Sea level Rise Adaptation Tools and Resources

Did you know….?

- Canada has the longest coastline in the world – approximately 151,019 miles (243,041.5 km)
- In British Columbia, 80% of population lives within 5 km from the coast.
- 59 municipalities out of 169 municipalities are coastal, 14 out 28 regional Districts contain coastal communities.
- The length of the coast is approximatively 29,000 km including the mainland and all islands from Haida Gwaii south to Vancouver Island and the Gulf Islands
- Coastal population: 3,500,000
- Major ports: Metro Vancouver, Prince Rupert and Victoria
- In BC, the government is planning for Sea Level Rise (SLR) using this projected data: **0.5m sea level rise by 2050, 1m by 2100 and 2 m by 2200**
- BC communities won't be affected by sea level rise in the same way due in part to vertical land movement. The highest relative sea level rise is projected to occur in the Fraser low land, the southern part of Vancouver Island and the North Coast of British Columbia
- The greatest threat to communities along the coast besides sea level rise is storm surge flooding. Coastal communities are already dealing with extreme water levels.

Four Strategies for dealing with Sea Level Rise

- **Protect – advance or hold the line**: Reactive strategy to protect people, property and infrastructure – dikes, seawalls for example, to keep the shoreline at the same position. May be very expensive, have limited effectiveness on long term and may increase the level of erosion instead of addressing it. Can create a false sense of security.
- **Accommodate – raise the line**: Adaptive strategy – Manage the way the coast is used to minimize potential risk to human and infrastructure.
  Example: Retrofitting buildings and infrastructure, revised Flood Construction Level (FCL) and setbacks
- **Retreat or Managed Retreat**: Adaptive strategy referring to decision to withdraw, relocate or abandon private or public assets. This is planned retreat from coast, not forced retreat.
- **Avoid:** Ensuring new development is avoided in areas of coastal hazards. This involves identification of the no-build areas and the use of zoning powers to prevent development in moderate to high risk areas.

About this Document

This primer highlights various approaches that can be used to inform the planning process for sea level rise and help with decision-making. Public education and community engagement should be the first step in this process, and continue throughout the process, to strengthen the effectiveness of the chosen approaches.

Communities faced with planning for sea level rise will require the assistance of professionals with experience in coastal hazard assessment, protection and restoration to accurately assess:

- where the new natural boundary of the ocean will be in 2050 and 2100,
- what types of solutions can be effective on a site-specific basis; and
- what costs will be entailed in creating and maintaining adaptive measures.

This guide is intended to provide an overview that will assist communities to ask the right questions, retain the right professionals and to understand the array of solutions that might be offered.

Table of Contents

Sea level Rise (SLR) Adaptation Tools

(adapted from SLR adaptation Primer)

1- Planning Tools

Note: Many of the tools listed in this document are interdependent and should be used in combination

Local and regional governments can use Planning and Management Objectives and Policies, mapping of potential hazards (essential technical basis for land-use planning in coastal areas), risk management plans and emergency plans to plan for coastal management. Coastal management plans can be reflected in Community, Strategic or Growth Management Plans, Official Community Plans (OCPs) and Regional Development Strategies. Such plans can be achieved through the use of regulatory tools such as zoning bylaws and development permits (DPs).

Before listing various regulatory tools to help with mitigation of SLR, it's important to be clear about the different levels of government involved and their specific powers and responsibilities for the governance of coastlines and infrastructure.

Federal Government

- Building and transferring knowledge
- Providing frameworks for coordinated action
- Implementing and supporting adaptation
- Regulating use and access to coastal waters and (some) sea beds
- Protecting public health and safety
- Establishing codes and standards for design and construction of Infrastructure

Provincial Government

- Regulating land, including foreshores; and air and fresh water
- Setting infrastructure design and building codes and standards
- Sharing responsibility with Federal Government for intertidal coastal environment
- Sharing responsibility with Local Government for emergency preparedness
- Managing land and resource development
- Setting policy and law to regulate development
- Empowering and delegating functions to Local Government

Local Government

- Planning and zoning land use, using delegated powers from the Province
- Planning for emergencies
- Inspecting and enforcing land use and building bylaws

First Nations

Historically, responsibility for stewardship of traditional territories and resources fell to elders referred to today as Hereditary Chiefs. With the passage of the Indian Act and the establishment of the Indian Reserve system, the federal government sought to erode traditional law and impose its own authority over (among other things) land use decisions. Elected Band Councils replaced Hereditary Chiefs as the authority recognized under federal law to exercise such powers as the federal government delegated to the Band (although it should be noted that Hereditary Chiefs can be elected in Indian Act elections and so the traditional leadership may be identical to the Indian Act leadership). A number of B.C. First Nations have maintained systems of traditional law, land and resource stewardship despite the federal legislation.

