictions have been made regarding rising temperatures and sea level rise, our precise future conditions will continue to remain uncertain. We understand that reducing greenhouse emissions is essential in mitigating the severity of the impact of climate change, but the requirement for broad and urgent adaptation measures is undeniable.

The City of Vancouver is aware of the challenges that our region and its inhabitants are facing. This has culminated in the Vancouver Climate Adaptation Strategy which defines Climate Adaptation as those actions that allow us to "respond to the impacts of climate change by taking advantage of opportunities or reducing the associated risks" (Climate Change Adaptation Strategy of the City of Vancouver, 2012).

Vancouver's False Creek is particularly vulnerable to several hydrological challenges. Many of these will be exacerbated by climate change. These challenges include contaminated runoff draining into the waterways or accumulating in areas with lower elevation and causing localized flooding. Simultaneously, storm surges and tidal forces continue to overtax our aging seawall. We know that sea levels will continue to rise, coastal flooding will get more severe, and that winter rainfall patterns will continue to intensify and become more frequent.

Climate Adaptation in this context must focus on recognizing the emergency we're in and thoughtfully consider how we got here, what our priorities are, and what we need to do to repair our situation. It requires decision-making that is both reflective and prospective, and an approach emphasizing a careful balance of taking control and ceding control.

PLANNING FOR UNCERTAINTY

Adapting to sea level rise requires comfort around uncertainty. We cannot precisely predict the extent of rainfall pattern and temperature change, or how quickly and to what level the sea will rise. It is possible that sea level will rise 1.0m or more in the coming 80 years. It is also possible that this change will be exponential, and that by 2100 the sea level will have risen 2.0m or more. Despite this uncertainty regarding those physical conditions, what is increasingly certain is that the impacts of climate change will continue to ripple and contribute to displacement, migration, loss of livelihoods, political instability, and conflict.

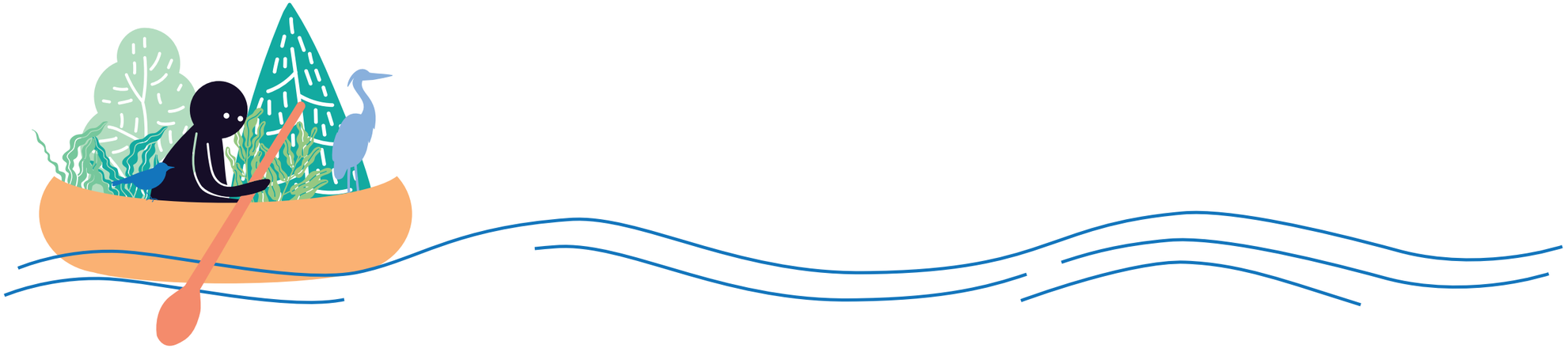
Acknowledging this uncertainty, there is also potential for positive change and cultural shifts that support more sustainable, equitable, and just communities. We need strategies that respond and adapt to future scenarios while simultaneously restoring, regenerating and contributing to collective long-term visions for False Creek.

To achieve climate adaptive design, a simplified Adaptation Pathways approach (see Section 3.2) can allow The City to plan the actions that need to be taken and their relative timing, while remaining flexible and agile when confronted with untimely future changes. This approach permits the mapping of strategies and measures over time, the definition of strategies' life cycles, and the identification of timing with regards to their implementation.

Instead of a linear process, the Adaptive Pathways method helps to identify tipping points–crucial moments to check assumptions and make decisions to avoid mal-adaptation. The approach allows The City to identify key moments to reflect on the initial vision and strategies and to determine if they are still relevant in that contextual moment (particularly considering sea level rise). This allows a change in direction or adjustment to the overall vision if necessary.

The Adaptation Pathways approach for False Creek considers a scenario where sea level could rise 2.0m by 2100. It addresses this scenario using three main strategies:

- Agile Tipping Points for the planned strategies and measures
- The Flood Management Ribbon: a flexible zoning plan
- Flood-resilient buildings, landscapes, and infrastructure



3.1 Adaptive Design

TIPPING POINTS

The Adaptation Pathways for the north shore of False Creek charts the life cycle of the various strategies and measures along with the time needed for their implementation.

It also includes intangible measures regarding education, collaboration, and communication.

These actions and measures:

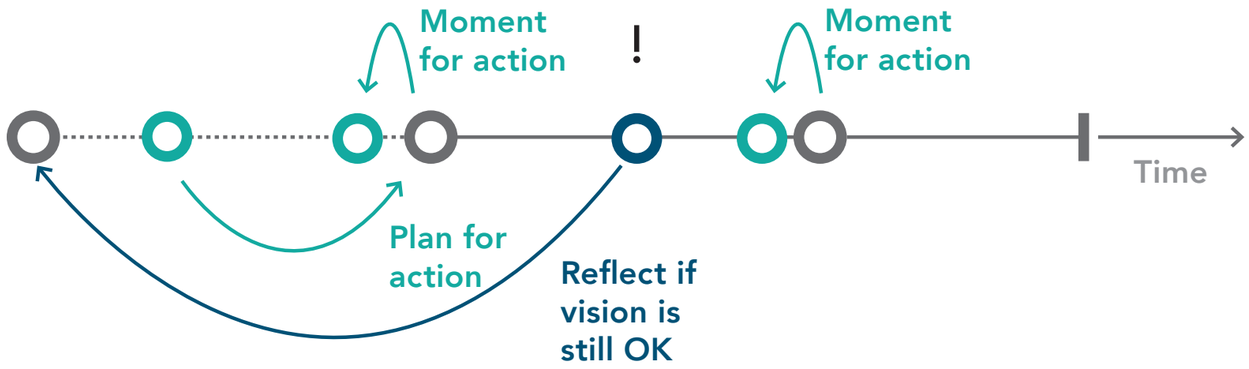
(a) uphold values,

(b) recognize what was, what is, and what could be;

(c) dive in;

(d) build resiliency and adaptability.

The mapping of these measures and actions accords to estimated sea levels for the short, medium, and long term. However, in recognition of the uncertainty ahead, the pathways of adaptation include reminders for when assumptions and estimations regarding SLR need to be checked. This allows for timely modification in the planning. For example, reinforcing the foundations and pumping systems of the underground levels of buildings in flood zones is planned to start between 2020 and 2030, before sea levels reach 0.5m. Buildings can then maintain their current functions up to 2050. If sea levels rise more rapidly than predicted, however, these actions might not be sufficient to compensate for sea level rise and will reach their tipping point sooner. Finally, when a measure or action reaches its tipping point, but is no longer a suitable intervention, alternative paths must be considered.



Tipping Points

THE FLOOD MANAGEMENT RIBBON—FLEXIBLE PLANNING

The False Creek Adaptation Plan is based on shoreline landscape zones that define the gradient of the shoreline and the transformation of the waterfront. The plan is not static—it changes gradually according to sea level rise. Shoreline zones will gradually shift upwards, reaching further into the upland zone. This plan assumes that the flood construction level (FCL) is 5.6m. This is aligned with an estimated sea level rise of 2.0m by 2200. If sea levels increase further before that time, this gradient of the shoreline will have to be reconsidered. This is indicated in the adaptation pathways.

The upland zone represents an area of safety, where critical infrastructure will be relocated and protected from rising sea levels.

Area of Flexible Zoning for Flood Management/Resilience

FLOOD-ADAPTIVE BUILDINGS AND LANDSCAPES

The formulation of clear, holistic climate adaptation guidelines for new structures is a crucial measure to mitigate future risk. The Sea Level Rise Catalogue (MVRDV 2022) provides an example of guidelines and principles that can be applied to both current and new designs both when retrofitting existing structures and when constructing new ones. It includes strategies such as: upgrading and raising critical utilities; reprogramming first and second floors to accommodate new ground level elevations; elevating the evacuation and circulation routes; and adapting underground levels to accommodate higher water tables.

Landscapes must also be designed to adapt incrementally to changes in water levels from coastal and pluvial flooding, and flexibly support multiple uses. This will require planting strategies that select salt and flood tolerant species that are climate adaptive and that migrate to higher elevations over time while consistently supporting diverse habitat and cultural needs.

The future provision of floating infrastructure is a long-term solution, creating circulation networks, constructed habitats, and cultural and recreational facilities that are adaptable to sea level rise.

Upgrade utilities

Re-purpose underground structures

Lift the ground floor

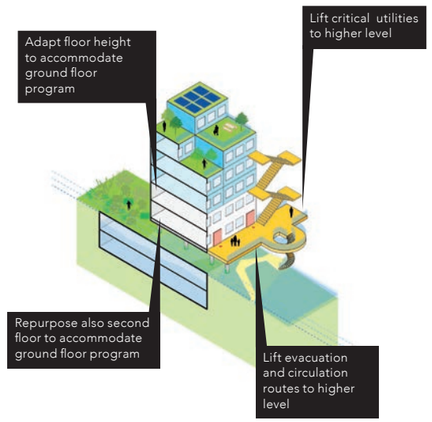
Flood-proof circulation

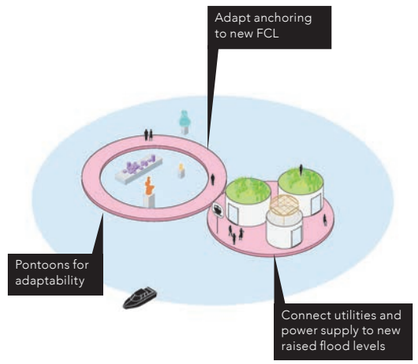
Re-shuffle & adapt program

Adapt structures

Principles of Flood-Adaptive Buildings

The Sea Level Rise Catalogue for building adaptive strategies (MVRDV)





Examples of flood-adapted structures

3.2 Adaptation Pathways

An Adaptation Pathway is a tool designed to plan for adaptation decision-making by identifying decisions and actions that need to be taken now and in the future. The typical approach supports strategic decision-making that is both structured and flexible.

