



Source: Kasian Architecture

Land Use Planning and Development for Skwxwú7mesh Reserve Lands

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Introduction

The land use planning and development group of REM642 was retained by Sḱw̓x̓wú7mesh Úxwumixw to evaluate opportunities for land use planning to help build flood resilience in planned developments on reserve lands. The Sḱw̓x̓wú7mesh Generational Plan - Úxwumixw 2050 – states that by 2050, Sḱw̓x̓wú7mesh Úxwumixw “will bring our people home. Everyone will be safely and securely housed and will have proper and appropriate access to healthcare and community services.” As such, there will be significant development on reserve lands to increase housing supply.

However, Sḱw̓x̓wú7mesh reserve lands are predominantly located adjacent to waterways, coastlines, and downslope of high topography areas, and are therefore at a heightened risk of flooding. In this report, flood risk is considered holistically to consider different means of water entering normally dry land through fluvial (river), pluvial (rainfall), and coastal (sea level rise, wave action, and tsunami) means. New development must be considered in terms of all types of flood risk and resilience.

Specifically, this work aims to contribute to the prevention and mitigation components of disaster risk management. Land use decisions can manage *where* development takes place and offer opportunities to prevent or avoid new disaster risks. Further, land use planning can shape the *form* of development, thereby contributing to mitigating or lessening the adverse impacts of disasters. Additional components of disaster risk management – Transfer and Preparedness – are important to managing overall risk and could be addressed through planning policy; however, they are not covered in this report.

Building upon phase one, this report first synthesizes findings to present a geographic flood risk profile for Sḱw̓x̓wú7mesh Úxwumixw reserve lands that members currently call home and those that are poised for new development. This risk scan identifies locations that are at risk of flooding due to a combination of factors, including geographic location, actions taken by neighbouring jurisdictions, and the state of nearby flood infrastructure. Overall, this section intends to present an overview of flood-risk considerations for development.

Finally, the report concludes with a series of directed policy scans regarding potential land use planning and other intervention opportunities that could support flood-resilient development. Each section presents a summary of the policy mechanism, a case study, and considerations for implementation. While strategic plans can contribute to building flood resilience, this report focuses on land use planning tools that include prevention-focused elements: development permit areas (DPAs), zoning and urban growth boundaries, as well as mitigation-focused elements: building bylaws, residential design plans, and design guidelines. Finally, the report provides novel planning opportunities to address both prevention and mitigation, including nature-based solutions for coastal and riverine flooding, and climate adaptation opportunities.

Sḵw̱w̱ú7mesh Úxwumixw Reserve Land - Risk Profiles

North Shore

Pursuant to its [Land Development Strategies](#) and 600 New Homes Plan, Sḵw̱w̱ú7mesh Úxwumixw plans to develop and re-develop lands at Xwmélch'sten, also known as the Marine Drive - Xwmélch'sten (Capilano) Site¹. These reserve lands are located at the mouth of the Capilano River, between the District of West Vancouver on one side, and the District of North Vancouver on the other.² Other nearby jurisdictions include Lion's Bay, Bowen Island, and the Tsleil-Waututh First Nation's reserve lands.

The **District of West Vancouver** makes up two-thirds of the lands bordering Xwmélch'sten, and a significant amount of the immediate upslope area. The District's flood planning measures may impact the hazard posed to Xwmélch'sten, in terms of pluvial, fluvial, and coastal flood risk.

The District of West Vancouver's land uses immediately upslope of Xwmélch'sten are primarily residential, and pluvial flooding from these areas impacting Xwmélch'sten is a possibility. The District's [2018 Official Community Plan](#) calls for measures such as expanding green infrastructure that could, if enacted in concrete terms, reduce pluvial flooding risk from the District in general.

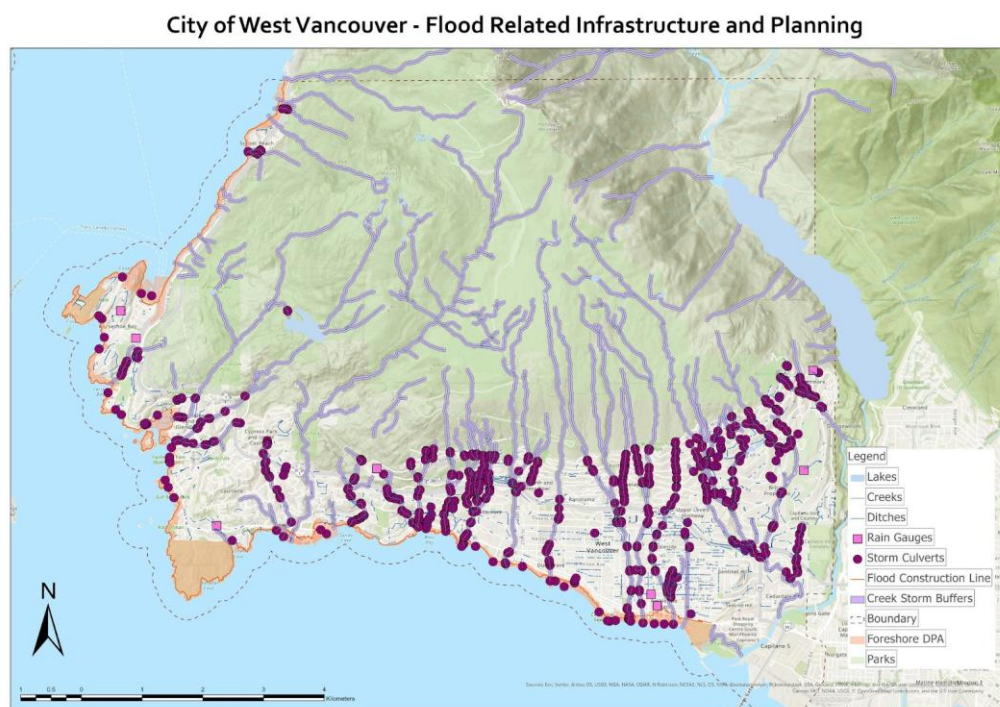


Figure 1. Culverts and creek storm buffers of West Vancouver.

¹ In the Land Development Strategies Update: <https://www.squamish.net/community-initiatives/land-development-strategies/>

² Risk considerations associated with the District of North Vancouver can be found in "North Vancouver" section.

Another potential source of flood risk to the proposed Xwmélch'sten development areas from the District of West Vancouver is riverine flooding. Flooding of the Capilano River could be driven or exacerbated by the creek systems located within West Vancouver that join the river immediately before it enters the main parcel of reserve land at Xwmélch'sten. Geographically, the most significant of these is Brothers Creek. In 2017, the District of West Vancouver created an [Integrated Stormwater Management Plan](#) for Vinson, Hadden, and Brothers Creek. The plan states an intention to balance stream health with flood flow-through, and it plans for upgrades to under-capacity in-stream culverts. There are dozens of culverts throughout the Brothers Creek system (Figure 1), and its overall flow-through rate under flood conditions could partially determine overall riverine flooding risk to Xwmélch'sten lands. It may be advisable to liaise with West Vancouver to seek an updated assessment of the condition of the Brothers Creek system and any changes made since 2017 to gain a more holistic understanding of the area's risk profile.

The District of West Vancouver has an [environmental development permit](#) that applies to anything built within 15 meters of the top bank of a watercourse. This would include any new earthworks and new flood protection measures constructed within municipal boundaries.

Finally, while it does not pose an immediate risk to the proposed development sites, the risk of coastal flooding to Xwmélch'sten lands is also in part mediated by land use decisions by other jurisdictions, including West Vancouver. There has been strong collaboration in this area in the recent past: Skwxwú7mesh Úxwumixw, West Vancouver, and other North Shore municipalities are partners on the 2021 [North Shore Sea Level Rise Risk Assessment and Adaptive Management Strategy](#). The strategy outlines a sea level rise adaptation plan for Xwmélch'sten's shoreline, to be undertaken in partnership with the District of West Vancouver, as part of two different "Comprehensive Adaptation Planning Zones"³. Reserve shoreline to the west of the Capilano River falls into the "Ambleside-Capilano West" zone⁴, and east of the river into the "Capilano East" zone⁵.

The Tsleil-Waututh Nation's stewardship undertakings⁶ are relevant to the environmental health of the North Shore and [Burrard Inlet](#) generally, and some of the Nation's approaches to flood resilience planning may be of interest and policy relevance to Skwxwú7mesh Úxwumixw. However, flood planning and policy for Tsleil-Waututh's reserve lands will not have any direct impact on flood risk considerations for Squamish reserve lands.

Finally, it is worth noting that the Lions Gate Bridge and its approaches, which pass directly through Xwmélch'sten, are BC Ministry of Transportation rights-of-way. The Ministry may have shared interests with Skwxwú7mesh Úxwumixw in reducing flood risks posed to these areas.

³ pg. 84

⁴ Details for this zone start on page 90 of the report.

⁵ Details start on page 94 of the report.

⁶For example, the x?əlilwətaʔ/Indian River Watershed Integrated Stewardship Plan 2022 <https://inlailawatash.egnyte.com/dl/h37T9B0Z0H>

North Vancouver

Three Sk̓wx̓wú7mesh Úxwumixw reserve lands border the City of North Vancouver and the District of North Vancouver: Eslhá7an (Mission), X̓wemelch'stn (Capilano), and Ch'ich'élxwí7kw (Seymour Creek). All three reserves lie downstream of the City of North Vancouver and the District of North Vancouver and therefore are directly impacted by the flood mitigation strategies undertaken by both municipalities; they, in turn, face fluvial, pluvial, and coastal flood risks, and their communities have dealt with an increase in flood events over recent years.⁷ The latter two reserves (X̓wemelch'stn and Ch'ich'élxwí7kw) were identified for further development as part of the Nation's goal to build 600 homes and bring members home with a priority focus on building out available lots at X̓wemelch'stn and constructing multi-family homes and apartments at sites on both reserves.⁸ The existing townhomes at Eslhá7an were also targeted for redevelopment in the long-term after priority projects on other reserves are undertaken.

X̓wemelch'stn is bordered by the District of North Vancouver along its eastern edge (with the District of West Vancouver comprising the rest of its land border⁹), while Ch'ich'élxwí7kw is bordered entirely by the District of North Vancouver on land. Land use in the District along the waterfront of Burrard Inlet is primarily medium to high-density industrial and commercial. Upstream along the Capilano River that runs through X̓wemelch'stn and to the East of the reserve, there are the communities of Norgate, Cedardale, and Pemberton Heights, which are mainly comprised of local parks and single-family residences. Along Seymour Creek at Ch'ich'élxwí7kw there is a clustering of low-density residential, along with Capilano University to the north and a municipal park (Cutter Island) bordering the reserve to the south.