Today, some B.C. First Nations exercise land use jurisdiction on lands owned by the Nation as a result of treaties; some have that jurisdiction over Reserve lands by virtue of signing on to the First Nations Land Management Act (S.C. 1999, c. 24), which provides for the creation of land codes for the management of Reserve lands. Some may still be governed wholly by the Indian Act, with Indigenous and Northern Affairs Canada holding responsibility for land use regulation.

It is not uncommon for First Nations to contract with nearby local governments for the provision of services such as fire protection, water and sewerage. In such cases, the contract may require the Nation to comply with elements of the local government's land use regulations, in order to protect the local government from liabilities associated with supplying the services.

Provincial law is of limited effect in respect of Reserve lands, which remain owned by the federal government. One notable exception to this is the regulation of major development projects on Reserve lands. The First Nations Commercial and Industrial Development Act (FNCIDA) S.C. 2005, c. 53, is federal legislation intended to close significant gaps in regulation on Reserves. That Act, and complementary legislation passed by B.C., allows B.C. to enter into agreements with Canada and First Nations to administer provincial laws on reserve lands for specific, designated projects.

2- Regulatory Tools

Local governments exercise regulatory authority delegated to them by the Province via the Local Government Act; and First Nations exercise regulatory authority over Reserve lands through the modalities described above. Both may be subject to scrutiny from senior levels of government: in the case of local governments, they may have to comply with Regional District, Provincial and/or Islands Trust policies; and in the case of First Nations, with the Indian Act or federal policy. This section focuses on the regulatory tools available to local governments.

- **Official Community Plan (OCP)**
  An Official Community Plan (OCP) is a comprehensive local government plan that considers both long-range and shorter-term goals and contains broad objectives and policies pertaining to planning and land-use management. It is a document that helps frame a vision for the community and is used to guide the adoption of bylaws. Every OCP is different, but all must contain some basic elements which include provisions restricting the use of land that is subject to hazardous conditions or that is environmentally sensitive to development.
- **Land Use or Zoning Bylaws** – Bylaws support the vision and goals of the OCP, identifying rules governing lot-specific development. They regulate how land and buildings are developed and used – including issues such as form, siting, height and density. Zoning bylaws may establish zones within the local government's area in which development is not permitted.
- **Development Permit Area**-- The DPA is used to meet specified objectives in an area prior to a development proceeding. In the case of sea level rise the objective is to protect both the natural environment and development from hazardous conditions. A DPA can be included in an Official Community Plan (OCP), Land Use or zoning bylaw.
- **Subdivision regulation** – Subdivisions may be subject to subdivision agreements by which lands are reserved to public uses and/or protected from development to meet concerns regarding sea level rise. Subdivision may also be refused altogether in areas where the land may be subject to flooding.
- **Building Regulation** -- The BC Building Code applies to the construction of buildings, including additions, substantial alterations, buildings undergoing a change of occupancy and upgrading of buildings to remove an unacceptable hazard. Building permits are issued by local government (either the region or municipality) and can be refused if the building inspector determines that the land is or may be subject to flooding. This is the last line of defence for coastal flooding and not one that should be relied upon as a SLR response strategy.
- **Foreshore Lease** – A local government may apply to the Province for a lease authorizing use(s) over intertidal and subtidal areas. The local government can then exercise zoning powers over the foreshore which may facilitate a more comprehensive shoreline management approach such as beach nourishment, sand dune or wetland creation or hard structural protection. The interests of riparian owners and First Nations must be considered by the Province when issuing foreshore tenures.