Refer to Appendix 1 : "Adaptation Pathways As Currents of Possibility" (Collaboratorium 3, July 2022)

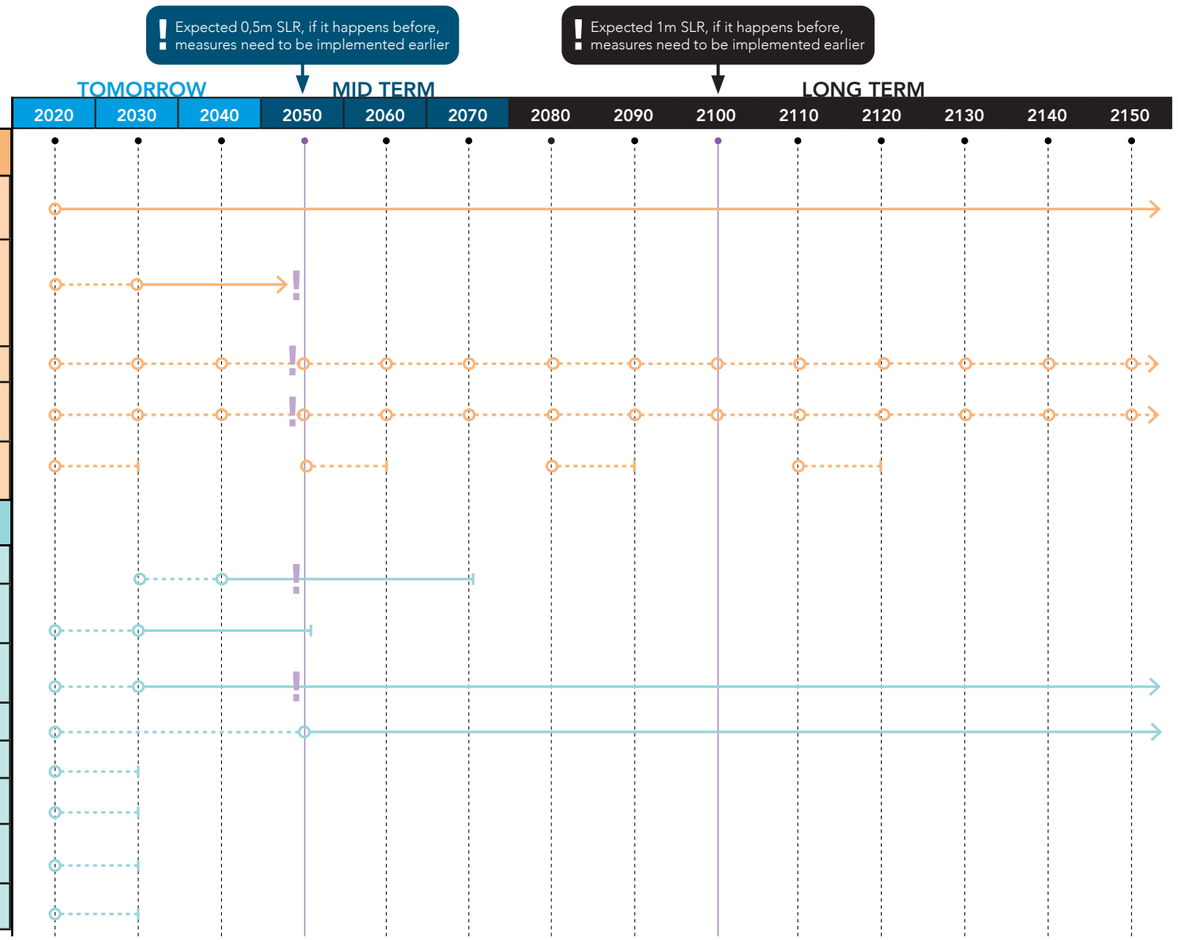
Maladaptation

Broadly defined, maladaptation is when climate change adaptation actions have the opposite of the intended effect: increasing vulnerability rather than decreasing it. An example of possible maladaptation may be the construction of mono-functional dykes to protect people from storm surges and sea level rise. While this may solve one (temporary) problem, it can also:

- create a false sense of security and encourage more development in high flood-risk areas
- create a barrier that separates access to the water's edge while trapping runoff and causing flooding
- limit the natural ability for the foreshore to absorb wave energy, storm surge and runoff

Legend

- time it takes to implement a measure
- lifecycle of a measure
- starting/renewal point
- tipping point: critical time to make a decision
- ! time to check SLR projections
- continues in the future



Uphold Host Nations and community values	
This adaptation approach seeks to decolonize the wider settler-colonial structure of power that has produced the very conditions to which we now must adapt. It demands that we all recognize and respect the gentle footsteps of Host Nations ancestors, and commit to listening to the teachings offered by the traditional territories of the Musqueam, Squamish and Tsleil-Waututh people on how to co-exist in reciprocal relationships with all living spirits. It requires us all to share our collective and diverse knowledge as well as the responsibility of stewarding the land and water.	Foster Good Relations: Seek direction from Host Nations and traditional land stewards
	Create diverse collaboration models and spaces for action with and for local innovators, sustainability pioneers, governance, first nations, local community initiatives
	Maintain Public Engagement and Education
	Initiate the creation of a Stewardship Plan. *Refer to Section 1.3: Future Recommendations.*
	Initiate Ecological Inventories of False Creek. *Refer to Section 1.3: Future Recommendations.*
Recognize what is, what was, and what could be	
We are in a climate emergency. It is essential that we understand how we got here, what the challenges are, and what we need to do to fix it. This requires critical reflection, rigorous studies and bold imagination. We need to be able to imagine a False Creek where all residents can recognize themselves and feel attached to the place and its future if we're going to create it. We also need to recognize our dependence on the more-than-human world by recognizing the damage that has been done by denying our kinship with it. A vibrant, fair, and regenerative future is possible but it demands continuously looking back while leaping forward.	Check/reinforce building foundations in flood zones
	Maintain and reinforce pumping system for underground parking
	Relocate critical infrastructure (transport, utilities, communications) to a flood safe elevation
	Separate sewer system
	Initiate MST archaeological investigations
	Calculate Cost of Inaction / Maladaptation
	Initiate study of existing trees in flood-prone areas, develop planting strategy for future tree canopy
	Explore Funding for Pilot Projects

Urgent action is needed, so dive in

Long-term objectives often require near-term decisions and actions. In the face of uncertainty, pilot projects can be immediately initiated to explore ideas, investigate what works and nurture a renewed sense of collective action in False Creek.

Beyond pilot projects, there are also general adaptation steps that need to be started early on in the process such as:

- strategize and implement flood-resilient, non-fossil mobility networks
- start dialogue about flexible waterfront zoning and legislation with the various stakeholders to ease the process of implementation
- conversations with strata's to create an adaptation plan per building
- test and measure/evaluate adaptation ideas such as floating structures, types of species and their climate adaptation potential and monitor their performance
- create diverse collaboration models and spaces for action with and for local innovators, sustainability pioneers, governance, first nations, local community initiatives

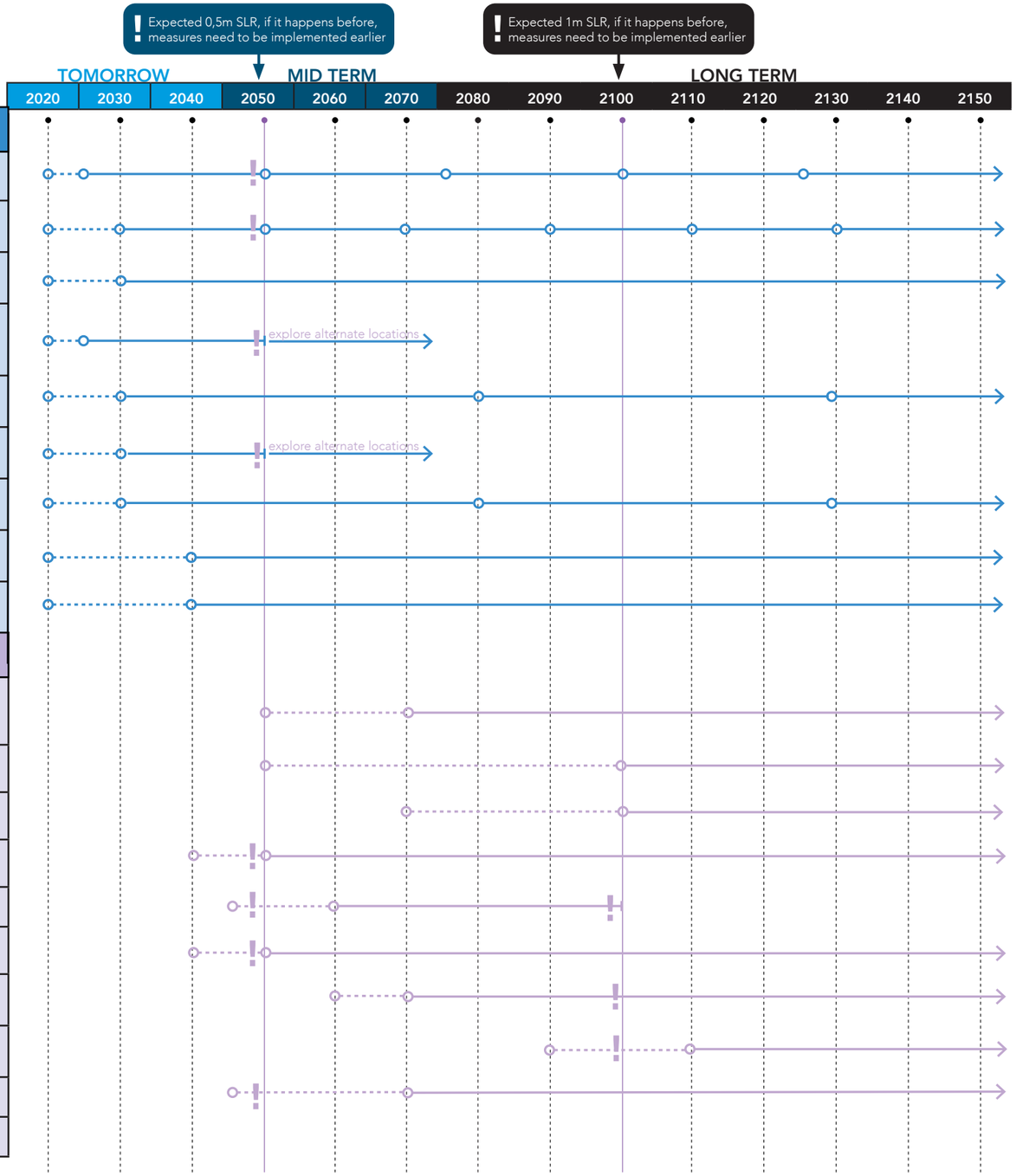
Pilot Project: Design, install and test stretch of Floating Walkways See page X
Pilot Project: Design, install and test a Floating Habitat Island. *Refer to Section 4.2i*
Pilot Project: Establish Micro-Forests in urban upland areas where space limited
Pilot Project: Work with Host Nations to establish a Coast Salish Native Plan Nursery and Demonstration Garden in False Creek. *Refer to Section 4.2ii*
Pilot Project: Design, construct and install a "Paddler's Pavilion" *Refer to Section 4.2iii*
Pilot Project: Design, construct and install a Host Nation Pavilion *Refer to Section 4.2iv*
Pilot Project: Design, construct and install a floating Mobility Hub
Initiate policies and strategies to protect, re-use, restore and manufacture urban soils
Integrate and connect blue-green infrastructure into the public realm (Rain City Strategy)

