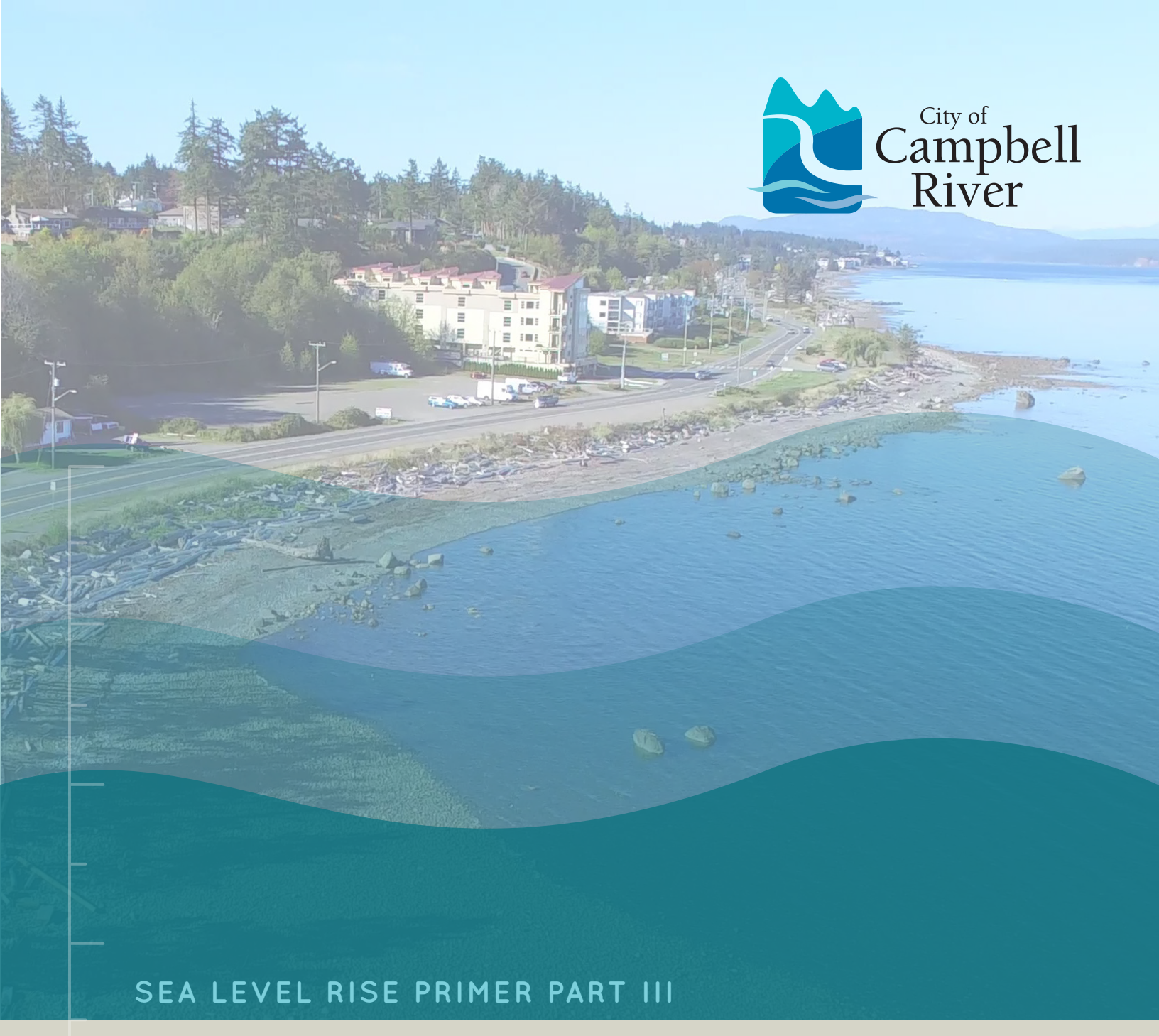

City of Campbell River

SEA LEVEL RISE PRIMER PART III

LOCAL ADAPTATION OPTIONS AND EVALUATION PROCESS

CAMPBELL RIVER

RISING SEAS

STRUCTURE OF THE SEA LEVEL RISE ENGAGEMENT SUPPORT PROCESS

THE SEA LEVEL RISE ENGAGEMENT SUPPORT PROCESS IS PRESENTED IN FOUR PARTS:

I. **Introduction to Sea Level Rise, Risks and Adaptation Methods** – a summary of why sea level rise adaptation is required, introduction to terms and local risks.

II. **Sea Level Rise Adaptation Best Practices** – a guide to common tools to address sea level rise adaptation in Campbell River, highlighting their strengths and challenges.

III. **Local Adaptation Options and Evaluation Process** – a summary of the evaluation process and proposed options to address sea level rise.

IV. **Sea Level Rise Strategy and Action Plan Recommendations** – reporting on how sea level rise adaptation may be strategically integrated into ongoing city planning and other processes and redevelopment in Campbell River.

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City of Campbell River

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LIST OF FIGURES (CONTINUED)

1.0 INTRODUCTION

As a coastal community, Campbell River has a history of flooding of low-lying areas, property damage, and coastal erosion from winter storms. Climate change and sea level rise will increase the need for mitigation of flooding risks along the ocean coast and river.

The City is examining the community's entire coastline, including the estuary, to determine the best course of action that will adapt existing buildings and infrastructure at the time of new development or reconstruction.

The risks and potential solutions are summarized in a series of printed primers and on the Rising Seas webpage at (http://www.campbellriver.ca/planning-building-development/sea-level-rise).

Sea Level Rise Primer Part I is a broad introduction to the sea level rise assessment project and addresses the following:

- defining coastal flood and sea level rise management concepts and terms
- recognizing the differences between coastal and inland flood management areas
- outlining typical adaptation approaches and best practices
- mapping what's at risk if no action is taken in four Campbell River focus areas

Sea Level Rise Primer Part II provides more detail on typical best management practices to adapt to sea level rise and flood risk:

- at a neighbourhood scale ranging from beach nourishment and living shorelines through various types of foreshore and shoreline protection, as well as techniques to drain inland flooding that may accumulate due to overtopping of coastal defenses or concurrent heavy rainfall.
- at a building / lot scale, including elevating buildings and building systems above floodwaters.

Sea Level Rise Primer Part III (this document) summarizes options under consideration:

- setting minimum elevations for new buildings- termed flood construction levels (FCLs)- to establish minimum levels for the base of wood structures or slabs for living spaces to be above the risk of flooding.
- introducing options that evaluate a variety of sea level rise best practices in four focus areas in Campbell River. A technical comparison of options is tabled as a background to public input on the values and criteria that should guide a recommended sea level rise adaptation strategy.

2.0 COMMUNITY ENGAGEMENT OUTREACH

SUMMARY OF PUBLIC AND STAKEHOLDER PROCESS

Community engagement is an important component in fine-tuning an appropriate sea level rise adaptation strategy for Campbell River. Opportunities for input include:

- Introduction to Sea Level Rise (Fall 2018) - results available at http://www.campbellriver.ca/planning-building-development/sea-level-rise
- Evaluation Options for Sea Level Rise (Winter 2019)
- Recommended Strategies for Sea Level Rise (Spring 2019)

Public Open House Workshop November 2018.

Coastal Engineers and Planners are undertaking technical analysis and evaluation of options in parallel with the community engagement process. Policy directions and draft technical recommendations will be refined through ongoing community engagement.

3.0 REQUIRED FLOOD CONSTRUCTION LEVELS

ADAPTATION AT TIME OF CONSTRUCTION

It is important that sea level rise be taken into consideration during the planning and construction of buildings and infrastructure. Each generation of building should be designed to account for sea level rise over the course of its serviceability.

FLOOD CONSTRUCTION LEVEL DEFINITION

The **Flood Construction Level (FCL)** is the required minimum elevation for the base of a wood floor structure for habitable floors or the storage of valuable goods. The flood construction level includes tidal and sea level rise effects, storm surge, wave effects that vary with local exposure and shoreline conditions, as well as an allowance for unknowns, called freeboard. Additional information about flood construction levels and other sea level rise and adaptation terms can be found in Primer I.

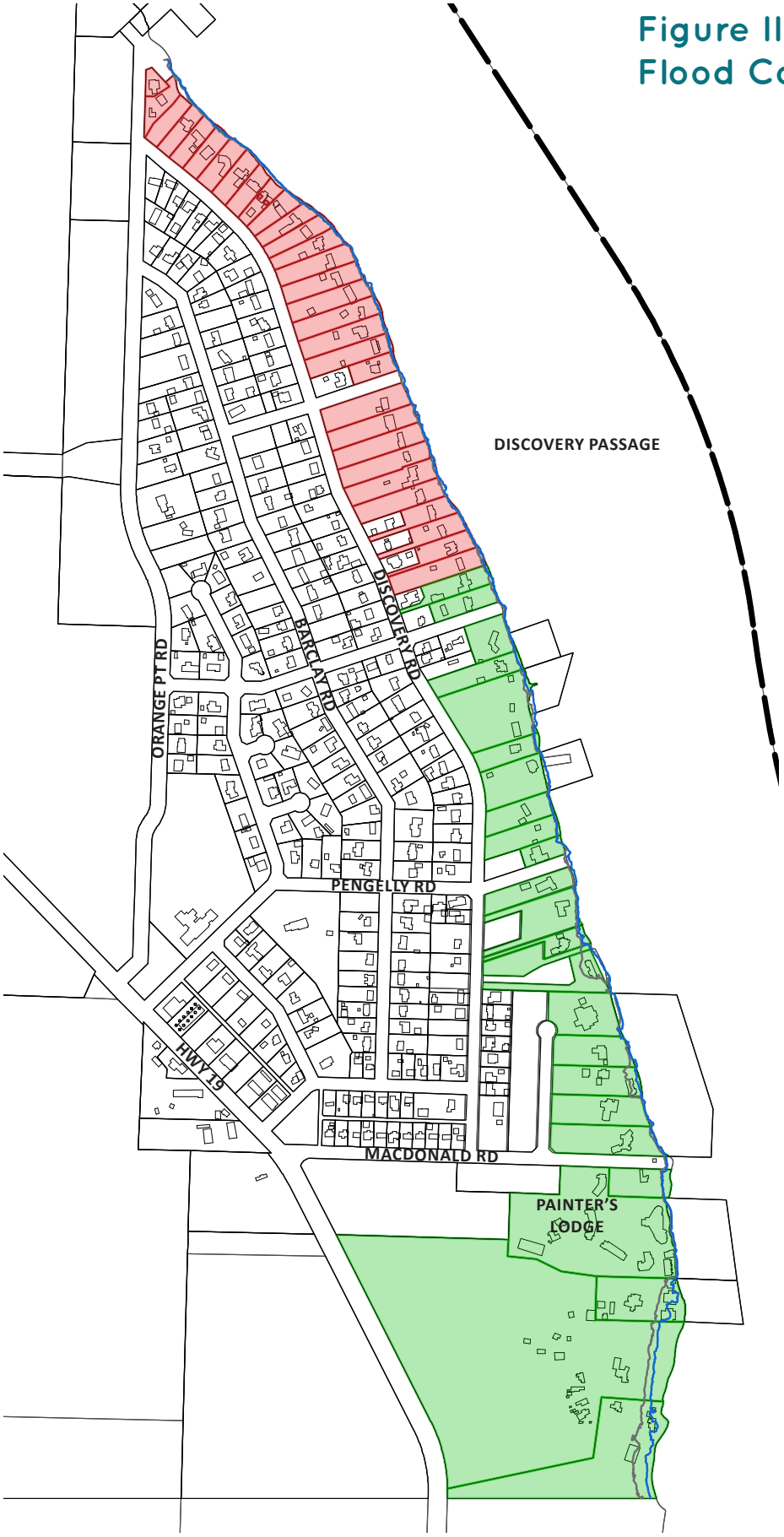
Southern shorelines of Campbell River are more exposed to high winds and waves from long fetches of open water than the more protected northern areas in Discovery Passage.

Because coastal flooding risk varies along Campbell River's shorelines, some buildings will be required to be higher than those in other areas. Some low-lying inland flood management areas in the Downtown Shoppers Row and Cedar Street area are also at risk in the event that waves overtop coastal defenses during storms, or from rainwater backing up because storm drains cannot discharge into the ocean during high tides.

The Flood Construction Maps (Figure III-1, III-2, III-3, III-4) provide Flood Construction Levels for coastal and inland properties in Campbell River that are at risk from a coastal flood. These maps do not include risks of flooding from rivers and creeks, which are documented separately.

Each property highlighted in Figures III-1, III-2, III-3, and III-4, is likely to have some portion at risk from sea level rise, either related to existing grades and utilities or potential grading during redevelopment.

Figure III-1: Painter Barclay Flood Construction Level Map



Legend
- Municipal Boundary
- Approximate Extent of DFL
- 4.0m Elevation (Geodetic)
- Inland Flood Area (FCL 3.7m)
- Coastal Flood Area (FCL 4.7m)
- Coastal Flood Area (FCL 4.8m)
- Coastal Flood Area (FCL 4.9m)
- Coastal Flood Area (FCL 5.0m)
- Coastal Flood Area (FCL 5.2m)
- Coastal Flood Area (FCL 5.4m)

0 100 200 300 m

1:9000

Notes:

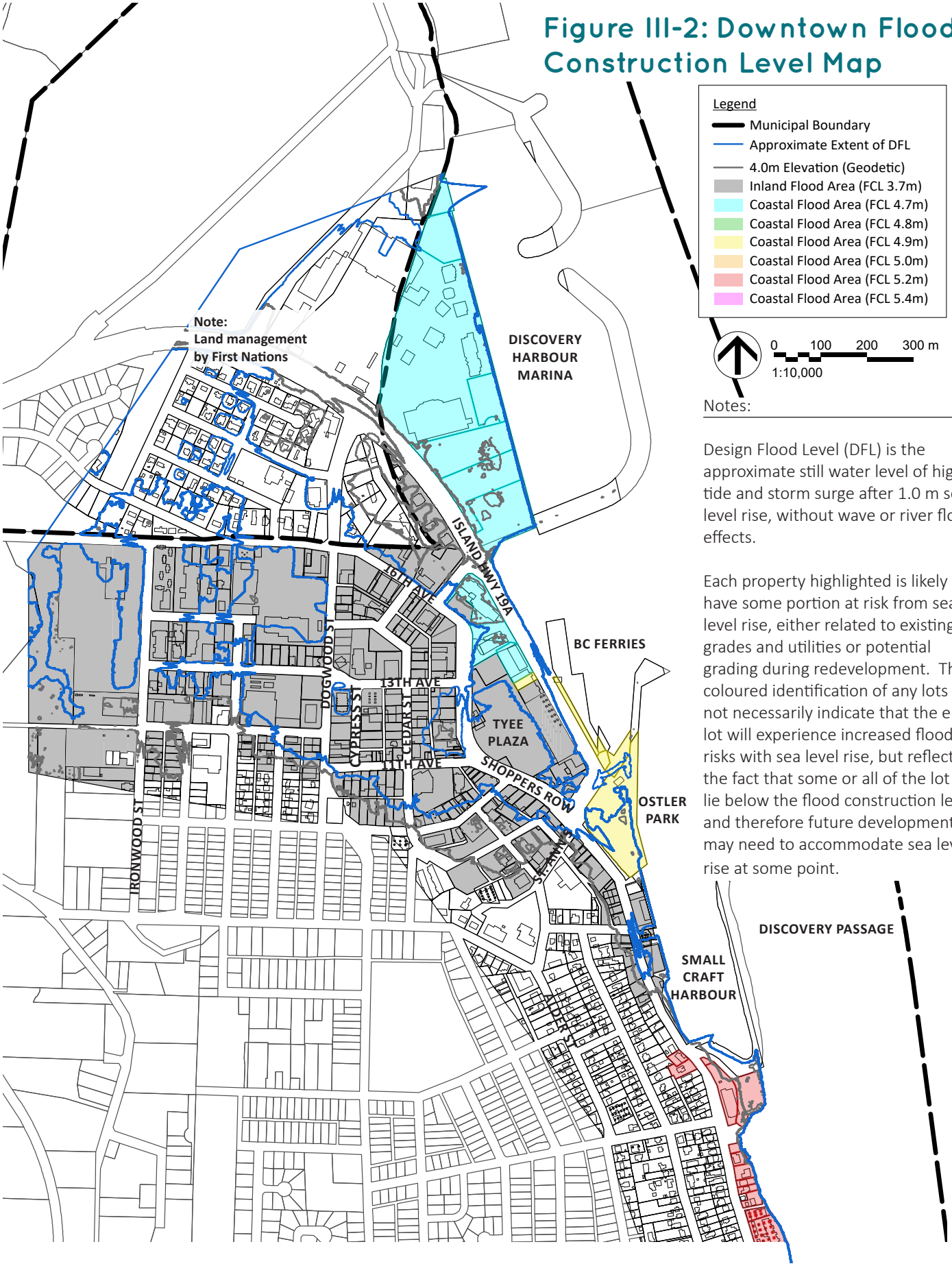
Design Flood Level (DFL) is the approximate still water level of high tide and storm surge after 1.0 m sea level rise, without wave or river flood effects.

Each property highlighted is likely to have some portion at risk from sea level rise, either related to existing grades and utilities or potential grading during redevelopment. The coloured identification of any lots does not necessarily indicate that the entire lot will experience increased flood risks with sea level rise, but reflects the fact that some or all of the lot may lie below the flood construction level, and therefore future development may need to accommodate sea level rise at some point.