3- Other Useful Tools

- **Land Acquisition** –Section 31 of the Community Charter allows a municipality to expropriate land under the Expropriation Act. Under that Act, municipalities can acquire land for the purpose of public safety or public use. A local government may acquire land by virtue of a gift, trust or covenant, described below. Land ownership enables the local government to prevent development and to use the land to control flooding.
- **Transfer of Development Potential** -- The transfer of a property's development potential under zoning provisions from one site to another is an increasingly popular approach to accommodating development that could instead be used to protect lands at risk of flooding: the development potential could be transferred to another parcel not at risk. This is a voluntary, market-based concept that has been used mainly for heritage conservation, but it could be used for sea level rise adaptation.
- **Easements, Covenants and Land Trusts –** Generally, these are agreements or promises between property owners and another party – often non-profit organizations or governments - to use the land in an agreed manner for a specific purpose – often with the goal of land conservation.

  a) **Easement** - An easement is a legal agreement in which a landowner grants the use of some property rights to another for a specific reason.
  b) **Covenant –** This is an agreement between a property owner and government that may be used to enforce a condition of land development or to protect lands in whole or in part.
  c) **Land Trust** – A land trust allows a non-profit organization to acquire, hold and manage land for a specific purpose, generally with a conservation goal in mind. Conservation objectives of existing land trusts may be able to address sea level rise, using strategies such as habitat creation or enhancement of coastal wetlands or sand dunes.

  Easements and covenants can be registered as a charge on the title of land. Some tax benefits may accrue to property owners granting covenants, such as that provided by the Natural Area Protection Tax exemption Program. This is **accessible to the landowners in the Islands Trust Area only,** and allows an annual 65% exemption on property taxes for the portion of the property protected by the covenant. Check the website for eligibility criteria.

- **Insurance**: Most home insurance in Canada does not cover damage from storm surges and tidal waves; and no insurance covers for sea level rise. As of 2018, The Co-Operators have announced the addition of coverage for storm surge, becoming the first and only one to do so in Canada (some conditions may apply). Those living at highest risk of flooding may have very high premiums or be unable to purchase flood insurance at all.

4- Hard Structural Tools:

Physical structures may be used to deal with sea level rise in two basic ways: (1) to keep the water from rising to inundate land and buildings, using seawalls, dikes or similar barriers; or (2) to allow the water to rise to its new natural boundary, but protect land and buildings from its damaging effects. The second approach uses tools like scour protection (armouring the land against erosion using rock, concrete or the like), elevation of buildings or constructing buildings so as to withstand water intrusion.

A Glossary of Hard Protection Structures

NOTE: These techniques may not be the favoured methods for smaller communities to address erosion or protect against storm surge and flooding as they can be expensive to build and maintain. In addition, some of these techniques can increase erosion instead of mitigating it; they can impede sediment transportation and also may have a negative effect on the local ecosystem. Hard structures usually interfere with access to the water, meaning they change the relationship of coastal communities to the water's edge.

Structures to hold the water back from inundating land and buildings:

Dikes – A dike is a linear, compacted earth structure that protects from inundation. Creation of a dike may require permitting from local government, the Province and the federal government where fisheries or other environmental concerns pertain.

Seawalls: Vertical concrete or rock walls used to elevate land above flood level and prevent erosion. Seawalls are meant to stop, or at least lessen the impact of waves.

Floodwalls: Vertical concrete barriers used in confined areas over short distance to prevent floods, used when there is limited space.

Storm Surge and Tidal Barriers: Hard, engineered structures with movable gates that can be closed to prevent flooding in case of extreme water levels. These are used for tidal inlets and estuary protection. One of the largest moving tidal and storm barrier is located in Rotterdam, Netherlands.

Structural Elevation or Dry Flood Proofing – This protection measure is mainly used for new buildings but can apply to an addition or renovation. It is regulated by local government, which may require qualified professional assurance that a property can be safely developed with the addition of fill and/or the placement of flood control features/structures to prevent flooding damage.

Structures to reduce the impact of water on land and buildings:

Scour Protection – Used to protect shoreline structures or buildings from erosion or other damaging effects of water, scour protection consists of structural elements designed to withstand wave action. Examples of scour protection structures include gabions, armour rock (rip rap), concrete slabs, etc.