Plan for uncertainty: stay resilient and adaptive

Planning for uncertainty means preparing for boulders and obstacles we can and can't see ahead. While "sustainability" has successfully encouraged a new lens through which we see ourselves in relation to the natural world and its finite resources, it has also led to a common misunderstanding that a balanced, sustained equilibrium is achievable. But we know in reality that the only thing constant is change and that life is a series of trying, failing, adapting, learning, and growing in endless cycles. With this in mind, change and disturbance - or unexpected boulders in our path - are accepted and expected characteristics of the larger system - and opportunities to increase resiliency.

Willows, for example, have flexible branches and the ability to root and grow from broken stems, while Cottonwoods need flooding for reproduction. Their resilience is the result of evolutionary adaptation that allows them to survive and thrive in dynamic and changing conditions. Ultimately, resilience is about designing receptive places instead of defensive ones - of going with the flow, despite the uncertainty, instead of against it.

Transform groundfloor of waterfront buildings & create flexible floating built structures along the shoreline
Deconstruct the shoreline (strategically replace the seawall with terraces and slopes)
Retrofit selected waterfront buildings, adding a floor on top and a green rooftop
Increase water storage in upland areas (detention ponds, wetlands, etc.)
Re-purpose underground parking structures
Establish a new ground level: move groundfloor and first floor programs up
Connect first floor of waterfront buildings; connect buildings to bridges
Deconstruct selected waterfront buildings reaching end of life & develop new housing typologies
Re-shuffle building programming for flexibility



4 “First Steps” Costing Brief

4.0 Introduction

Long-term objectives require near-term actions and investments. In the face of uncertainty, pilot projects can be immediately initiated to explore ideas, investigate what works and nurture a renewed sense of collective action in False Creek, and beyond.

The following pages explore diverse opportunities for getting our collective feet wet. These projects range from bold ideas that test innovative technologies to nature-based "quick-starts", and include costing considerations that aim to support a decision-making process.

COSTING APPROACH

Cost estimates are important tools for project planning, business cases and justifying funding requests. While a typical "project cost estimate" provides a prediction of the most likely total cost to complete the identified scope of work, this costing brief is intended to be strictly preliminary in nature.

The information provided prioritizes key costing considerations rather than precise cost estimates given the uncertainty of pricing and the broad range of potential modifications to any given pilot projects. These selected projects are designed as pilots, in part to test and refine the approach (including value/costing) before implementing a full-scale version.

Objectives:

- Contribute supportive information that is typically required for funding applications
- Provide information, inspiration and resources for decision-makers for business cases and value analysis
- Support and initiate cross-jurisdictional cooperation by providing potential partnership opportunities and relevant case studies

Costing Assumptions

Costing assumptions that are specific to each pilot project are included in each respective project's details. The following assumptions are general and apply to all projects and work:

- Costing includes projected construction costs as order of magnitude in today's dollars
- Costing for Construction & Material includes labour and installation, unless otherwise noted
- Projected costs are based on design descriptions as outlined in each of the pilot projects
- Excludes land acquisition costs
- Excludes City staffing costs - while this isn't included in the costing, it is anticipated that staff time would need to be allocated for a range of departments and will depend on the design components and jurisdiction.

Uncertainty and Risk

Uncertainty factors will vary from project to project and site to site, but the following are factors typical of most pilot projects presented on the following pages.

- Location: Site ownership and jurisdiction overlaps can lead to ambiguous or redundant responsibilities and delay initiation
- Operations and Maintenance: Possible limitations such as inability for City to access marine structures from water resulting in costs for additional equipment/personnel
- Land value: Inherent uncertainty and risk in any land acquisition process
- Price fluctuation: Inflation rate, exchange rate, and increase in building material costs
- Material: (Un)availability of building materials
- Permits: Interpretation and implementation of relevant policies, permits, bylaws, zoning etc.
- Political factors: buy-in from local government/initiatives for land owner to implement pilot projects

Capital vs Operational

Costing summaries include capital costs and operational considerations, both of which are essential to viability of each pilot project. Capital costs are the upfront costs for planning, design and construction. Operational costs include management, monitoring and maintenance. It is recommended that Capital Budgets earmarked for the pilot projects will also consider operational costs, to avoid future financial burden and ensure essential management.

Key Performance Indicators

As pilot projects, it's important to measure how well each project achieves the concept goals and aspirations. Key Performance Indicators (KPIs) established prior to implementation provide metrics for each project and enable clear evaluation, which may validate, disprove or suggest adjustments to the respective projects. A list of potential KPIs are provided below. Specific metrics should be developed prior to implementation of each pilot project.

- Number of visitors
- Awareness: Number of visits to project website and photos tagged to the location or using the project hashtag
- Accessibility: qualitative analysis by people with disabilities (such as the Persons with Disabilities Advisory Committee)
- Sustainability and ecological metrics
- Number of volunteers engaged or number of volunteer hours donated

Procurement and Indigenous Representation

Each costing summary includes considerations for professional expertise in the "Design & Engineering" phase. It is hoped that CoV will advance efforts to expand and support Indigenous representation in as many professional disciplines as well as ensuring Musqueam, Squamish, and Tsleil-Waututh representatives are included in all phases of the project - especially during early Planning phase.

Revenue and Funding

Pilot projects offer potential revenue through public and private partnerships, particularly relating to facilities that provide services such as the Paddlers Pavilion and Host Nations Pavilion that have the ability to offer food and beverage facilities, rentals and paid programs.

Note: General funding opportunities for broad Sea2City recommendations and concepts can be found in ***Section 1.3.***

4.1 Pilot Project Overview

SELECTING THE PILOT PROJECTS

The following pages explore 4 distinct pilot projects, selected to represent a variety of approaches, locations, variables, budgets, functions and timelines.

When selecting these pilot projects, consideration was given not only to the amenity value or community benefit each project would provide, but also to its ability to test a technology, approach or construction methodology that requires further study.

REPEATABILITY

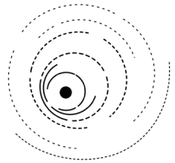
An important consideration was each pilot project's "repeatability" - or potential for broader influence. These were categorized in the following ways:

Growth: Projects that are modular or have the ability to grow or expand over time.

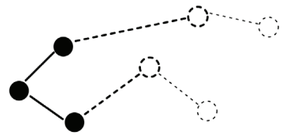
Ripple-effect: Projects that catalyze positive change and energy by integrating cultural value, diversity and inclusive access into a specific area.

Satellite: Projects that can easily multiply or connect to other locations.

Growth



Ripples



Satellite

On Water

1. Floating Island and Walkway

Est. Cost: $2.5-3 million

Timeline: Near-term (1-5 years)
Dependent on permits, R&D, location and coordination/collaboration

Location: Adaptable. For first pilot: adjacent to seawall in marina is recommended.
See map on facing page

Typology: Modular Infrastructure and Habitat
Mobility network and habitat restoration

Scale: Medium (75m long walkway, 200sm island)

Repeatability: Satellite and Growth

3. The Floating Paddler's Pavilion

Est. Cost: $4-5 million

Timeline: Near-term (2-5 years)
Dependent on permits, R&D, location and coordination/collaboration

Location: Adaptable. For first pilot project, Between Bridges site is recommended. Must be outside of navigable channel and intertidal zone. *See map on facing page*

Typology: Floating Structure
Recreational and water mobility hub

Scale: Medium (200sm)

Repeatability: Ripple-effect, Satellite

On Land

2. Coast Salish Cultural Learning Garden and Test Plot Nursery

Est. Cost: $1-1.5 million

Timeline: Quick-start (1-2 years)
Dependent on permits and collaborations/engagement

Location: Site-Specific but Adaptable
See map on facing page

Typology: Landscape
Cultural Learning Garden and Test Plot

Scale: Large (2000sm)

Repeatability: Satellite and Growth

4. The Host Nation's Pavilion

Est. Cost: $2.5-3 million

Timeline: Near-term (1-5 years)
Highly dependent on permits, assessments and collaborations