The District of North Vancouver addresses flood risk comprehensively and utilizes a collection of planning tools to control development, most prominently through [Development Permit Areas](#) (DPAs). The District uses a Creek Hazard DPA to limit occupancy to above flood construction levels, a Streamside Protection DPA to delineate 15-30 meter setbacks for development along relevant watercourses, and a Slope Hazard DPA to prevent debris flows and erosion. The District also has multiple Local Area Plans for context-specific flood mitigation measures, including plans for the [Lynmour](#), [Maplewood](#), and [Lower Capilano](#) areas adjacent to Sk̓wx̓wú7mesh reserves that call for the construction of dykes and riprap, stormwater management, on-site filtration, and hydrological impact assessments. Their [Development Service Bylaw](#) additionally targets flood mitigation via the implementation of green infrastructure and drainage solutions at the site level, while policy in the [Official Community Plan](#) promotes nature-based solutions to infiltration, including rain gardens, absorbent soils, and native vegetation.

⁷ Sk̓wx̓wú7mesh Úxwumixw. (2024). Climate Legacy Strategy.

⁸ Sk̓wx̓wú7mesh Úxwumixw. (2024). Build 600 Affordable Homes Action Plan.

⁹ Risk considerations associated with the District of North Vancouver can be found in "North Shore" section.

While not directly impacting the development sites of X̱wemelch'stn or Ch'ich'élxwí7kw, the City of North Vancouver encircles Eslhá7an and therefore directly impacts long-term Sḵwxwú7mesh housing development goals. The City integrates flood mitigation into multiple regulatory tools, but generally does not center flood risk as one of its primary concerns. The City delineates a flood construction level in the [Sewerage and Drainage Utility Bylaw](#), along with flood plain areas on which the flood construction level applies. Stormwater infiltration infrastructure is regulated primarily via a [Streamside Protection and Enhancement DPA](#) that delineates 10-15 meter setbacks for development directly upstream of Eslhá7an. Stormwater management via increased site-level infiltration and retention is the primary focus for City policy regarding flooding, as reflected in the [Official Community Plan](#) and the [Integrated Stormwater Management Plan](#).

Both municipalities, along with the District of West Vancouver, manage flood emergency planning and response primarily through the collaborative [North Shore Emergency Management](#) initiative, which provides community education, outreach, reporting, and response services across all three municipalities. Flood responses outlined in the [Emergency Management Plan](#) (the same plan is shared between the City and the District) include sandbagging, emergency pumping, and emergency evacuation for affected areas.

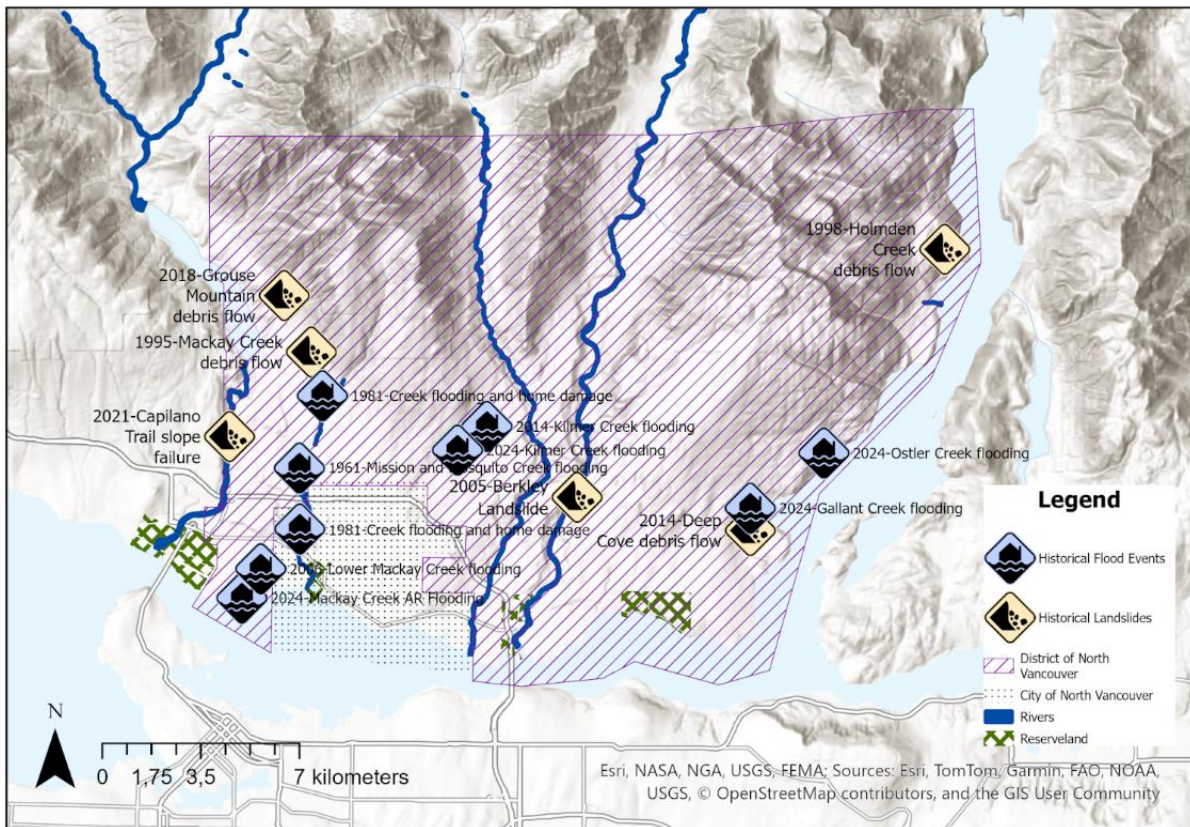


Figure 2. The boundaries of the City and District of North Vancouver, Sḵwxwú7mesh Úxwumixw reserve lands, rivers and watercourses, and major historical hazards.

Sunshine Coast

The Sk̓wx̓wú7mesh Úxwumixw have indicated interest in developing one reserve in the Sunshine Coast area. Ch'kwélhp is one of the [Nation's main origin villages](#) and is being explored for [land use development](#). The reserve is situated between the Town of Gibsons (ToG) and West Howe Sound, or Electoral Area F of the Sunshine Coast Regional District (SCRD).

There are multiple resources related to Ch'kwélhp's coastal flood risk. The [SCRD Climate Action Plan](#) outline actions for the District to undertake related to coastal flood awareness and resilience, including [floodplain mapping](#) and the [Green Shores program](#). Part of the SCR D's Coastal Flood Plan Network also includes the development of the [Coastal Flood Adaptation Policy](#). [The Coast's Hazard, Risk and Vulnerability Analysis](#) highlights concern for evacuating ToG due to its low-lying elevation. Such concern would extend towards Ch'kwélhp as the reserve contains low-lying land. The Town of Gibson's [Coastal Resilience Project](#) expands on the risk profile for the area. The project identifies the northern marina area (just south of Ch'kwélhp) as a high-risk area, particularly to tide levels. The plan recommends the consideration of grey infrastructure, like dykes, and managed retreat. Coastal flooding resilience without Squamish Nation collaboration could greatly impact the viability of Ch'kwélhp development opportunities.

The area surrounding Ch'kwélhp also has multiple resources related to flooding beyond sea level rise. The 2025 update of the [ToG OCP](#) provides an extensive consideration of climate impacts, stormwater mitigation, flood mitigation, and protection of areas that increase flood resilience. The ToG also considers pluvial flooding in its [Integrated Stormwater Management Plan](#) and [Urban Forest Plan](#). The SCR D considers flooding in its [Integrated Stormwater Management Plan](#) for the West Howe Sound area, and the plan primarily focuses on grey infrastructure for flood mitigation.

Both the SCR D and ToG fall short in addressing flood risk in their strategic plans. The [SCR D 2023-2027 Strategic Plan](#)'s considerations of water center on solid waste and water stewardship, and the [ToG 2023-2027 Strategic Plan](#) centers on water conservation rather than flooding. However, the ToG emphasizes that a climate resiliency lens is applied to all work of the District. Resources specific to the West Howe Sound (the electoral district north of Ch'kwélhp) are limited to its [OCP](#), which does not explicitly reference flooding beyond its DPAs.

The spatial analysis of flood-related policy in the Sunshine Coast project revealed two key considerations for Ch'kwélhp. First, the Gibson Creek, which was identified by the ToG to have related geotechnical hazards, flows through the reserve. Second, mapped sea level rise projections (as identified by the SCR D) show the potential for land loss on the seaside of Marine Drive in Ch'kwélhp.

Valley

Sḵw̱wú7mesh Úxwumixw has indicated its intention to build 150 homes in the Squamish Valley as part of its vision to house all of its members within a generation.¹⁰ Within the Squamish Valley, the St'á7mes, Siyí7ch'em, and Wikweḵ'em reserves are priority sites for development and housing.¹¹ However, these three reserves are located along the Squamish River, which has been identified as a high-risk river system. These reserves are within the Flood Hazard and Overland Flow areas identified by the District of Squamish (DOS).¹² The Siyí7ch'em and Wikweḵ'em reserves are protected by river dikes, and the proposed Xwu'nekw Park Sea Dike would provide protection to the St'á7mes reserve. However, the sea dike has not yet been completed, and dikes along the Squamish and Cheakamus Rivers require upgrading to meet provincial minimum protection standards.¹³ Overland flooding or dike failure may subject these reserves to future flood risk. Land use planning in neighbouring jurisdictions also influences the current and future flood risk of Sḵw̱wú7mesh Úxwumixw reserves.

The DOS has a comprehensive flood mitigation approach and has completed extensive flood risk assessment and mapping through its [Integrated Flood Hazard Management Plan](#) (IFHMP) and [Community Risk Assessment Report](#). These reports identify that the primary flood risk in the DOS is fluvial flooding in the Squamish, Mamquam, Cheakamus and Stawamus Rivers, coastal flooding and sea level rise (SLR), and debris-flow hazards in the Cheekeye fan. Downtown and highly populated areas within the DOS are located within the 200-year floodplain. DOS's flood risk assessments inform over 100 mitigation measures and tools captured in the IFHMP that are tailored to each flood hazard area and risk levels. Measures include a priority system for upgrading and expanding the DOS's extensive flood protection infrastructure network. The IFHMP recommendations also inform the DOS's land use planning tools, including the [Floodplain Management Bylaw](#), [Zoning Bylaw](#), and [Protection from Flood Hazard DPA](#). In combination, these tools restrict where and how development may occur, outline appropriate land uses, define minimum flood construction levels and setbacks, and include floodproofing requirements. However, the DOS still enables development within its secondary floodway and has designated an area within its downtown as being exempt from flood construction levels. The DOS also heavily relies on flood protection infrastructure, which may encourage development in hazardous areas and undermine the implementation of more proactive and transformative flood mitigation strategies.

