

Sea Level Rise Doesn't Stop at Municipal Boundaries:

Collaborative, Multi-sectoral Adaptation Planning on Vancouver's North Shore

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Objectives



- Showcase a collaborative, multi-sectoral approach to sea level rise adaptation planning
 - *North Shore Sea Level Rise Risk Assessment & Adaptive Management Strategy*
- Make the case for going beyond high-level approaches
 - Myths and obstacles of “Protect-Accommodate-Retreat-Avoid”
 - How a toolkit of adaptation measures can enable more rich, integrated planning discussions



Where is the North Shore?



- Mountains, creeks, fjords, beaches, and mudflats
- 3 municipalities and 2 First Nations (4 reserves)
- 180,000+ residents (3 higher density urban centres)
- 12 terminals of the Port of Vancouver
- Major employment areas and transportation hubs/corridors
- No dikes or significant coastal flood protection works



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North Shore Sea Level Rise Strategy Partners



- Collaboratively developing a strategy to coordinate adaptation planning for 10+ years



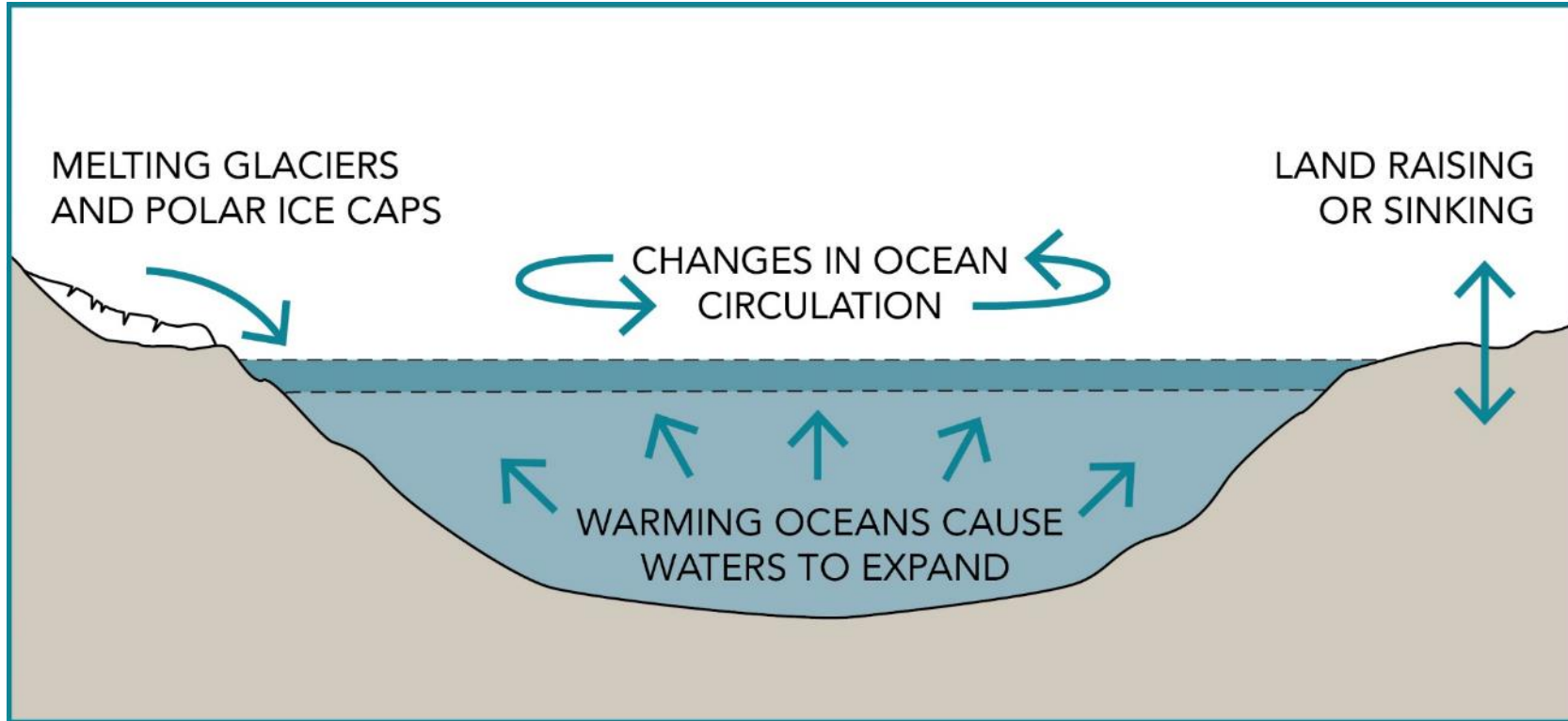