Much of the Painter Barclay area lies many meters above sea level, therefore most lots are already located well above flood construction levels and will not be affected by flooding. Erosion of the escarpment however remains an issue. Most existing residential buildings are already above the flood construction levels and likely will not be affected, however, in the case of any future developments in the limited lower-lying areas or near the base of the slope, structures will meet minimum elevation requirements, minimizing risks to human health, safety and property.

City of Campbell River

Figure III-2: Downtown Flood Construction Level Map



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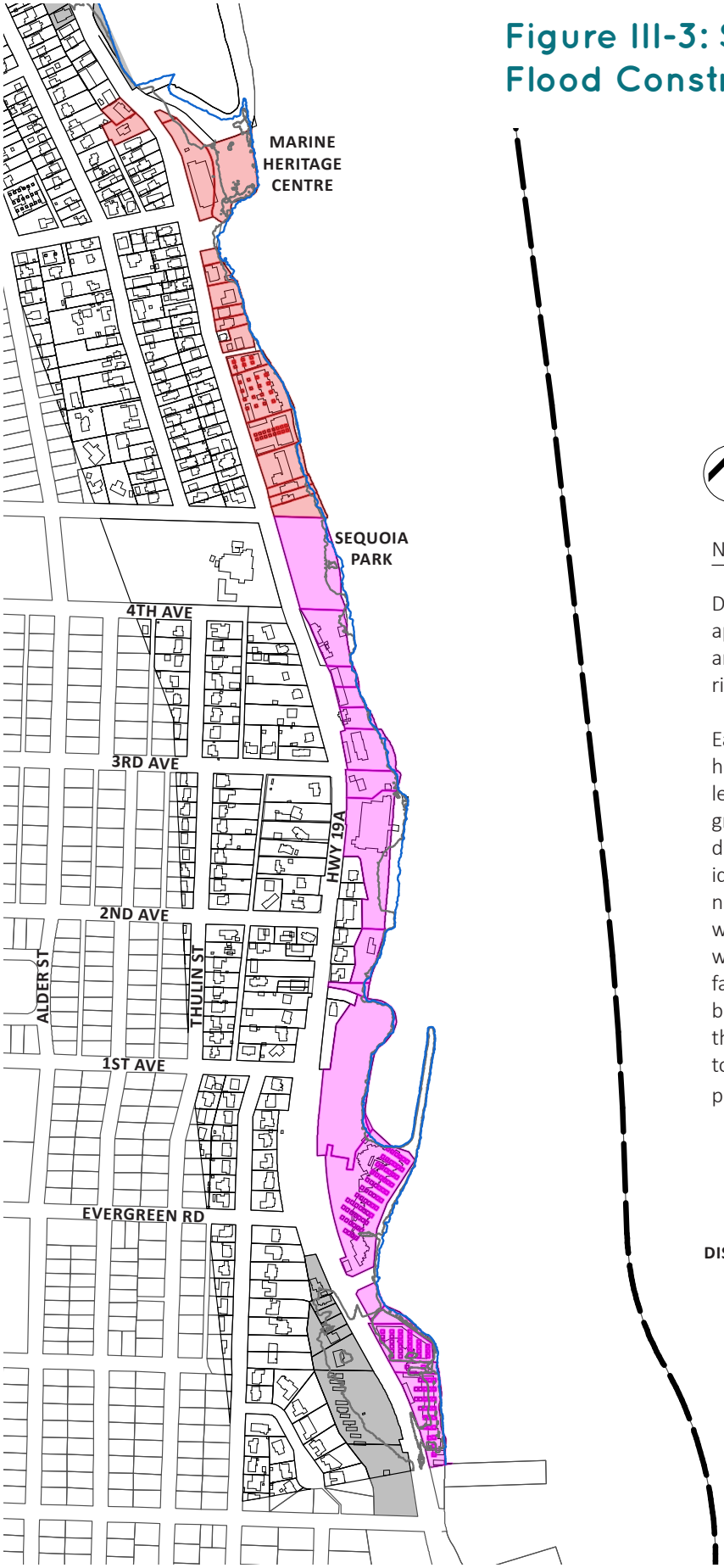
Each property highlighted is likely to have some portion at risk from sea level rise, either related to existing grades and utilities or potential grading during redevelopment. The coloured identification of any lots does not necessarily indicate that the entire lot will experience increased flood risks with sea level rise, but reflects the fact that some or all of the lot may lie below the flood construction level, and therefore future development may need to accommodate sea level rise at some point.

Figure III-3: Sequoia Park Flood Construction Level Map



Legend

- Municipal Boundary
- Approximate Extent of DFL
- 4.0m Elevation (Geodetic)
- Inland Flood Area (FCL 3.7m)
- Coastal Flood Area (FCL 4.7m)
- Coastal Flood Area (FCL 4.8m)
- Coastal Flood Area (FCL 4.9m)
- Coastal Flood Area (FCL 5.0m)
- Coastal Flood Area (FCL 5.2m)
- Coastal Flood Area (FCL 5.4m)

0 100 200 300 m

1:7500

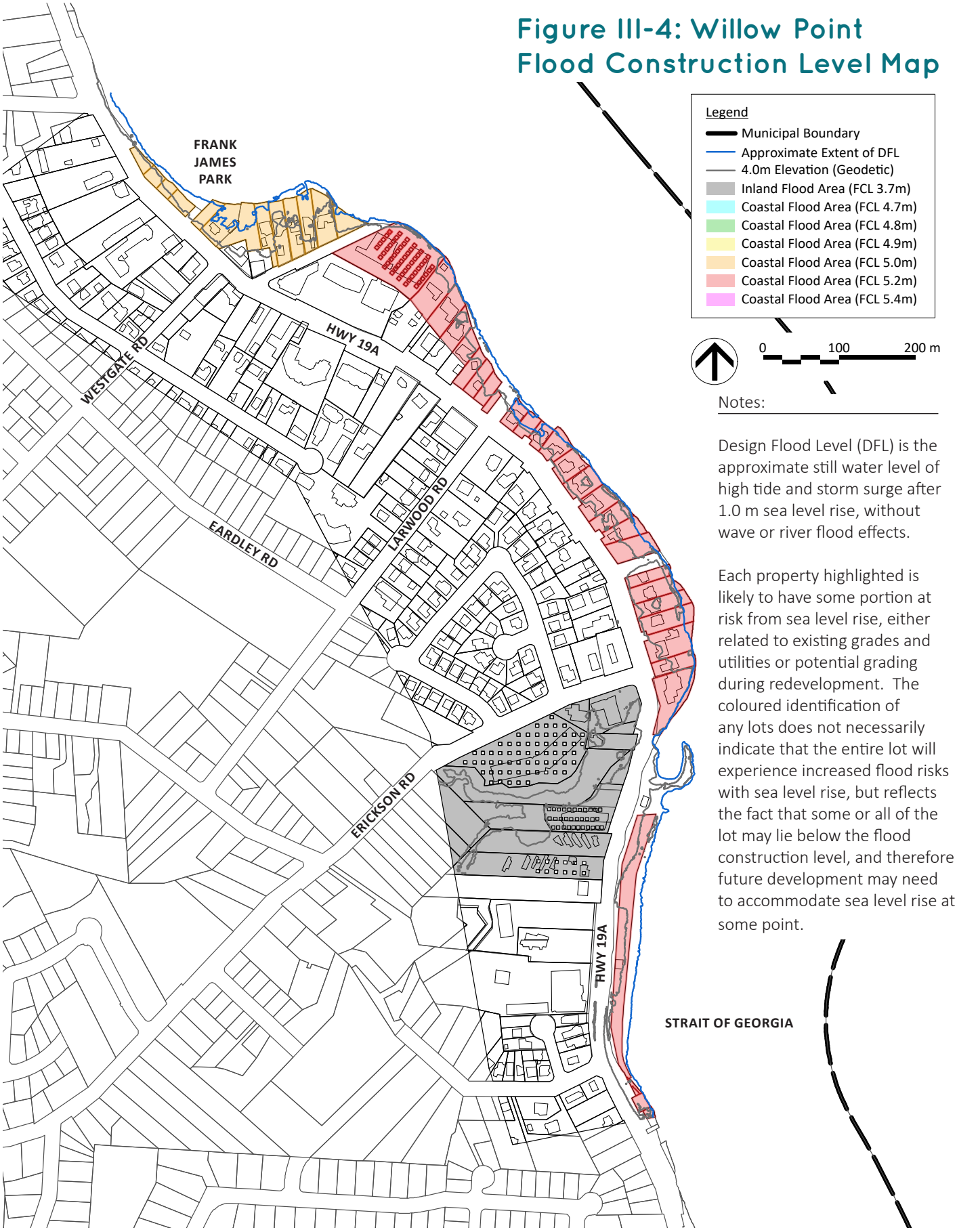
Notes:

Design Flood Level (DFL) is the approximate still water level of high tide and storm surge after 1.0 m sea level rise, without wave or river flood effects.

Each property highlighted is likely to have some portion at risk from sea level rise, either related to existing grades and utilities or potential grading during redevelopment. The coloured identification of any lots does not necessarily indicate that the entire lot will experience increased flood risks with sea level rise, but reflects the fact that some or all of the lot may lie below the flood construction level, and therefore future development may need to accommodate sea level rise at some point.

City of Campbell River

Figure III-4: Willow Point Flood Construction Level Map



Notes:

Design Flood Level (DFL) is the approximate still water level of high tide and storm surge after 1.0 m sea level rise, without wave or river flood effects.

Each property highlighted is likely to have some portion at risk from sea level rise, either related to existing grades and utilities or potential grading during redevelopment. The coloured identification of any lots does not necessarily indicate that the entire lot will experience increased flood risks with sea level rise, but reflects the fact that some or all of the lot may lie below the flood construction level, and therefore future development may need to accommodate sea level rise at some point.

PRINCIPLES OF NEIGHBOURHOOD AND BUILDING SCALE ADAPTATION

There are a variety of strategies that can be used to adapt coastal areas to sea level rise. These strategies involve actions at various scales, from individual buildings to coastal reaches. Primer II contains a range of specific building and neighbourhood scale solutions to address sea level rise.

In considering options to adapt, a key variable is whether individual building/lot property should be the focus of adaption, or if broad neighbourhood-scale solutions are appropriate. Several key principles apply:

I. Protecting property from coastal flooding and erosion risk has traditionally been the responsibility of the waterfront property owner. Broad community financial support to protect private waterfront property would be a change in practice.

II. Unless Crown foreshore lease and environmental approvals are gained for works on the public foreshore, adaptation would be exclusively on the parcel above the natural waterfront boundary. This boundary will move inland with sea level rise.

III. Setbacks to new building construction must account for the inland migration of the sea and associated wave-driven spray, logs and debris for the serviceable time of the building, which may be 75 to 100 years into the future.

IV. In the Campbell River context, fiscal responsibility would link public investment in waterfront improvements and protection to public benefits – which may range from protecting tax base or economic development and jobs, to improved public waterfront access, recreation and environmental protection. Community financial support could range from no public support, to fully public-funded support from senior governments as well as the City. Blending of public and private funding is also possible, in proportion to benefits received.

V. The City of Campbell River has an established waterfront property acquisition program. To date, the program has acquired properties on a willing seller basis when the sale price is fair. Such properties have sometimes been rented for a period, and eventually converted to public open space and parkland, with provisions for public road and utilities as well as improvements to the Seawalk. If this program were to incorporate giving priority to smaller properties that may not have space to effectively adapt to sea level rise, the City would assume coastal flood and environmental protection risks, adaptation costs, and would also be losing the associated tax base, and sale prices would need to reflect these considerations. Due to high costs, purchase of commercial or multi-family property is usually a lower priority.

It may not be desirable or affordable to have widespread community acquisition of private property. Where property acquisition by the community is a worthwhile priority, ideally it would involve contiguous parcels to allow neighbourhood scale solutions that include soft shores with beaches, sea walk and environmental improvements. In other cases where sea level rise adaptation might involve using fill to raise beaches on public foreshore, it may be desirable to arrange granting of riparian rights, which protect boat access to the shoreline, and also a right to fill a strip of private land so that the on-foreshore beach fill could extend up to meet grade on private property- often burying existing rock armouring.

EXAMPLES OF BUILDING / SITE ADAPTATIONS

Flood Construction Levels are generally higher than existing site and building levels. While existing buildings would remain until the end of their serviceable life, new buildings likely need to be adapted to the higher levels. Examples of typical solutions are introduced below.

WATERFRONT RESIDENTIAL ADAPTATION IN THE COASTAL FLOOD MANAGEMENT AREA

In the coastal flood management area, the flood construction levels may be in the range of 1.1 to 2.4 m higher than existing, depending on location exposure to waves and existing site levels.*

Figures III-5 and III-6 show conceptual cross sections of two approaches to site and building development to accommodate sea level rise on a typical waterfront residence. Shorelines with gradual slopes provide more ecological benefits than rock armour approaches. Both examples follow existing development permit objectives to implement the most soft approach feasible – with example III-5 preferred but example III-6 possible where a property has less depth.

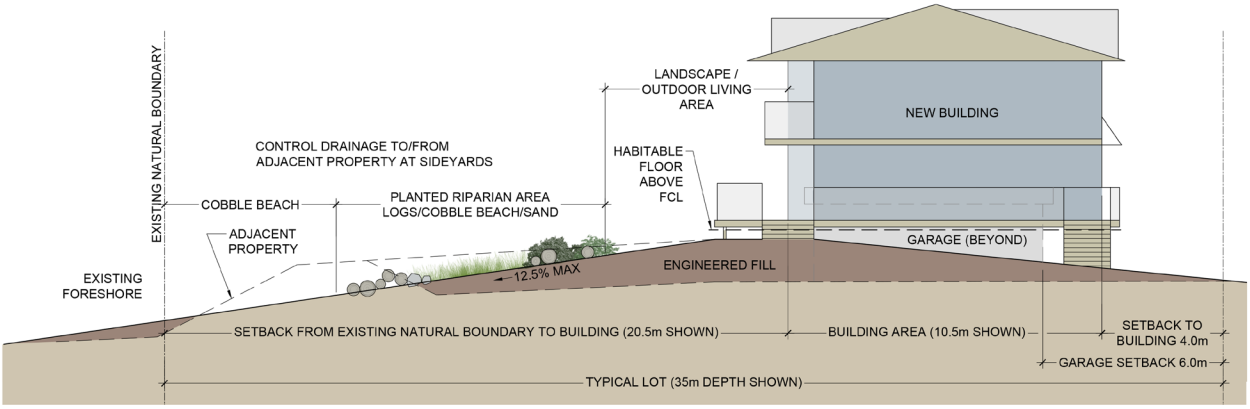


Figure III-5: Waterfront Residential Development Concept A

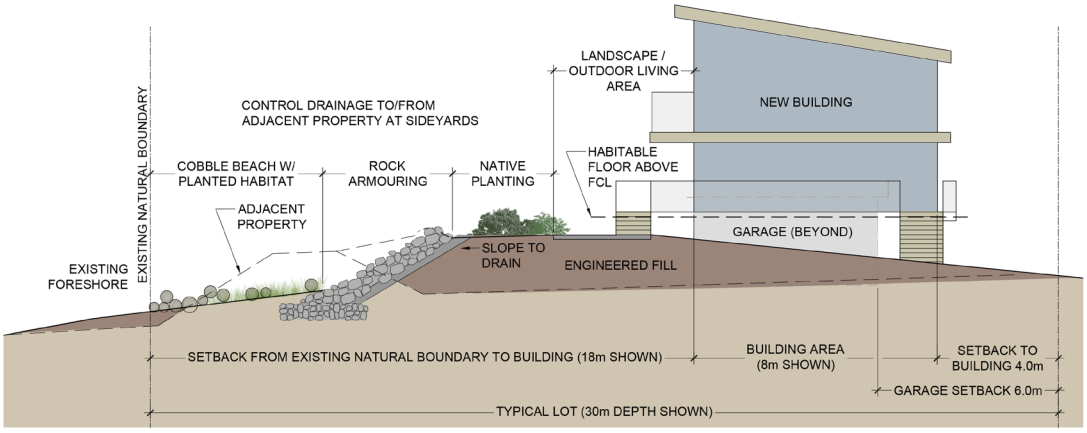


Figure III-6: Waterfront Residential Development Concept B

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* Flood construction levels for new buildings vary from 4.1 m to 5.4 m in geodetic datum - based on mean tide being elevation 0.0 m. Each existing building has a different elevation, but typical existing conditions may range from below 3.0 m to as high as 4.0 m. geodetic elevation.

DOWNTOWN STREETS AND DEVELOPMENT ADAPTATION IN THE INLAND FLOOD MANAGEMENT AREA

Low lying land that is vulnerable to flooding (the inland flood management area) is concentrated in the Shoppers Row, Pier Street and Cedar Street areas of downtown. While this area is potentially sheltered from wave effects from shoreline defenses, it is at risk of stormwater back-up and rainfall accumulation during periods of high tides and waves that block storm drainage outfalls.

Existing site and building elevations are highly variable in the downtown, but the increase in floor elevation may be up to 1 m in some locations.*

The streets and sidewalks in these areas also need to be raised at the time of their reconstruction to continue to provide public safety, emergency access and egress during a storm event. Streets vary in elevation to allow for gravity drainage and are designed to carry surface water at roadsides for short periods during extreme storm events. A guideline for future street elevations is to be between 3.1 and 3.7 m geodetic or higher, so that they are generally above design flood elevations but below building floor elevations. While existing street elevations vary, this rise in street level could range from 0.3 to 0.9 m.