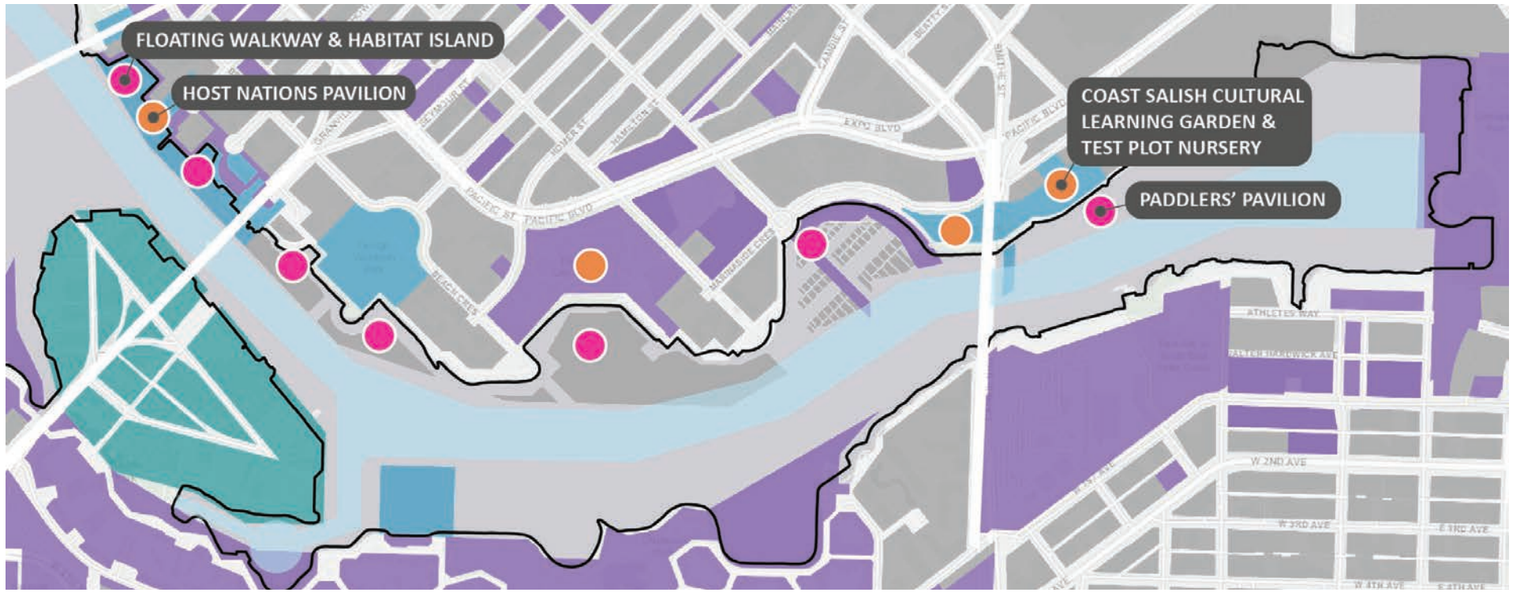
Location: Site-Specific
See map on facing page

Typology: Structure
Education and cultural exchange centre

Scale: Medium (160sm)

Repeatability: Ripple-effect

LOCATION CONSIDERATIONS



Ownership

- Federal
- Provincial
- Municipal
- Private
- Navigable Channel

Pilot Projects

- Potential location for land-based pilot project
- Potential location for floating pilot project

Provincial (Crown) Land

Established lease agreements exist between the Province and the City with respect to established parks and existing residential leasehold lands that would require involvement from both levels of government to consider use changes once leases have come to term.

Provincial (Crown) Water Lots

Existing lease agreements exist with the Province between either the City of Vancouver or private operators such as the Aquabus and Private Marinas that would require involvement from both levels of government to consider use changes once leases have come to term.

Municipal Land

Largely related to City Park Spaces and community facilities which provides the greatest level of autonomy for City-led policies and initiatives to happen

Municipal Water Lots

Largely related to marine structures that are public or leased to private operators, potential for future (new) uses at the end of lease terms.

Private Land

Private lands require involvement of property owners and strata corporations, in concert with the legal jurisdictions in which they reside.

Private Water Lots

Private water lots require involvement of property owners and operators, in concert with the legal jurisdictions in which they reside.

4.1 Pilot Project Costing

I. Floating Island and Walkway

WHAT IS IT?

A Floating Walking and Habitat Island Pilot Project would test out the technology to prepare for a future where significant stretches of the City's beloved (but vulnerable) seawall is transformed to accommodate rising waters.

WHY NOW?

False Creek has inadequate opportunities for habitat, water quality issues, and sections of the seawall are already being impacted by higher and stronger storm surges and erosion.

This Pilot Project would allow for continuous waterfront pathway and effective re-routing strategy for pedestrians during the deconstruction of the existing seawall as part of the foreshore naturalization process.

HOW?

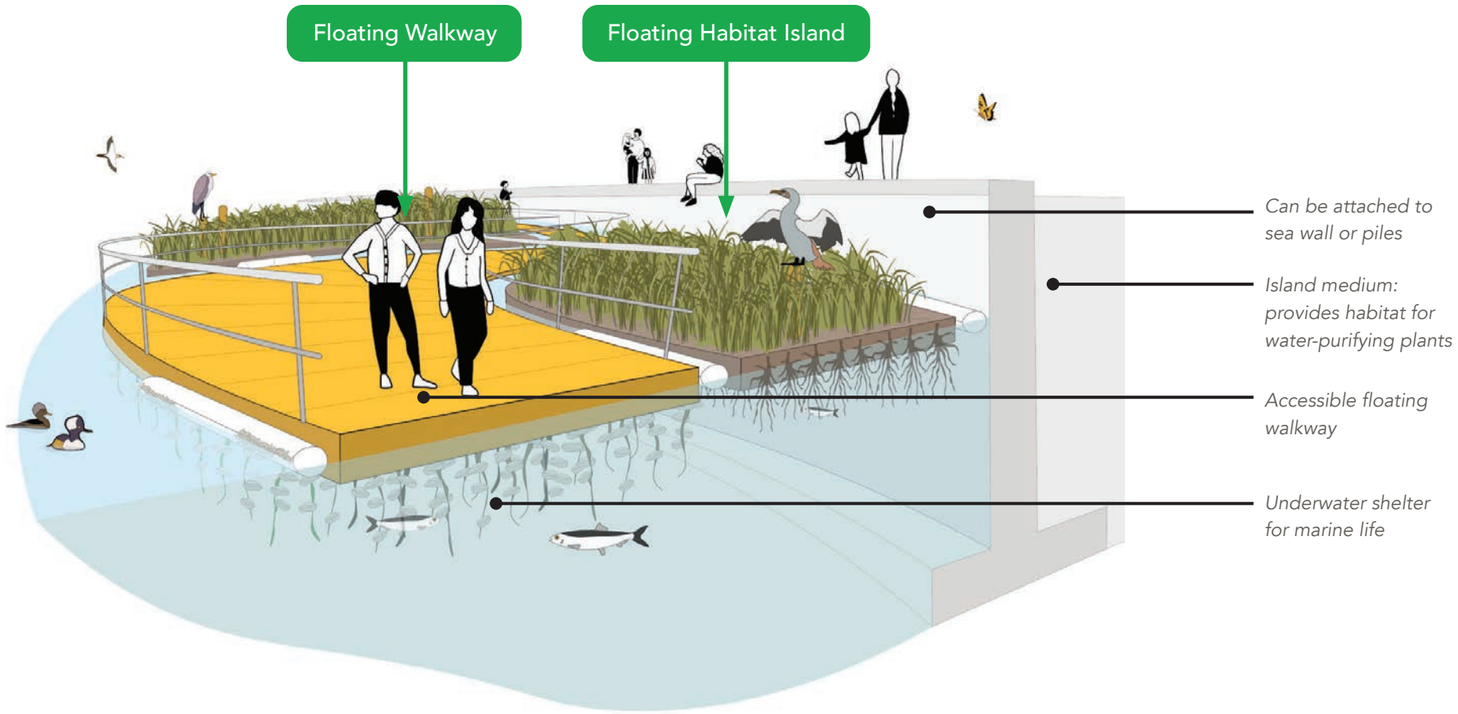
Sections of the Floating Walkway and Habitat Island can be deployed in modules that can easily be moved, reconfigured and expanded as capital budgets allow.

FIRST STEPS IN DESIGN

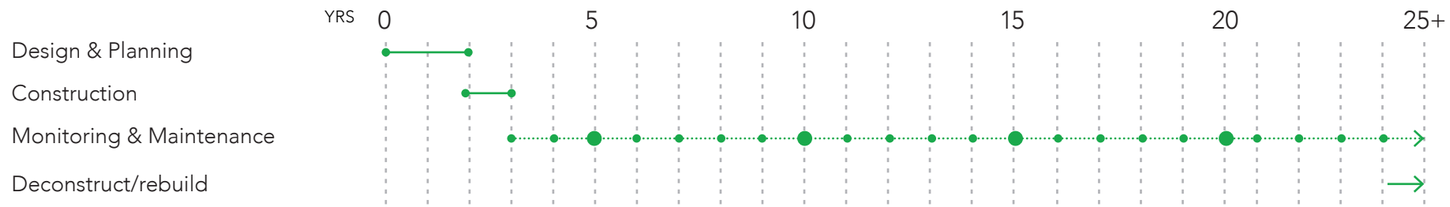
- Consider assembling project partners to create a self-governing "floating ribbon" initative that is accountable to itself, ensuring project costs and generated revenue are self-contained within the project
- Begin process of aquiring necessary approvals and permits
- Begin off-site construction of walkway/habitat modules with assembly and construction on site - explore opportunities for partnership with technical institutes, stewardship groups etc.

FOR FURTHER INVESTIGATION

- What is the most suitable flood-resilient construction and form/width/material for the walkway?
- Location and ownership/management model?
- How to support aquatic habitat and water filtration?
- Where to locate and how to moor?