The Squamish-Lillooet Regional District (SLRD) and Electoral Area D have also completed several hazard risk assessments for their respective jurisdictions, providing strong evidence of the SLRD's and Electoral Area D's flood risk. The assessments identify that riverine, freshet, storm surge, and outburst flooding pose the largest threats to the region, with Squamish River,

¹⁰ Sḵw̱wú7mesh Úxwumixw. (2024). Build 600 Affordable Homes Action Plan. (p. 12).

¹¹ Sḵw̱wú7mesh Úxwumixw. (2024). Build 600 Affordable Homes Action Plan. (p. 34).

¹² Squamish-Lillooet Regional District (2021). *Community Risk Assessment Report*. (p. 59).

¹³ District of Squamish. (2017). *Integrated Flood Hazard Management Plan*. (p. 7-2, 8).

Cheakamus River, Brandywine Creek, and Furry Creek identified as being particularly high-risk systems.¹⁴ The SLRD identifies the need to mitigate flood risk through land-use and building regulations, including restricting development in the floodplain and enhancing emergency response capacity.¹⁵ The SLRD has also proposed stabilizing and enhancing river banks along the Squamish Valley Road and constructing dikes to ensure continuity of service and access for upstream locations, including Sk̓wx̓wú7mesh Úxwumixw reserves on the Upper Squamish River.¹⁶ Electoral Area D is mitigating flood risk by restricting development in flood-prone areas and leveraging [Natural Hazard Development Permit Areas \(DPAs\)](#), including a Coastal Hazard DPA and a Creek Hazard DPA, which include guidelines for setbacks, flood construction levels, and other mitigation measures. However, additional regulatory tools are limited, and it is unclear what investments have been made in infrastructure upgrades. As a result, development in the SLRD or Electoral Area D that is outside of the designated DPAs may exacerbate flood risk for Sk̓wx̓wú7mesh Úxwumixw reserves.

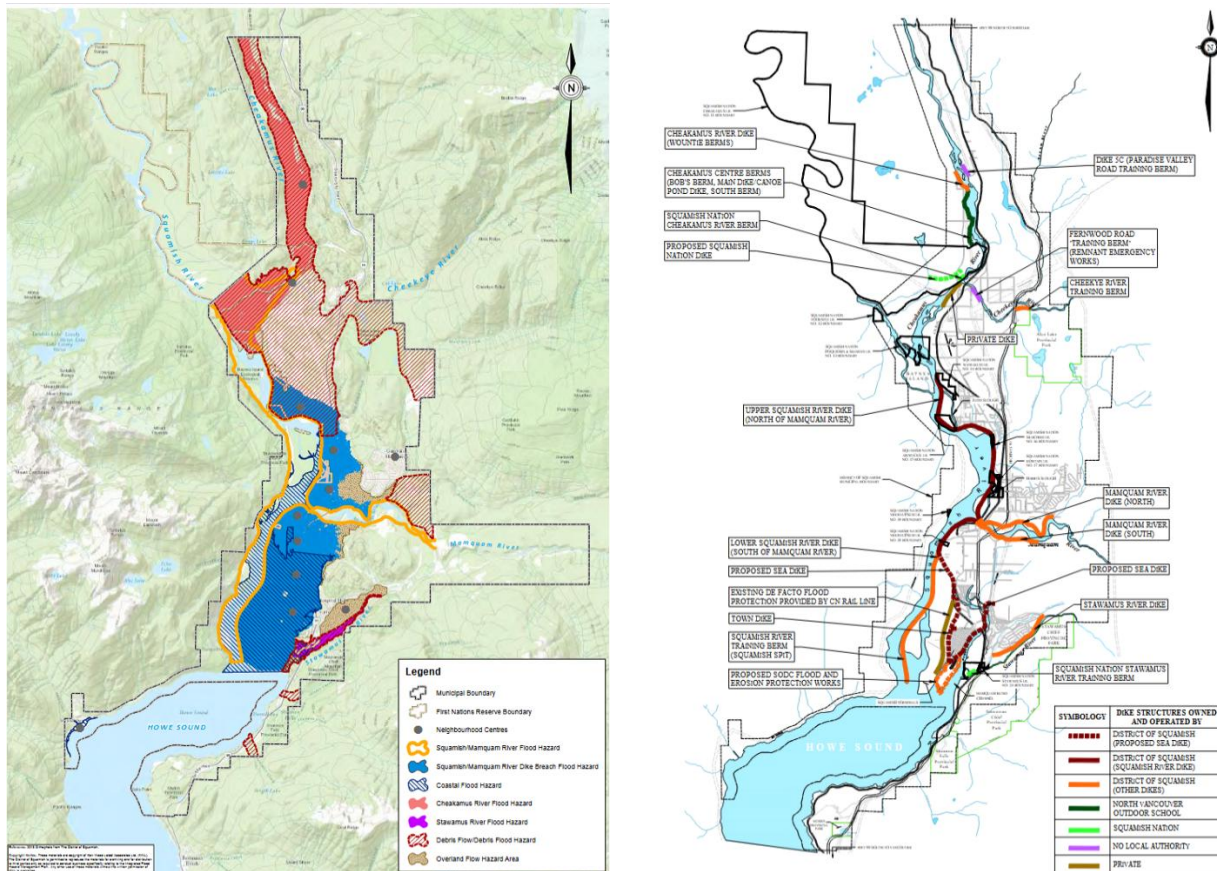


Figure 3. Flood hazards (left) and existing flood protection infrastructure (right) in the District of Squamish.

¹⁴ Squamish-Lillooet Regional District (2021). *Community Risk Assessment*. (p. 54).

¹⁵ Squamish-Lillooet Regional District (2010). *Regional Growth Strategy Bylaw No.1062*. (pp. 48-52).

¹⁶ Squamish-Lillooet Regional District (2023). *Upper Squamish River Flood Hazard Mapping and Risk Assessment*. (p. 30).

Vancouver

Señákw is an ancestral village of the Skwxwú7mesh Stélmexw located on the south shore of False Creek within the City of Vancouver (CoV). In 2003, 10.48 acres of the original 80-acre reserve were returned to Skwxwú7mesh through a court ruling and in 2019, the majority of Skwxwú7mesh members voted in favour of developing Señákw. This development is the “largest First Nations real estate developments in Canadian history,”¹⁷ and will support economic independence and housing of the Skwxwú7mesh Stélmexw for generations. Skwxwú7mesh Úxwumixw has signed a [government-to-government agreement](#) with the CoV committing the City to providing municipal services for Señákw. Phase One of Señákw is comprised of three towers that will provide 1,409 units of housing beginning in summer 2026. In total, the project includes four phases and over 6,000 rental units.

Señákw lies downstream of highly urban land uses, on the bank of False Creek, increasing flood exposure for the development. First, there is a risk of pluvial flooding as highly urbanized land results in high runoff and increased potential for flash flooding downgradient. Second, Señákw lies only slightly above sea level, increasing exposure to sea level rise and flooding from king tides and resulting in an overall coastal flood risk.

The CoV demonstrates a prioritization of flood resilience through its network of strategic plans. For example, the [Vancouver Plan](#) identifies high-level goals and key priorities for flood prevention through infrastructure upgrades, green infrastructure, and stormwater management. Across plans, CoV speaks to both coastal and pluvial flood risk. For coastal flooding, CoV prefers a combined approach of grey and green infrastructure, as well as policy mechanisms. For example, the [Vancouver Shoreline Flood Preference Design Reference](#) outlines preferences for grey infrastructure such as dykes and retaining walls, green infrastructure such as wetlands and floodable parks, as well as a resist, accommodate, move, and combination approach that could include raising Flood Construction Levels (FCLs) in building bylaws. Similarly, the [Rain City Strategy](#) establishes targets to capture and treat stormwater on site through green infrastructure such as rain gardens and other mechanisms for reducing impermeable surfaces in the City.

Since Señákw is surrounded by CoV land, the City’s actions greatly impact flood risk for the development. Much of the flood-related CoV strategic planning has yet to be implemented; however, based upon their high-level goals, it appears that CoV is committed to actions that reduce flood risk for Señákw. For example, mechanisms such as floodable parks or raised dykes could reduce coastal flood risk for all of False Creek. Similarly, increased on-site capture and treatment of stormwater should reduce the pluvial flood risk at Señákw. However, CoV actions might also risk increasing flood risk at Señákw if they are not implemented with intentional considerations. Stormwater routing should be careful to avoid discharging at Señákw land, and coastal flood infrastructure should extend to include Señákw.

¹⁷ Skwxwú7mesh Úxwumixw (n.d.). <https://www.squamish.net/partnerships-entities/partnerships/senakw/>

Opportunities for Flood Resilient Development

Development Permit Areas

Overview

Development Permit Areas (DPAs) are land use planning tools that local governments can utilize to restrict, guide, and regulate development in specific locations. Local governments can leverage DPAs to enforce higher standard development regulations. Development regulations are applicable to new developments and alterations of existing developments, such as renovations or additions. DPA guidelines can regulate site design, building materials, landscaping, professional reports, and restrictive covenants.¹⁸ DPAs are commonly utilized to protect riparian and sensitive ecosystems, as well as regulate building character and form. However, increasingly, local governments in BC are leveraging DPAs to protect residents and property from hazards such as flooding and wildfire.

Case Study: The District of Squamish, B.C.

In combination with the District of Squamish's (DOS) Floodplain Bylaw and Controlled Densification Areas Framework, the District has designated a [Protection from Flood Hazard DPA](#) to restrict and regulate development within and adjacent to areas designated as Primary Floodway, Secondary Floodway, and Debris Hazard Area, defined as:

- Primary Floodway: “A river corridor or un-diked floodplain area that is reasonably required to discharge the flow of a designated flood.”
- Secondary Floodway: “An area within a dike-protected floodplain that is critical for conveying floodwaters in the event of a dike breach to maintain modelled flood levels.”
- Debris Flow Hazard Area is defined as “An area exposed to Debris Flow or Debris flood hazards.”¹⁹

The Protection from Flood Hazard DPA applies to the subdivision and alteration of land, and the construction, addition to, and alteration of buildings and other structures. The DPA outlines specific development regulations for each hazard area.²⁰ Within areas designated as Primary Floodway, all development, fill, and infrastructure are prohibited to protect the flood conveyance capacity of the river systems. In Secondary Floodway areas, property owners are required to submit a flood risk report by a qualified professional, abide by a minimum setback of 30 metres, and design and site buildings and structures to support flood conveyance. In Debris Flow Hazard Areas, property owners are required to submit a risk assessment report by a qualified professional, and site, design, mitigate, and certify developments to minimize hazard risks.

¹⁸ Government of British Columbia. (2011). Development Permit Areas for Climate Action: A Guide for Energy Conservation, Water Conservation and GHG Emissions Reduction. (p. 3).

¹⁹ District of Squamish. (2017). *Official Community Plan Bylaw No.2500*. (p. 204)

²⁰ District of Squamish. (2017). *Official Community Plan Bylaw No.2500*. (pp. 200 – 203).