Much of the downtown area has buildings that are setback from the street edge property line and can accommodate changes in street elevations by gradual slope transitions to buildings. Zero lot lines (no setback from street property line) exist at most buildings on Shoppers Row, parts of 11th Avenue and some other buildings. There are complications in adapting the building floors and street elevations one-building at a time during reconstruction. One building may be redeveloped with higher floors than the street, while an adjacent older building floor may not be redeveloped until after the street is raised. Ramps and steps would need to be added to suit. Alternatively, the interior floors of retail buildings could be adjusted to match street level if ceiling heights and building systems allow.

Figures III-7 and III-8 show conceptual cross sections for a staged adaptation to reduce flood risk of downtown commercial floors of buildings and streets at time of redevelopment. Strategies include:

1. Raising streets to be above the design flood level (3.1 m geodetic). Buildings in areas with existing zero lots line strive for designs that are near this minimum.
2. Use flush curbs and gutters for drainage rather than upright curbs. The flush design reduces the cumulative increase in street edge at the property line while still allowing for drainage away from buildings.
3. Design raised streets with a street edge property line elevation that accommodates a maximum of three steps up to lowest residential floor level (3.7 m geodetic) and a maximum of three to four steps down to existing commercial floor levels before building redevelopment.
4. Considering raising floors of existing retail buildings to the new street level. Most commercial spaces have high ceilings, allowing for the floor elevation to be raised while still retaining a reasonable wall height to existing ceilings.

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* Inland flood construction levels for new residential and commercial buildings are ideally above a single level of 3.7 geodetic to allow for a design flood level for still water of 3.1 plus a freeboard for safety and unknowns of 0.6 m. However, for pragmatic purposes, exemptions are possible for zero lot line commercial uses, with a minimum floor elevation of 3.2 m geodetic for non-residential building floors in zero lot line conditions provided that a covenant accepting flood risk is placed on land title.

5. Where floors of existing buildings are not raised to match the street, work with property owners to design and install stairs and ramps that provide safe public access and egress while also maintaining an attractive commercial interface with the street. The change in grade could be at exterior alcoves or just inside entrance doors. Combinations are also possible where parts of building floors are raised to street level (e.g. front areas) and other parts (e.g. rear areas) are left at lower levels while recognizing flood risks. In this case, changes would be made to stairs and ramps inside of buildings, away from the storefronts.
6. When commercial buildings are reconstructed, (if the proposal has retail space) the retail floor would be just above the level of the street edge, and in all cases above the design flood level (3.2 m geodetic).
7. Mixed use commercial / residential buildings could have retail floor levels at street level (above 3.2 m geodetic) and residential areas above 3.7 m geodetic.
8. On larger sites, it may be desirable to have micro-retail facing the street above the design flood level (3.2 m geodetic), with parking behind the retail in the lot interior. A second level pedestrian-dominated concourse and courtyards above elevation 7.0 m geodetic may provide public access to multi-storey mixed commercial residential buildings.
9. Underground parking should be designed and waterproofed to withstand flood waters and buoyancy, and have entrance drives designed to be floodproof – with driveway crests above the design flood level.
10. Mechanical and electrical systems, including electric car chargers, should be floodproof or above the flood construction level of 3.7 m geodetic.

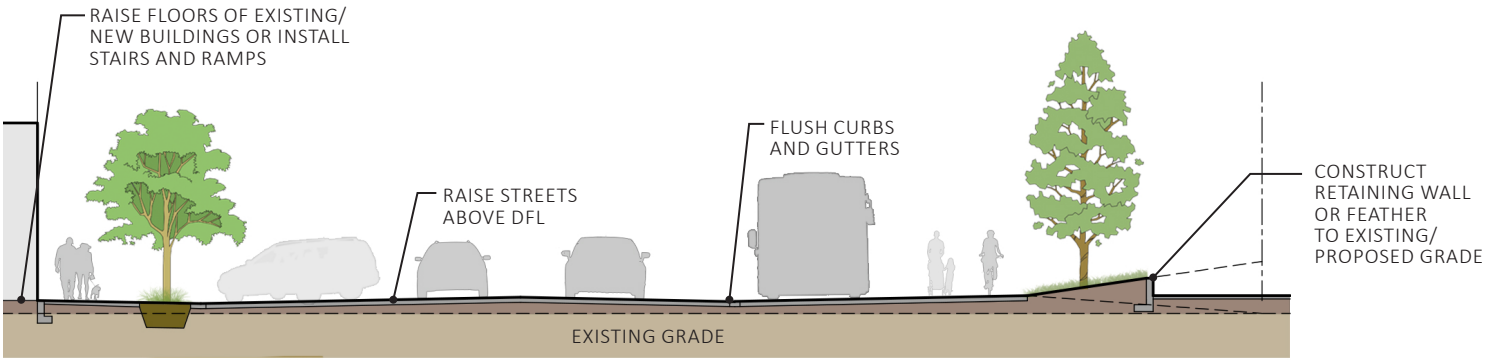


Figure III-7: Shoppers Row- Lower Adaptation

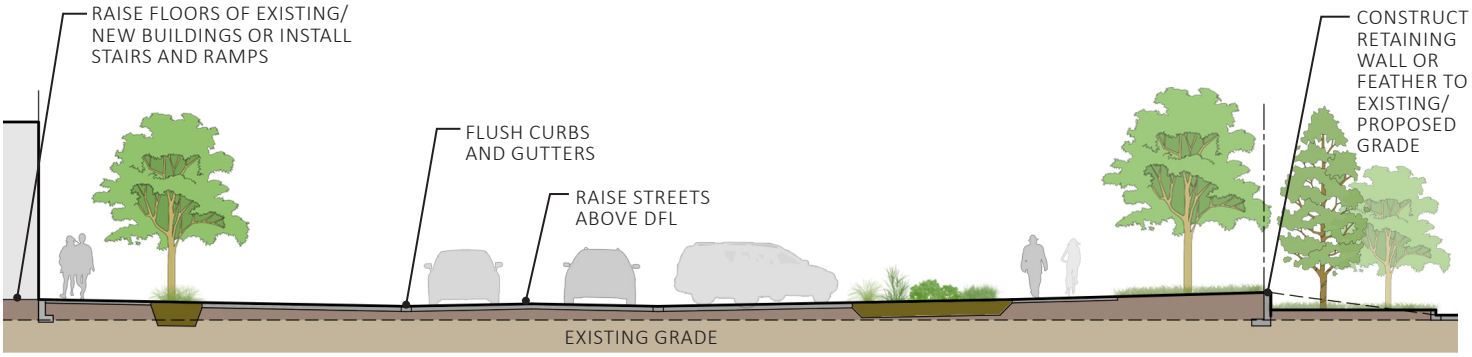


Figure III-8: Shoppers Row- Upper Adaptation

4.0 COMMUNITY ADAPTATION OPTIONS

Conceptual Framework Summary for Community-Wide Options

Three proposed adaption options under consideration illustrate a range of approaches to private / parcel-scale adaptation, public / neighbourhood-scale adaptation, and mixes of the two that allow a choice of priorities for public investment.

- Option A: Parcel-Scale Adaptation, Minimum Community Intervention
- Option B: Neighbourhood Scale Adaptation, Extensive Community Intervention
- Option C: Balanced Intervention with Limited Neighbourhood Scale Priorities

Figure 9 below summarizes key concepts for each option.

Figure III-9: Community Adaptation Options

Option A	Option B	Option C
Minimum Community Intervention	Extensive Community Intervention	Balanced Intervention by Priority
Adaptation at Property Scale	Adaptation at Neighbourhood Scale	Mixed Property/Neighbourhood Scale
City addresses adaptation in public streets and street ends, parks, infrastructure only	City pursues on-foreshore adaptation fronting private waterfront wherever possible, in addition to adaptation for public infrastructure	City pursues on-foreshore adaptation fronting private waterfront only where there is a cummunity-wide benefit, in addition to adapting public infrastructure
Private waterfront owners protect shoreline independently and raise buildings/lots at time of reconstruction at their own expense	Private waterfront owners face reduced costs for shoreline protection. Owners raise buildings/lots at time of reconstruction at their own expense	Private waterfront owners and City share costs in proportion to benefits for neighbourhood shoreline protection where feasible. Private waterfront owners raise buildings/ lots at time of reconstruction at their own expense

All options are technically feasible. The options compare standard approaches with others that are more creative. Through the community evaluation process, it may be evident that another mix or combination of option elements or distribution of solutions to geographic area is more suitable for Campbell River.

Options A, B and C all assume that existing land uses are anticipated to continue under their existing zoning. Another option, introduced in Primer I, is the concept of managed retreat. In the Campbell River context, retreat would likely be accomplished by the gradual purchase and conversion of land to public uses like trails, parks and open space. The City has been active in waterfront land acquisition, both at Tyee Spit and at various locations along the waterfront. It is possible that the City may continue its established policy of purchasing waterfront property on a confidential and willing-seller basis when the circumstances are fair.

All technically feasible options will be evaluated through public engagement and Council deliberation, based on a range of values that are important to Campbell River. Recommendations on a preferred option or mix of options will be finalized once public engagement has concluded.

5.0 MAKING CHOICES AMONG COMMUNITY ADAPTATION OPTIONS

INTRODUCTION TO EVALUATION APPROACHES

Selecting which options best suit Campbell River locations involves a complex analysis of technical considerations and public values. To assist the community and City Council, a structured decision-making process is advised.

Values Criteria – including six categories of People, Economy, Environment, Recreation/Culture and Infrastructure. Each value has a key indicator (e.g. under people the key indicator is highest number of people protected).

Impact and Risk of Failure – what is the likelihood of failure for each option, and the consequence of that failure on vulnerable assets and people? A rating of overall risk is summarized.

Cost Criteria- including relative public costs to design and construct (capital costs); to operate and maintain. Also included are relative values for cost to private landowners or businesses including cost of construction and inconvenience or loss of business. Costs may be reduced to local taxpayers by access to co-funding through other agencies or senior governments. In addition, the long term adaptation cost, beyond 1 m sea level rise, is taken into account for each option.

How each option compares to these criteria is summarized in Figures III-15, III-27, III-31, and III-36. A baseline of no adaptation action is also shown for discussion.

TECHNICAL AND COMMUNITY EVALUATION PROCESS TO DATE

Figures III-15, III-27, III-31, and III-36 are DRAFT evaluations undertaken by City staff and consultants, reflecting their technical knowledge and expertise.

Community engagement is on-going concurrent with the technical evaluation. Public input on community values was received in November and December 2018 – results are available on the City's Rising Seas webpage at http://www.campbellriver.ca/planning-building-development/sea-level-rise.

The community engagement, technical engineering and planning process continued through early 2019. Evaluation criteria, community values, and new ideas may come forward, and a combination of options may provide the most appropriate strategy for Campbell River.

Draft Recommendations for a Sea Level Rise Adaptation Strategy will be refined through additional community feedback.

6.0 PAINTER BARCLAY ADAPTATION OPTIONS

City of Campbell River

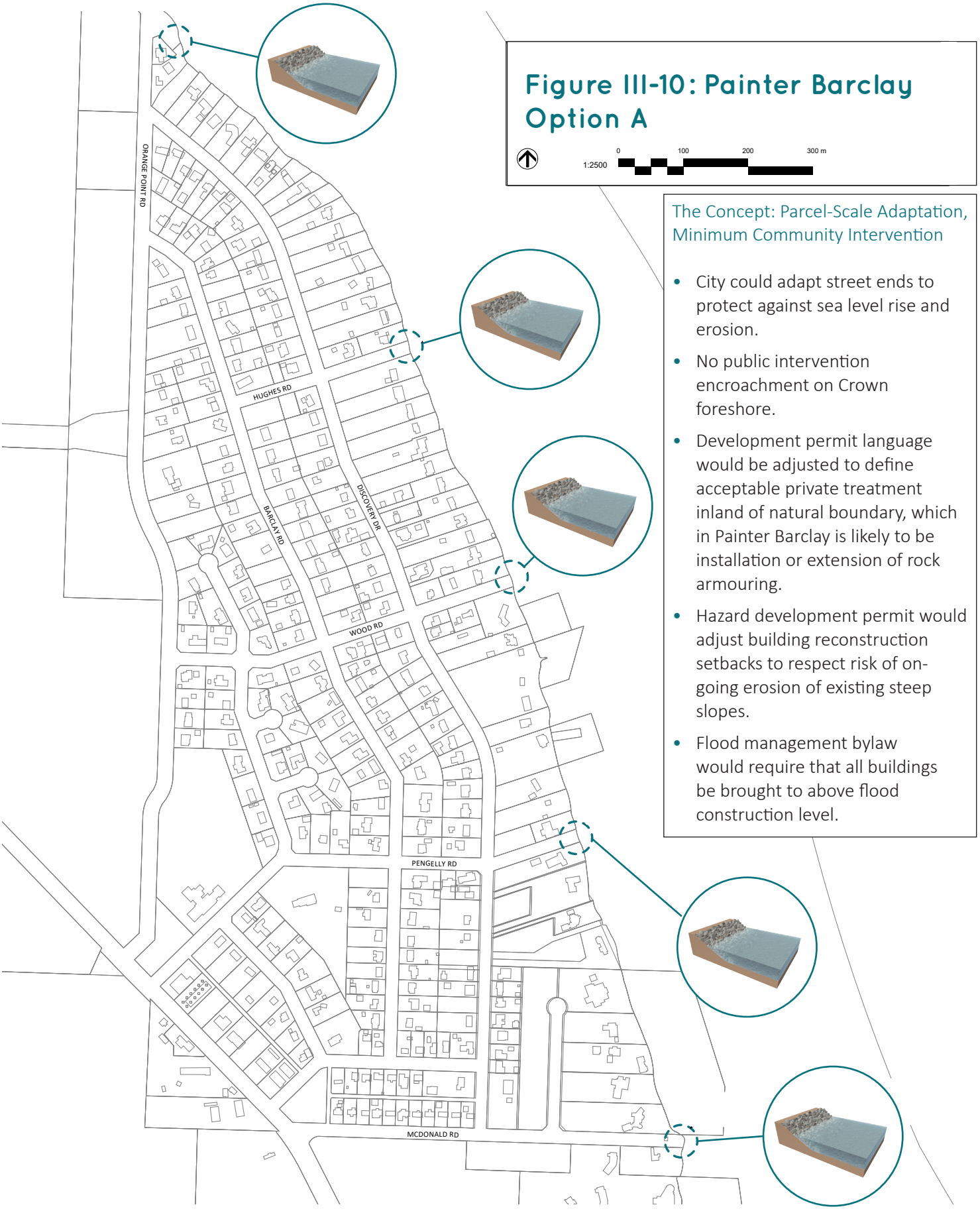


Figure III-10: Painter Barclay Option A

The Concept: Parcel-Scale Adaptation, Minimum Community Intervention

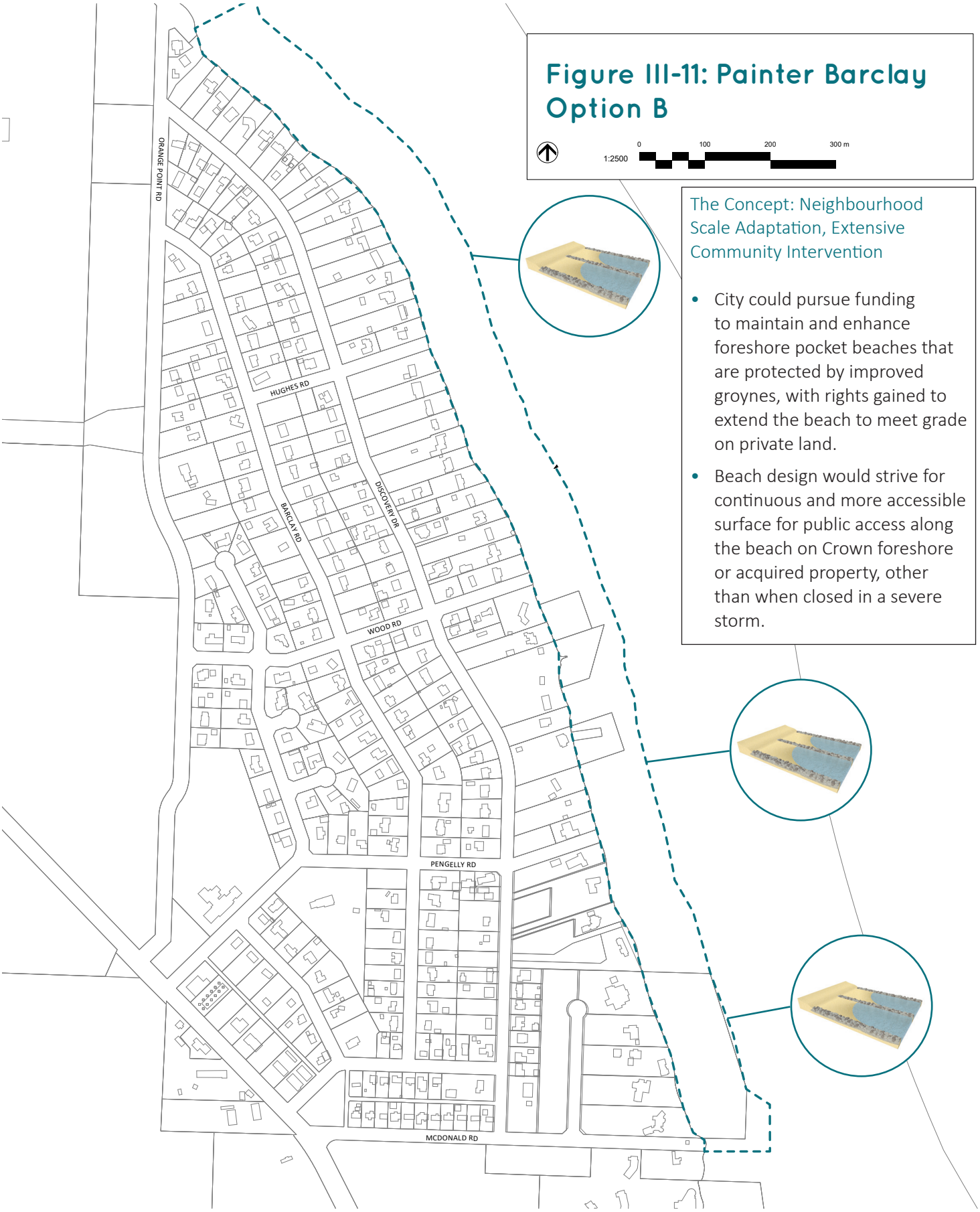
- City could adapt street ends to protect against sea level rise and erosion.
- No public intervention encroachment on Crown foreshore.
- Development permit language would be adjusted to define acceptable private treatment inland of natural boundary, which in Painter Barclay is likely to be installation or extension of rock armouring.
- Hazard development permit would adjust building reconstruction setbacks to respect risk of on-going erosion of existing steep slopes.
- Flood management bylaw would require that all buildings be brought to above flood construction level.