PHASING STEPS / TIME LINE



COST ESTIMATE

CATEGORY	DESCRIPTION	QUANTITY	COST
1. Project Planning	**Pre-Project Initiation (Need input from COV)** • Conduct and assemble relevant assessments[1] • Prepare RFP , financing, feasibility	For consideration only	N/A
	Confirm all required approvals, authorizations and permits[1] • Host Nations Approval Process • Federal Fisheries Act Self-Assessment Process • Seismic Design Guidelines	Assume 7% of construction budget	$103,250
	Engagement and Consulting • General Public Engagement • Host Nations Community Engagement (and/or dept. heads) • Focused Engagement with impacted and affected parties (ie. Host Nations representatives, The Friends of False Creek, Marinas owners, local neighbourhood groups, etc.)	Assume 7% of construction budget	$103,250
2. Design & Engineering	**Consultants and Registered Professionals** *This may include (but is not limited to):* • Indigenous Cultural Planner/Coordinator • Indigenous Specialist (Knowledge Keeper, Ethnobotanist, Orator, etc.) • Structural Engineer • Landscape Architect • Biologist/Ecologist	Assume approximately 20% of construction budget [2]	$295,000
	Total Soft Costs		**$501,500**
3. Construction & Material	i. Walkway Module (assuming 5m wide) ii. Floating Habitat Island - Base iii. Planting and growing medium iv. Anchoring System	$15,000 lm (linear m) $1,000/sm $500/sm $50,000 unit price	$1.125m $200,000 $100,000 $50,000
	Total Hard Costs (Construction and Labour)		**$1.475m**
4. Contingency	Assuming a Class D level (per APEGBC definitions)[3]	50%	$737,500
	Gross Capital Costs		**$2.714m[4]**
5. Operations & Maintenance	**List of Ops and Maintenance Considerations** • Habitat island vegetation management (assume monthly) • Seasonal monitoring (assume 4x a year) • Walkway maintenance and monitoring	For consideration only	Dependent on City costs/stewardship initiatives

NON-MONETARY BENEFITS

Ranked based on community values criteria

Far Worse
Moderately Worse
No Change
Slightly Better
Far Better

Local Economy:
Destination/tourism, construction/maintenance

Community/Housing Benefit:

Ecological Benefit:
Aquatic, avian habitat, flora, water quality

Recreational Benefit:
Paddleboat launch/destination, walkway

Cultural Benefit:

Infrastructural Benefit:
Expands mobility network

Health Benefit:
Supports active mobility, water quality

COSTING ASSUMPTIONS AND CONSIDERATIONS

Lifespan: 20+ years for component replacement

Size (for costing): Assuming 75m length, 200sm island

Repeatability: Module based, transportable

Location: Subtidal; Anchored to existing seawall or marina

i. Depends largely on location - See map in section 3.2
ii. Based on anticipated complexities of design and engineering, some R&D
iii. Association of Professional Engineers and Geoscientists of British Columbia
iv. Based on modularity of design, this pilot project could easily be phased to support smaller sources of funding

FUNDING SOURCES AND CONSIDERATIONS

Private: Capital campaigns, relevant corporations, foundations, donors

Public: Grants, municipal budget, acadmic partnerships

Other: High potential for citizen science and stewardship initiatives to support construction and on-going maintenance, reducing both capital and operational costs.

II. Coast Salish Cultural Learning Garden and Test Plot Nursery

WHAT IS IT?

A Cultural Learning Garden & Test Plot Nursery offers a much-neeed opportunity to put reconciliation into action while reintroducing native plant species to False Creek, connecting the community with land stewardship, and testing/cultivating species for adaptation. This Pilot Project is imagined as a space that could provide multiple benefits with a relatively low barrier to entry compared to many other interventions, allowing for immediately visible and interactive plant cultivation.

WHAT IS BEING TESTED?

While multiple studies are underway to examine the impacts of climate change of local plant species, few (if any) of these studies focus on urban foreshore and backshore environments.

WHY NOW?

Cultural Indigenous-led gardens make up only 0.002% of square metres out of all park land. The Vancouver Park Board (VPB) is committed to improving "access to resources that would promote Indigenous food sovereignty such as land, space, facilities and programs"1 and is currently undergoing a 5-year plan for future development and management.

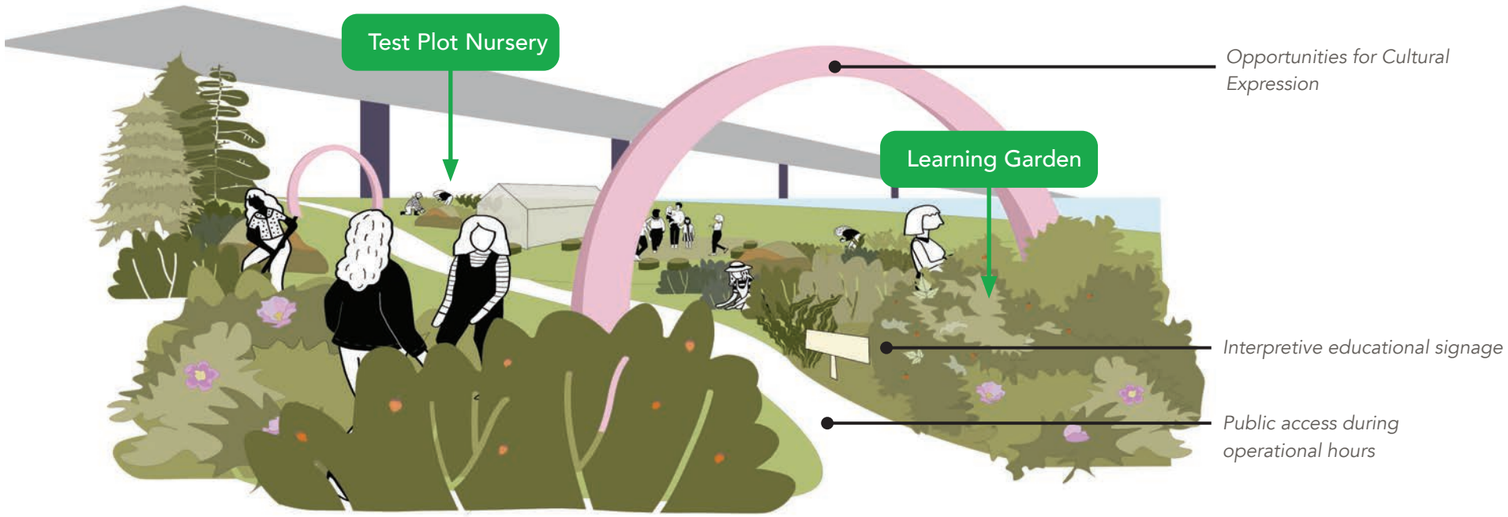
There is significant park space on the North Shore of False Creek that will need to adapt to rising sea levels by reconsidering programming and making space for dynamic and productive natural systems.

HOW? NEXT STEPS IN DESIGN

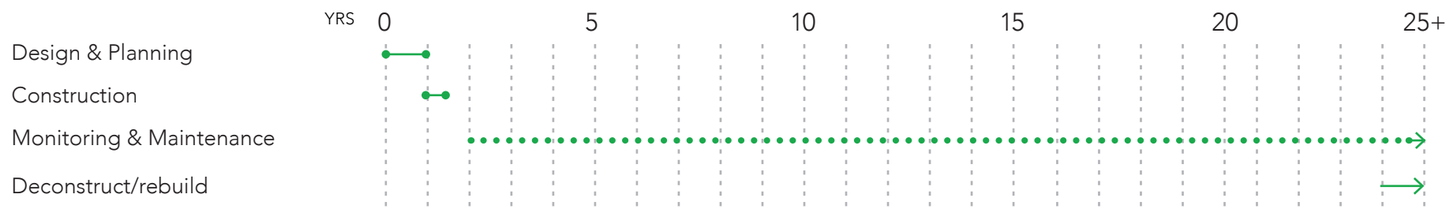
- Option 1: Establish or confirm a registered non-profit societies or cultural practitioners to operate a Food/Culture Garden on Park Board Land and submit an Urban Agriculture Expression of Interest to VPB staff for review
- Option 2: Assemble a working group to initiate a co-creation and co-management plan with the VPB and MST Host Nations to transform select existing park space
- Align with First Nations artists(s) and/or design consultant(s) to ensure Host Nation design language + narrative

FOR FURTHER INVESTIGATION

- What is the process for confirming group who would be interested in managing/running?
- Is the soil contaminated?
- How will co-management work? Issues of park by-laws being in contradiction to intent of a demonstration garden/nursery



PHASING STEPS / TIME LINE



COST ESTIMATE

CATEGORY	DESCRIPTION	QUANTITY	COST
1. Project Planning	**Pre-Project Initiation** • Create Working Group with Representatives from Vancouver Park Board, City of Vancouver, Host Nations	For consideration only	N/A
	Confirm all required approvals, authorizations and permits[1] • Host Nation Approval Process • Vancouver Park Board	Assume 7% of construction budget	$58,583
	Engagement and Consulting • General Public Engagement • Host Nations Community Engagement (and/or dept. heads)[2]	Assume 7% of construction budget	$ 58,583
2. Design & Engineering	**Consultants and Registered Professionals** *This may include (but is not limited to):* • Indigenous Cultural Planner/Coordinator • Indigenous Specialist (Knowledge Keeper, Ethnobotanist, Orator, etc.) • Landscape Architect • Biologist/Ecologist and Coastal Environmental Professional • Horticultural/Plant Production Specialist	Assume approximately 20% of construction budget	$167,380
	Total Soft Costs		**$ 283,546**
3. Construction & Material	i. Site Preparation and regrading ii. Soil and remediation, if necessary iii. Planting and Installation iv. Hardscape v. Site furnishing vi. Greenhouse/Nursery structure (shed) vii. Irrigation/water source viii. Equipment	$50/sm allowance $75/sm allowance $100/sm allowance $120/sm allowance $60/lm allowance	$105,000 $157,500 $168,000 $50,400 $30,000 $100,000 $126,00 $100,000
	Total Hard Costs (Construction and Labour)		**$836,900**
4. Contingency	Assuming a Class D level (per APEGBC definitions)[3]	50%	$418,450
	Gross Capital Costs		**$1.539mil** [4]
5. Operations & Maintenance	**List of Ops and Maintenance Considerations** • Volunteer and Stewardship management and education • Vegetation management • Nursery/Test Plot Regular Employee/Steward (assume 2 full time + seasonal)	For consideration only	Dependent on City costs/stewardship initiatives

NON-MONETARY BENEFITS

Ranked based on community values criteria

Far Worse
Moderately Worse
No Change
Slightly Better
Far Better

Local Economy:
Plant sales, destination, workshops, events

Community/Housing Benefit:

Ecological Benefit:
Biodiversity, native plant restoration

Recreational Benefit:

Cultural Benefit:
Knowledge/culture sharing, food sovereignty

Infrastructural Benefit:
Planting could support GI projects

Health Benefit:
Supports gardening, mental health, social

COSTING ASSUMPTIONS AND CONSIDERATIONS

Lifespan: Limited only by changing shoreline, space

Size (for costing): ~2100sm

Repeatability: Easily replicated, could function as a satellite

Location: See map in section 3.2 for potential location

i. Depends largely on location
ii. Dependent on Host Nations desired/available capacity
iii. Association of Professional Engineers and Geoscientists of British Columbia
iv. Based on modularity of design and volunteer opportunities, this pilot project could easily be phased to support smaller sources of funding

FUNDING SOURCES AND CONSIDERATIONS

Private: Horticulture industry, academic partners, community organizations

Public: Grants, municipal budget

Other: High potential for citizen science and stewardship initiatives to support construction and on-going maintenance costs.