+ Progress and Timeline



July 2018



+ Sea Level Rise



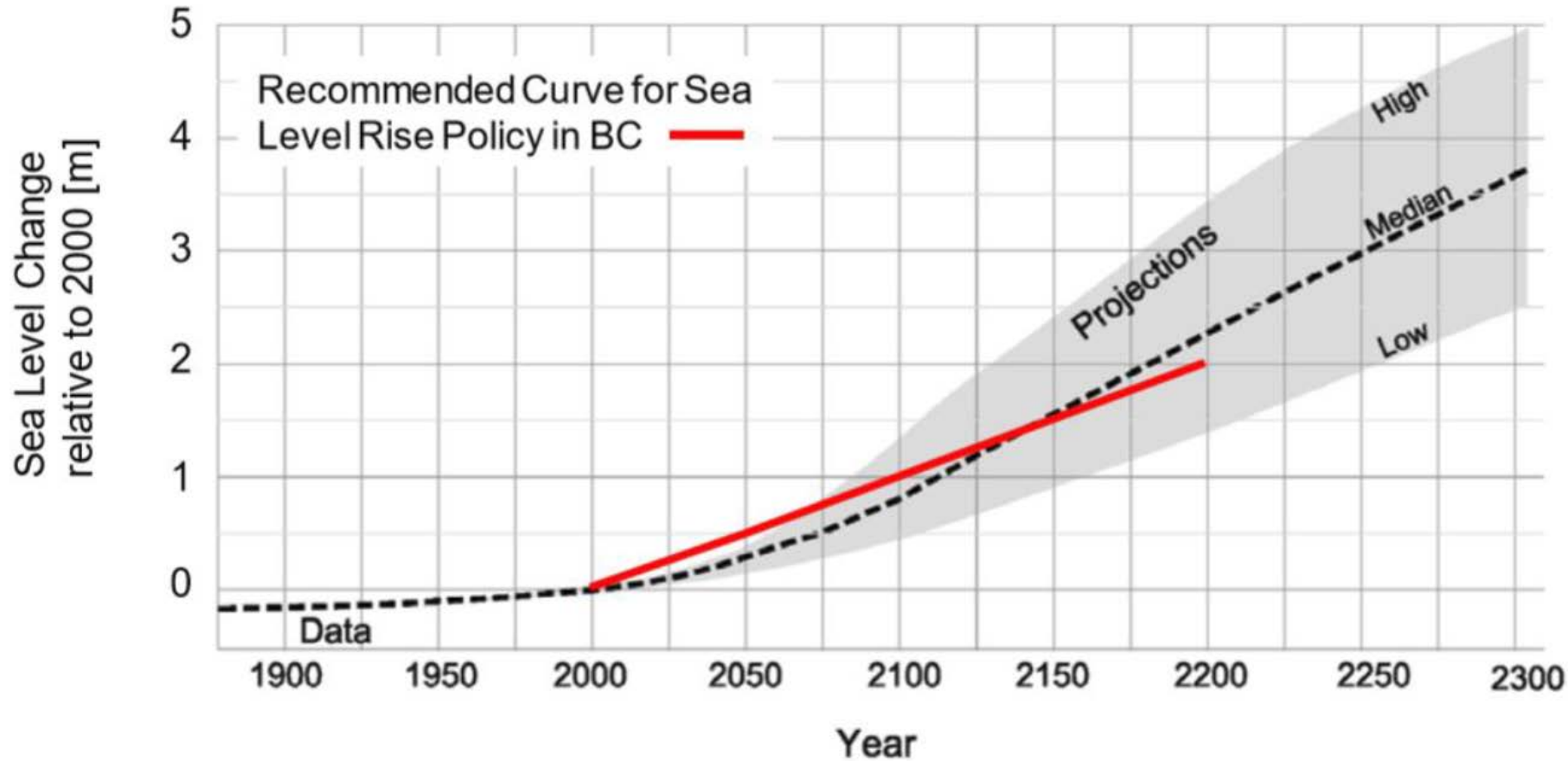
District of North Vancouver

Measured rise (20th Century):

- **Global average:**
0.17m (7")
- **Vancouver:**
0.04m (1.5")
- **Varies due to local conditions**



Sea Level Rise



(MOE/Ausenco Sandwell, 2011)

Project Approaches:

- Look up to 2 m
- De-emphasize timing & promote flexibility
- Adaptive management for decision-making

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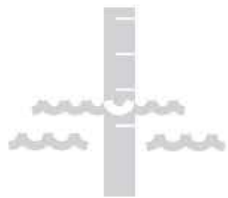
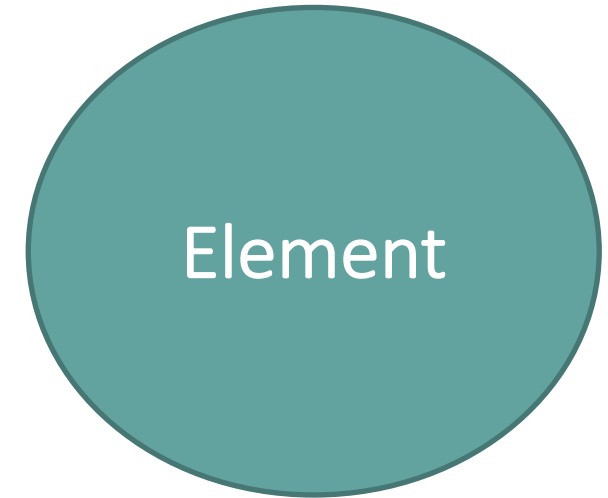
Sea Level Rise Will Have Various Impacts



SOURCE

PATHWAY

RECEPTOR



Sea Level Rise



Coastal Flooding



Housing



Sea Level Rise Hazard Pathways



Source

Sea Level Rise

Pathway

Tides

Coastal Floods

Waves

Sub-pathways

- Intertidal area shift (coastal squeeze)
- Storm sewer backup
- Creek and river backup

- Overland flooding
- Creek and river backup

- Shoreline erosion

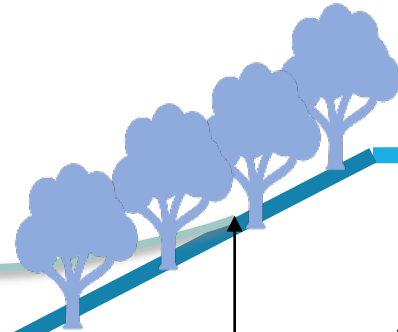
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Sea Level Rise Impacts Tides, Floods, & Waves



Sea Level Rise

Wave Effects



Wave runup
(temporary with waves/wind)