PAINTER BARCLAY OPTION A BREAKDOWN

Costs	PUBLIC: $ PRIVATE: $$$$
Phasing Logistics	• Not all owners would install rock armour concurrently. • Access for rock armour construction may be un-coordinated / difficult.
Key Benefits	• Toe of bank stabilized against erosion. • Risk of steep slope failure reduced (but not eliminated). • Least cost to public finances.
Remaining Risks	• Wave energy on rock armour may increase erosion of existing beaches and may accelerate erosion on adjacent unarmoured properties. • Public access along the foreshore would be reduced as beach erodes and sea level rise continues. • Rock armour damages shoreline vegetation and ecology.

Rock armouring, Qualicum Beach. (Credit: Sanctuary Studios)

Figure III-11: Painter Barclay Option B



The Concept: Neighbourhood Scale Adaptation, Extensive Community Intervention

- City could pursue funding to maintain and enhance foreshore pocket beaches that are protected by improved groynes, with rights gained to extend the beach to meet grade on private land.
- Beach design would strive for continuous and more accessible surface for public access along the beach on Crown foreshore or acquired property, other than when closed in a severe storm.

PAINTER BARCLAY OPTION B BREAKDOWN

Costs	PUBLIC: $$$$ PRIVATE: $
Phasing Logistics	• Foreshore environmental and property approvals may be challenging. • Upland owner riparian rights or access would require negotiation.
Key Benefits	• Toe of bank stabilized against erosion. • Risk of steep slope failure reduced (but not eliminated). • Public access along the foreshore maintained / enhanced. • Shoreline vegetation protected, ecology potentially enhanced.
Remaining Risks	• Proper engineering of the groynes and beach nourishment will be critical to minimize rate of foreshore erosion. • Expect some foreshore erosion and material movement – top-up of beach materials may be required periodically. • Higher cost to public finances.

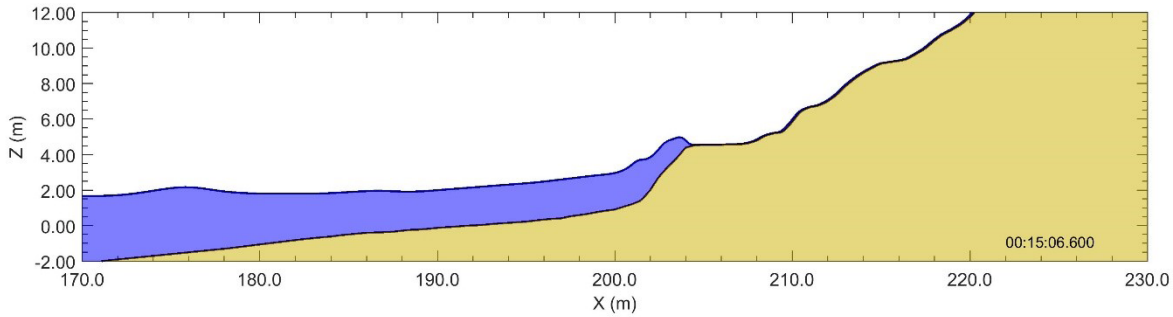


Figure III-12: Wave model simulation of present day conditions (NHC)

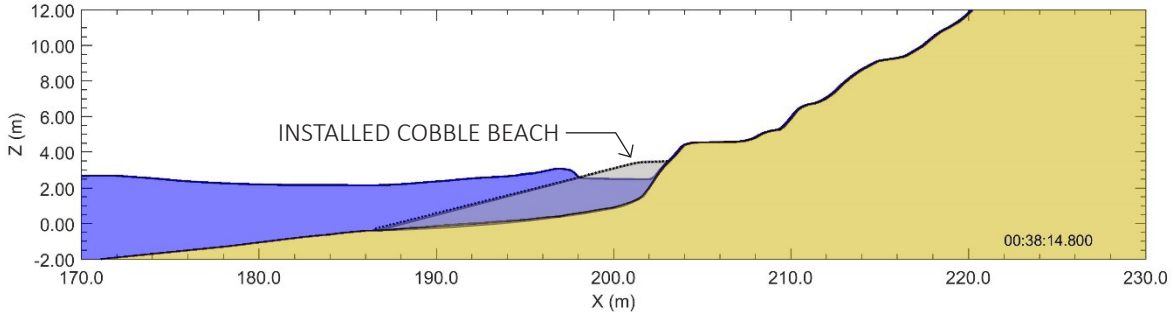


Figure III-13: Wave model simulation after cobble beach nourishment (NHC)

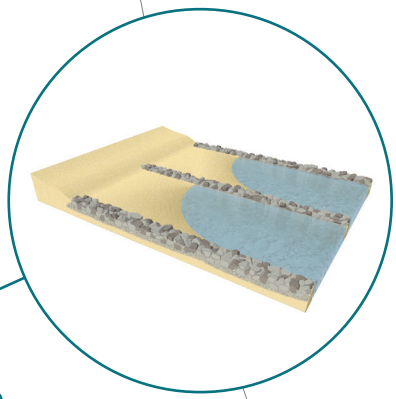
Figure III-12 and 13 illustrate the relationship between water depth and wave interaction with the shoreline bluff. Higher nourished beach levels reduce wave-driven erosion of the bluff; and allow retention of existing vegetation and habitat on the slope.

Figure III-14: Painter Barclay Option C

1:2500 0 100 200 300 m

The Concept: Balanced Adaptation, Limited Community Intervention

- City could provide design and approval assistance and facilitate private-funded neighbourhood improvement projects for constructed combinations of groynes and beach nourishment.
- Beach design and implementation may improve public beach access, but continuity of public access is not assured.



PAINTER BARCLAY OPTION C BREAKDOWN

Costs	PUBLIC: $$ PRIVATE: $$$
Phasing Logistics	• Foreshore environmental and property approvals may be challenging. • Upland owner riparian rights or access would require negotiation.
Key Benefits	• Toe of bank stabilized against erosion. • Risk of steep slope failure reduced (but not eliminated). • Public access along the foreshore maintained / enhanced but not formalized in a seawalk. • Shoreline vegetation protected, ecology potentially enhanced. • City service to design / gain approvals / arrange financing and supervise construction has economy of scale over owners acting independently.
Remaining Risks	• Proper engineering of the groynes and beach nourishment will be critical to minimize rate of foreshore erosion. • Expect some foreshore erosion and material movement – top-up of beach materials may be required periodically. • Financing is likely to rely on a local improvement approach, which requires neighbourhood approval.

Offshore headlands, Qualicum Beach. (Credit: Sanctuary Studios)

OPTIONS EVALUATION

	Baseline No Adaptation	Option A Parcel Scale Minimum Intervention	Option B Neighbourhood Scale Extensive Intervention	Option C Balanced Intervention / Neighbourhood Priorities
VALUES CRITERIA				
People Highest # Protected	Far Worse	Moderately Better	Far Better	Far Better
Economy Sustained jobs and tax base	Far Worse	No Change	Slightly Better	Slightly Better
Environment Sustained/improved long term	Far Worse	Moderately Worse	Moderately Better	Moderately Better
Recreation/Culture Views / access / shoreline	Far Worse	Moderately Worse	Moderately Better	Moderately Better
Infrastructure Road / emergency / utility function	Far Worse	No Change	No Change	No Change
IMPACT AND RISK OF FAILURE				
Overall Risk	Very High	Moderate	Moderate	Moderate
COST CRITERIA				
Capital Cost to Taxpayers	N/A	$	$$$$$	$$$
CR Operations and Maintenance Effort	N/A	$$$	$$$$$	$$$$
Cost/Inconvenience to Private Sector	N/A	$$$$	$$	$$$
Partnership Potential (Co-fund)	N/A	$	$$$	$$$$$$
Future Longterm Adaptation Cost	N/A	$$$	$$$	$$$

Figure III-15: Painter Barclay Evaluation Criteria

7.0 DOWNTOWN ADAPTATION OPTIONS

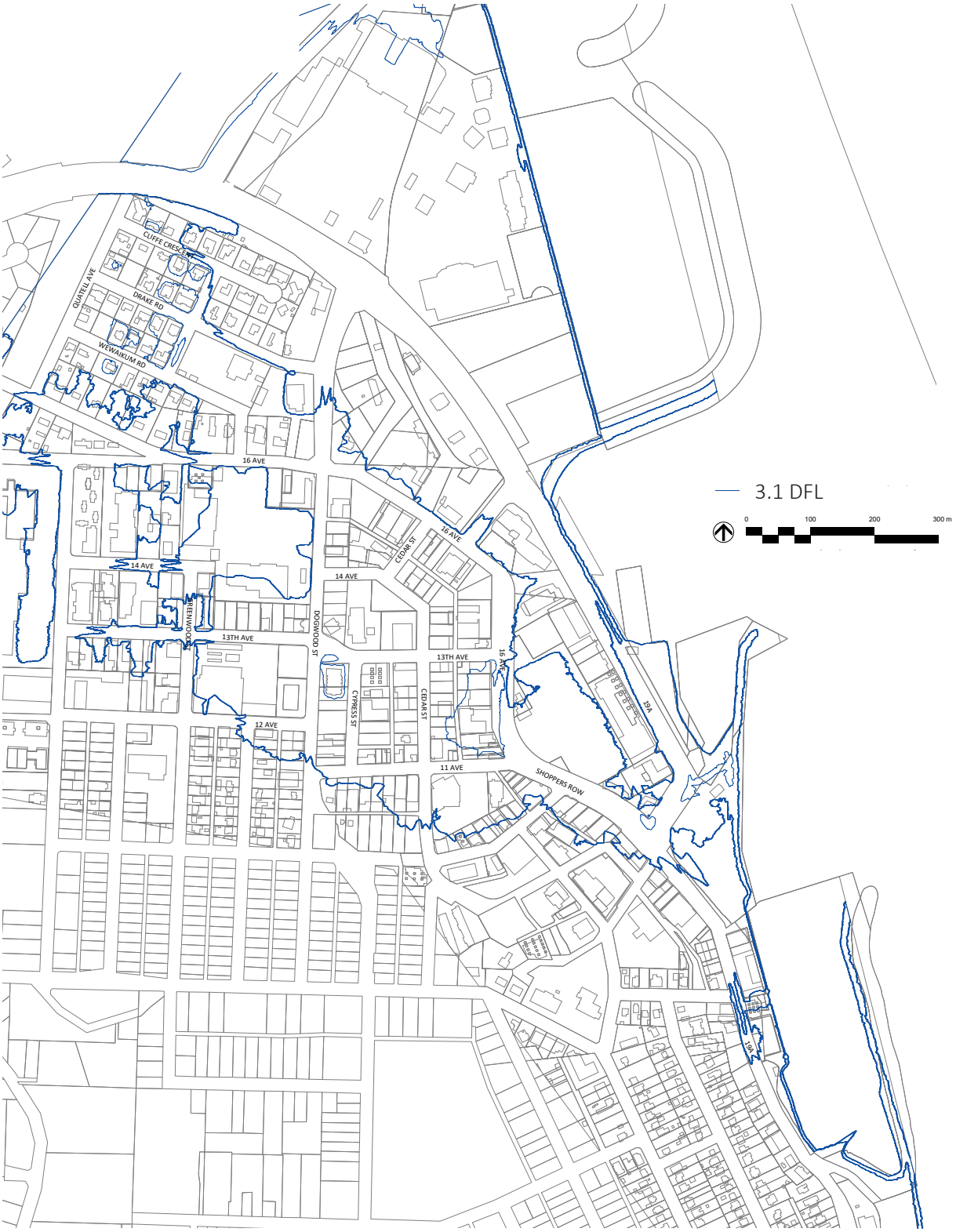
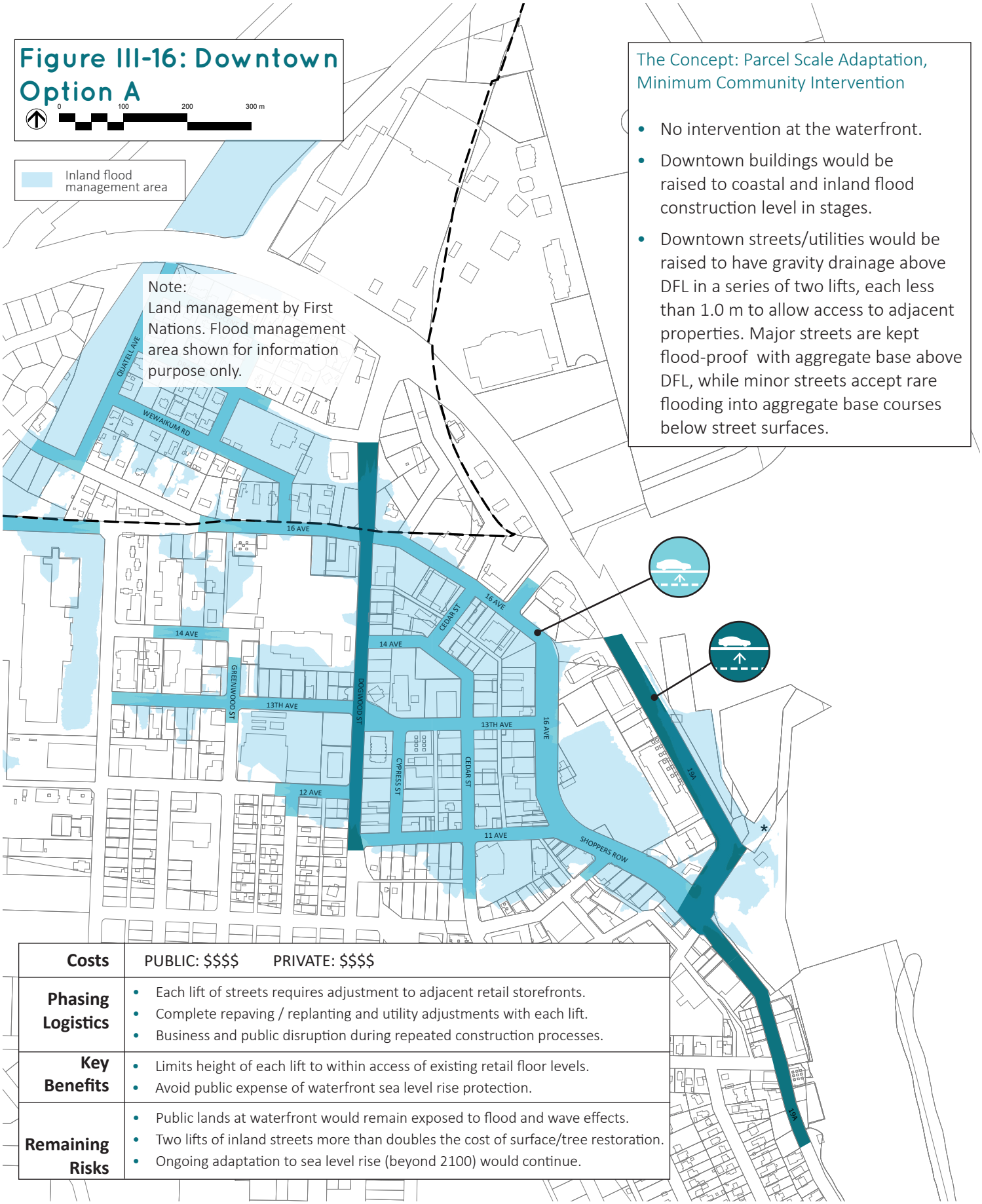


Figure III-16: Downtown Option A



The Concept: Parcel Scale Adaptation, Minimum Community Intervention

- No intervention at the waterfront.
- Downtown buildings would be raised to coastal and inland flood construction level in stages.
- Downtown streets/utilities would be raised to have gravity drainage above DFL in a series of two lifts, each less than 1.0 m to allow access to adjacent properties. Major streets are kept flood-proof with aggregate base above DFL, while minor streets accept rare flooding into aggregate base courses below street surfaces.

Costs	PUBLIC: $$$$ PRIVATE: $$$$
Phasing Logistics	• Each lift of streets requires adjustment to adjacent retail storefronts. • Complete repaving / replanting and utility adjustments with each lift. • Business and public disruption during repeated construction processes.
Key Benefits	• Limits height of each lift to within access of existing retail floor levels. • Avoid public expense of waterfront sea level rise protection.
Remaining Risks	• Public lands at waterfront would remain exposed to flood and wave effects. • Two lifts of inland streets more than doubles the cost of surface/tree restoration. • Ongoing adaptation to sea level rise (beyond 2100) would continue.

Design Flood Level (DFL) is the approximate still water level of high tide and storm surge after 1.0 m sea level rise, without wave or river flood effects.