Property owners are also required in Secondary Floodway and Debris Flow Hazard Areas to register a restrictive covenant on the property. This case study is a useful example in demonstrating how development regulations can be tailored to hazard type and risk level, as well as proximity to flood protection infrastructure, ensuring that development is avoided in high-risk areas.

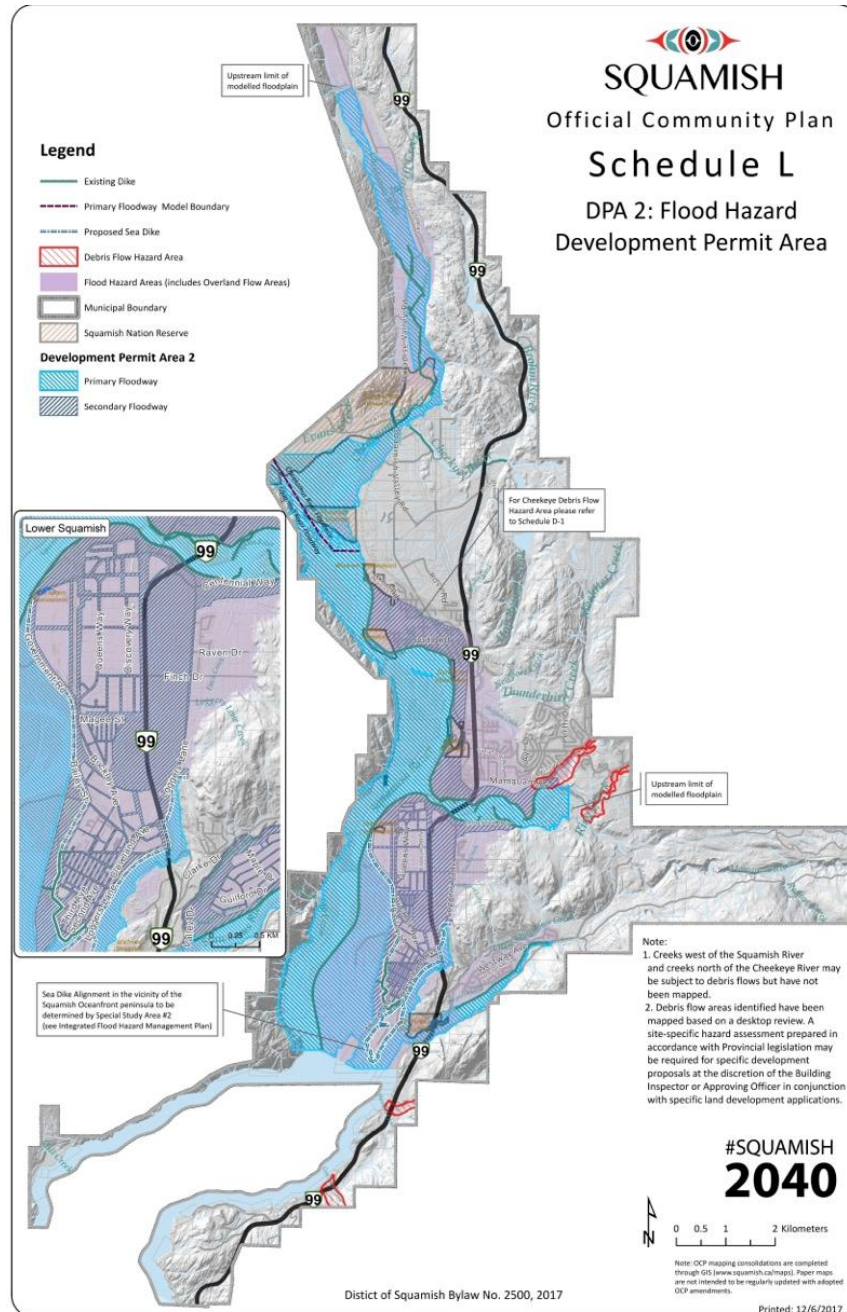


Figure 4. Applicable areas for the District of Squamish Flood Hazard DPA.

Case Study: City of Nanaimo, B.C.

The City of Nanaimo has designated a [Sea Level Rise DPA](#) in areas that are at risk of coastal flooding and sea level rise (SLR) up to the year 2100. The DPA applies to all new habitable construction, as well as additions and alterations to existing buildings and structures that alter the building footprint, requiring that all habitable areas are located above the SLR flood construction level. Development applicants are required to submit a report prepared by a qualified professional that identifies the wave and wind effects and proposed setbacks, elevations, and other conditions to protect the development from SLR, as well as a site-specific flood construction level. Additionally, development applicants must utilize landscaping to mitigate the impact of coastal flooding.

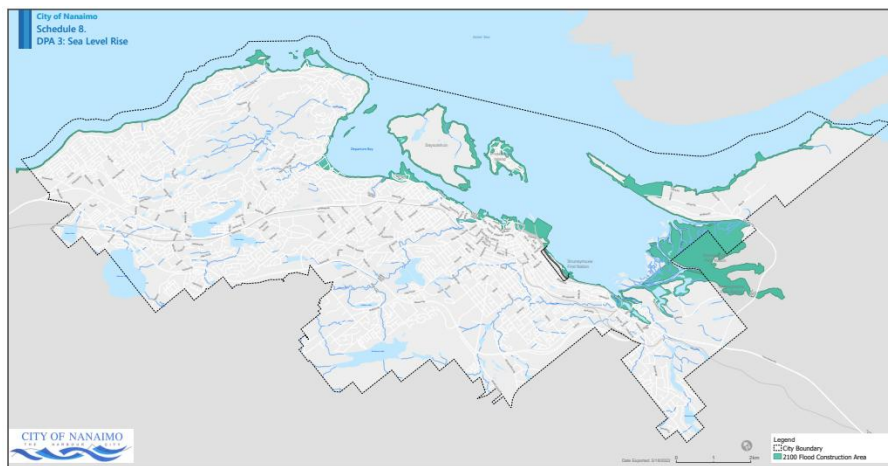


Figure 5. Applicable areas for the City of Nanaimo Sea Level Rise DPA.

Summary

Given that many of the Sḵw̱x̱wú7mesh Úxwumixw reserves being prioritized for future development and housing are located in areas of high flood risk, particularly in the Squamish Valley, a Flood Protection DPA may be an appropriate tool to ensure that new developments are sited, designed, and built to mitigate flood risk. According to the DOS flood hazard and risk mapping, St'á7mes reserve is adjacent to Primary Floodway, and Wíkweḵ'em, Yekw'ápssem, Siyí7ch'em and Kaw'tin reserves are within Secondary Floodway areas. The DOS's Protection from Flood Hazard DPA guidelines, and the DOS's flood hazard and risk assessments and mapping, may be useful references for development on these reserves. Furthermore, many other municipalities within BC are utilizing DPAs to protect from flood risk, including sea level rise, and fluvial, pluvial, groundwater, and coastal flooding. Other local governments' DPA guidelines may be useful resources to inform the development of a Flood Hazard DPA for Sḵw̱x̱wú7mesh Úxwumixw. However, an important consideration is that DPAs require additional capacity and expertise to review and approve development permit applications.

Zoning

Overview

Under a Zoning Bylaw, local governments can designate different areas of their jurisdiction for different land uses, as well as regulate parcel configuration, density of land use, siting and standards of buildings and structures.²¹ Zoning can be leveraged for flood-prone areas to restrict development or vulnerable land uses such as residential or critical infrastructure and facilities. Zoning can also be leveraged to enforce flood-resilient standards for building and infrastructure in different zones.²² However, the BC Government recommends in its Flood Hazard Area Land Use Management Guidelines that local governments enact a Floodplain Bylaw rather than use the Zoning Bylaw.²³

Case Study: City of Calgary, Alberta

Following the 2013 floods in Calgary, the City incorporated rules and regulations for development in areas designated as Floodway, Flood Fringe, and Overland Flow into its [Land Use Bylaw](#). For Floodway Areas, the construction of new buildings and structures is prohibited, with the exception of replacing accessory residential buildings or single-detached and semi-detached buildings that do not alter the existing building footprint. In Fringe and Overland Areas, all buildings must be set back a minimum of 6 metres from the edge of the floodway, with specific regulations for certain waterways. In Fringe Areas, buildings must be designed to prevent structural damage from floodwaters and be built above the designated flood level, with electrical and mechanical equipment located above the designated flood level. Similarly, in Overland Flow Areas, buildings must be built to prevent structural damage by floodwaters, with minimum construction levels.²⁴

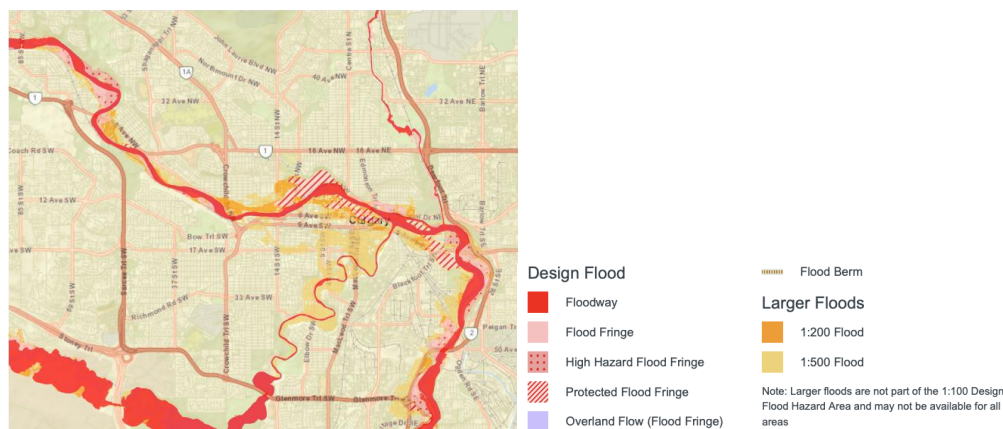


Figure 6. Flood awareness map for the City of Calgary.

²¹ Government of British Columbia. (2018). Flood Hazard Area Land Use Management Guidelines. (p. 7).

²² UFCOP. (2017). *Land Use Planning for Urban Flood Risk Management*. (p. 10).

²³ Government of British Columbia. (2018). Flood Hazard Area Land Use Management Guidelines. (p. 7).

²⁴ City of Calgary, *Land Use Bylaw*, pp. 69 – 71.