Stillwater Level

Combination of tide and **storm surge**

High Tide

Mean Sea Level

Low Tide



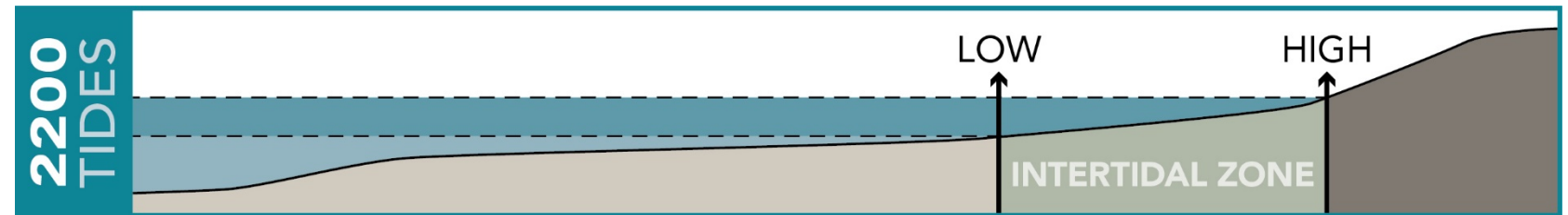
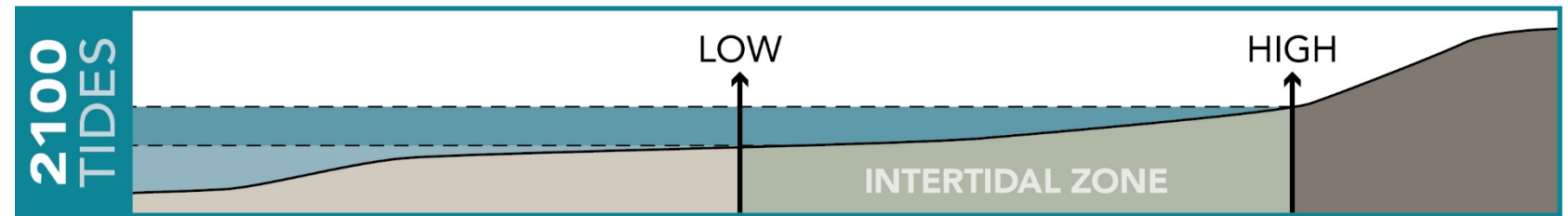
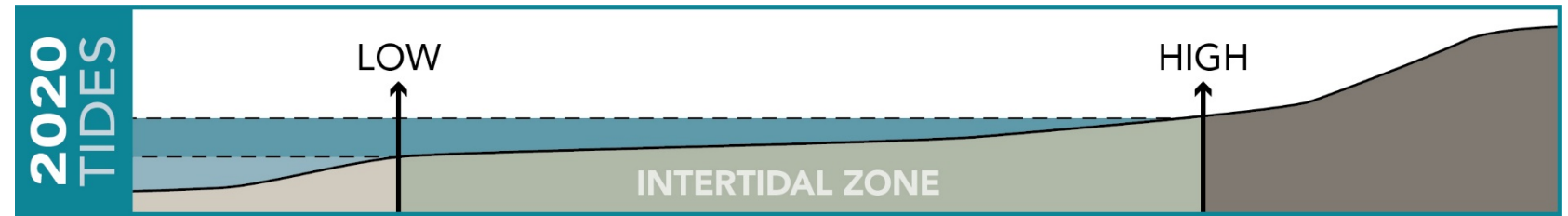
Sea Level Rise Impacts Tides & Intertidal Areas



- Coastal squeeze (Intertidal area change) impacts on natural and armoured shorelines



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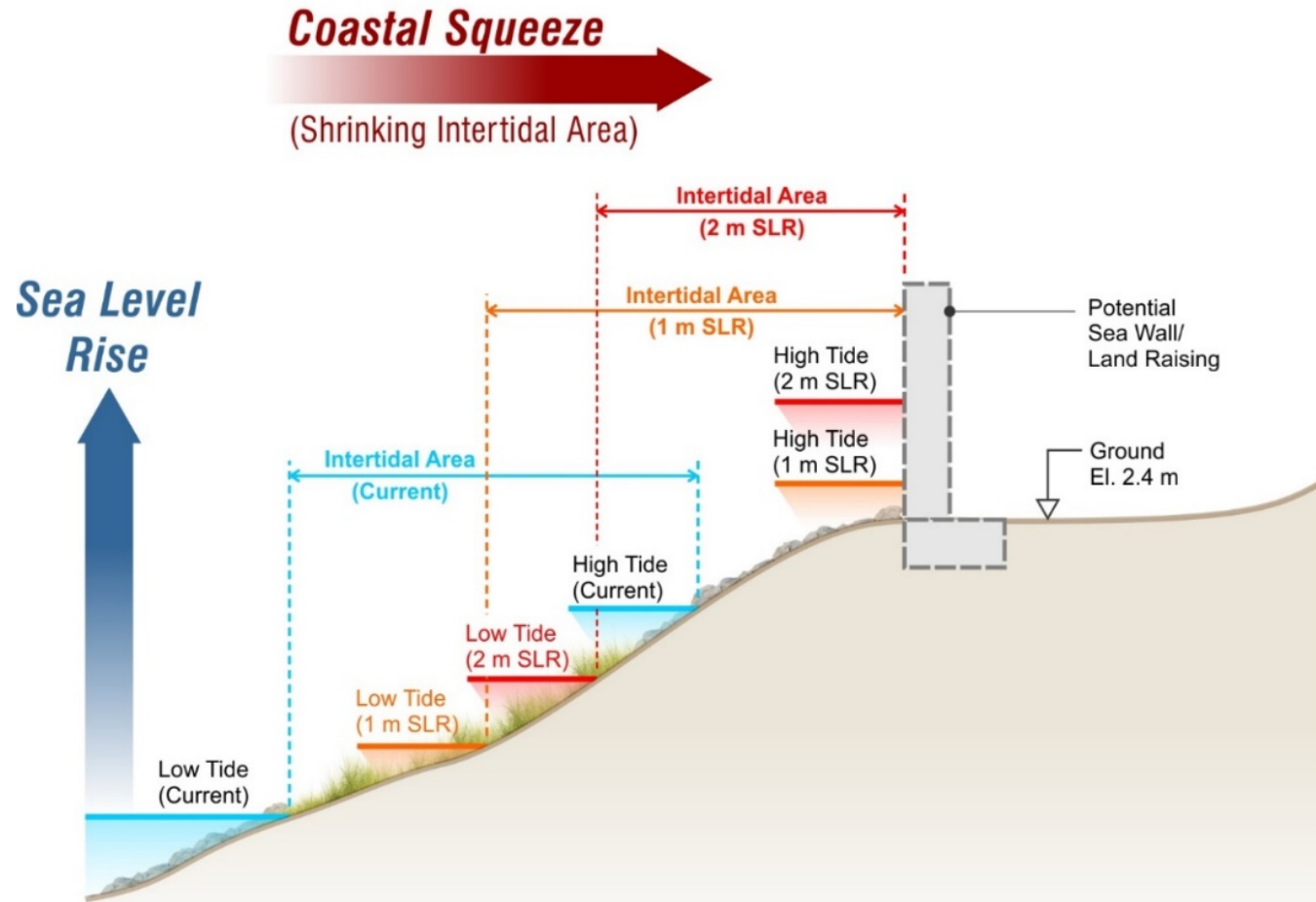


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Sea Level Rise Impacts Tides & Intertidal Areas