Revetments: Covers or facings that provide erosion protection to slopes. They can be made of concrete, timber, riprap, gabions and other materials including cut trees (see Bio-Technical Slope Protection Methods).

Groynes: Rigid structures constructed of riprap of other heavy material extending from the foreshore into the water, used to dissipate wave energy

Gabions: From the Italian gabbione meaning "big cage" – wire mesh cages filled with stone to better stabilize slopes or construct retaining walls. They can be combined with geotextile or biotechnical methods (vegetated gabion) to control erosion.

Wet Flood proofing – These are measures that allow water to enter and exit a building with minimal damage using flood proofing materials, elevation of electrical and mechanical services and drainage. Again, local government approval is required and qualified professional assurance will likely be demanded, to prove that the structure can withstand periodic flooding.

Breakwaters: Rigid structures parallel to the coast with the purpose of decreasing wave energy. They are used to protect marinas, ports, harbours and shoreline infrastructure from storms and wave action. Check the Living Breakwater Project which uses oyster reefs to address shoreline erosion and attenuate storm waves while increasing habitat biodiversity.

Offshore Bulkheads: These are designed to build up a beach or prevent its further erosion. They consist of a vertical wall designed to trap soils washed down rivers, or to trap beach soils eroded by wave action.

5 Non-structural or soft armouring techniques

"Soft" or "green" shoreline techniques go by a variety of names in the literature, but all refer to techniques that try to mimic natural systems. Often referred to as **Living Shorelines**, they involve the management of coastal areas to protect, restore, enhance and create shoreline habitat by using techniques to decrease erosion and maintain natural processes – for example, the use of groynes, sills and breakwaters in combination with added sand, marsh plantings, vegetation or other natural materials. The habitat created attracts fish, wildlife and other living organisms, improves water quality and stores nutrients. Living shorelines can outperform hardened shorelines during storm events. On the west coast, Green Shores offers a program that uses a range of techniques, promoting sustainable protection of coastal areas.

The choice of soft armouring technique will depend largely on the type of shoreline under consideration. The shorelines more prone to change and erosion are sand and gravel, coastal bluffs, estuaries and mud flats. Rocky or boulder-and-cobble shorelines are less erodible.

Advantages: They are cost effective, require no specialized skills or heavy equipment to install. They are environmentally compatible, with a natural appearance and provide wildlife habitat and cover. They use natural/native materials and are self-repairing during and after stress events such as extreme weather. **Disadvantages:** Vegetation provides less control than a hard structure, so there is a higher risk of water damage during extreme events. During the introduction period, there is higher maintenance as these methods need time to establish themselves; and they are more sensitive to seasonal changes.

A Glossary of Biotechnical Methods

Creation or restoration of wetlands – This technique can be used to actualize strategies to protect or accommodate sea level rise, when created or restored at the water's edge. Inland, creation of a wetland might help avoid the intrusion of water into other areas. Providing the rate of sea level rise is not too rapid, wetlands are capable of adapting to rising waters without further intervention, so they can be a very resilient and low-cost approach.

Building or rehabilitating sand dunes – Sand dunes are inherently mobile, wind- and wave-influenced natural structures that can assist with buffering the impact of storm surge and wave action. While they are ineffective as barriers to sea level rise (because they're inherently unstable), dune systems may be enhanced with vegetation or sand-trapping structures to help mitigate the impacts of rising waters. There are relatively few natural dune systems in B.C.

Beach nourishment – The term means, literally, feeding a beach without dealing with the cause of its erosion. The beach can be built up with any of a variety of techniques—adding sand mechanically; or placing structures and or vegetation to enhance the natural accumulation of sand/soil. It will need ongoing maintenance and monitoring, because it is inherent in the concept that the added material is gradually sacrificed to the rising waters. Consideration must accordingly be given to the cost of materials, monitoring and maintenance.

Vegetated Rock Gabions – Gabions filled with a combination of stone for stability and earth for growing medium, lined with erosion control fabric and planted with resilient shrubs or other vegetation. Used to stabilize slopes.