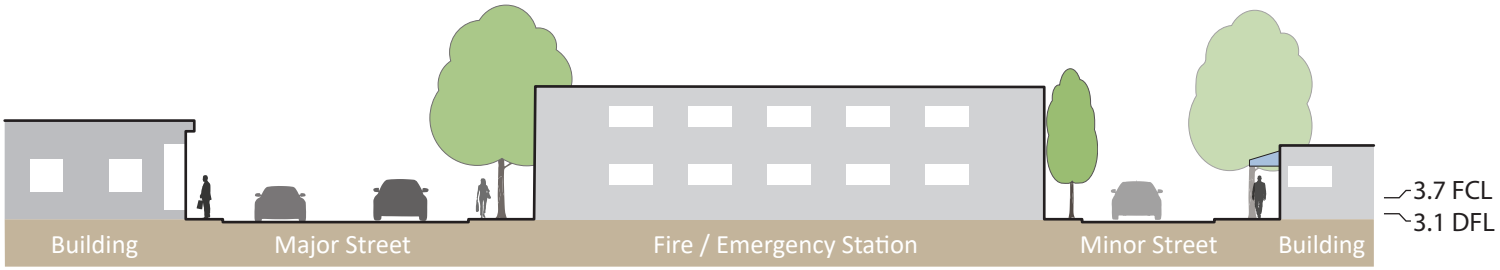


Figure III-17: Existing Downtown Conditions - Interior Flood Management Area

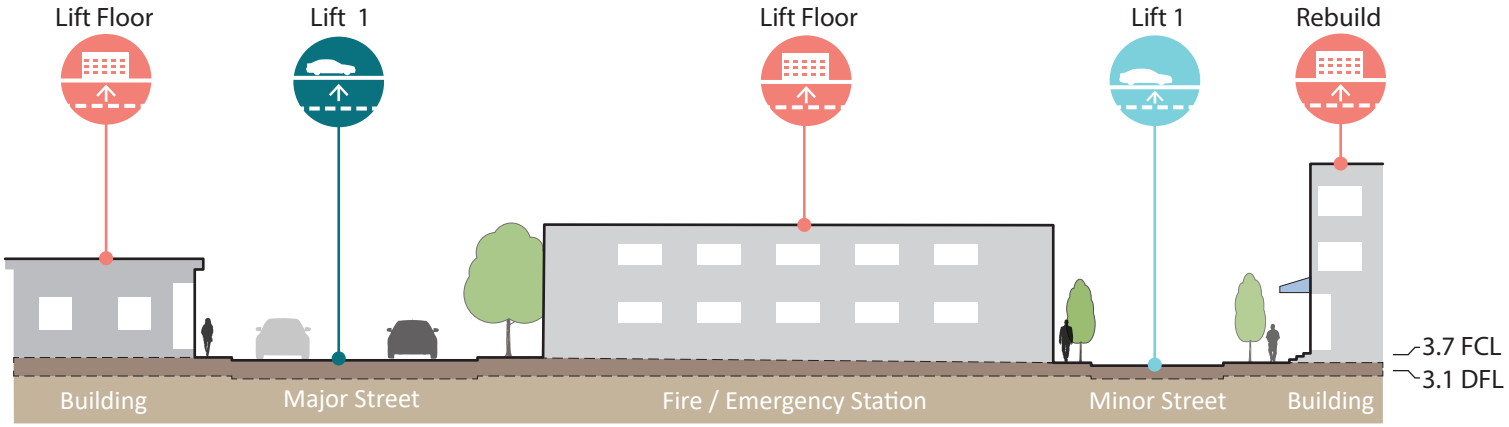


Figure III-18: Phase A1 - Interior Flood Management Area

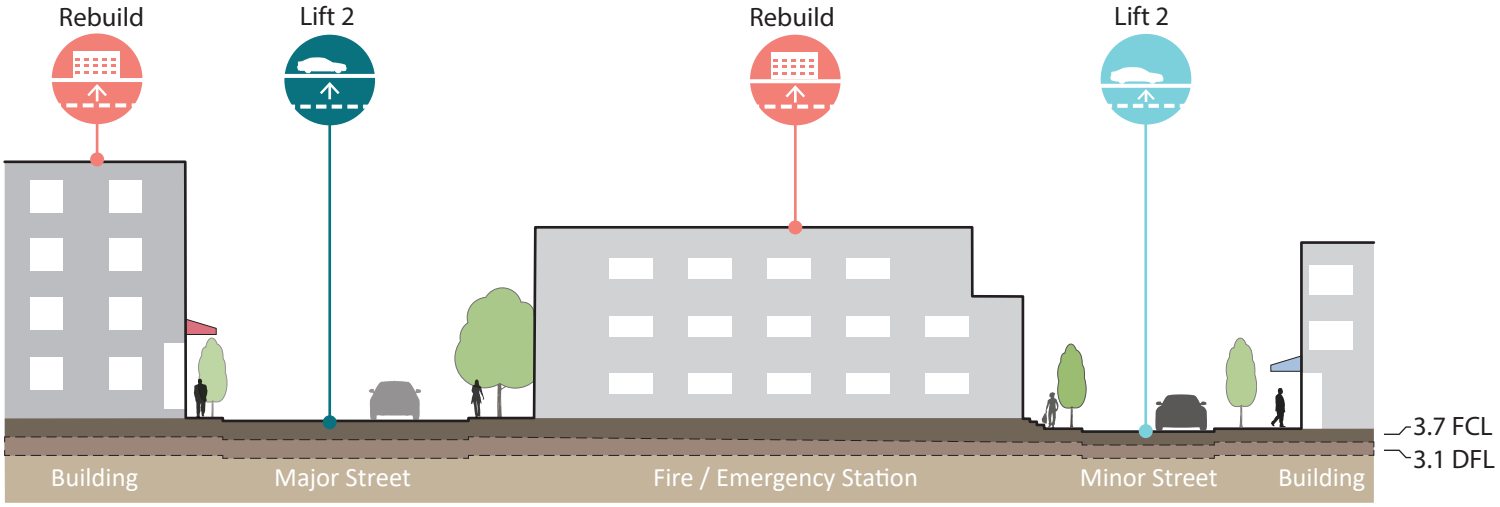


Figure III-19: Phase A2 - Interior Flood Management Area

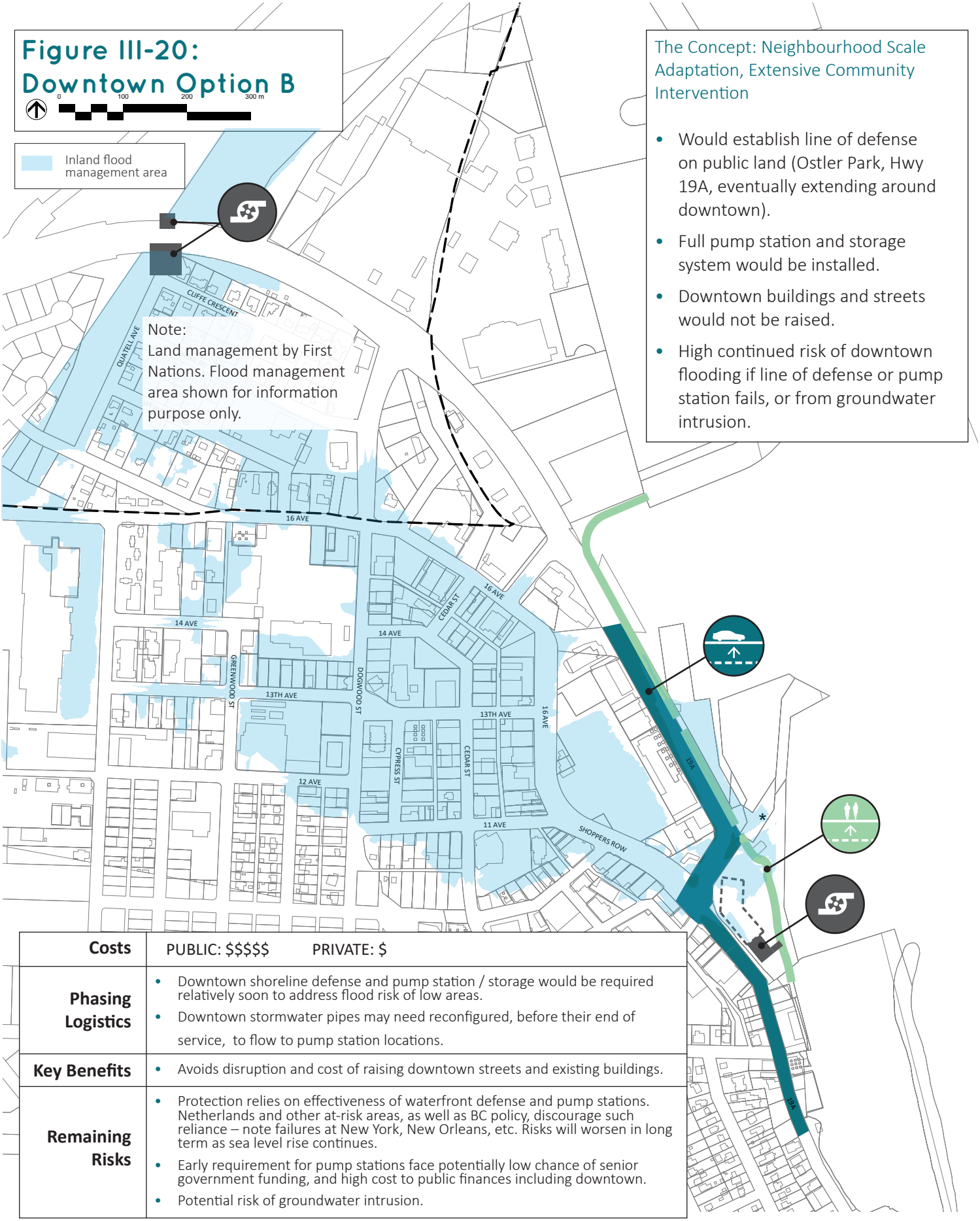
Raise major streets / utilities above DFL in 0.7m lifts

Raise minor streets / utilities above DFL in 0.5m lifts

Raise existing building floors to FCL in stages or rebuild buildings

City of Campbell River

Figure III-20: Downtown Option B



The Concept: Neighbourhood Scale Adaptation, Extensive Community Intervention

- Would establish line of defense on public land (Ostler Park, Hwy 19A, eventually extending around downtown).
- Full pump station and storage system would be installed.
- Downtown buildings and streets would not be raised.
- High continued risk of downtown flooding if line of defense or pump station fails, or from groundwater intrusion.

Costs	PUBLIC: $$$$$ PRIVATE: $
Phasing Logistics	• Downtown shoreline defense and pump station / storage would be required relatively soon to address flood risk of low areas. • Downtown stormwater pipes may need reconfigured, before their end of service, to flow to pump station locations.
Key Benefits	• Avoids disruption and cost of raising downtown streets and existing buildings.
Remaining Risks	• Protection relies on effectiveness of waterfront defense and pump stations. Netherlands and other at-risk areas, as well as BC policy, discourage such reliance – note failures at New York, New Orleans, etc. Risks will worsen in long term as sea level rise continues. • Early requirement for pump stations face potentially low chance of senior government funding, and high cost to public finances including downtown. • Potential risk of groundwater intrusion.

Design Flood Level (DFL) is the approximate still water level of high tide and storm surge after 1.0 m sea level rise, without wave or river flood effects.

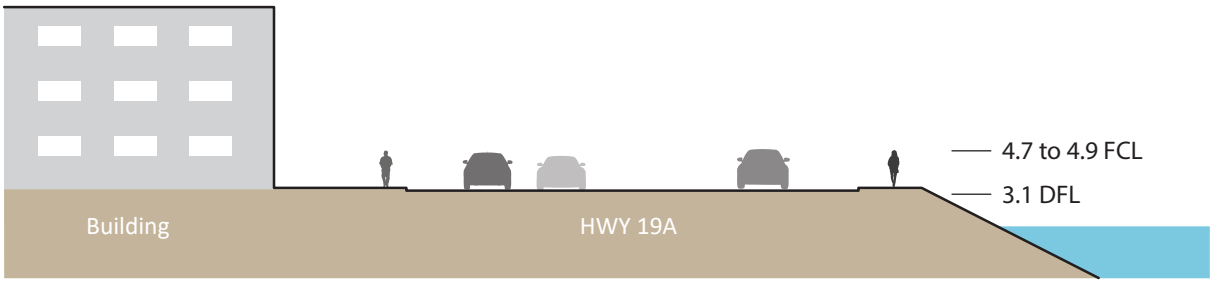


Figure III-21: Existing Downtown Conditions - Coastal Flood Management Area

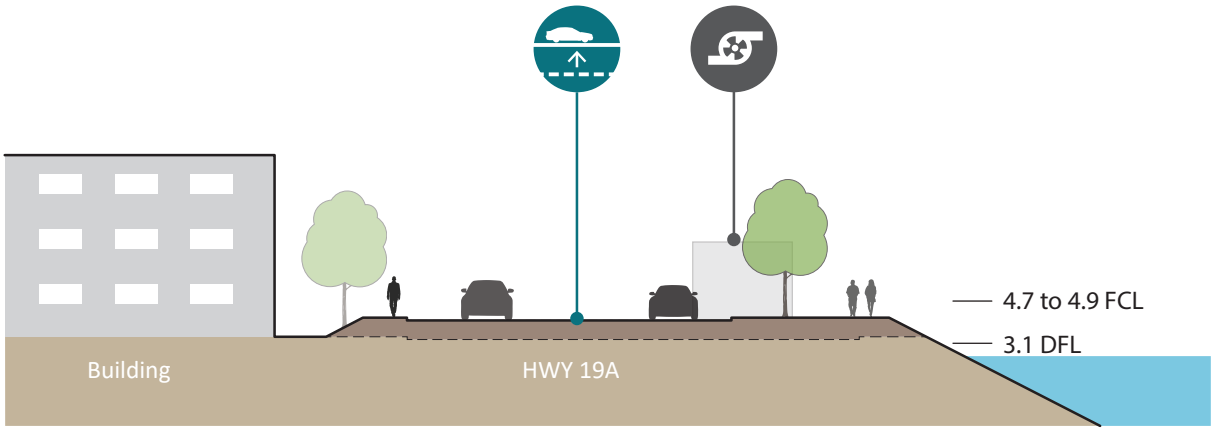


Figure III-22: Phase B1 - Coastal Flood Management Area

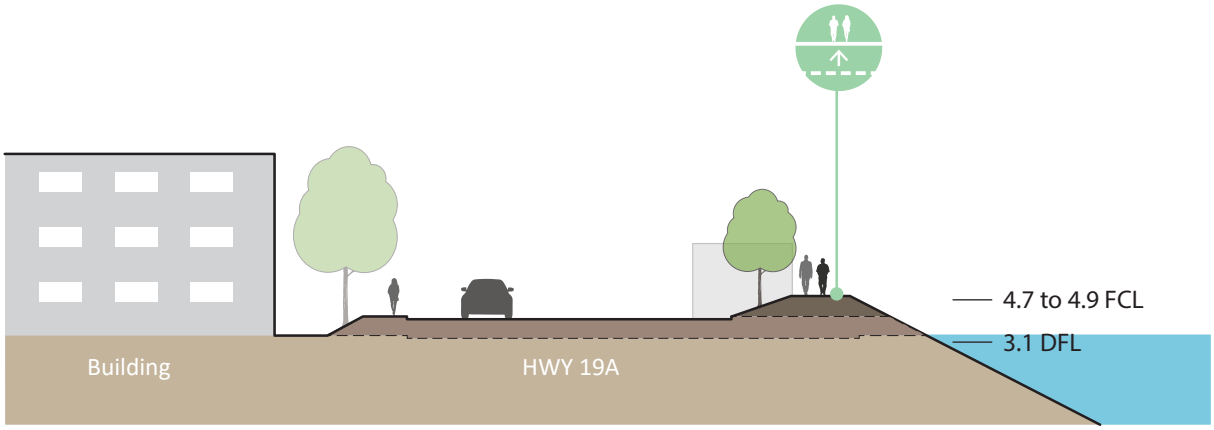


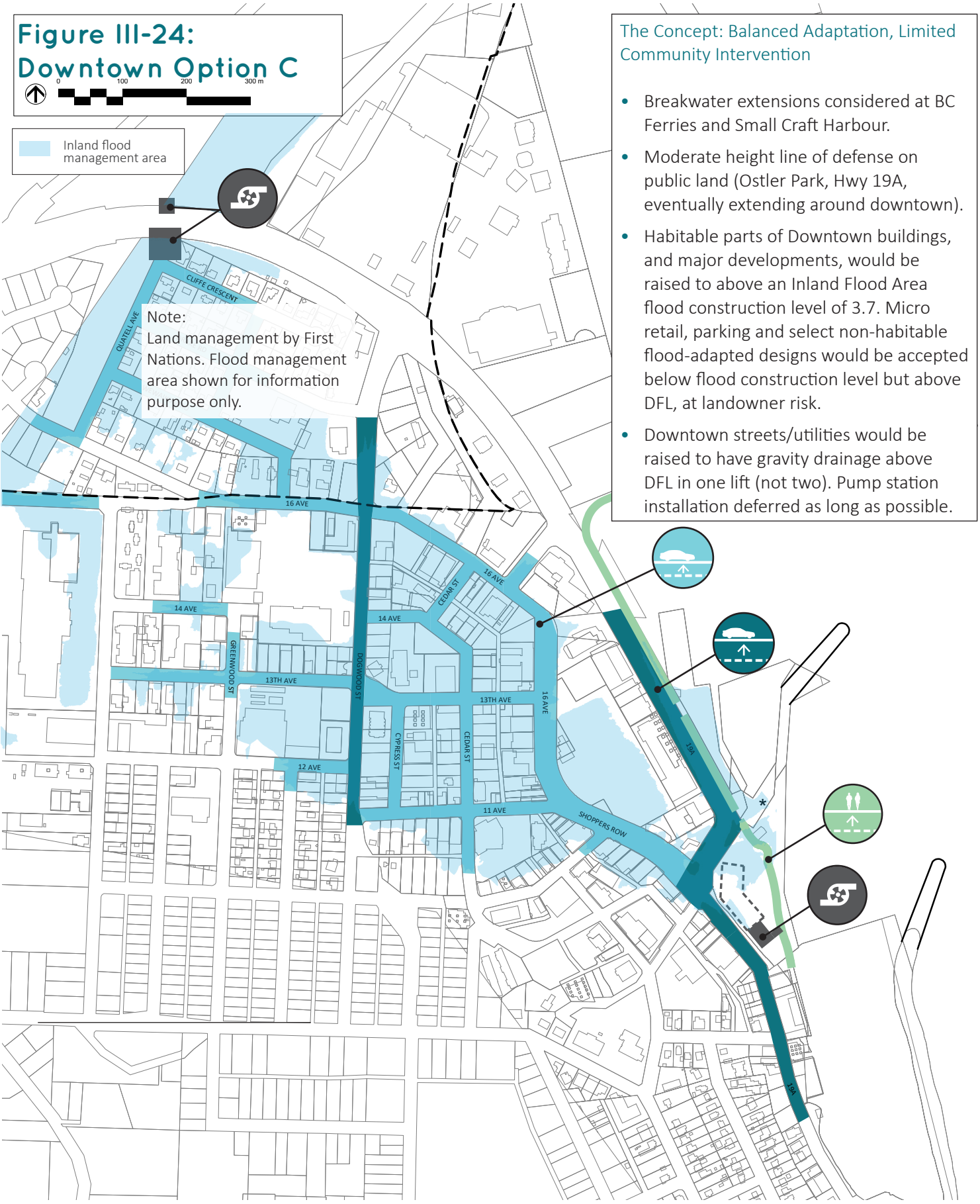
Figure III-23: Phase B2 - Coastal Flood Management Area