- Coastal squeeze will be intensified if we choose to build or raise sea walls

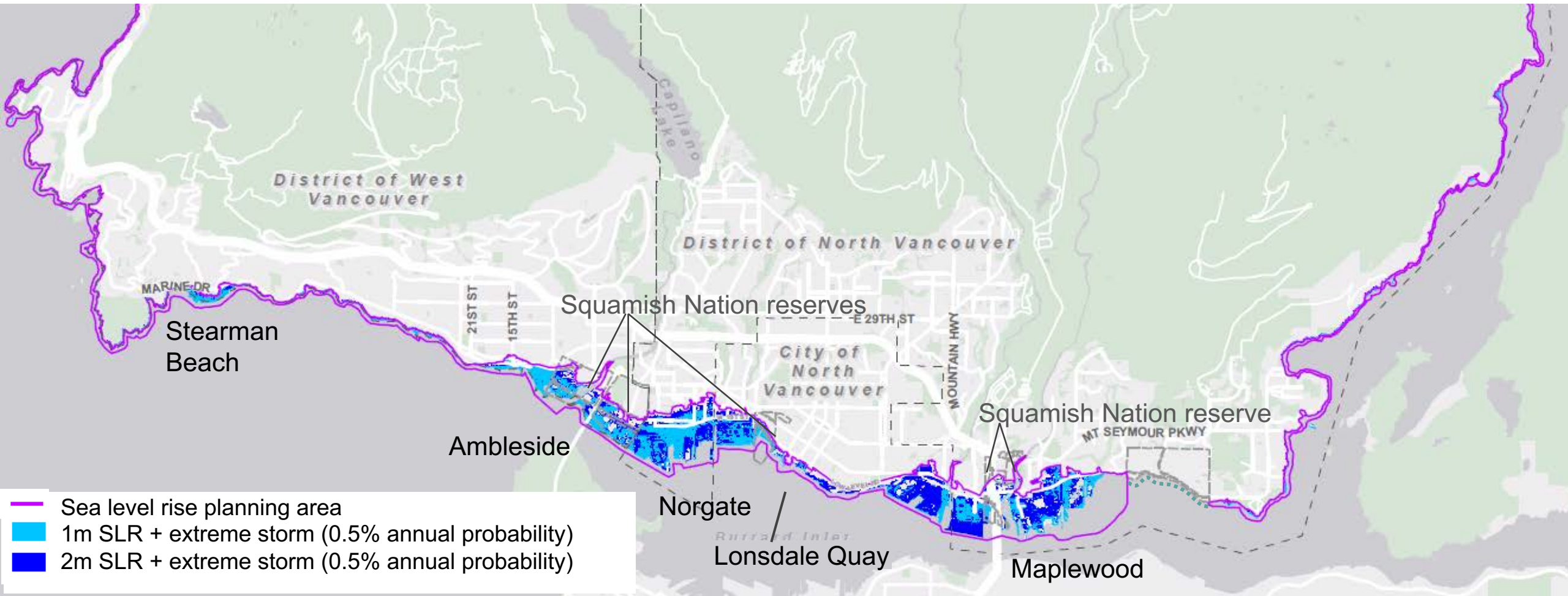




Sea Level Rise Impacts Coastal Floods



- Stillwater (no waves) extreme flood extent mapping under sea level rise

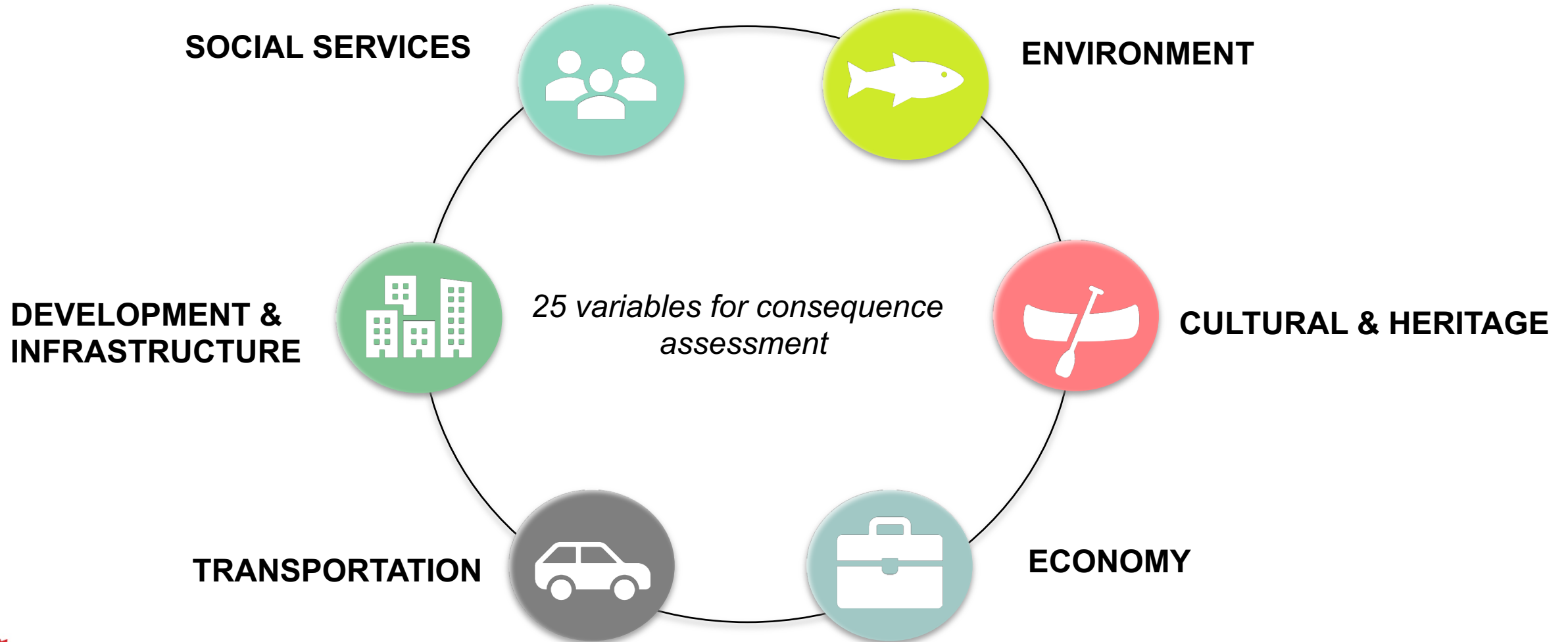




Consequences – what if we don't adapt?