Case Study: The City of Regina, Saskatchewan

The City of Regina utilizes its [Zoning Bylaw](#) to designate areas of the city that are subject to periodic flooding, or within the floodway of certain waterways, as Floodway Overlay Zone. The City has also zoned all areas within the city that are located in the Canada/Saskatchewan Flood Damage Reduction Program or within the floodway fringe of certain waterways as Floodway Fringe Overlay Zones. Areas that are zoned as Floodway Overlay prohibit all new construction and reconstruction in the floodway, as well as infill, additions or renovations to structures, and alteration of land. Areas of the city zoned as Floodway Fringe Overlay are subject to special review procedures and performance regulations and are required to comply with flood proofing requirements.²⁵

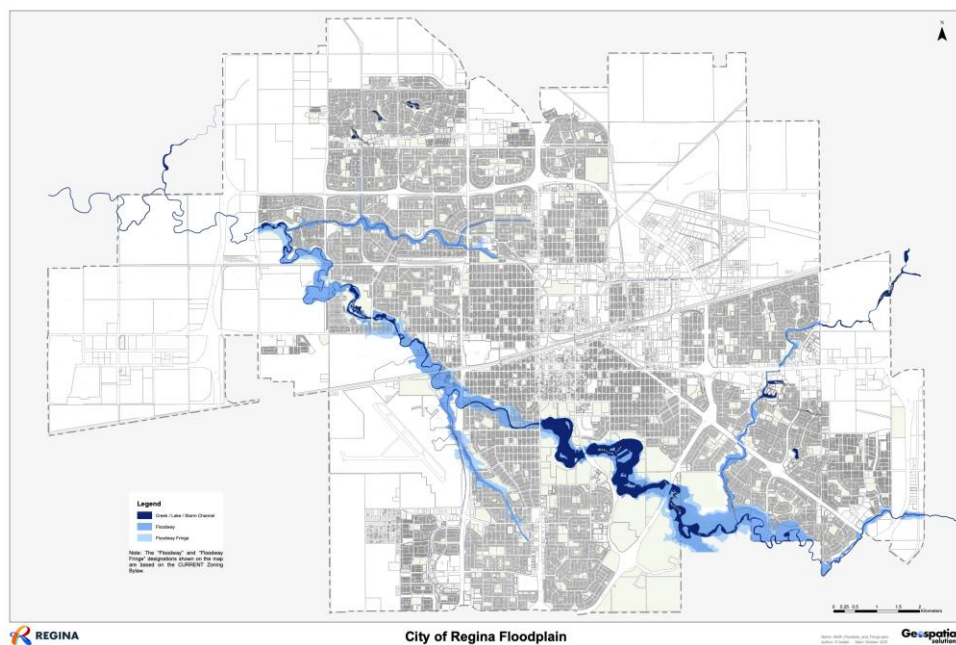


Figure 7. Floodplains identified in the City of Regina.

Summary

Zoning is a strong regulatory tool that can strategically direct high-occupancy and vulnerable uses, such as residential or critical infrastructure, to less hazardous areas of the community, and encourage development patterns that support water conveyance, storage, and drainage. For S_kw_xw₇mesh Úxwumixw, zoning may be utilized to strategically protect areas that contain natural ecosystems that provide flood mitigation capacity. Furthermore, for S_kw_xw₇mesh Úxwumixw reserves that are being prioritized for development, zoning can ensure that lower occupancy uses, such as recreation or ecotourism, are directed to higher-risk areas. Land uses that are more vulnerable to flooding, such as affordable housing or childcare, may be zoned in areas that are lower-risk or be subject to floodproofing requirements.

²⁵ City of Regina. (2019). Zoning Bylaw. (pp. 8.27, 8.61).

Urban Growth Boundary

Overview

An urban growth boundary (UGB) is a broad-scale land-use planning tool that can direct future urban growth and development in desired locations and prohibit development beyond the identified boundary. UGBs can target future growth in existing neighbourhoods to achieve multiple objectives, including creating compact and sustainable communities and reducing the burden of infrastructure and servicing expansion. In B.C., UGBs are commonly used to protect agricultural lands or environmentally sensitive ecosystems. However, UGBs are increasingly being used to limit urban growth in hazardous areas, such as the wildland-urban interface.

Case Study: Portland Metropolitan Region, Oregon

In 1973, the State of Oregon mandated that all municipalities designate a UGB due to concerns of urban sprawl into surrounding natural ecosystems and agricultural lands.²⁶ In the Portland Metropolitan Region, the Metro regional government coordinates the designation of the UGB for 27 jurisdictions.²⁷ The UGB supports multiple objectives, including encouraging the efficient use of urban land, protecting natural ecosystems and agricultural lands, and coordinating growth with neighbouring cities.²⁸ The Metro has also created a land reserve system for adding land to the UGB based on periodic reviews of projected 20-year population growth and the supply of buildable land. Under this system, land is designated as Rural or Urban Reserves. Urban reserves are areas that are prioritized for addition to the UGB. Rural reserves are areas that are protected from development for 50 years after designation, and contain agricultural land, forests, and rivers, wetlands, or floodplains.²⁹ While the Portland Metropolitan Region's UGB and rural and urban reserves system are not explicitly focused on mitigating flood risk, the designation of floodplain ecosystems as rural reserves indirectly targets urban growth away from high-risk flood areas, making it a valuable case study.

Summary

The Skwxwú7mesh Úxwumixw may utilize a UGB to avoid development in areas that have high flood risk. As many of the Skwxwú7mesh Úxwumixw reserves are located adjacent to waterways, the UGB could strategically exclude floodplains along key rivers such as the Squamish River, low-lying coastal areas that are vulnerable to sea level rise, or wetlands and estuaries from development. The Skwxwú7mesh Úxwumixw could also utilize something like Portland's land reserve system to identify lower-risk areas outside of the UGB that may be more appropriate for development as the nation pursues its housing goals.

²⁶ Metro. (n.d.). *The Nature of 2040*. (p. 2).

²⁷ Metro. (n.d.). *The Nature of 2040*. (p. 2).

²⁸ Metro. (n.d.). *The Nature of 2040*. (p. 6).

²⁹ Metro. (n.d.). Urban and Rural Reserves. <https://www.oregonmetro.gov/what-metro-does/land-use-and-development/2040-growth-concept/urban-and-rural-reserves>

Building Regulations

Overview

Building bylaws are regulatory policy mechanisms that regulate minimum standards in design and construction of new developments. These bylaws have often been designed for structural safety considerations; however, there has been a recent movement towards addressing climate hazards. Some jurisdictions have relied upon floodplain bylaws to serve a similar utility within the floodplain, which may include a DPA, as discussed above. Common mechanisms include requiring units to be built above Flood Construction Levels (FCLs), requiring setbacks from watercourses, and minimum requirements for critical flood mitigation infrastructure.

Bylaws exist in addition to provincial building codes. Therefore, building bylaws and floodplain bylaws enable the local governing body to adopt requirements that are context-specific and exceed minimum safety requirements set by the province. However, careful consideration and consultation is often required with the development and construction communities to ensure that the requirements are feasible to implement.

Case Study: City of Vancouver, B.C.

The [City of Vancouver's Building By-law](#) includes additional requirements for units within the floodplain, and further guidance is provided by the [City of Vancouver Flood Plain Standards and Requirements](#) document. Requirements within the bylaw apply to buildings within the designated floodplain, including regulating FCLs and setbacks and encouraging adequate drainage systems and other protective measures.

Summary

Bylaws have significant enforceability and are excellent tools for setting minimum standards in new buildings. However, as requirements within the bylaw are applicable to every development, they are not designed to provide aspirational targets. Specifically, regulating overly high standards within building bylaws can risk increasing cost and timelines for new developments. Therefore, more targeted bylaws can increase standards for buildings within the floodplain, thereby helping to reduce the exposure of sensitive developments to flooding.

However, the development and improvement of flood protection infrastructure, such as dikes, can encourage more sensitive development, such as residential areas, in floodplains and create a false perception of security. Implementing regulations on flood infrastructure minimums should be paired with other tools like design guidelines and zoning to strengthen community resilience.

Residential Design Plans

Overview

Building plans can be made available to the public to support and guide new buildings that suit local contexts. These plans can either be pre-approved by the governing body, which expedites the permitting process as the plan has already been deemed to suit the relevant local and provincial policies and risk factors. Or, the plans can be provided as examples, like the [BC Standardized Housing Design Catalogue](#), which could summarize best practice building plans for risks, such as flooding. Residential design plans are a voluntary policy tool which encourages residents to select, either for free or at a reduced cost, from existing options to expedite the process. Since this is voluntary, residents can also proceed as normal with their own design plan.

Case Study: District of Squamish, B.C.

The District of Squamish conducted a [design competition for flood-resilient multi-unit housing](#). Through this competition, nine building plans have been identified as suitable for Squamish's context, including zoning, development regulations, and flood risk. For example, Higher Ground is a medium-density development with stormwater management features and elevated living spaces to increase flood resilience (Figure 9). Plans can be purchased from the architect.



Figure 8. Higher Ground Residential Building Plan

Summary

Residential design plans can be paired with other tools, such as DPAs, to ensure that the plans are tailored to specific risk profiles. Pre-approved residential design plans require a high input of upfront resources to develop the plans and tailor them to the local context. However, this option requires fewer resources during the permitting review and approval process. Standardized residential design plans can offer a greater variety of choices, but still require a full permitting review. Skwxwú7mesh Úxwumixw could consider partnering with architects to develop their own standardized design plans. This policy tool can exclusively be used for new construction.

Design Guidelines

Overview

Design guidelines are a voluntary policy mechanism that communicates the governing body's goals and/or preferred approaches to developers and homeowners. Guidelines are tailored to suit the local context and can include a combination of text and visuals. The overall aim of this tool is to communicate above-minimum preferences for buildings, often housing. Overwhelmingly, design guidelines have been used to manage aesthetic qualities. However, there has been a recent emergence of design guidelines that support adaptation and resilience to climate hazards.

While design guidelines are voluntary policy mechanisms, they can be used in combination with other mechanisms – such as DPAs – for stronger enforcement in new development. For example, pairing a flood DPA with a flood design guideline could enforce that new development follows a preferred approach for building within the floodplain. Further, design guidelines can be used to communicate opportunities for existing buildings to retrofit and increase their flood resilience.

Case Study: City of Logan, Australia

The City of Logan, Australia, has experienced periodic flooding from the Logan and Albert Rivers, a risk that has been heightened due to land use decisions and climate change. In response, the City acknowledges that preventing flooding may not be possible; however, reducing the consequences of flooding is achievable. Therefore, Logan developed [a Flood Resilient Home Design Guideline](#) to communicate best practices for building “materials, construction systems, and house design types.” (p.1). Specifically, the guide intends to build flood resilience by reducing the impacts (i.e. reducing floodwater perfusion) and supporting recovery (i.e. reducing damage to valuable items).

The guideline provides an overview of different flood resilience opportunities across home types found in the City (Figure 9). Strategies are separated into wet proofing - such as replacing flooring with flood-resilient flooring or building swales around the building to divert water away from the home – and dry proofing strategies, such as including flood doors that minimize water entry into the building. The guide concludes with a “Flood Resilient Design Checklist.”

Some of the opportunities presented in the guide could be used to retrofit existing buildings. In these cases, the guideline helps to provide information to homeowners. However, these guidelines can also provide developers with a checklist of best practices that the jurisdiction would like to see included in new buildings.