Live Fascines – Essentially, a series of terraced hedges built perpendicular to the flow of water on a slope, by placing bundles of branches into shallow trenches filled with soil. The best use is on sloping areas to redirect or slow the flow of water and reduce erosion, where there is low to medium hazard potential should slope failure happen. The slope must be 1:1 (45 degrees) or flatter.

Brush Mattress - Brush mattresses are used to form an immediate, protective cover over a slope. A thick mat of dormant cuttings is placed on the bank and held down with stakes. The goal of a brush mattress is to create structural streambank protection that will eventually root and provide vegetative stabilization (Scheuler). This technique is often used in conjunction with other methods such as live stakes and stone toe protection.. It can resist temporary inundation but not scour or undercutting.

Live Staking - Live stem cuttings, sharpened and planted along the waterline to establish or re-establish vegetative cover. This technique is best used for repair of small earth slumps and for stabilization of raw streambanks. It could also be used for uncomplicated site conditions with limited construction time and requiring inexpensive methods. This method is not intended where structural integrity is needed or to resist large, lateral earth pressures.

Pole Planting – Larger and longer live stakes providing better bank protection during plant establishment.

Brush or Branch Layering – Live brush such as willow alternating with successive lifts of soil fill. It can be applied to stabilize slope areas above flow line of streambanks as well as cut and fill slopes. It can be used for slopes up to 2:1 in steepness and 20 feet in height.

Live Siltation or Vertical Brush Layering - Willow cuttings are placed along a trench excavated at water's edge, so that the growth is inclined to overhang the river to encourage deposition and reduce erosion. This revegetation technique is used to secure the toe of a streambank and trap sediment , creating aquatic habitat.

Live Cribwall – This is a combination of vegetation and structural elements, with layers of logs alternated with long, live branches protruding out between them. The logs are spiked together and anchored into the bank with earthfill to create a wall. Generally applicable where flows are less than 6 feet per second and where no degradation of streambank occurs. Useful where space is limited and a more vertical structure is required. It is not intended to be used where integrity of a road or a structure depends on the cribwall, as it is not designed to resist large earth pressures.

Tree Revetment – A tree revetment, made by anchoring trees without root wad horizontally along a stream bank, is an inexpensive, effective way of stopping stream bank erosion. The trees greatly slow the current along the eroding bank; this decreases erosion and allows silt and sand to be deposited along the bank and within the tree branches. The deposited material forms a good seed bed in which the seeds of river trees can sprout and grow. The resulting trees spread roots throughout the revetment and stream bank. By the time the revetment trees have decayed, the bank should be stabilized by the roots of the living trees. As an added benefit, tree revetments provide excellent fish and wildlife cover.

Branchpacking - For small areas, this method alternates live branch cuttings and soil placed between long posts driven in for support. It provides repair to existing slopes with small slips or slumps.

Rolled Erosion Control Products (RECP) - A coconut fiber, straw or excelsior woven roll encased in jute, nylon or burlap used to dissipate energy along bodies of water. It is best used where water surface levels are constant and provides a good medium for introducing vegetation.

Vegetated Mechanically stabilized Earth (VMSE) – It consists of alternating layers of live willow cuttings with soil wrapped in natural fabrics, stacked in offset layers to recreate a streambank.

Vegetated riprap – bent pole method/willow bundle method – A technique using willow poles or cuttings placed at incline, against prepared slope, and layer of stone and/or boulder armouring placed on top of cuttings and poles.

Ref: Biotechnical measures for erosion and sediment control 2005 and Streambank stabilization using bioengineering and biotechnical methods 2006

NOTE ON EROSION: Before starting any erosion work, one should look at the cause of it. If streambed is not stable, little good is done by doing erosion mitigation.

Appendix 1: Flood Level Construction Calculation (FCL)

(see Glossary for definitions)

New Provincial guidelines (2018) adjust the calculation of FCL to account for future projections of sea level. Note that the guidelines suggest that the setbacks be revisited every ten years or as required by the publication of new science on sea level rise. Note also that local and regional governments may not have yet updated their bylaws to reflect the new guidelines, so local FCL may be different from the information following. Building setbacks from the FCL are recommended to be 15 meters in most locations, with special considerations for buildings on coastal bluffs or behind dikes.