III. The Paddler's Pavilion

WHAT?

False Creek lacks real interaction with the water. The Paddler's Pavilion provides a safe spot to enter and exit the water with boats or even for swimming. It also measures and monitors the water quality, letting its users know when it is safe to enjoy the water.

WHY NOW?

False Creek lacks places to access and exit the water safely for recreational and cultural use. At the same time, the water quality of False Creek needs to be monitored and gradually improved to allow for safe water recreation and restore our relationship with the water. As this process takes time, it's important to start now.

HOW?

The Kayak Hotel provides public decks to get in and out of the water by boat, kayak, SUP, or swimming. By displaying real-time water sensor data on the water quality, explaining the possible origin and risk of pollution, citizens understand when and why water conditions allow safe water activities. This enables a gradual increase of interaction with the water.

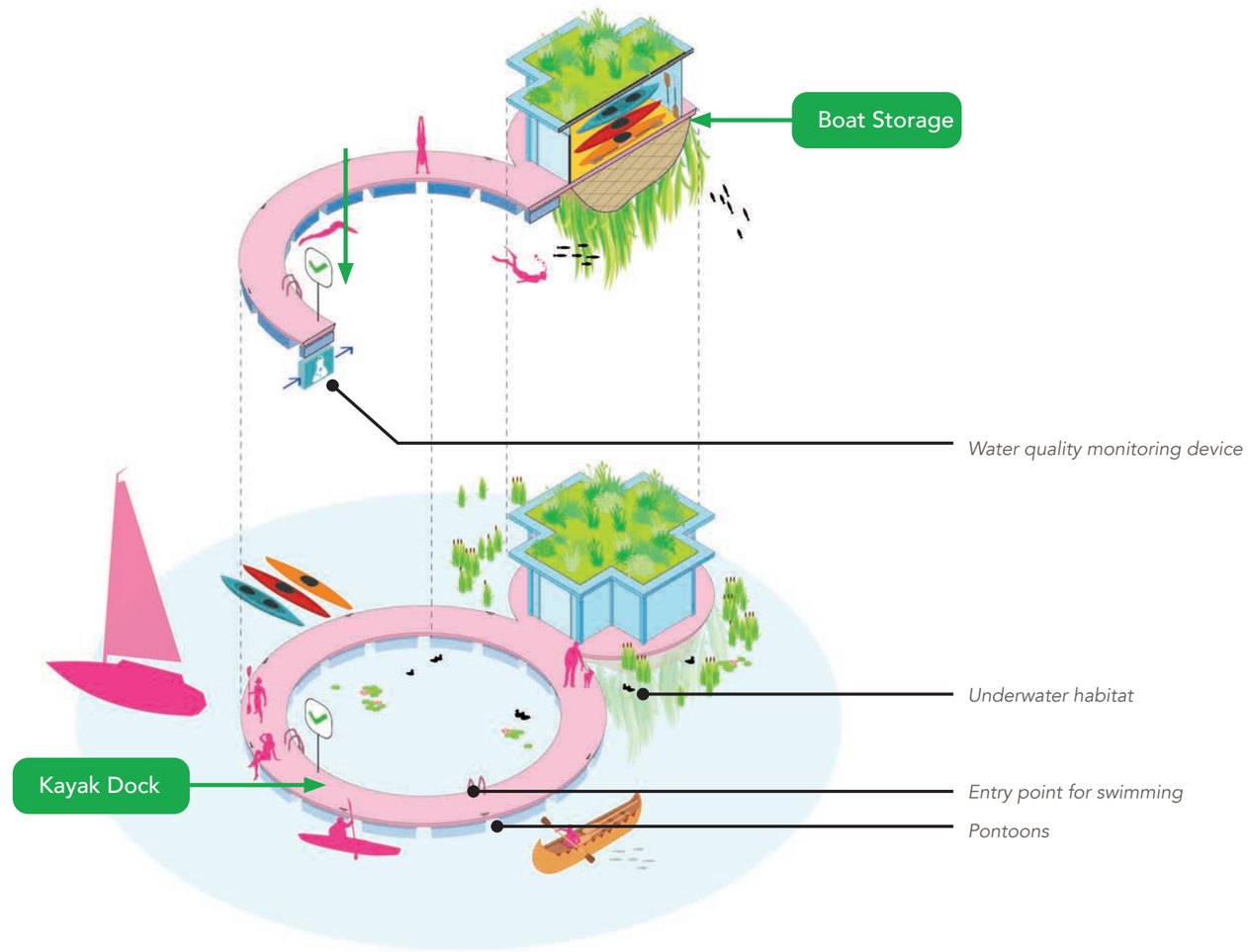
FIRST STEPS IN DESIGN

Adapt the design and shape of the platform and pavilion to:

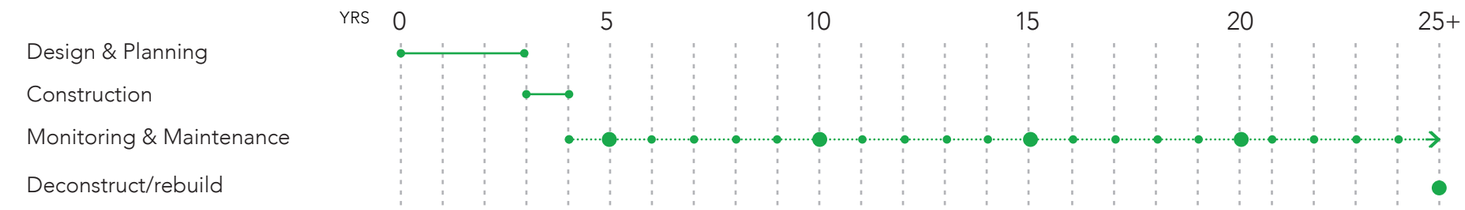
- The direction of the waves, wave action and currents
- Enhance seabed flora and fauna
- The needs of paddling club program and boat storage
- Ensure close proximity to a new or existing gangway

FOR FURTHER INVESTIGATION

- Is it possible for shared access to gangways that are operated by Aquabus or Marinas?
- What is the potential for leasing of marina slip as an alternative location?
- How will water be monitored and displayed?
- Who will own/operate? How to i



PHASING STEPS / TIME LINE



COST ESTIMATE

CATEGORY	DESCRIPTION	QUANTITY	COST
1. Project Planning	**Pre-Project Initiation**	For consideration only	N/A
	Confirm all required approvals, authorizations and permits[1] *This may include (but is not limited to):* • Ownership/landlease models and lifespan/exploitation time • Stewardship models i.c.w. First Nations • Study of jurisdiction and permit options • Accessibility study • Pollution assessment • Structural design of floating elements i.r.t. waves, currents, etc. • Environmental impact analysis (shadow, underwater fauna and flora) • SD and DD of architecture and subtidal structures • Demountability and reuse/urban mining study • Circular material and waste/water reuse study i.c.w. local producers • Building permits	Assume 7% of construction budget	$207,270
	Engagement and Consulting General Public Engagement & Host Nations Community Engagement (and/or dept. heads)[2]	Assume 7% of construction budget	$207,270
2. Design & Engineering	**Consultants and Registered Professionals** *This may include (but is not limited to):* Indigenous Consultants, Architect, Mobility advisor, Landscape architect/marine biologist, Hydraulic and maritime engineer, Structural and civil engineer	Assume approximately 40% of construction budget	$1,184,400
	Total Soft Costs		**$ 1,598,940**
3. Construction & Material	Building (incl. facade, roof) & Floating deck[3]	~ $11,800/sm [1] ~ $6500/sm [1]	$2,376,000 $585,000
	Total Hard Costs (Construction and Labour)		**$2,961,000**
4. Contingency	Assuming a Class D level (per APEGBC definitions) [4]	50%	$1,480,500
	Gross Capital Costs		**$4.708mil** [4]
5. Operations & Maintenance	**Considerations for Operating Expenses** • Infrastructure (utilities, transport and green): % of cap. infra. • Development • Sales and marketing: % of revenues • Overheads: % of revenues • Insurance expenses: % of revenues	For consideration only - but for general estimate, assume 10% of construction budget	$296,100

NON-MONETARY BENEFITS

Ranked based on community values criteria

Far Worse
Moderately Worse
No Change
Slightly Better
Far Better

Local Economy:
Boat rental, events, workshops

Community/Housing Benefit:

Ecological Benefit:
Reduction in motorized boat traffic, water quality

Recreational Benefit:
Water recreation, boat access

Cultural Benefit:
Cultural activities

Infrastructural Benefit:
Extends water-based mobility network

Health Benefit:

COSTING ASSUMPTIONS AND CONSIDERATIONS

Lifespan: 20 years

Size (for costing): 200sm

Repeatability: Very repeatable across locations once tested

Location: See map in section 3.2 for potential location

i. Estimate based on Benchmark project (Floating Paviliion), designed by Studio Ossidiana and adjusted for inflation/currency exchange.
ii. Piers and/or anchor system is not included -—dependant on location
iii. Association of Professional Engineers and Geoscientists of British Columbia

FUNDING SOURCES AND CONSIDERATIONS

Private: Recreational (paddleboat) company, sports club

Public: Grants, municipal budgets, sports club, non-proft

Other: Local paddle boat clubs, organizations, fundraising, revenue from rental/usage fees

IV. The Host Nations Pavilion (on-land)

WHAT?

The First Nations have been monitoring and managing the natural resources in their homelands and waters for millennia. Repurposing the viewing deck on the waterfront of In Between Bridges provides space for an education center and cultural exchange pavilion. It provides the opportunity to employ community members and is the home for the land stewards. It is a space to learn about the Indigenous relationship to the landscape, and for testing and monitoring the environment. The lifted viewing deck will show the level of the future ciruclation, where roads and access will be lifted to the first floor.

WHY NOW?

Bringing life back to the waterfront means startting with the people that understand and can share knowledge about a reciprocal lifestyle with water. Waterfront community building and knowledge sharing of Host Nations need to be a starting point of the adaptation process and dialogue.

HOW?

A community center offers spaces for workshops, outdoor crafts and events and spaces for display and practice of Indigenous culture. A lifted circular viewing deck anticipates future lifted walkways and allows people to experience this future perspective. The rooftop garden provides a space for showcasing re-wilding efforts and upland biodiversity, while the gangway connects users directly with the water.