- Multi-sectoral approach





Coastal Flood Consequences (if we don't adapt)



- Consequences estimated over 2 coastal flood scenarios
 - 1 m SLR + major storm (10% annual probability)
 - 2 m SLR + extreme storm (0.5% annual probability)
- Methods:
 - GIS exposure analysis (flood vs. inventory)
 - HAZUS building damage & population displacement
 - **Power outage mapping**
 - Collaboration with BC Hydro
 - Substation failure criteria
 - Block-level power shutdown criteria
 - **Business disruption analysis**
 - Based on (Chang *et al.*, 2008) using flood and power outage
 - Fed by business license data



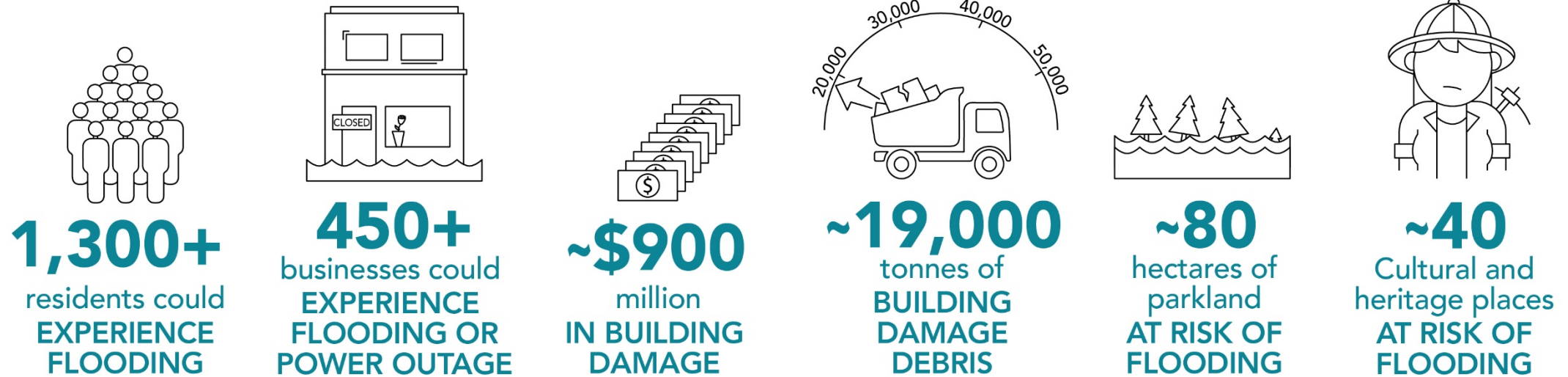
A substation in the floodplain



Coastal Flood Consequences (if we don't adapt)



- A major coastal storm (10% annual probability) after 1 m of sea level rise



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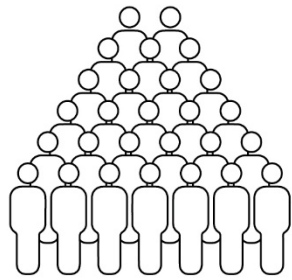
- Message: large consequence can occur even outside of extreme events



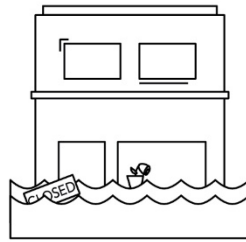
Coastal Flood Consequences (if we don't adapt)



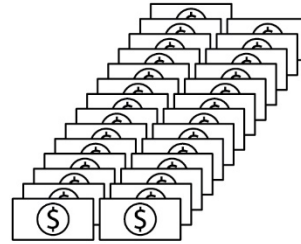
- An extreme storm (0.5% annual probability) after 2 m of sea level rise



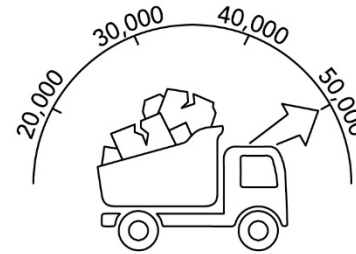
2,700+
residents could
**EXPERIENCE
FLOODING**



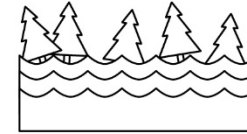
~1,900
businesses could
**EXPERIENCE
FLOODING OR
POWER OUTAGE**



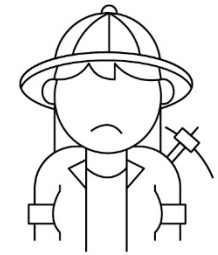
~\$2.7
billion
**IN BUILDING
DAMAGE**



~50,000
tonnes of
**BUILDING
DAMAGE
DEBRIS**



~105
hectares of
**PARKLAND
AT RISK OF
FLOODING**



~50
Cultural and
heritage places
**AT RISK OF
FLOODING**

District of North Vancouver

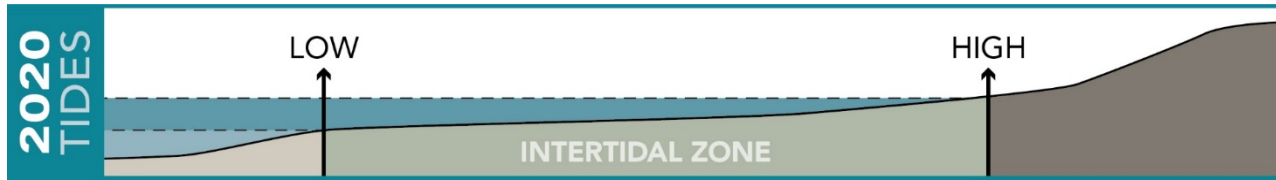
- Message: On the same order of damage as recent major disasters (Calgary 2013 floods, etc.)