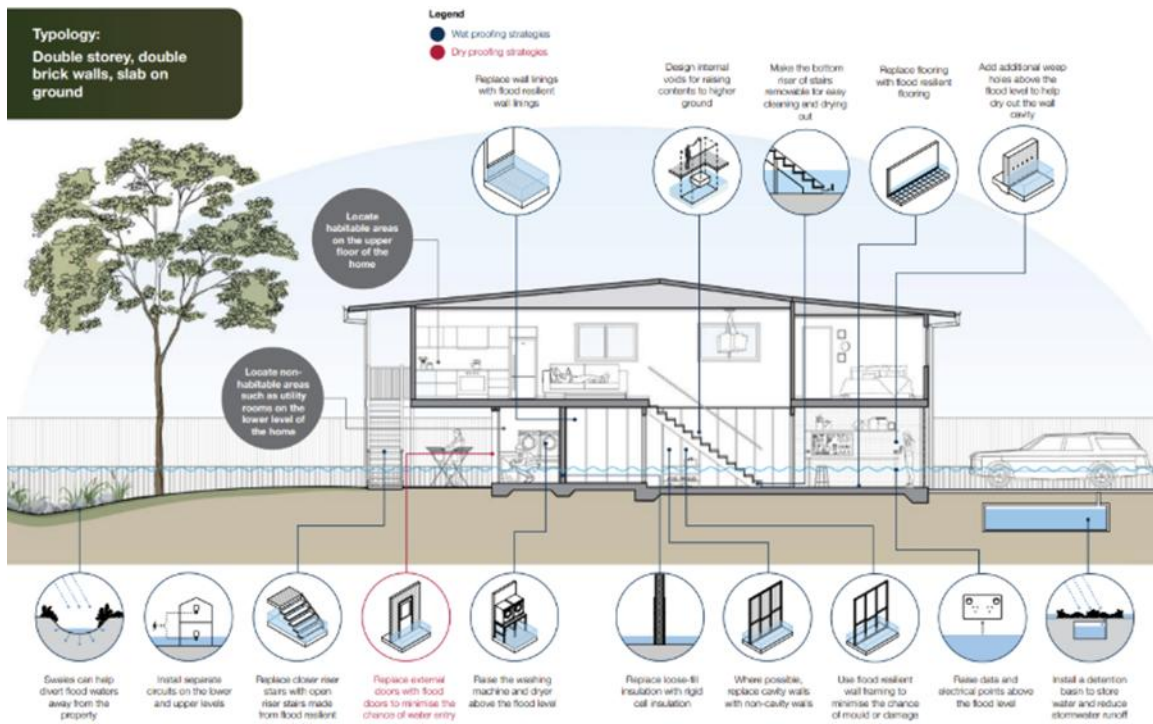


Figure 9. City of Logan Flood Resilient Design Guideline for a Double Story Residential Building.

Summary

Since design guidelines can be entirely tailored to the context, they provide governments with flexibility to shape development in their community. For Słwǫwú7mesh Úxwumixw, this could include guidelines that provide information on opportunities for retrofitting existing homes, which could be complemented with other retrofit programs. Or Słwǫwú7mesh Úxwumixw could develop guidelines that help shape new development by increasing construction standards where there are heightened flood risks.

The flexibility of this tool can also increase resource demand, both for writing the guidelines and reviewing development applications to ensure alignment. Further, since design guidelines are voluntary policy mechanisms, they do not guarantee an uptake of community flood resilience.

Coastal Restoration for Flood Risk Mitigation

Overview

Coastal restoration projects are a category of flood risk mitigation measures that use the ecological restoration of shorelines to reduce the impacts of sea level rise and coastal erosion. These types of projects may also be known as ‘living shoreline’ interventions.³⁰ They operate on the basic principle that healthy shorelines can better absorb wave energy and resist coastal erosion than ecologically degraded ones. These types of projects are often considered as an alternative to engineered ‘grey’ flood prevention infrastructure such as dikes and dams. Coastal restoration can avoid some of the negative costs and land-use tradeoffs associated with constructed flood infrastructure. They also characteristically have benefits beyond simple flood protection, such as enhancement of natural shoreline dynamics, improvement of coastal habitat, and enhanced opportunities for human access to the shoreline.

Case Study: Tsleil-Waututh Reserve Shoreline Adaptation & Restoration Project

Tsleil-Waututh First Nation (TWN) is currently undertaking a [multi-year nature-based shoreline restoration project](#) on their reserve lands on the north shore of Burrard Inlet to strengthen and protect community lands and improve community member access to the shoreline in the face of worsening coastal erosion and coastal squeeze. TWN's shoreline is actively eroding, in part due to climate change, vessel wakes on Burrard Inlet (which will likely increase with larger vessels in the future), and loss of upland sediments.³¹ Up to 13 meters of land has already been lost in some places. Previously, rip rap had been placed along the shoreline to try to address these impacts, but this wasn't successful at mitigating erosion and disrupted habitat and intertidal connectivity.



Figure 10: Area of TWN Reserve Shoreline Adaptation and Restoration Project.

³⁰ British Columbia Ministry of Environment, 2013, p. 82

³¹ DHI, 2025

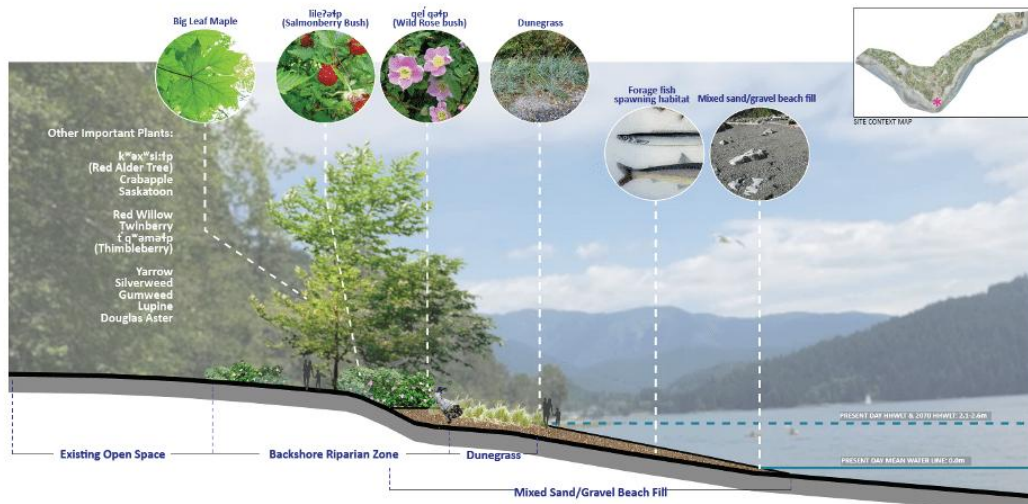


Figure 11: Coastal restoration “cross-section” from another similar project being undertaken by Tsleil-Waututh at Whey-ah-Wichen (Cates Park).³²

The project work will include creating rock headlands, oyster revetments, and a habitat island in the project area, placing clean fill in the upper intertidal zone to feed the beach, and planting new shoreline and intertidal vegetation that is appropriate for the area.³³ The shoreline restoration work aligns with multiple objectives outlined in TWN's [Land Use Plan](#), and builds on and supports their Comprehensive Community Plan, [Stewardship Policy](#), and [Burrard Inlet Action Plan](#).



Figure 12: Planned timeline for TWN Reserve Shoreline Adaptation and Restoration Project.

The work is being supported by a \$10.1 million investment, consisting of \$7.6M from the Green Infrastructure Stream of the Investing in Canada Infrastructure Program and \$2.5M from TWN with support from the Province of BC.^{34,35}

³² Tsleil-Waututh Nation, 2025

³³ <https://twnation.ca/twn-reserve-shoreline-adaptation-project/#introductiontoproject>

³⁴ <https://news.gov.bc.ca/stories/federal-government-invests-in-shoreline-adaptation-and-restoration-for-the-tsleil-waututh-nation>

³⁵ <https://www.nsnews.com/local-news/tsleil-waututh-nation-receives-over-75-million-to-restore-their-shores-10406178>

Case Study: Mud Bay Nature-based Foreshore Enhancements

The City of Surrey, in partnership with the City of Delta and Semiahmoo First Nation, is undertaking a nature-based coastal flood risk mitigation project through the [Mud Bay Nature-based Foreshore Enhancements Project](#). The project was identified as part of Surrey's [Coastal Flood Adaptation Strategy](#), and it is one of thirteen coastal flood adaptation projects throughout the City of Surrey being supported by \$76 million from the [Government of Canada's Disaster Mitigation and Adaptation Fund](#). The project plans to create a 'living dyke', using extra sediment, salt marsh plants, and other materials to gently raise the shore level in front of important roads and other infrastructure. Notably, an adaptive management approach is a central aspect of the project. Two initial restoration test sites are being developed as pilots, and different stabilization, fill, and planting techniques are being tried, evaluated, and refined as the project progresses to help inform techniques and approaches for similar future projects in the region.



Figure 13: Mockup of planting of the Mud Bay living dyke site.

Summary

Sk̓w̓x̓wú7mesh Úxwumixw has had some recent experience in coastal restoration work through partnership on the [Restore the Shore project](#) in the Skwelwil'em Squamish River estuary. While Restore the Shore emphasizes ecosystem function and habitat as its primary goals, many of the same techniques, structures, and expertise could potentially be leveraged towards similar undertakings aimed at reducing community flood risks.

Coastal restoration projects can reduce coastal flood risk by improving the integrity of a shoreline area in a way that is relatively cost-effective, as well as providing local ecological and human benefits. While their relative benefits are many, one significant trade-off is that they have vis-a-vis traditional engineered infrastructure is that they often take up more square footage than, for example, a sea wall. Therefore, coastal restoration as a primary flood risk mitigation measure may not be practicable where buildings or infrastructure are already close to the foreshore and available land is constrained. That said, the Mud Bay project provides an example of a coastal restoration project being undertaken that attempts to expand the littoral zone back outward without taking up additional existing space on land. It is important to remember that coastal restoration and traditional flood defenses are not either-or. Where space and finances permit, they can also be combined to gain some of the benefits of both.