FCL= HHWLT + SLR + Storm Surge + Wave effect + Freeboard

HHWLT: average of highest high tide water levels
SLR: projections for the **Year 2100 (1 meter),** adjusted for regional ground movement (uplift or subsidence)
Storm Surge: determined on a site-specific basis
Wave effect – wave run-up, wave set-up or overtopping (see glossary)
Freeboard: To account for uncertainties, add the greater of 0.6m or tsunami hazard level.

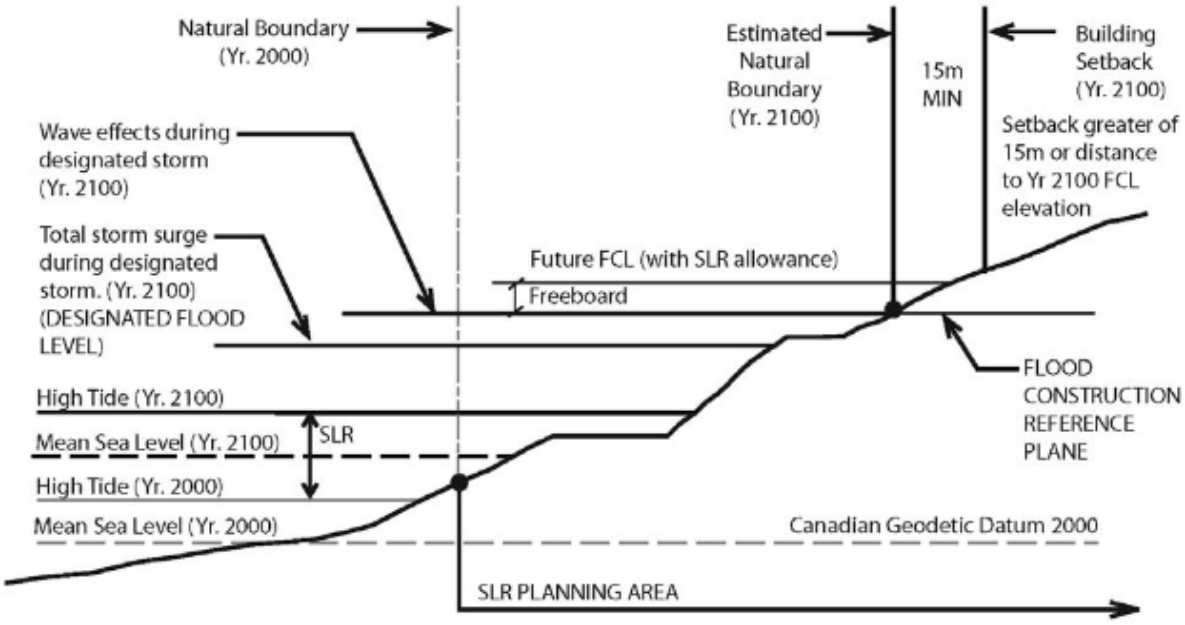

Figure 2-2: Definitions for Updated FCL and Setbacks

Appendix 2: Sea Level Rise Professional Practitioners

Topographic Mapping

Terra Remote Sensing Inc – Sydney, BC
Contact: Taylor Davis- LIDAR Applications Specialist – 250-686-0283

Smart Shores – Vancouver
Contact: Nathan Vadeboncoeur - Drone Mapping and Visual Mapping – 778- 350-9010

Consulting - general

Greenshores program – Stewardship Centre for BC (Vancouver based Program)
Contact: DG Blair, Executive Director (dg@stewardshipcentrebc.ca) **1-866-456-7222**

Consulting Engineers

Northwest Hydraulics Consultants (International Consulting Firm)
Contact: Nanaimo Office: 250-754-6425

Services included: Coastal Engineering for sea level rise – such as sediment transport analysis, surveys on bathymetry, wave generation (including run-up), assessment of flooding, storm surge, flood construction level and sea level rise, floodplain analysis, mapping and management and other related services

Kerr, Wood, Leidal
Contact: Vancouver Island Office: 250-595-4223

Services include Asset Management – Construction of Stormwater Management Systems, Flood Protection, Remediation related to Flood and Stormwater, Erosion