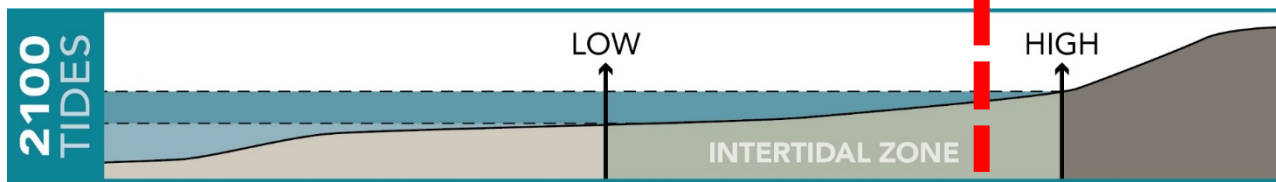
Intertidal Area Change Consequences



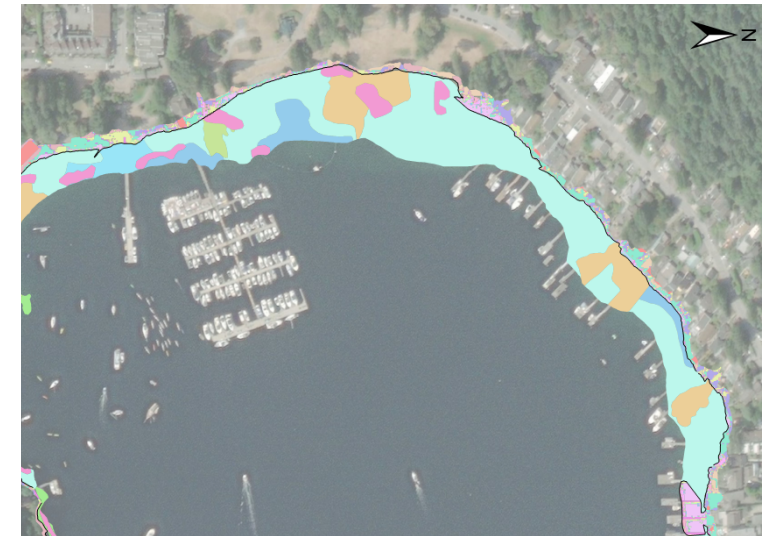
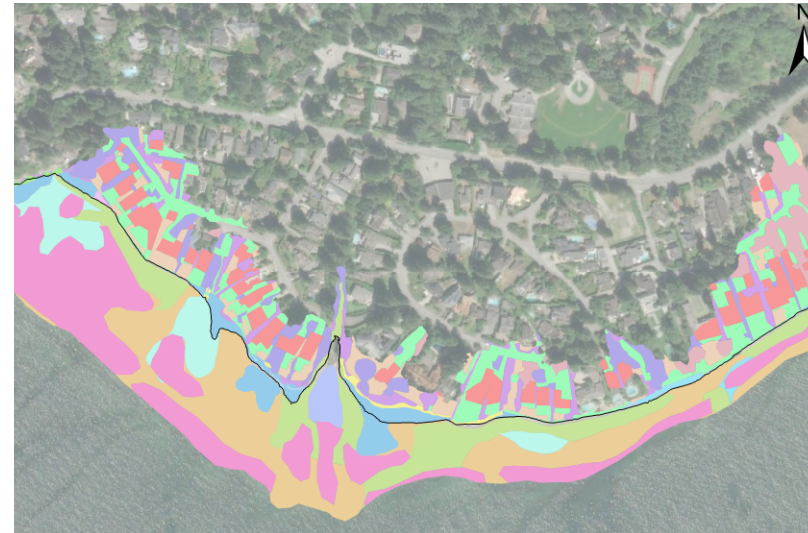
- If we build vertical walls to contain high tide to where it is today...



District of North Vancouver



- Coastal squeeze consequences under:
 - 1 m SLR: ~50% decrease in intertidal area
 - 2 m SLR: ~80% decrease in intertidal area
- Impacted habitats mapped



+ Community Engagement

- Recently started public engagement phase www.dnv.org/sealevelrise (Survey until Feb 23)
- Common website + each community will be conducting unique engagement events
- Initial phase:
 - Inform about hazards and consequence if we don't adapt
 - Inform about high-level adaptation approaches
 - Gather feedback on what matters and what should be considered in developing adaptation measures