Riverine Restoration for Flood Risk Mitigation

Overview

Riverine restoration projects utilize the flood mitigation properties inherent to wetland ecosystems, river shorelines, and meandering watercourses to build long-term flood resilience with additional ecological and social co-benefits often in the form of increased biodiversity and improved community access to natural spaces and shores.³⁶ Often falling under the umbrella terms of ‘nature-based solutions’ and ‘green infrastructure,’ these projects serve as an alternative to engineered riverine infrastructure such as riprap and dikes that often narrow and artificially direct watercourses at the cost of environmental degradation and decreased resilience. Riverine restoration projects also typically lower total costs of projects, but can also require increased space to implement and can therefore be difficult in space-constrained urbanized areas; to increase feasibility, they can be combined with traditional ‘grey’ infrastructure where needed to produce ‘hybrid’ projects that both maximize benefits and minimize trade-offs. Green infrastructure incorporated into the constructed environment adjacent to rivers, such as permeable soils and stormwater cisterns, can function synergistically alongside natural river restoration projects to further reduce flood risk to affected communities.³⁷

While project details are not publicly available, there are a number of Indigenous-led riverine restoration projects currently being undertaken by First Nations across Canada with funding from the [Indigenous Community-Based Monitoring Program](#) and the [First Nations Adapt Program](#). These programs provide funding across multiple stages of natural flood mitigation projects, including initial assessment and planning, implementation, and ongoing monitoring. As of 2025, the Seabird Island Band and the Leq'á:mel First Nation, both located in the Lower Mainland along the Fraser River, respectively received \$138,000 and \$631,000 for natural approaches to flood mitigation and adaptation on their traditional territories.³⁸

Case Study: Syilx Okanagan Nation Alliance River Restoration Initiative

Originally conceived in 2000 after significant channelization and diking of the Okanagan River, the Syilx Okanagan First Nation Alliance is currently implementing its long-term [River Restoration Initiative](#) with the goal of returning the watershed to natural conditions by restoring ecological and hydrological functions that include reconnecting historical floodplains, re-establishing river meanders, and creating wetland pond habitat for spawning salmon. After phase I implementation in 2009, monitoring found significantly increased rates of natural vegetation growth, usage by key species at risk, and sockeye salmon survival rates.

³⁶ Skidmore, P., & Wheaton, J. (2022).

³⁷ Huang, Y., Tian, Z., Ke, Q., Liu, J., Irannezhad, M., Fan, D., Hou, M., & Sun, L. (2020).

³⁸ <https://www.rcaanc-cirnac.gc.ca/eng/1509728370447/1594738205979> and <https://www.rcaanc-cirnac.gc.ca/eng/1481305681144/1594738692193#cp5>

Most recently, in January 2026, the initiative restored functionality to 20,000 m² of riverine habitat and 50,000 m² of floodplain habitat and incorporated grey and green infrastructure by following a vision drawn from Syilx traditional ecological knowledge³⁹. Project phases have involved multiple and diverse partners, including the provincial and federal departments, nature trusts, habitat non-profit organizations, and other First Nations; most recently, funding was secured from the South Okanagan Conservation Fund.

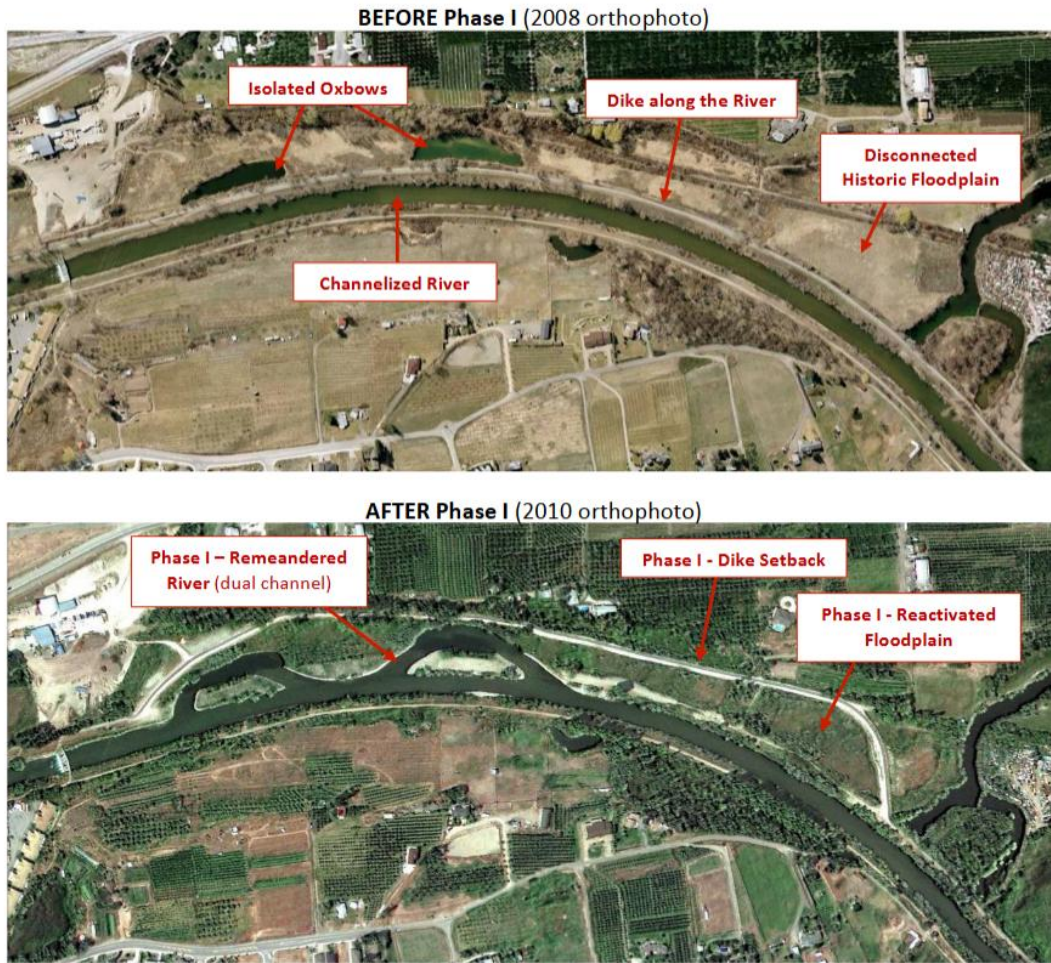


Figure 14. Results of Phase I of the Syilx Okanagan Nation Alliance River Restoration Initiative.

While flood protection is not a primary stated goal of the project, the initiative nevertheless provides an effective (and thus far successful) blueprint for natural riverine restoration that implements nature-based wetland habitat and watercourse restoration that improves natural flood resilience with simultaneous benefits to habitat for culturally important fish and wildlife. The success of this initiative also illustrates that incorporating the framing of natural riverine restoration projects around wildlife habitat restoration can increase funding opportunities, project partners, and inter-departmental collaboration to achieve flood mitigation goals.

³⁹ South Okanagan Conservation Fund (2025).

Case Study: City of Courtenay Municipal Natural Assets Initiative

The downtown core of the City of Courtenay lies along the Courtenay River corridor and after multiple substantial flood events in 2009, 2010, and 2014, the City explored the costs, benefits, and overall feasibility of using natural assets for flood mitigation. The resulting [Courtenay River Municipal Assets Initiative Technical Report](#) assessed the trade-offs between economic cost and flood protection for three different approaches: an approach that used only traditional grey infrastructure, an approach that uses a mix of grey infrastructure and natural asset restoration, and an approach that used only natural asset restoration (that would additionally require the buyout and managed retreat and relocation of riverside properties due to spatial requirements).

Assessed natural asset approaches included widening the Courtenay River to naturalize the full river channel, the restoration of natural foreshore and water flow paths, the re-establishment of natural flow paths, and the gradual managed retreat from the impacted floodplain. Results showed that proposed natural asset restoration could effectively mitigate costs and damages from future flood scenarios by up to \$2.4 million, but additional strategies such as engineered dikes and policy changes would also be required, given the urbanized nature of the Courtenay River corridor. The City is now undertaking the development of a flood management plan that will incorporate both natural asset restoration and engineered approaches to create a comprehensive hybrid approach to flood mitigation in its downtown core.



Figure 15. Natural and engineered assets utilized in the study (left) and the aftermath of a 2014 flood in downtown Courtenay (right).

The Courtenay River study illustrates how the restoration of natural assets can be incorporated with traditional grey infrastructure flood mitigation approaches to balance effectiveness with spatial and economic constraints in an urbanized area. Where managed retreat is not possible due to either spatial or financial constraints, effective natural solutions can still be combined with spatially efficient grey infrastructure to increase flood protection. Ongoing efforts from the City to develop a comprehensive flood management plan are funded through the [BC Community Emergency Preparedness Fund](#), which provides funding for municipalities and First Nations to develop climate adaptation, disaster risk reduction, and structural flood mitigation strategies.

Summary

Nature-based solutions to riverine flood mitigation can leverage land use planning, emergency preparedness and response, and environmental restoration to synergize and combine goals across jurisdictions and improve lines of inter-departmental and inter-jurisdictional communication. Skwxwú7mesh Úxwumixw could utilize riverine nature-based solutions across multiple reserves as they can be shaped to provide benefits in both rural and urban areas with differing contexts and needs. They can also provide numerous social and cultural benefits, including increased access to shorelines and increased abundance of culturally relevant riverine plants.

As shown in the preceding case studies, riverine restoration projects are flexible and can be applied on both large (watershed level) and small (neighbourhood level) scales. Nature-based solutions to riverine flooding can be adapted according to area-specific contexts, goals, and constraints via multi-stakeholder collaboration and the incorporation of hybrid solutions that incorporate both grey and green infrastructure. These flood mitigation projects also mesh well with wildlife and restoration projects and can be framed through both lenses to garner additional opportunities for funding, support, and collaboration from wildlife and restoration institutions.

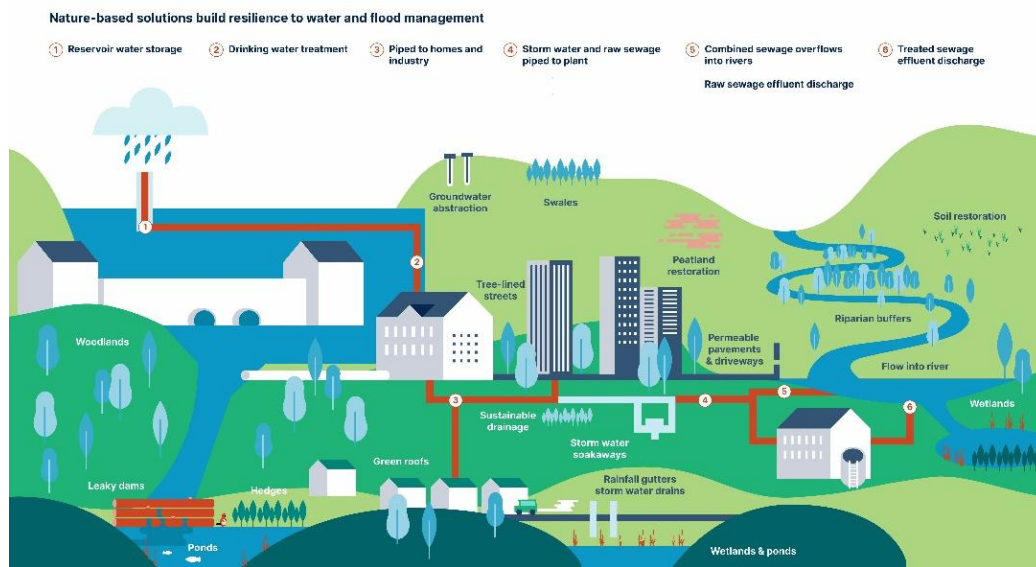


Figure 16. Examples of riverine nature-based solutions using natural restoration and green infrastructure.