Association of Consulting Engineering Companies British Columbia

Contact: **here, for information on how to select a professional consultant.**

here, for a searchable list of local companies

Appendix 3: Funding Resources (compiled as at March, 2019)

Community Emergency Preparedness Fund- (flood risk Assessment, flood mapping and flood mitigation planning) -program to enhance local governments resiliency in responding to emergencies including flood preparedness due to storm surge–application by Feb 22, 2019 to a maximum of $150,000

Disaster Mitigation and Adaptation Fund- Merit-based program providing investment of $2 billion to support large-scale infrastructure projects with a minimum of $20 million in eligible expenditures (design and planning, capital cost as well as costs required to meets requirements

EcoAction Community Funding Program- supports projects that have positive impacts on the environment.
Aboriginal organizations are eligible for funding. Municipal governments are ***only*** eligible if they partner with a non-profit organization on a project proposal. Up to **50% total project costs** with maximum of $100,000.

First Nations Adapt Program- **No deadline** –Provides funding to First Nations to assess and respond to Climate Change impacts on community infrastructure and emergency management. Focused on adaptation planning i.e studies on baseline information on coastline characteristics and integration of climate change projections, community risk assessment, floodplain mapping, community planning, for example. If you have questions, contact them for the specifics: aadnc.adaptation.aandc@canada.ca.

Island Coastal Economic Trust Grant program- Enables local governments and indigenous communities in the Trust Regions (excludes Capital Region District) to develop infrastructure required to support strategic economic development initiatives. Must demonstrate economic benefits of the project(incremental business case)on a short term (3 to 5 years)–non-repayable matching funding contributions up to maximum $400,000

Municipal Asset Management Program- 5 year $50M program to help municipalities to make informed decisions about infrastructure in 4 ways -Broadening adoption and sound asset management practices -Training and workshops on best practices-Help with planning, data management and analysis-Gathering and sharing relevant knowledge and lessons learned

Municipalities for Climate Innovation Program – Five year $75M program helping municipalities prepare for and adapt to Climate Change. (Now closed –offering on a call for proposal basis ONLY going forward –sign up for e-newsletter to find out about new funding announcements)

Structural Flood Mitigation – Funding accessible to prevent, eliminate or reduce hazard impacts through structural flood mitigation projects. Grant maximum is $750,000.

Appendix 4: Deeper research resources

Educating Coastal Communities About Sea Level Rise (ECoAS) Webpage

On our project website (www.sealevelrise.ca), you will find a host of resources and tools to start your SLR rise planning process. Check the discussion tool-kit page to help you navigate the first steps of the SLR process.

Islands Trust

Static maps of Islands Trust islands, as well as the MapIT tool with many layers such as shorelines, ecosystems and property boundaries that lets you customize and print views with exactly the information you need for planning. Some information on shorelines: How to take care of my shoreline

GreenShores

Local government Working Group – supporting local governments to facilitate implementation of Greenshores program. Register as a local community member and be part of a forward thinking committee of local governments on your province.

Contact: DG Blair, Stewardship Centre for BC Executive Director greenshores@stewardshipcentrebc.ca

Preparing for Climate Change – an implementation guide for local governments in British Columbia, prepared by Deborah Carlson, West Coast Environmental Law.

Coastal Flood plain Mapping– Guidelines and Specifications (2011) using LiDAR technology – Ministry of Forests, Lands and Natural Resource (BC Government) - Help to identify the coastal flood hazard and provide technical basis for planning and developing bylaws. Floodplain mapping is the first step in creating a flood hazard management plan – it identifies where the flood hazard potentials are and gives information on spatial distribution of Flood Construction Levels (FCLs).

BC Ministry of Environment Sea Dike Guidelines (2011):

> This document provides guidelines for sea dikes design for low lying lands exposed to coastal flooding. This document and the companion document "Guidelines for Management of Coastal Flood Hazard Land Use 2010" are specific to flood hazards.

Guidelines for Management of Coastal Flood Hazard Land Use (2010) – companion document to Sea Dike Guidelines

> Provides guidelines for the management of lands exposed to coastal flood hazards to help local governments, land managers and others to develop and implement land-use management plans.