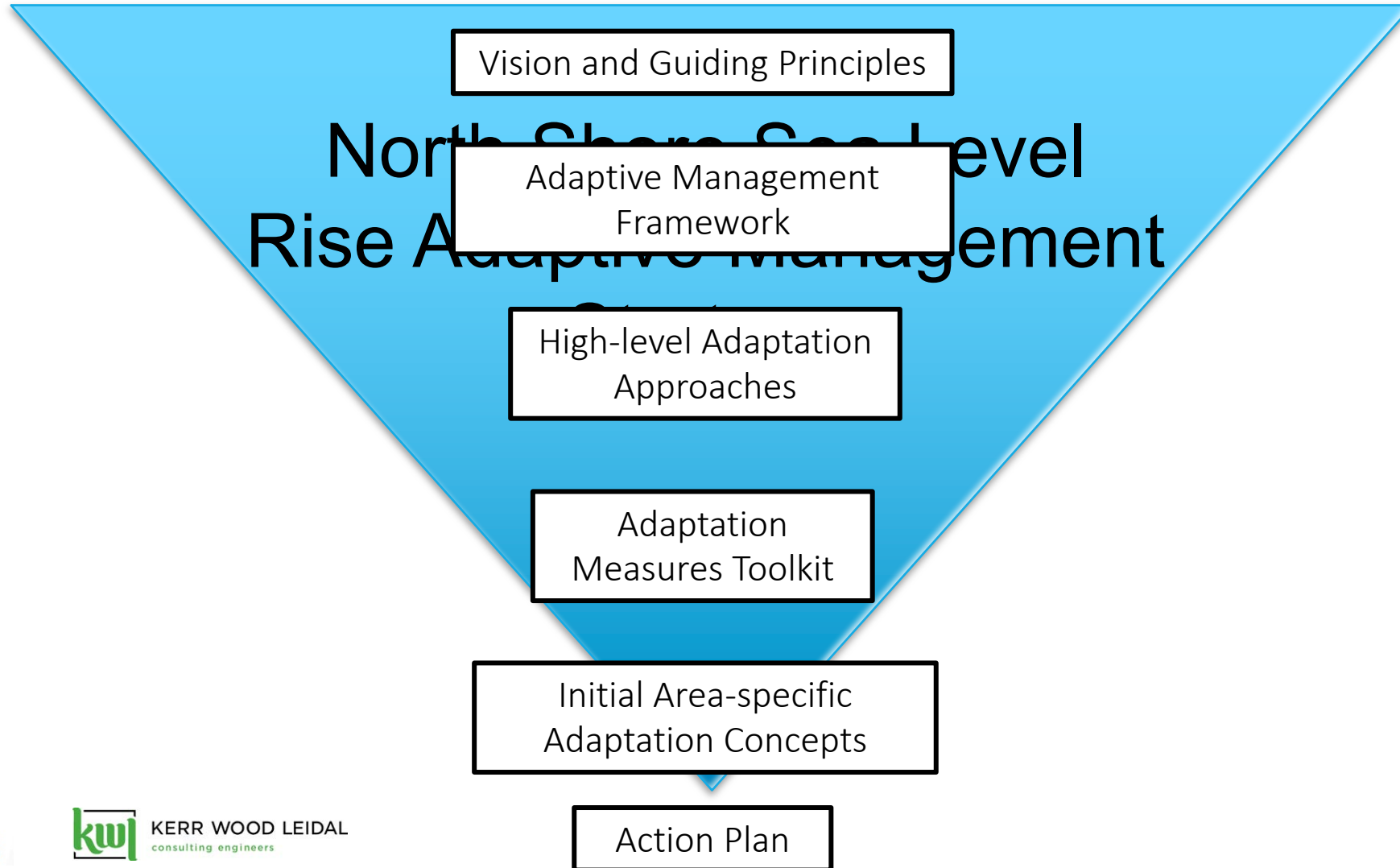




Adaptation Planning & Strategy (underway)



- **To be refined based on community engagement input**





High-level Adaptation Approaches



- Based on “Protect-Accommodate-Retreat-Avoid” (PARA)





Going Beyond High-level Approaches



- Benefits of high-level approaches:
 - Simplicity in communication
 - Low-barrier entry point for planning
- Common misconceptions, obstacles, and issues:
 - Approaches are treated as mutually exclusive
 - *We choose “protect” (dike) and that’s it right?*
 - Unrealistic oversimplification is not helpful for day-to-day planning work
 - *How do you translate “accommodate” into municipal policy or design standards?*
 - Lack of definition can lead to implementation of ‘perceived’ easier approach
 - *Accommodate sound vague. We know how to implement dikes, so let’s implement dikes*
 - Mostly focused on floods, but don’t forget coastal squeeze and erosion



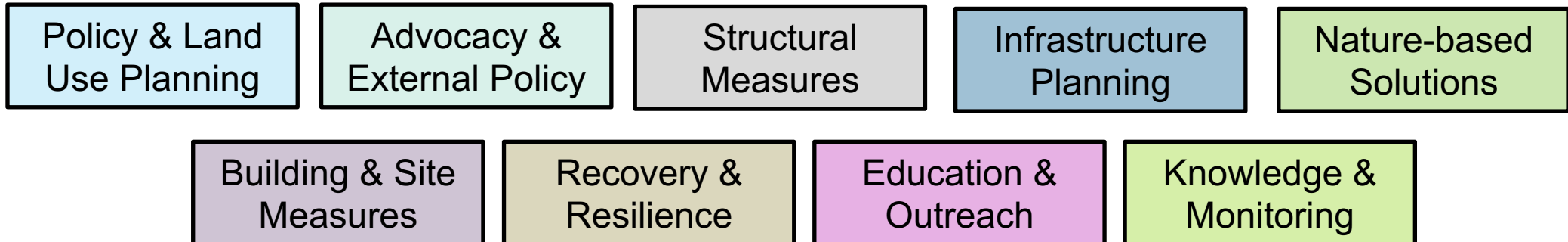
Going Beyond High-level Approaches



- Explore and describe adaptation measures in more detail
- Enable communities to develop adaptation plans that:
 - Use combinations of approaches spatially and temporarily
 - Spark deep discussions of trade-offs and risk tolerance
 - Reflect local context and community engagement input

North Shore Sea Level Rise Adaptation Measures Toolkit

50 + measures over 9 categories





Applying Adaptation Measures in an Example



- What could an “accommodate”-themed concept look like here?



+ Applying Adaptation Measures in an Example

- What could an “accommodate”-themed concept look like here?

Can we offset coastal squeeze here?