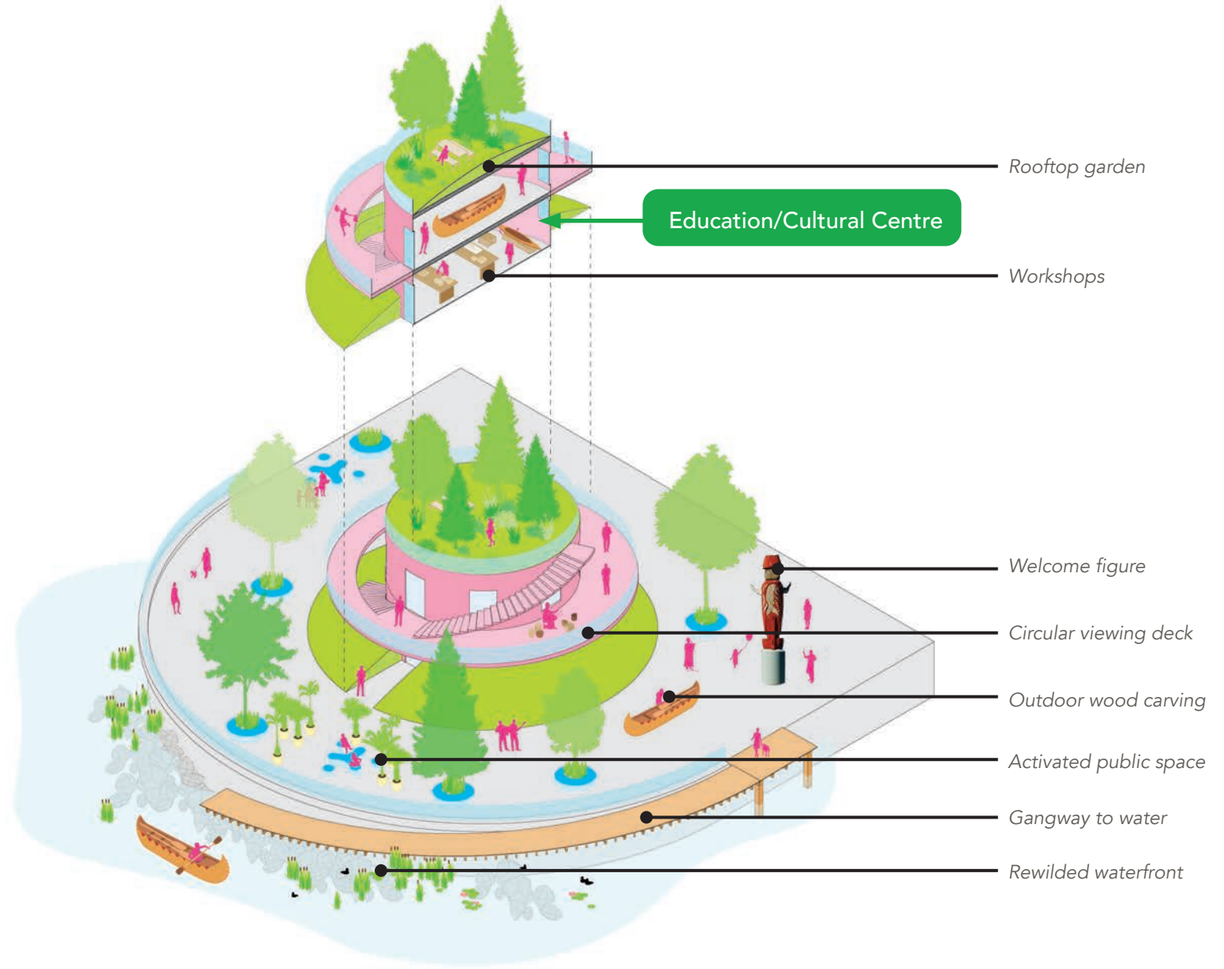
FIRST STEPS IN DESIGN

Adapt the design, size and shape of the pavilion to:

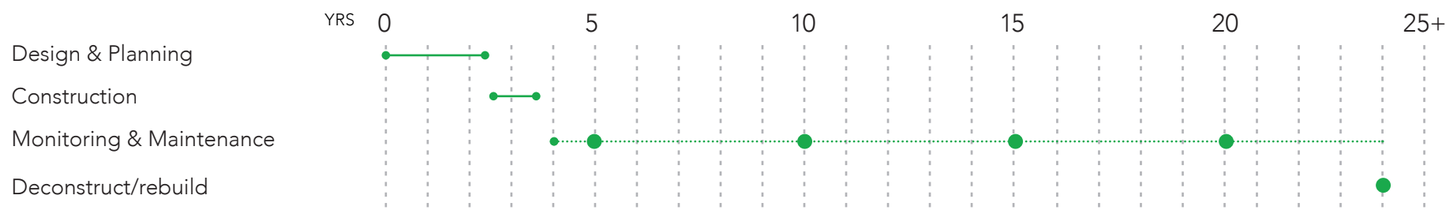
- Establish a culturally relevant program
- Align with First Nations artists(s) and/or design consultant(s) to ensure Host Nation design language + narrative

FOR FURTHER INVESTIGATION

- Does the size of the pavilion reflect the desired program?
- What stakeholders can be involved?
- Who is the owner, and what is the applicable jurisdiction on site?
- How does the accessibility and circulation of the site work?
- How often does the pavilion need maintenance?



PHASING STEPS / TIME LINE



COST ESTIMATE

CATEGORY	DESCRIPTION	QUANTITY	COST
1. Project Planning	Pre-Project Initiation	For consideration only	N/A
	Confirm all required approvals, authorizations and permits[2] *This may include (but is not limited to):* • Ownership/landlease models and lifespan/exploitation time • Stewardship models i.c.w. First Nations • Structural / LCA of existing deck construction • SD and DD of architecture and public space design • Demountability and reuse/urban mining study • Circular material study i.c.w. local producers • Climate adaptation and water reuse study • Environmental impact analysis • Building permits	Assume 7% of construction budget	$121,660
	Engagement and Consulting • General Public Engagement • Host Nations Community Engagement (and/or dept. heads)[2]	Assume 7% of construction budget	$121,660
2. Design & Engineering	Consultants and Registered Professionals *This may include (but is not limited to):* • Indigenous Consultants • Architect • Landscape architect/green roof specialist • Structural and civil engineer (with marine structure experience)	Assume approximately 40%[4] of construction budget	$695,200
	Total Soft Costs		**$ 938,520**
3. Construction & Material	i. Pavilion building (incl. facade, roof, viewing deck) ii. Outdoor public space improvements, on structure	~ $8,800/sm [1] ~ $550/sm [1]	$1,408,000 $330,000
	Total Hard Costs (Construction and Labour)		**$1,738,000**
4. Contingency	Assuming a Class D level (per APEGBC definitions)[3]	50%	$869,000
	Gross Capital Costs		**$2.607mil**
5. Operations & Maintenance	Considerations for Operating Expenses • Infrastructure (utilities, transport and green): % of cap. infra. • Development • Sales and marketing: % of revenues • Overheads: % of revenues • Insurance expenses: % of revenues	For consideration only - but for general estimate, assume 10% of construction budget	$173,800

NON-MONETARY BENEFITS

Ranked based on community values criteria

Far Worse
Moderately Worse
No Change
Slightly Better
Far Better

Local Economy:
Creative workspaces, collaboration with cultural institutions, job opportunities

Community/Housing Benefit:
A diverse and inclusive community building typology

Ecological Benefit:
Habitat support (greenroof), stormwater management

Recreational Benefit:

Cultural Benefit:
Inclusive spaces for knowledge/cultural exchange

Infrastructural Benefit:

Health Benefit:

COSTING ASSUMPTIONS AND CONSIDERATIONS

Lifespan: Dependent on structural assessment, shoreline.

Size (for costing): 160sm

Repeatability: Potential for satellite programming at other sites

Location: See map in section 3.2 for potential location

i. Estimate based on Benchmark project (Fuggerei Pavillion), designed by MVRDV and adjusted for inflation/currency exchange.
ii. Structural assessment of current deck for additional load has the potential to add significantly to overall cost and should be done first to confirm feasibility.
iii. Association of Professional Engineers and Geoscientists of British Columbia

FUNDING SOURCES AND CONSIDERATIONS

Private: Private donor or managing institution

Public: Grants, municipal budget, cultural subsidies

Other: Potential for self-funding through revenue generating by sales, tickets, events, etc.

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References

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2. *Coastal Adaptation False Creek*, The City of Vancouver (2021)
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4. *Field Guide to Noxious Weeds and Selected Invasive Plants of BC*, Government of BC in collaboration with Invasive Species Council of BC (Tenth Edition, 2019)
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6. *Guidelines for Universal Access to Public Docks in False Creek*, The City of Vancouver (2012)
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10. *Memorandum: Sea2City Design Challenge – Internal Drainage Flood Assessment (Draft A),* The City of Vancouver, Engineering Services (2022)
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13. *Northeast False Creek Shoreline Flood Protection Performance Criteria*, The City of Vancouver (2021)
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17. *"Plants, Places, and the Storied Landscape: Looking at First Nations Perspectives on Plants and Land"*, BC Studies, Leslie Main Johnson (2013)
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23. *Vancouver Raincity Strategy,* The City of Vancouver (2019)
24. *Vancouver Shoreline Flood Protection Design Reference*, The City of Vancouver (2021)

Appendices

Appendix 1: Sea2City Summary of Referenced Work

DATE	TASK OR DELIVERABLE	DOCUMENT FORMAT	NOTES
March 2022	**Collaboratorium 2** • Detailed Site Analysis of both sites and broader False Creek • Draft Exploratory Concepts (Resist, Accommodate, Move) • Evaluation worksheets	• Presentation (PowerPoint) • Presentation (PowerPoint) and Posters (printed) • Worksheets for attendees (printed)	*These deliverables were prepared for an in-person event in order to share initial findings and get feedback from the advisory groups. They were considered drafts rather than refined deliverables for publication.*
June 2022	**Public Outreach and Communications - shared during public open houses and events** • Refined Site Concepts • Design Approach Adaptation Pathways	• Posters (printed) • Posters (printed)	
July 2022	**Collaboratorium 3** • Preferred Design Concepts for each site • Pilot Project Summary	• Presentation (PowerPoint) and Posters (printed) • Presentation (PowerPoint) and Posters (printed)	
July 2022	**Sea Level Rise Catalogue**	• Booklet (printed)	*A value-added submission from MVRDV that highlights building adaptation and provides an example of design guidelines for sea level rise*

Appendix 2: Precedent Projects

A2.1 Nature-Based Flood Management

Estuary Edges

London, UK

A series of 17 distinct interventions, including intertidal terraces, on the Thames in London to restore esturaries in the urban waterway. The Estuary Edges website is a 'how to' guide on ecological design and gives planners and developers detailed advice on how to boost biodiversity, erosion control and flood management, by replacing "hard" foreshore infrastructure with more eco-friendly materials.