Raise and narrow HWY 19A (elevation 4.0; width 14.4m)

Raise waterfront trail to FCL

Install underground stormwater tanks and pump stations at Ostler Park and Nunns Creek

Figure III-24: Downtown Option C



The Concept: Balanced Adaptation, Limited Community Intervention

- Breakwater extensions considered at BC Ferries and Small Craft Harbour.
- Moderate height line of defense on public land (Ostler Park, Hwy 19A, eventually extending around downtown).
- Habitable parts of Downtown buildings, and major developments, would be raised to above an Inland Flood Area flood construction level of 3.7. Micro retail, parking and select non-habitable flood-adapted designs would be accepted below flood construction level but above DFL, at landowner risk.
- Downtown streets/utilities would be raised to have gravity drainage above DFL in one lift (not two). Pump station installation deferred as long as possible.

Design Flood Level (DFL) is the approximate still water level of high tide and storm surge after 1.0 m sea level rise, without wave or river flood effects.

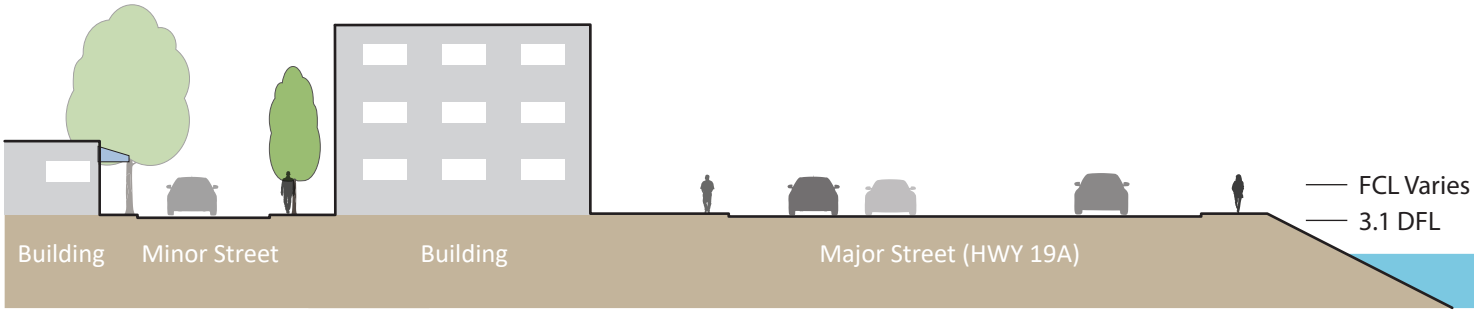


Figure III-25: Existing Downtown Conditions - Coastal Flood Management Area

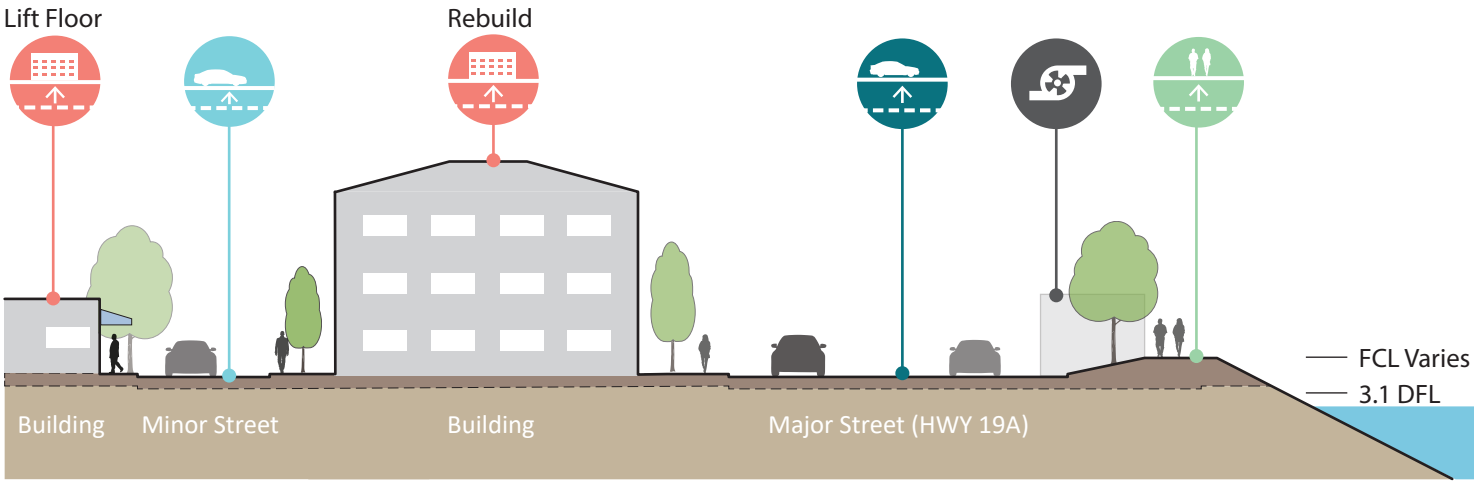


Figure III-26: Option C - Coastal Flood Management Area

Raise major streets / utilities above DFL in one lift

Raise habitable parts of existing buildings to FCL or rebuild buildings. Non-habitable, flood-adapted designs are allowable below FCL, but above DFL

Raise waterfront trail to established FCLs as sea levels rise.

Raise minor streets / utilities above DFL in one lift

Install underground stormwater tanks and pump stations at Ostler Park and Nunns Creek (as needed)

Additional adaptation measures
-Extend breakwaters at BC Ferries and small craft harbour
-Install temporary flood barriers at BC Ferries

Costs	PUBLIC: $$$ PRIVATE: $$$
Phasing Logistics	• Downtown shoreline defense could be phased with ferry, harbour, parks and street renewal projects. Pump stations would be delayed as long as possible. • Reconfiguration of downtown stormwater pipes to flow to pump station locations could occur during infrastructure upgrades. • A single lift of downtown streets and buildings would be necessary.
Key Benefits	• Extension of offshore breakwaters reduces required height of shoreline defense and maintains ground level views of Discovery Passage. • Delays single lift of downtown streets. Ideally most buildings would redevelop concurrent with or prior to street raising. • Delayed pump station investment provides time to investigate/apply for funding options such as senior government partnering or development cost charge funding. • Combination of shoreline defense and one lift of streets reduces risks compared to other options. • Shoreline defenses have room to be raised in response to ongoing sea level rise.
Remaining Risks	• Remaining risk is low similar to Option A, but with lower elevations in the downtown due to the offshore breakwaters. Ongoing adaptation to sea level rise would be required after 2100.

OPTIONS EVALUATION

	Baseline No Adaptation	Option A Parcel Scale Minimum Intervention	Option B Neighbourhood Scale Extensive Intervention	Option C Balanced Intervention / Neighbourhood Priorities
VALUES CRITERIA				
People Highest # Protected	Far Worse	Moderately Better	Slightly Better	Far Better
Economy Sustained jobs and tax base	Far Worse	Moderately Worse	Slightly Better	Slightly Better
Environment Sustained/improved long term	Far Worse	No Change	No Change	No Change
Recreation/Culture Views / access / shoreline	Far Worse	No Change	Moderately Worse	Slightly Better
Infrastructure Road / emergency / utility function	Far Worse	Moderately Better	Moderately Better	Far Better
IMPACT AND RISK OF FAILURE				
Overall Risk	Very High	Moderate	High	Low
COST CRITERIA				
Capital Cost to Taxpayers	N/A	$$$$	$$$$$	$$$$
CR Operations and Maintenance Effort	N/A	$$$$	$$$$	$$$$
Cost/Inconvenience to Private Sector	N/A	$$$$$	$	$$$
Partnership Potential (Co-fund)	N/A	$	$$$	$$$$$
Future Longterm Adaptation Cost	N/A	$$$$$$	$$$$$	$$$$

Figure III-27: Downtown Evaluation Criteria

8.0 SEQUOIA PARK ADAPTATION OPTIONS

Public Land

1:2500 0 100 200 300 400 m

City of Campbell River

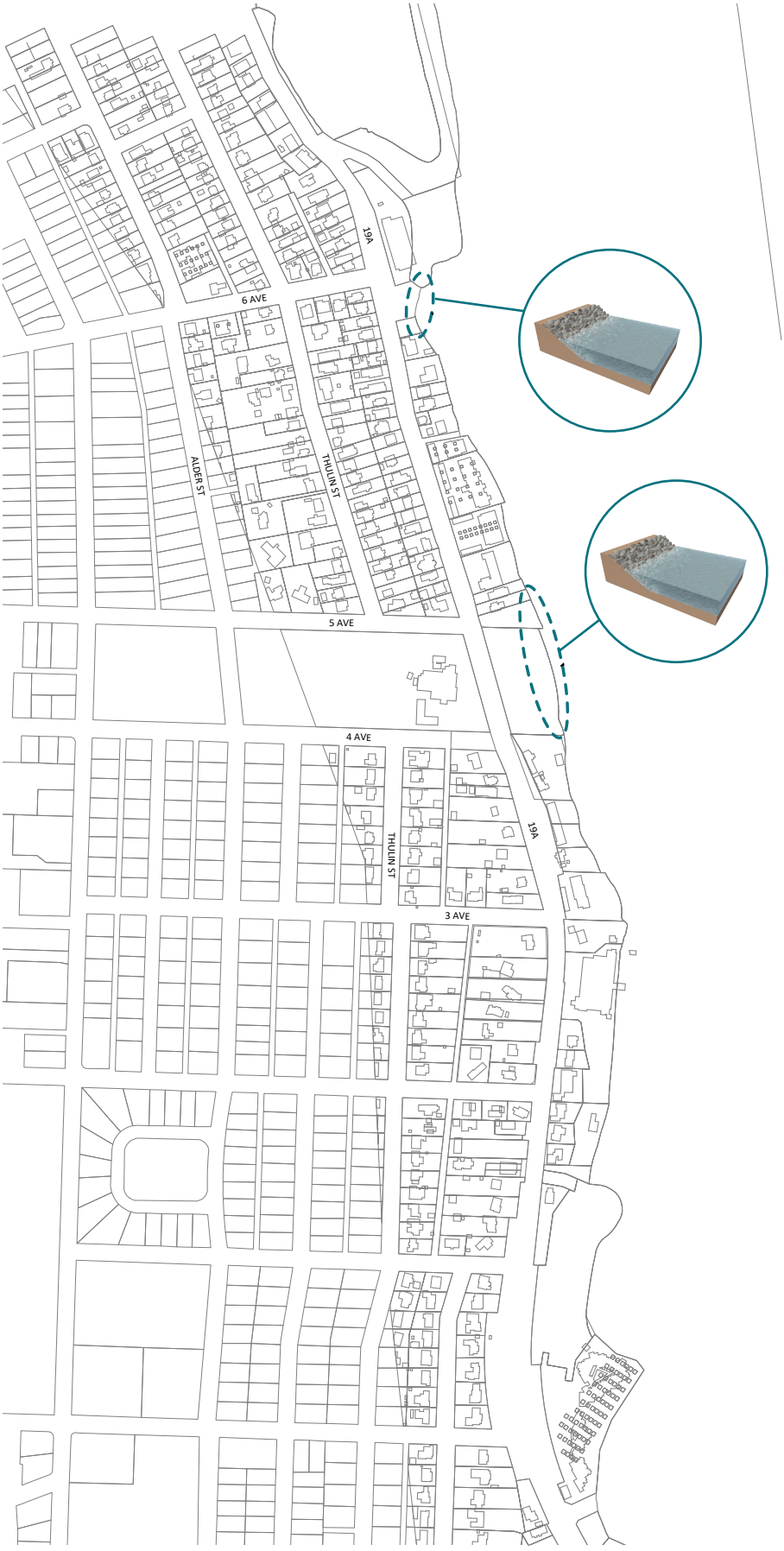


Figure III-28: Sequoia Park Option A

1:2500 0 100 200 300 400 m

The Concept: Parcel-Scale Adaptation, Minimum Community Intervention

- City could adapt street ends and park shorelines to protect against sea level rise and erosion.
- No public intervention encroachment on Crown foreshore.
- Development permit language would be adjusted to define acceptable sea level rise adaptation on private land inland of the natural boundary, which in most cases is likely to rely on extending existing rock armouring.
- Flood management bylaw would require that all buildings are brought to flood construction level at reconstruction.

SEQUOIA PARK OPTION A BREAKDOWN

Costs	PUBLIC: $ PRIVATE: $$$$
Phasing Logistics	• Not all owners would install rock armour concurrently. • Access for rock armour construction may be un-coordinated / difficult.
Key Benefits	• Toe of bank stabilized against erosion. • Risk of steep slope failure reduced (but not eliminated). • Minimum costs to public finances.
Remaining Risks	• Wave energy on rock armour may increase erosion of existing beaches and may accelerate erosion on adjacent unarmoured properties. • Public access along the foreshore reduced as beach erodes and sea level rise continues. • Rock armour continues to damage shoreline vegetation and ecology.

Rock armouring, Qualicum Beach. (Credit: Sanctuary Studios)

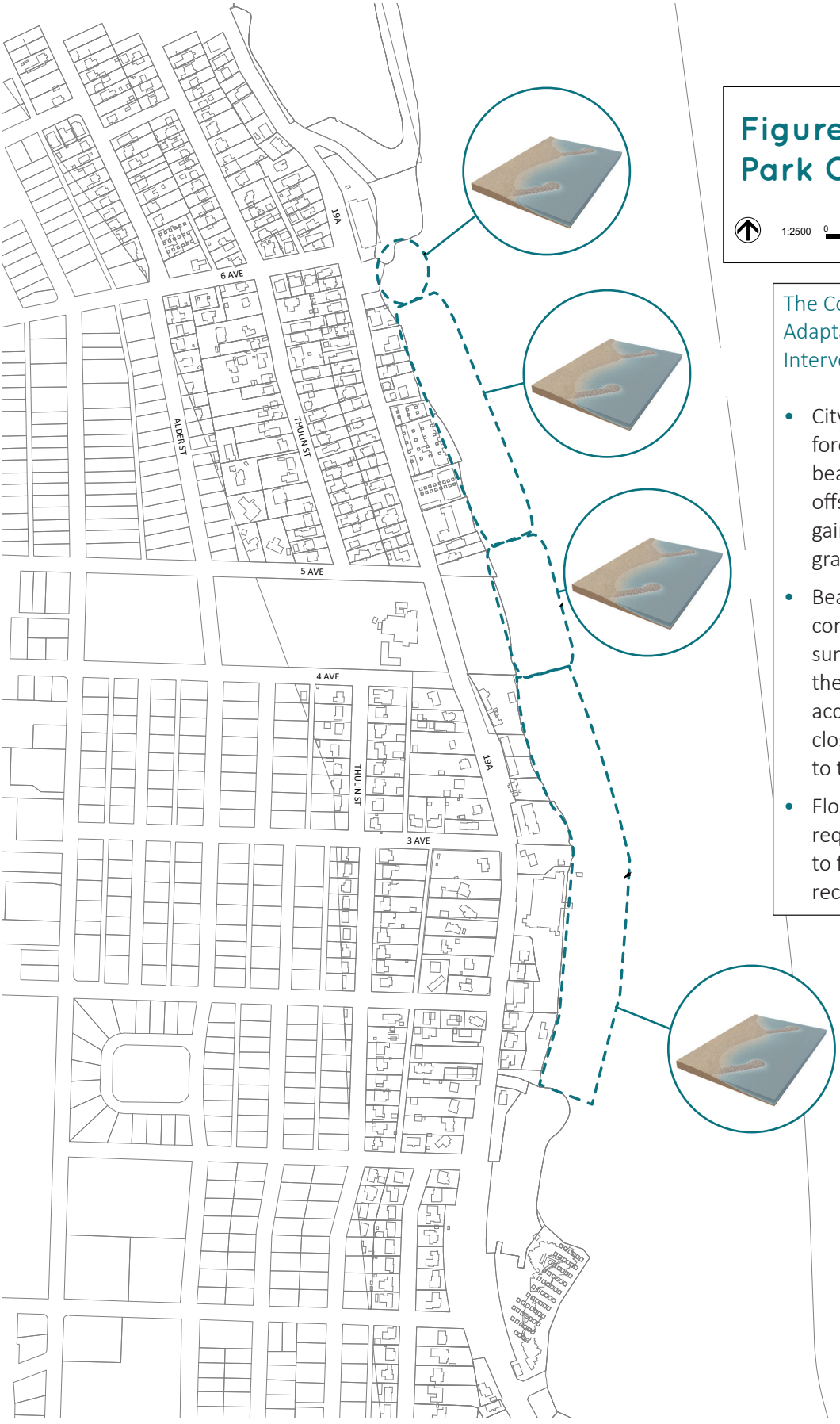


Figure III-29: Sequoia Park Option B

1:2500 0 100 200 300 400 m

The Concept: Neighbourhood Scale Adaptation, Extensive Community Intervention

- City could pursue funding for foreshore constructed pocket beaches that are protected by offshore headlands, with rights gained to extend the beach to meet grade on private land.
- Beach design would provide continuous and more accessible surface for public access along the beach on Crown foreshore or acquired property, other than when closed in a severe storm, connecting to the Seawalk.
- Flood management bylaw would require that all buildings be brought to flood construction level at reconstruction.