Policy & Land Use Planning

Reshape Waterfront Park for Future Intertidal Area

Nature-based Solutions

Building & Site Measures

Dry Floodproofing

Minimum Site Grade

Policy & Land Use Planning

Infrastructure Planning

Road Raising Plan

Overland Drainage Routes

Advocacy & External Policy

Education & Outreach

Flood Risk Tolerance Area Policy

Municipal Pump Station Floodproofing

Third-party Infrastructure

Nuisance Flood Forecasting

Flood Insurance

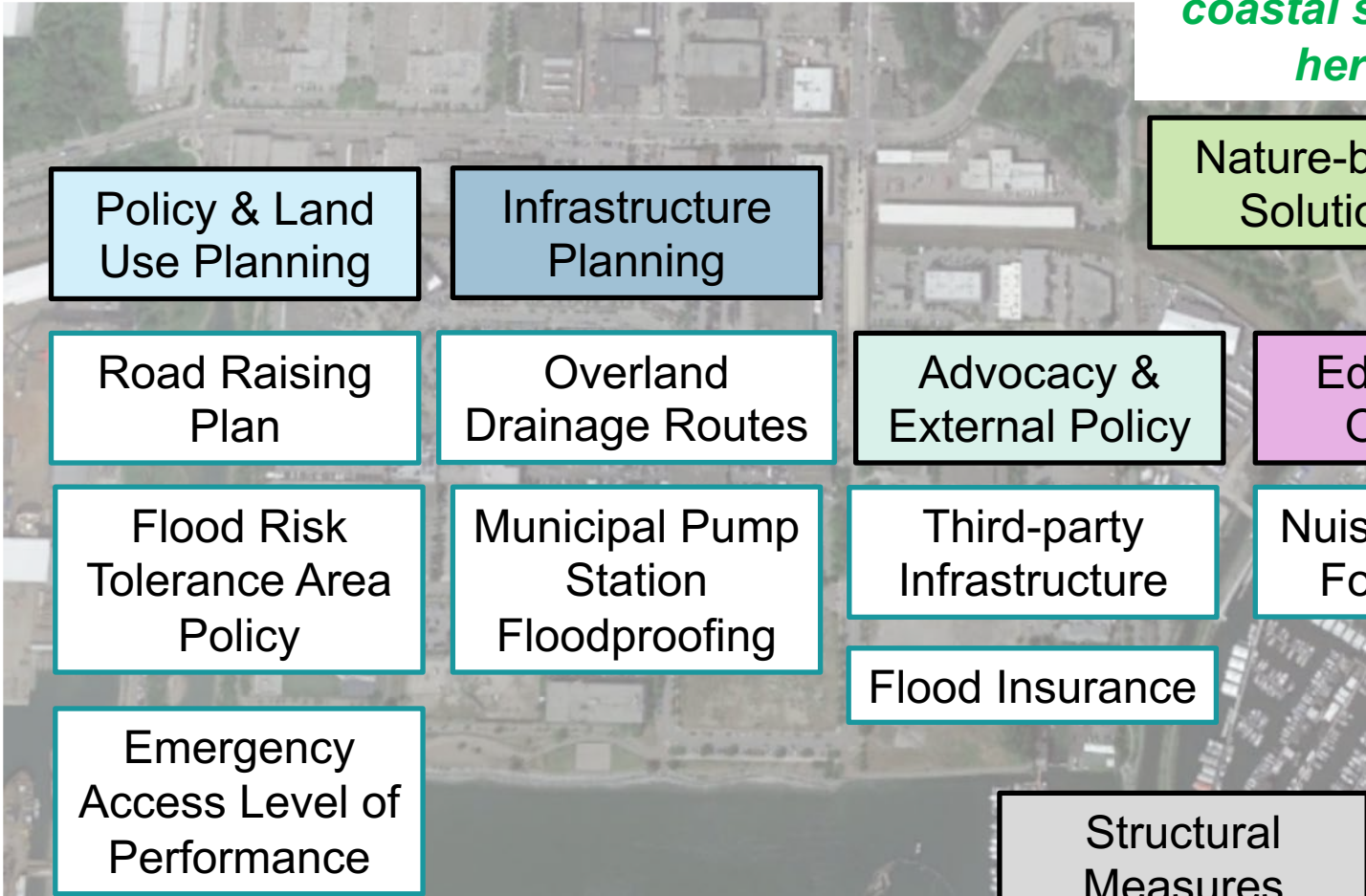
Emergency Access Level of Performance

Structural Measures

Nature-based Solutions

Dike Planning Corridor

Greenshores Shoreline



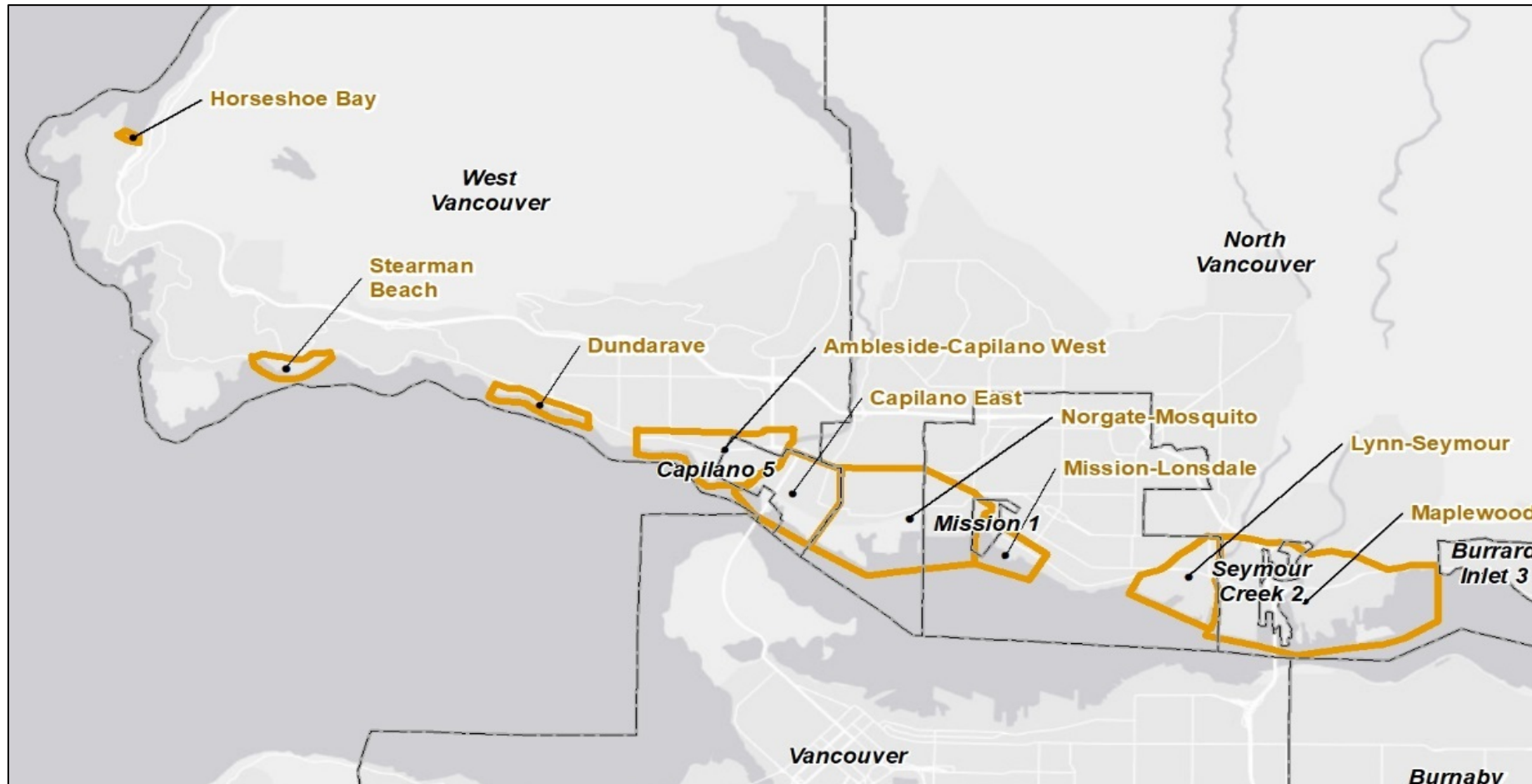
What if sea level rise accelerates?



Area-specific Adaptation Concepts



- 7 areas identified for comprehensive adaptation planning (future)





Thank you and Acknowledgments



- North Shore Partners & Steering Committee:
 - District of North Vancouver: Nicole Foth, Steve Bridger
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