Further Information:

Estuary Edges

New Brighton Park

Vancouver, CA

Partnered with local host nations and achieving a gold Green Shores Rating, New Brighton Park transformed a post-industrial site into a thriving coastal lagoon and marsh, replete with culturally important indigenous grasses, shrubs, and trees. The project affirms tidal flux, previously stymied by historically existing hard infrastructure onsite, to attend to the problem of juvenile salmon mortality. Its 290 metres of new intertidal and riparian habitat also assists resting shorebirds.

Further Information:

Green Shores Case Study: New Brighton Park

Thornton Creek Water Quality Channel

Seattle, USA

Transformed from a parking lot, the Thornton Creek Water Quality Channel layers public open space with stormwater management and water quality treatment.

Further Information:

Wild Mile Chicago Organization

Hunter's Point Park

New York, USA

Once considered radical in its concept design, Hunter's Point Park represents 11 acres of continuous waterfront, including a parkland peninsula, a renovated beach, and 1.5 acres of new wetlands that fill twice daily with the tide. The site, composed entirely of fill from the city's historical tunnels, has been reshaped into an early example of blue-green wetland infrastructure that absorbs and slowly releases stormwater.

Further Information:

Hunter's Point South Park Is a Model for Urban Flood Resiliency

Qunli National Urban Wetland

Qunli New Town, CN

The Qunli Stormwater Park is a 34 Ha wetland, surrounded on all sides by the dense development of Qunli New Town and thereby severed from its original water sources. Landscape Architect Turenscape's proposal redirected flows of city stormwater into the site to nurse it back to health. Now regulating stormwater and providing habitat for local critters, the park is also a gathering place for the denizens of New Town, who immerse themselves in its green environs.

Further Information:

The Transformed Stormwater Park: Qunli National Urban Wetland

Weiliu Wetland Park

Xianyang City, CN

A comprehensive restoration and reconstruction of the local floodplain ecosystem to address complex challenges facing the site, including water pollution, ecological degradation and flooding.

Further Information:

Weiliu Wetland Park by Yifang Ecoscape

A2.2: Floating Elements

Floating Pavilion

Almere, NL

Studio Ossidiana's floating "Art Pavilion M" is an example of an innovative architectural destination, and offers multiple cultural, economic, and commmunity benefits. It includes three distinct elements: "The Port," a ring-shaped promenade that visitors can walk around, "The Stage," a floating terrace encircled by the former, and "The Observatory," a lightweight timber and polycarbonate structure housing art exhibitions.

Further Information:

Art Pavilion M

Floating Wetland

Baltimore, USA

In 2010, Baltimore's National Aquarium created America's first floating wetland system. This was part of a citywide effort to ecologically restore the industrialized harbour. The system would become an iterative series of prototypes with an emphasis on experimentation, monitoring, and testing the capacity of these floating wetlands. With small changes in elevation, a central shallow-water habitat channel, and an inbuilt aeration system, the present system enhances biodiversity, with 248 species identified through DNA barcoding. The Aquarium seeks to someday supersede this prototypical microhabitat of 40m2 with a 1400m2 floating wetland..

Further Information:

National Aquarium "Floating Wetlands: Five Lessons Over Eleven Years"

The Wild Mile

Chicago, USA

A floating, wildlife-first educational park along a 1-mile stretch of the Chicago River, combining floating walkway and habitat.

Further Information:

Wild Mile Chicago Organization

Royal Docks

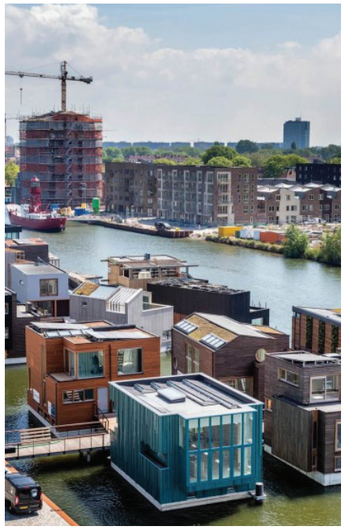
London, UK

Part of an initiative to transform East London's industrial areas from "grey to green," and a result of cross-institutional collaboration, the Royal Docks represent 315 square metres of buoyant wetland habitat for approximately 4,000 aquatic plant species. The biomimetic floating gardens, planted by volunteers and community groups, provide access to water and needed urban greenspace, while presenting opportunities to educate the public on local ecologies.

Further Information:

Royal Docks

Ecological Assessment Report (PDF)



Schoonschip Floating Neighbourhood

Amsterdam, NL

A floating, circular neighbourhood constructed in 2019 as a community-driven project set to become a prototype for floating urban developments. It includes 46 dwelling across 30 plots connected by jetty and features decentralized and sustainable energy, water and waste

Further Information:

A Sustainable Floating Community

Floating Pavilion

Rotterdam, NL (currently relocated)

A floating conference and event space that was constructed in 2013 as a pilot project and a catalyst for floating construction as an initiative of Rotterdam Climate Proof.

Further Information:

Floating Pavilion (Public Domain Architects)

A2.3: Adaptive Design Elements

Water-Retention Boulevard

Belval, LU

An elevated pedestrian and cyclist promenade connects all living, working and shopping areas of the neighbhourhood above the water-retention corridor that manages stormwater and flooding.

Further Information:

Water-Retention Boulevard

Tide Decks

New York, USA

Pier 26 at Hudson River Park features a monumental “tide deck” for observing the estuarine ecology of their engineered rocky salt marsh. The salt marsh is designed to flood regularly with tides from the Hudson River, and to accommodate and showcase different animals at different tidal intervals, from mollusks to mallards. Various small habitat enrichment features include native plantings, engineered tidal pools, and submerged structures which act as media for oysters, are observable from tide deck, and immersive tours of the ecosystem are available during park hours.

Further Information:

Pier 26 Tide Deck

The Halifax Floating Walkway

Halifax, CN

Halifax’s new 160m long walking bridge permits pedestrians to avoid construction and congestion. The bridge was constructed and is owned by Waterfront Development Corporation. Being a monolithic structure affected by tidal action, the bridge was closely monitored for safety and accessibility.

Further Information:

Floating boardwalk now open on Halifax waterfront

A2.4 Adaptive Buildings

Tainan Spring

Tainan City, TW

The remains of China-Town Mall, once built over the city's old harbor in 1983, have been adapted into a public lagoon and urban jungle. Its parkade, now daylighted, serves as a bathing area surrounded by native plants, emulating natural environments elsewhere in Taiwan.

Further Information:

MVRDV transforms old Taiwanese shopping centre into "lush lagoon"

Skygarden

Seoul, KR

Dubbed a "living dictionary" of Korea's native plants, Seoul's elevated 983 metre public park is built on the remains of a highway viaduct. The project acts to redefine Seoul's image, and adds value both in its greenery and in 16 pavilions which offer various cultural and commercial services.

Further Information:

Seoullo 7017 Skygarden

Floating Office Rotterdam

Rotterdam , NL

This newly-created three-storey building sits atop 15 "concrete barges" floating in a former industrial harbour on Rotterdam's Maas river. Light-weight and sustainable materials, combined with advanced technical systems, including a heat exchanger integrated with its concrete flota-tion devices make this project an exemplar for adaptable buildings in our future cities.

Further Information:

Powerhouse Company builds floating office in Rotterdam's Rijnhaven

A2.5 Cultural and Learning Landscapes

Coast Salish Plant Nursery

North Vancouver, CA

A partnership between Wild Bird Trust and the Tsleil-Waututh host nation, the Coast Salish nursery seeks to promote cultural connections of coast salish plants and their utility in improving local habitat. The exclusively endemic nursery provides education and community service to the public by employing indigenous ethnobotanists, holding native plant exhibitions, and imparts literacy on reconciliation and conservation. Sales go toward propagation and local replanting of indigenous species, in a circular economic model.

Further Information:

Coast Salish Plant Nursery

Native Plant Garden

Washington, USA

Once a barren half-acre plot, this volunteer garden, started in the 1990's, stands today as a showcase for the aesthetic beauty of plants endemic to the Pacific Northwest. Seeking to tout native plants as eminently viable alternatives for home gardeners, the garden operates as a site for the propagation and protection of native plants, and is open to the public daily.

Further Information:

Salal Native Plant Garden

Indigenous Health Garden, UBC

Vancouver, CA

The Indigenous Health Research and Education Garden (IHREG) at UBC Farm has emphasized teaching, learning, and research since its establishment under the UBC Institute for Aboraiginal Health in 2007. Honoring indigenous land values, the site acts as a fixture for testing and researching indigenous land stewardship.

Further Information:

Indigenous Health Garden - Alexander Suvajac

The Indigenous Health Research and Education Garden- UBC

A2.6 Waterfront Development

De Ceuvel

Amsterdam, NL

The Amsterdam municipality made a polluted former shipyard 'Ceuvel Volharding' available for a period of ten years to the most innovative plan that was proposed. The winning proposal, De Ceuvel, has been described as a "cleantech playground" and "purification park" for the exploration and testing of new phytoremediative green technologies as they become available. Decomissioned houseboats were adapted as temporary accommodations.

Further Information:

Circular incubator in self-purifying park

Chicago Navy Pier

Chicago, IL

This 2010 renovation of a beloved centenarian park received a gold level SITES rating. The project retained 72.8% of the site's existing vegetation and healthy soils, and introduced new sustainable infrastructure for irrigation, lighting, and other engineered components. All structural waste, and 99.84% of infrastructural waste was diverted from landfill.

Further Information:

Chicago Navy Pier

Brooklyn Bridge Park

New York, USA

Spanning 2km of shoreline, Brooklyn Bridge Park is built on the grounds of a defunct shipping complex. It establishes both new and revitalized connections between urban environment and riverfront, and activates the post-industrial site in multifaceted manners.

Further Information:

Brooklyn Bridge Park