SEQUOIA PARK OPTION B BREAKDOWN

Costs	PUBLIC: $$$$ PRIVATE: $
Phasing Logistics	• Foreshore environmental and property approvals may be challenging. • Upland owner riparian rights or access would require negotiation.
Key Benefits	• Public access along the foreshore enhanced – linking to the Seawalk. • Public pocket beaches created for recreational use. • Opportunities for enhanced shoreline revegetation. • Foreshore ecology potentially enhanced for forage fish and intertidal habitat. • Toe of bank stabilized against erosion. • Risk of steep slope failure reduced (but not eliminated).
Remaining Risks	• Proper engineering of the headlands and ongoing monitoring and beach nourishment would be critical to minimize rate of foreshore erosion. • Expect some foreshore erosion and material movement – top-up of beach materials may be required periodically. • High cost to public finances.

Offshore headlands, Qualicum Beach. (Credit: Sanctuary Studios)

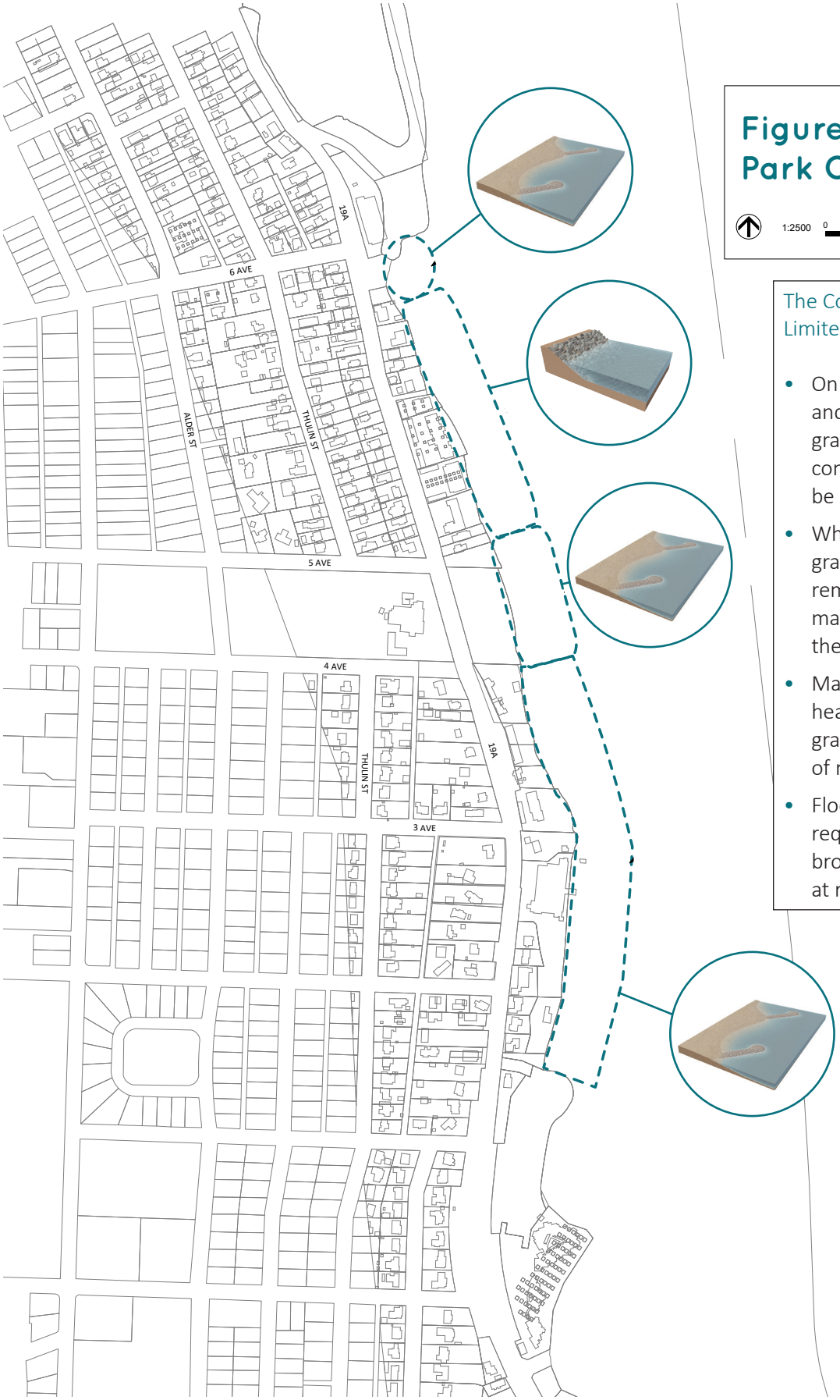


Figure III-30: Sequoia Park Option C

1:2500 0 100 200 300 400 m

The Concept: Balanced Adaptation, Limited Community Intervention

- On the foreshore at public lands and where riparian rights are granted fronting private land, constructed pocket beaches could be protected by offshore headlands.
- Where riparian rights are not granted, existing foreshore would remain as exists and upland owners manage their flood risk inland of the natural boundary.
- May develop waterfront pocket/ headland/access over time with gradual land acquisition or granting of rights.
- Flood management bylaw would require that all buildings are brought to flood construction level at reconstruction.

SEQUOIA PARK OPTION C BREAKDOWN

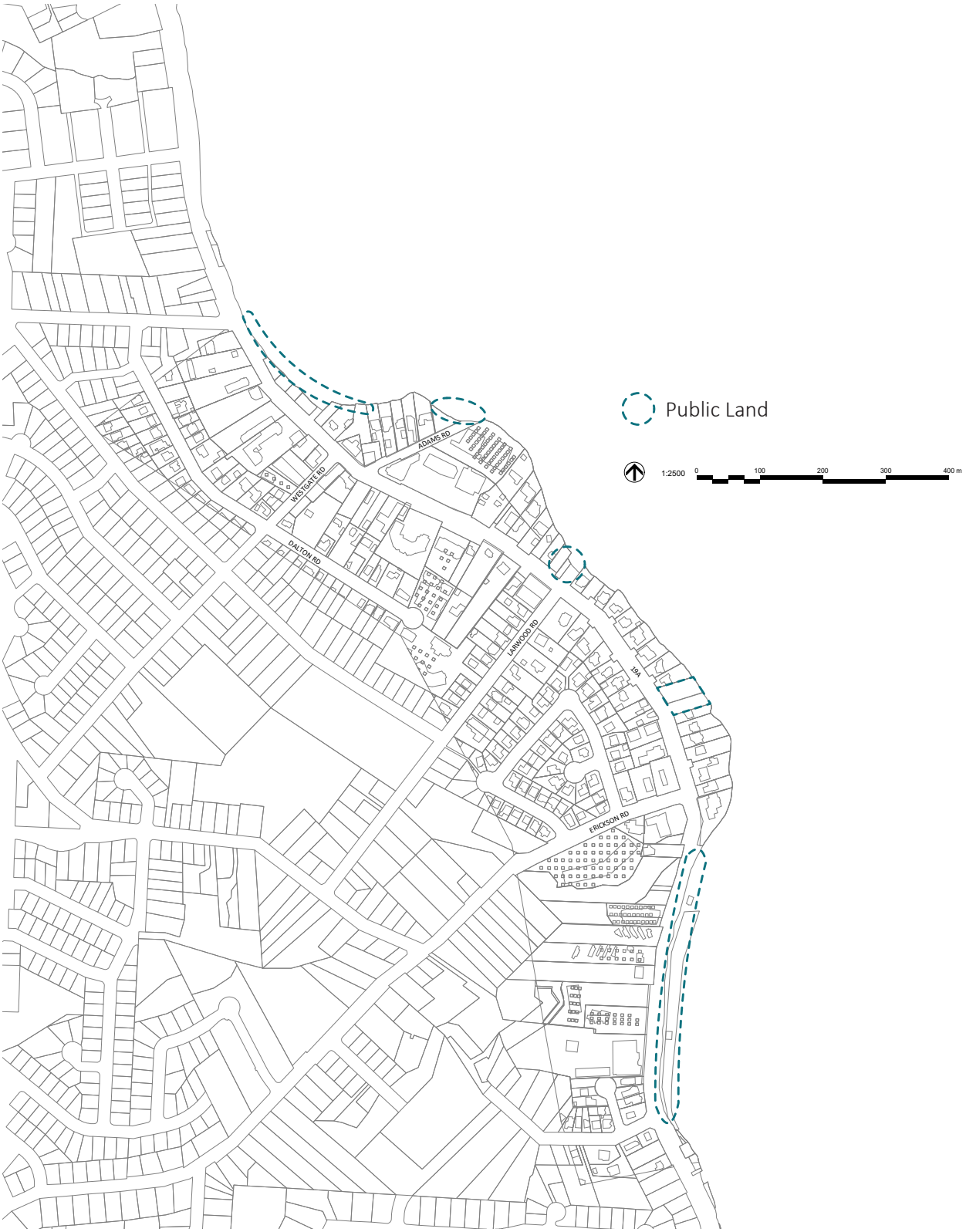
Costs	PUBLIC: $$$ PRIVATE: $$
Phasing Logistics	• Foreshore environmental and property approvals may be challenging. • Upland owner riparian rights or access would require negotiation. • Where riparian rights are not granted, existing or eroding beach would remain, restricting public access along the shoreline. In these locations, waterfront land owners would be responsible for shoreline protection.
Key Benefits	• Where rights are gained, public access along the foreshore is enhanced. • Public pocket beaches created for recreational use. • Opportunities for enhanced shoreline revegetation. • Foreshore ecology potentially enhanced for forage fish and intertidal habitat. • Toe of bank stabilized against erosion. • Risk of steep slope failure reduced (but not eliminated). • City service to design / gain approvals / arrange financing and supervise construction. Has economy of scale over owners acting independently.
Remaining Risks	• Proper engineering of the headlands and ongoing monitoring and beach nourishment would be critical to minimize rate of foreshore erosion. • Expect some foreshore erosion and material movement – top-up of beach materials may be required periodically. • Shared financing likely to rely on a local improvement approach, which requires neighbourhood approval. • High cost to public finances. • Potential delay until continuous raised public access along shoreline.

OPTIONS EVALUATION

	Baseline No Adaptation	Option A Parcel Scale Minimum Intervention	Option B Neighbourhood Scale Extensive Intervention	Option C Balanced Intervention / Neighbourhood Priorities
VALUES CRITERIA				
People Highest # Protected	Far Worse	Slightly Better	Far Better	Far Better
Economy Sustained jobs and tax base	Far Worse	No Change	Slightly Better	Slightly Better
Environment Sustained/improved long term	Far Worse	Moderately Worse	Moderately Better	Moderately Better
Recreation/Culture Views / access / shoreline	Far Worse	Moderately Worse	Moderately Better	Slightly Better
Infrastructure Road / emergency / utility function	Far Worse	No Change	No Change	No Change
IMPACT AND RISK OF FAILURE				
Overall Risk	Very High	Moderate	Low	Moderate
COST CRITERIA				
Capital Cost to Taxpayers	N/A	$	$$$$	$$$
CR Operations and Maintenance Effort	N/A	$$$	$$$$	$$$$
Cost/Inconvenience to Private Sector	N/A	$$$$	$	$$
Partnership Potential (Co-fund)	N/A	$	$$$$	$$$$$
Future Longterm Adaptation Cost	N/A	$$$$	$$$$	$$$$

Figure III-31: Sequoia Park Evaluation Criteria

9.0 WILLOW POINT & SOUTH ADAPTATION OPTIONS



City of Campbell River

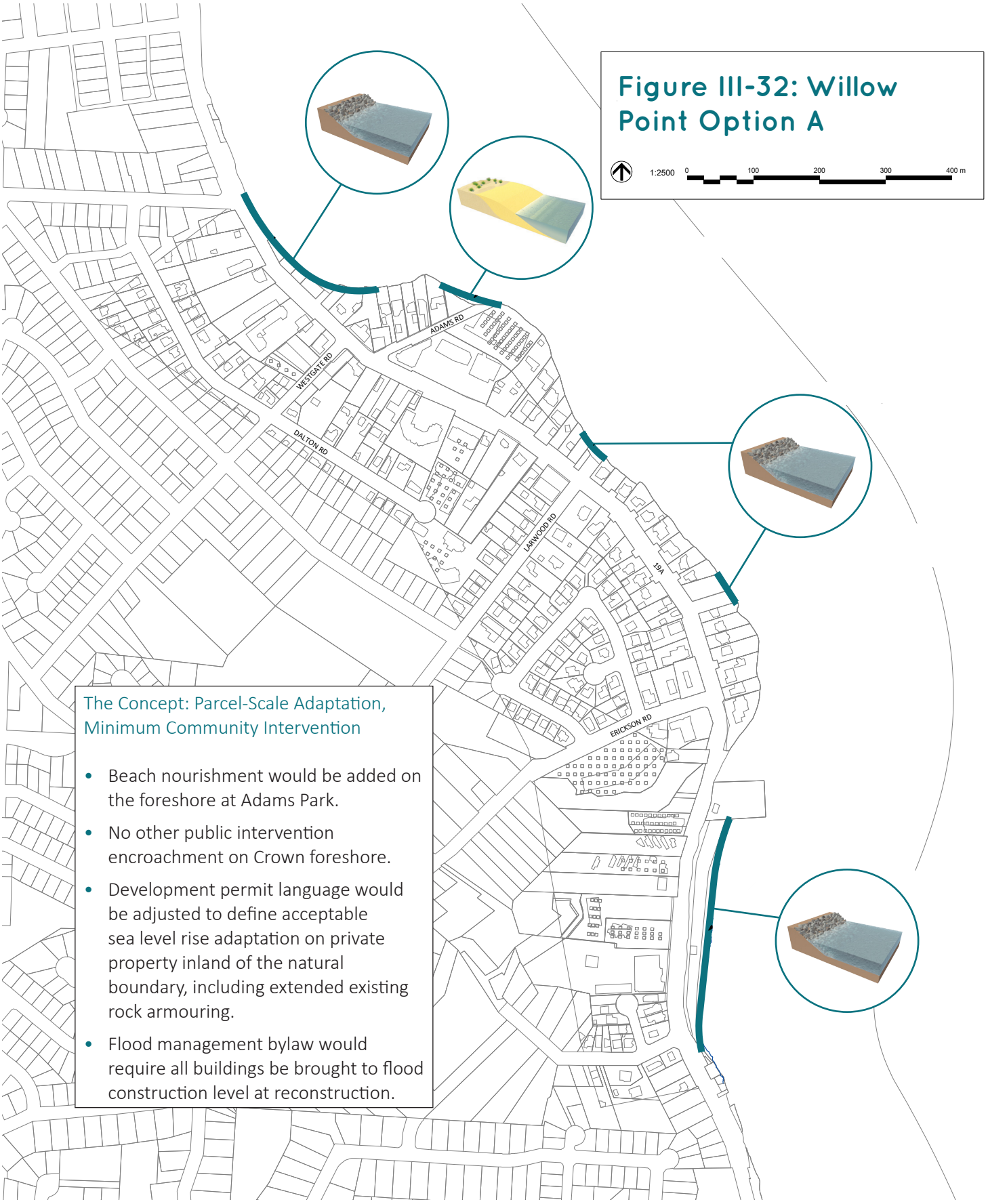


Figure III-32: Willow Point Option A

The Concept: Parcel-Scale Adaptation, Minimum Community Intervention

- Beach nourishment would be added on the foreshore at Adams Park.
- No other public intervention encroachment on Crown foreshore.
- Development permit language would be adjusted to define acceptable sea level rise adaptation on private property inland of the natural boundary, including extended existing rock armouring.
- Flood management bylaw would require all buildings be brought to flood construction level at reconstruction.