Sea Level Rise Adaptation Primer – a toolkit to build adaptive capacity on Canada's South Coasts (2013) – BC Ministry of Environment

Adapting to Climate Change: a Risk Management Guide for Utilities: (Electricity sector Climate Adaptation Planning Guide) - Document to support effective creation of climate change adaptation plans using a risk-based framework that defines key considerations in adaptation planning with examples to guide the process.

Combatting Canadas Rising Flood Costs: Natural infrastructure is an underutilized option: Analysis of natural infrastructure as an effective way to mitigate cost incurred from flooding and extreme weather events and offering environmental and social benefits. Includes an implementation framework.

Canada's Marine Coasts in Changing Climate – Perspectives on Canada's West Coast Region

Government of Canada publication (NRCan, 2016). Key findings on Climate change and its impacts – on ecosystems, various industry sectors and communities - and adaptation planning (Chapters 1 to 3 - Climate Change and its impacts, Chapter 6 – West coast Perspectives)

Adapting to Climate Change Team (ACT), Simon Fraser University

Crescent Beach Community meeting series – Summary Report on Coastal Flooding and Climate Change. Engaging Surrey residents and stakeholders in developing a strategy on increasing the understanding of impacts and explore options for climate change adaptation

Adaptation to Sea Level Rise in Metro Vancouver: A Review of Literature for Historical Sea Level Flooding and Projected Sea Level Rise In Metro Vancouver (2012). This literature review seeks to establish the vulnerability of Metro Vancouver to sea level rise.

ICLEI Canada, **BARC Building Adaptive and Resilient Communities**

Program offering tools, resources and consulting services to increase adaptive capacity. Can be summarized in 3 phases: Connecting leaders, accelerating action and solutions.

Climate Action Secretariat, BC Ministry of Environment

Government webpage on Climate Change – adaptation and climate impacts, resources, videos

Collaborative for Advanced Landscape Planning (CALP), University of British Columbia: Delta Sea Level Rise Visioning Study (Delta-RAC): Options for sea level rise adaptation using scenarios and 3D landscape visualizations

Federation of Canadian Municipalities

Webpage provides a host of resources on Climate Change on the context of local governments.

Fraser Basin Council

ReTooling for Climate Change – adaptation resources page to support local government and First Nations in BC for climate change adaptation

ReTooling Essentials section – tools and resources to consider to address climate change

Climate Change and its impacts –summary of expected climate changes in BC

Adaptation Planning: the local government experience – what are the challenges and opportunities that can impact local government action on climate change.

Community profiles – examples of communities implementing adaptation strategies

Adaptation Support for communities – list of organizations that can help with adaptation planning and action

Funding Support for climate mitigation – list of assistance programs with link to BC grants database

Intact Centre on Climate Adaptation (ICCA)

University of Waterloo research centre funded by insurance company to focus on practical and cost effective solutions to climate change and extreme weather events with 3 different programs: Home Adaptation Assessment program, Natural Infrastructure Adaptation Program and Corporate Specific Adaptation Program

Glossary

Flood Construction Level (FCL) *is often defined as the 'safe' level at which to build, taking into account elevation of the natural boundary between water and land. It is calculated having regard not just to sea level rise, but factors such as storm surge, wave effects and recommended freeboard to account for uncertainties and tsunami effects – it refers to the effect that ocean has on soil and vegetation and is site and time specific)*

LiDAR technology (mapping): Light Detection and Ranging; A method that uses light in the form of a pulsed laser to measure distances to the Earth. The light pulses – combined with other data – generate precise three-dimensional information on the shape of the earth and its surface. The instrument consists of laser, scanner and GPS receiver. It allows the examination of natural and manmade environments with accuracy, precision and flexibility.

Natural Boundary Definition: **Visible high water mark of any lake, river, stream or other body of water where the presence and action of the water are so common and usual, and so long continued in all ordinary years, as to mark on the soil of the bed of the body of water a character distinct from that of its banks, in vegetation, as well as in the nature of the soil itself;* *(Ref: Land Act)*

Wave Run-up: Vertical distance that waves run-up the seaward slope of a structure or a shoreline. (uprush, swash)

Wave Set-up: Increase in water surface close to shoreline caused by wave action

Wave overtopping: Passage of water over top of seawall or dike

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