WILLOW POINT OPTION A BREAKDOWN

Costs	PUBLIC: $ PRIVATE: $$$$
Phasing Logistics	• Existing building and rock armour heights and conditions vary – failures may occur. • With upgrading of rock armour or addition of habitat elements triggered by redevelopment, improvements would not be concurrent.
Key Benefits	• Beach improvements at Adams Park. • Least cost to public finances.
Remaining Risks	• Wave energy on rock armour may increase erosion of existing beaches and may accelerate erosion on adjacent unarmoured properties. • Public access along the foreshore will be reduced as beach erodes and sea level rise continues. • Rock armour continues to damage shoreline vegetation and ecology.

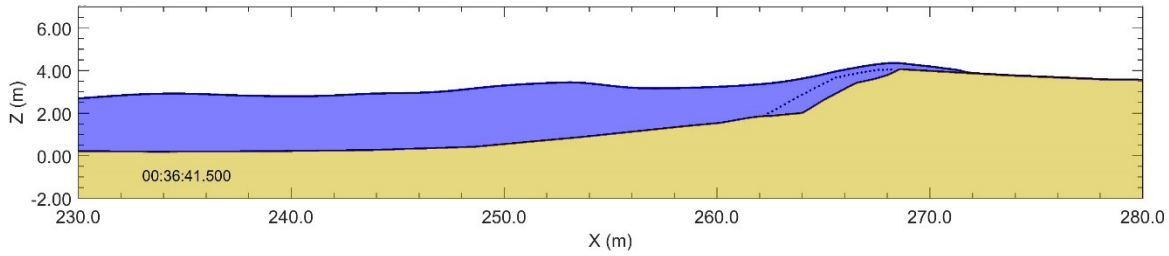


Figure III-33: Wave model of present day shoreline conditions at Jaycee Park with 1 m of Sea Level Rise (NHC)

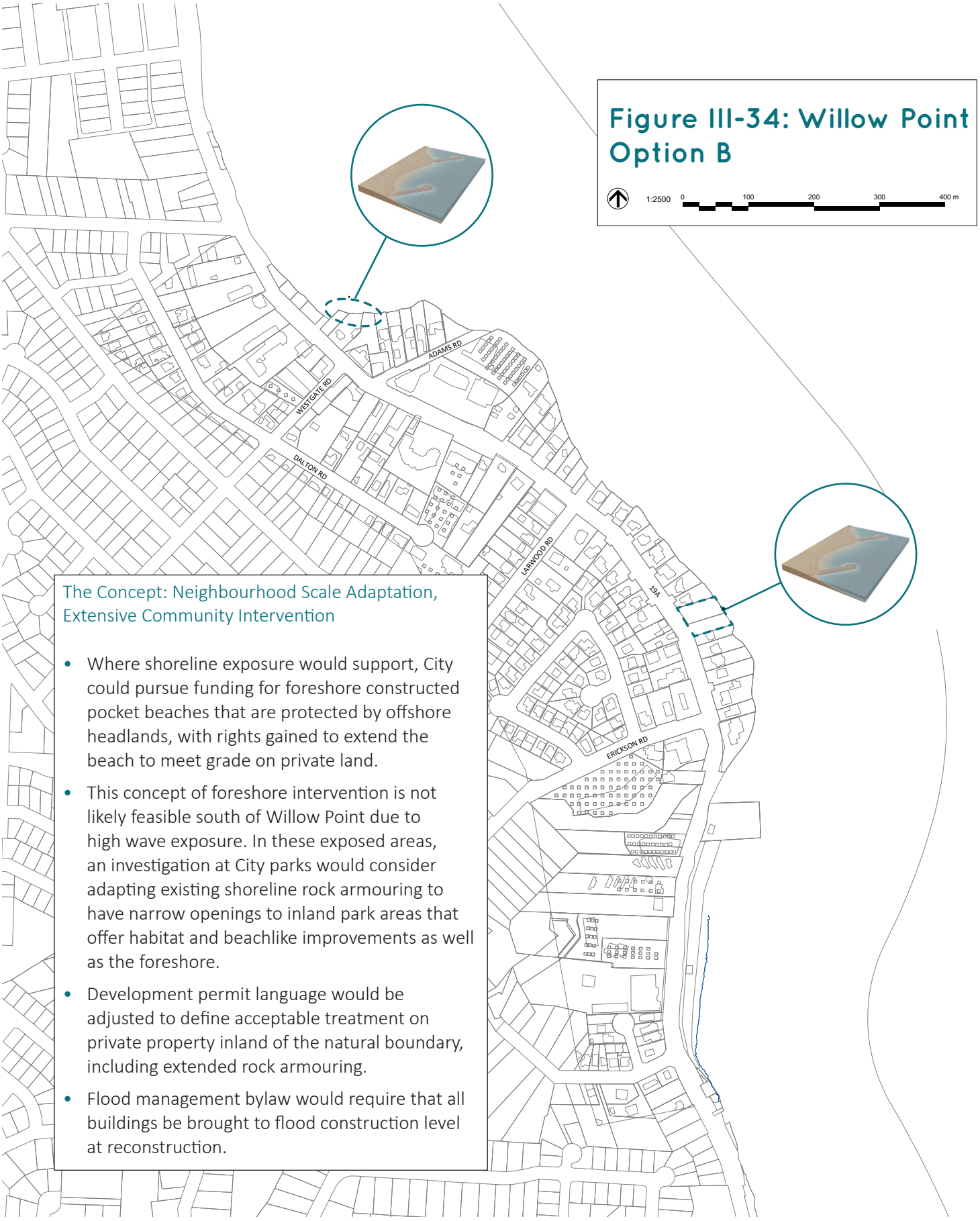


Figure III-34: Willow Point Option B

1:2500 0 100 200 300 400 m

The Concept: Neighbourhood Scale Adaptation, Extensive Community Intervention

- Where shoreline exposure would support, City could pursue funding for foreshore constructed pocket beaches that are protected by offshore headlands, with rights gained to extend the beach to meet grade on private land.
- This concept of foreshore intervention is not likely feasible south of Willow Point due to high wave exposure. In these exposed areas, an investigation at City parks would consider adapting existing shoreline rock armouring to have narrow openings to inland park areas that offer habitat and beachlike improvements as well as the foreshore.
- Development permit language would be adjusted to define acceptable treatment on private property inland of the natural boundary, including extended rock armouring.
- Flood management bylaw would require that all buildings be brought to flood construction level at reconstruction.

WILLOW POINT OPTION B BREAKDOWN

Costs	PUBLIC: $$$ PRIVATE: $$$
Phasing Logistics	• Foreshore environmental and property approvals may be challenging. • Upland owner riparian rights or access would require negotiation.
Key Benefits	• Where headlands and beach nourishment are feasible, public access along the foreshore enhanced. • Public pocket beaches created for recreational use. • Opportunities for enhanced shoreline revegetation. • Foreshore ecology potentially enhanced for forage fish and intertidal habitat.
Remaining Risks	• Proper engineering of the headlands and ongoing monitoring and beach nourishment would be critical to minimize rate of foreshore erosion. • Expect some foreshore erosion and material movement, in particular in more exposed locations south of Willow Point – top-up of beach materials may be required often. • High cost to public finances.

Offshore headlands, Qualicum Beach. (Credit: Sanctuary Studios)

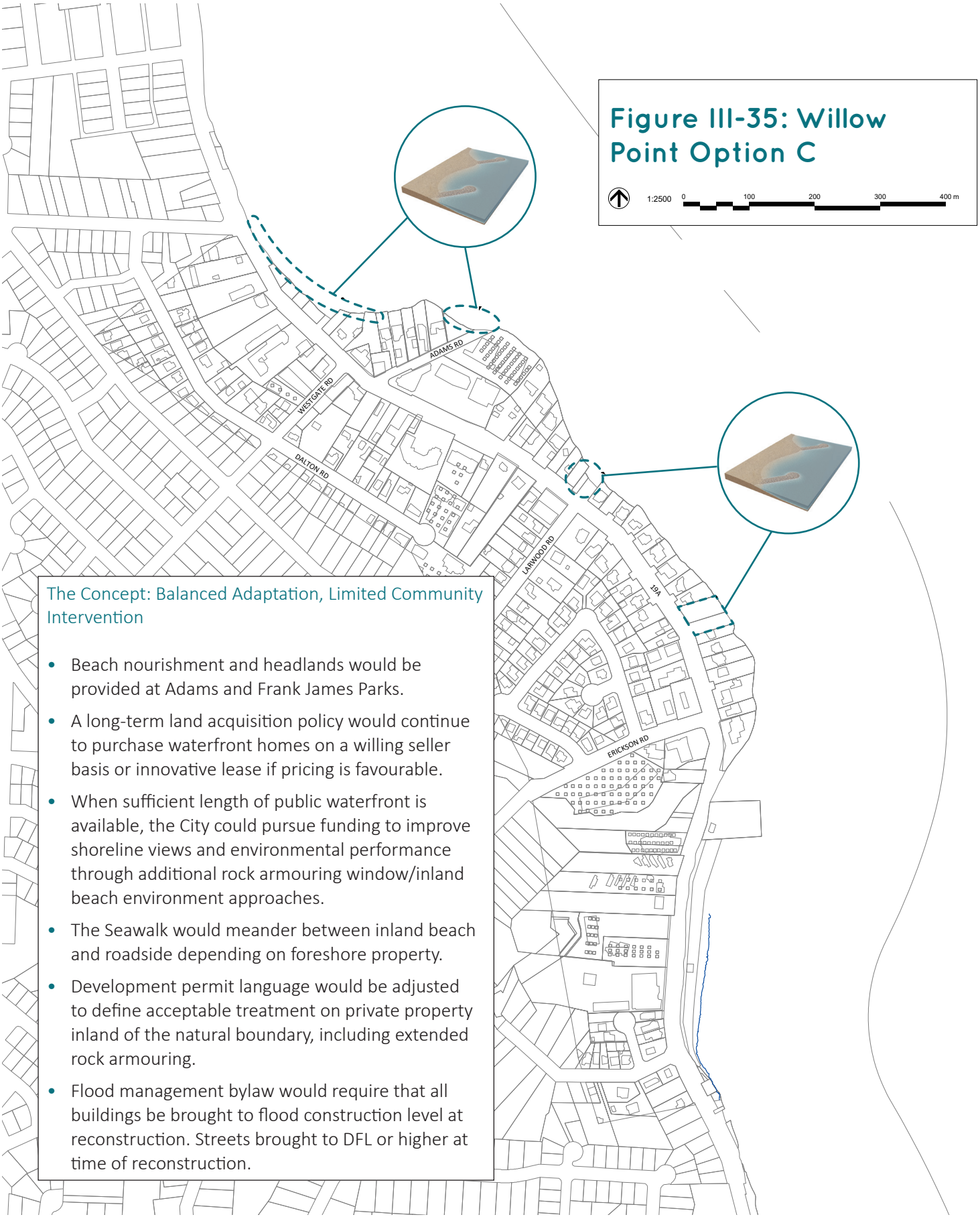


Figure III-35: Willow Point Option C

The Concept: Balanced Adaptation, Limited Community Intervention

- Beach nourishment and headlands would be provided at Adams and Frank James Parks.
- A long-term land acquisition policy would continue to purchase waterfront homes on a willing seller basis or innovative lease if pricing is favourable.
- When sufficient length of public waterfront is available, the City could pursue funding to improve shoreline views and environmental performance through additional rock armouring window/inland beach environment approaches.
- The Seawalk would meander between inland beach and roadside depending on foreshore property.
- Development permit language would be adjusted to define acceptable treatment on private property inland of the natural boundary, including extended rock armouring.
- Flood management bylaw would require that all buildings be brought to flood construction level at reconstruction. Streets brought to DFL or higher at time of reconstruction.

WILLOW POINT OPTION C BREAKDOWN

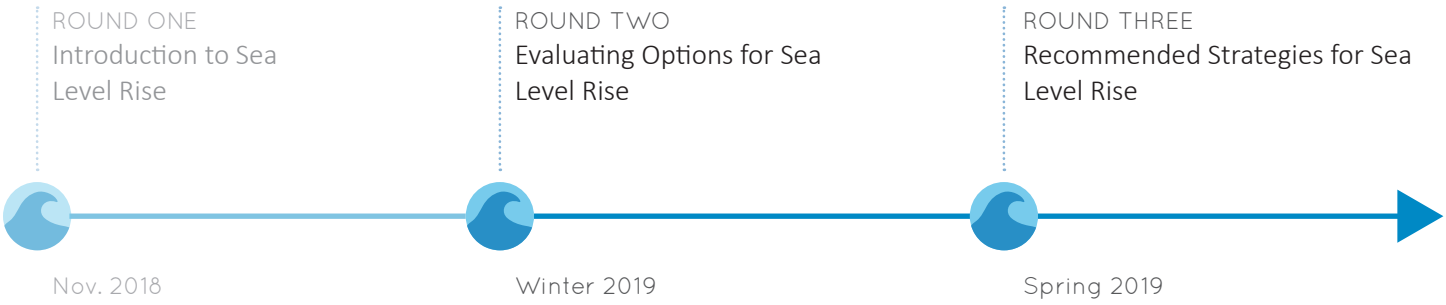
Costs	PUBLIC: $$$$ PRIVATE: $$$
Phasing Logistics	• Public parks have City riparian rights allowing beach nourishment and headlands to proceed when funded and where feasible. • Land acquisition is a long-term and unpredictable process in terms of what land may be assembled / available. • Improvement of beach access / windows through rock armour at other public parks depends in part on adjacent land acquisition timing.
Key Benefits	• Public pocket beaches created for recreational use. • Opportunities for enhanced shoreline revegetation at parks. • Foreshore ecology at parks potentially enhanced for forage fish and intertidal habitat. • Less cost to public finances.
Remaining Risks	• Proper engineering of the headlands and ongoing monitoring and beach nourishment would be critical to minimize rate of foreshore erosion. • Expect some foreshore erosion and material movement – top-up of beach materials may be required periodically. • Potential delay until park expansion and greater foreshore access. • High land acquisition cost.

OPTIONS EVALUATION

	Baseline No Adaptation	Option A Parcel Scale Minimum Intervention	Option B Neighbourhood Scale Extensive Intervention	Option C Balanced Intervention / Neighbourhood Priorities
VALUES CRITERIA				
People Highest # Protected	Far Worse	Slightly Better	Slightly Better	Slightly Better
Economy Sustained jobs and tax base	Far Worse	No Change	Slightly Better	Slightly Better
Environment Sustained/improved long term	Far Worse	Moderately Worse	Slightly Better	Moderately Better
Recreation/Culture Views / access / shoreline	Far Worse	Moderately Worse	Slightly Better	Moderately Better
Infrastructure Road / emergency / utility function	Far Worse	No Change	No Change	No Change
IMPACT AND RISK OF FAILURE				
Overall Risk	Very High	Moderate	Moderate	Moderate
COST CRITERIA				
Capital Cost to Taxpayers	N/A	$	$$$	$$$$
CR Operations and Maintenance Effort	N/A	$$$	$$$$$	$$$$
Cost/Inconvenience to Private Sector	N/A	$$$$	$$$	$$$
Partnership Potential (Co-fund)	N/A	$	$$$	$$$$
Future Longterm Adaptation Cost	N/A	$$$$	$$$$	$$$$

Figure III-36: Willow Point Evaluation Criteria

10.0 WHAT'S NEXT



OPPORTUNITIES FOR INPUT

- November 28, 2018: Introduction to Sea Level Rise (Small-group Public Workshop #A1)
- November 29, 2018: Introduction to Sea Level Rise (Small-group Public Workshop #A2)
- Winter 2019: Understanding Values and Evaluating Options for Sea Level Rise (Small-group Public Workshop #B)
- Spring 2019: Recommended Sea Level Rise Strategies (Small-group Public Workshop #C)
- Online at www.campbellriver.ca/rising-seas
- By email: policy@campbellriver.ca
- By phone: (250) 286-5727

FOR MORE INFORMATION

CITY OF CAMPBELL RIVER WEBSITE LINKS

www.campbellriver.ca/rising-seas

BACKGROUND INFO FROM OTHER SOURCES

Engineers and Geoscientists BC
Legislated Flood Assessments in a Changing Climate in BC
https://www.egbc.ca/getmedia/f5c2d7e9-26ad-4cb3-b528-940b3aaa9069/Legislated-Flood-Assessments-in-BC.pdf.aspx

Flood Hazard Area Land Use Management Guidelines (2018)
https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/integrated-flood-hazard-mgmt/flood_hazard_area_land_use_guidelines_2017.pdf

Ausenco Sandwell
Climate Change Adaptation for Sea Dikes and Coastal Flood Hazard Land Use
http://www.env.gov.bc.ca/wsd/public_safety/flood/pdfs_word/draft_policy_rev.pdf

Ministry of Forests, Lands and Natural Resource Operations
Coastal Floodplain Mapping – Guidelines and Specifications (June, 2011)
http://www.env.gov.bc.ca/wsd/public_safety/flood/pdfs_word/coastal_floodplain_mapping-2011.pdf

BC Ministry of Environment and Climate Change
Sea Level Rise Adaptation Primer A Toolkit to Build Adaptive Capacity on Canada's South Coasts (January 2013)
https://www2.gov.bc.ca/assets/gov/environment/climate-change/adaptation/resources/slr-primer.pdf

BC Ministry of Environment and Climate Change
Professional Practices in Assessing Flood Protection Guidelines (June 30, 2014)

BC ADAPTS VIDEO SERIES

Includes a BC Climate Change Backgrounder, plus six video shorts on Coastal Flood Management
www.gov.bc.ca/gov/content/environment/climate-change/adaptation/bc-adapts

CONTACT US

Long Range Planning and Sustainability - Sea Level Rise
Email: policy@campbellriver.ca
Phone: 250-286-5725

City of Campbell River

nhc northwest hydraulic consultants

LANARC