Climate Adaptation for Flood Management

Overview

Flooding frequency and magnitude are being altered by climate change. Sea level rise, increased and changing precipitation, and temperature increases will impact flooding in and around Skwxwú7mesh Úxwumixw reserves.⁴⁰ One way to consider the influence of climate change on flooding is through a climate resiliency or climate adaptation plan. Such a plan would align with goal 14 of the [Skwxwú7mesh Úxwumixw Climate Legacy Strategy](#), which outlines the goal of implementing adaptation strategies to manage climate hazards. Climate adaptation plans center on climate impacts, where resiliency plans additionally consider other stressors on community values like population dynamics and cumulative effects. Both types of plans can be used to identify priority areas for adaptation action.

In climate plans, adaptation priorities are often determined through a risk or vulnerability assessment. Risk assessments are a more technical assessment and are used to determine what areas of a community are most at risk based on the probability of an event and its impact (often expressed as risk = likelihood x consequence).⁴¹ A vulnerability assessment can help identify key areas of concern and is sometimes used in conjunction with a risk assessment to determine priority areas for action. Vulnerability assessment methods can vary, but are sometimes expressed as vulnerability = sensitivity x exposure x adaptive capacity.⁴² Sensitivity refers to how affected the community would be if it were to interact with a given hazard, exposure refers to what is exposed or the degree of interaction with a hazard, and Adaptive Capacity refers to the ability to adapt and adjust to changing conditions.⁴³

Case Studies: City of Prince Rupert, B.C. and Tsleil-Waututh Nation

[The City of Prince Rupert Climate Change Adaptation Plan](#) undertakes both a vulnerability and risk assessment. The plan uses vulnerability and risk assessments to identify six risk themes for the city and proposes 23 actions to adopt. This plan is an excellent resource as it provides transparency in how each assessment is conducted in the appendices. Flooding emerges as the fifth-highest climate hazard risk to the city and directly affects half of the identified risk themes.

⁴⁰ ClimateData (2026). Total Precipitation. *Climatedata.ca*.




















⁴¹ Local Governments for Sustainability (ICLEI). (2025). *Building Adaptive and Resilient Communities: A Framework for Local Action*.

⁴² Tsleil-Waututh Nation. (2019). *Understanding our community's climate change vulnerabilities*.

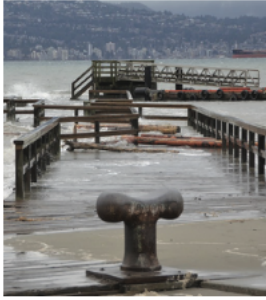
⁴³ City of Prince Rupert. (2025). *The city of Prince Rupert climate change adaptation plan*.

The Tsleil-Waututh Nation’s Climate Resiliency Plan is an excellent example of an Indigenous climate strategy that centres on a vulnerability assessment, which is best outlined in the report [Tsleil-Waututh Nation: Understanding our Community’s Climate Change Vulnerabilities](#). The report includes a matrix that identifies each assessed community element’s vulnerability to each assessed hazard on a low-high scale, as seen in Table 1. The assessment helps identify which elements are most vulnerable to climate change, helping prioritize the Nation’s actions in the next phases of the plan.

Table 1. Summary of TWN’s Climate Vulnerability Assessment.

SECTOR	ELEMENT	Coastal Flooding	Coastal Erosion	Intertidal Area Change	Ocean Acidification	Harmful Algal Blooms	Other Ocean Conditions	Creek Flooding	Creek Erosion	Urban Flooding	Extreme Heat Events	Wildfire	Vector-Borne Diseases	Invasive Species	OUR MOST VULNERABLE ELEMENTS 	
		SEA LEVEL RISE			OCEAN CHANGES			PRECIPITATION CHANGE			TEMPERATURE CHANGE					
 Ecological Systems	Shellfish		Med	High	High	Med	High		Low					Med		
	Salmon			High	Med	Med	High	Med	Low					Med		
	Forage fish		Med	High	Med	Med	High							Med		
	Other finfish			Med	Med	Med	High							Med		
	Marine birds and waterfowl			Low	High	Med	Low	High								
	Marine and semi-aquatic mammals			Low	Med	Med	Low	Med				Low				
	Beaches and shoreline	Med	High	High	Med				Med			Low	Med		Med	
	Tidelands and marine habitats	Med	Low		Med			High				Low			Med	
	Marine water quality	Low	Low			Med	High	Med	Low	Med	Low					
	Upland wildlife	Low	Low	Low	Low	Low	Low	Low	Low			Med	High			
	Forested areas and medicinal plants	Med	Med						Low	Low		High	High		Med	
	Freshwater creeks, streams, wetlands, and groundwater	Med	Low						Med	Low	Med	High	Low			
Air quality											High	High				
 Land Use and Real Estate	Near-shore lands	Low	Low					Low	Low	Med		Med		Med		
	TWN community housing	Low	Med					High	Low	High		High	High	Med		
	Market (leasehold) housing							Low		Low		High		Low		
	Community buildings	Med	Low					Low	Low	Med		High		Med		
	Hazardous sites	Med														
	Future land use opportunities	Low	Med					Low		Low			Med		Med	
 Infrastructure and Community Services	Water supply and distribution system	Low	Med					Med	Med		Med	Low				
	Sewer/Wastewater collection system	Med	High					High	Med			Low				
	Stormwater system	Med	Med					High	Med	Low		Low				
	Roads and emergency access	Med	High					High	Med	Med	Med	Med	Med			
	Energy and telecommunication systems	Low	Med					Low	Med	Low	Med	Med				
 Archaeological and Cultural Heritage Sites	Archaeological sites	High	High	Med	High			High	Low	Low	High	High		Med		
	Cemetery	Low	Med							Low		Low				
	Other cultural and traditional use sites	High	Med	High				High	Med		Med	Med	Low	Med		
 Community and Cultural Health	Physical health (general population)	Low	Low			Med		Low	Low	Low	Med	Med	Low	Med		
	Mental health	Med	Low	Low				Low	Low	Low	Low	Med	Low	Med		
	Vulnerable populations	Low						Low	Low	Low	High	Med	Med	Med		
	Social, cultural, and spiritual well-being	Med	Low	High	Med	Med	High	Med	Med		High	Med	Low	Med		
 Economy	Employment and productivity	Med	Med					Med	Med	Med	Low	Med	Low			
	Commercial assets	Low	Low	Med						Low		Low				
	Future economic development opportunities	Low	Med			Med		Low	Low			Med				

Both plans are strengthened by the integration of community knowledge, climate projections, and some consideration of hazard impacts. TWN’s work was informed by a climate summit, presentations, a youth and elders forum, and a working group. Prince Rupert’s work was informed by a workshop, focus groups, interviews, and an advisory committee. For hazard impacts, Prince Rupert’s assessment provided a score of the threat based on projections, whereas TWN’s provided a qualitative description of hazard impacts related to projections. Examples of both methods can be seen in Figure 17.



COASTAL FLOODING



Coastal flooding occurs when a combination of tides, wind, and waves cause ocean water levels to rise and flood shoreline areas. Flooding will be even more severe when added to longer-term sea level rise (SLR). **Coastal flood hazard modelling results showed that most waterfront properties may experience flooding during an extreme flood under a 2 m sea level rise scenario. The most impacted structures are located near the mouths of George Creek and include a sewer main, the community canoe shed, and other cultural sites along the shore.**

Flooding Summary		
Hazard Threat	Very Low (0.8)	Events are anticipated to be similar to historic trends, where very small increases in frequency and severity will be seen in the mid-term future. Changes to precipitation indicators are all less than 20%.

Figure 17. Flooding considerations in the TWN (above) and Prince Rupert (below) Climate plans.

Summary

Climate adaptation could be developed by Sᓵwᓵwú7mesh Úxwumixw to create adaptation responses applicable to the broad territory and to the contexts of specific reserves. Though there are multiple approaches to climate adaptation and climate resilience work, a useful starting point is the Centre for Indigenous Resources, which provides a [6-guidebook resource](#) on undertaking climate adaptation planning in an Indigenous community. Such work undertaken by Sᓵwᓵwú7mesh Úxwumixw may be eligible for funding, including funding from the [First Nation Adapt Program](#). The program can help fund the development of assessments, the identification of interventions, and the application of interventions (under \$250,000).

When specifically considering the threat of flooding, climate adaptation resources can be developed to emphasize the level of concern for this hazard. For instance, TWN differentiates between the vulnerabilities associated with coastal, urban, and creek flooding, which enables readers to understand the diversity of pressures associated with climate change and flooding. The process of climate planning also provides an opportunity to integrate the lived experiences of members and insight from elders and knowledge holders. Such insight can place emphasis on top community concerns, so flood mitigation planning tools can be applied appropriately.

As climate change is already altering the status quo, adaptation measures are necessary to uphold the well-being of members and values. Climate adaptation and climate resiliency work are opportunities for culturally relevant and appropriate interventions to take place. Stewarding reserve lands using a climate adaptation lens enables the continuation and resurgence of Sᓵwᓵwú7mesh Úxwumixw ways of being, knowing, and doing. As Sᓵwᓵwú7mesh Úxwumixw reserve inventory is extensive and geographically diverse, the Nation may consider prioritizing populated reserves or reserves the Nation is considering developing for reserve-specific adaptation measures.

Conclusion

Skw̓wú7mesh Úxwumixw reserve lands in Vancouver, the North Shore, the Squamish Valley, and the Sunshine Coast are at risk of flooding, in different proportions, from pluvial, fluvial, and coastal sources. Neighbouring jurisdictions in these areas employ a wide variety of flooding plans, and policies that, depending on the specific geographic context, may decrease the overall local risk of flooding, or in some contexts may actually increase the risk posed to Skw̓wú7mesh reserve lands.

A variety of land use and other planning tools exist that may be useful for Skw̓wú7mesh in decreasing flood risk to reserve lands, especially for areas slated for new development in the near term. The risk profile for each area of land is context-specific, and the particular sources of local risk will help determine which tools may be most effective or appropriate in each instance. Flood risk mitigation measures may be used alone or in combination with each other in different areas.

The planning tools we reviewed in this report fall under three primary themes. The first is managing growth patterns to minimize risk, which includes zoning and urban growth boundaries that guide or restrict development away from areas especially vulnerable to flooding. Avoiding flood hazard in this way is ideal from a pure risk point of view, but in Skw̓wú7mesh's context of planning for development on relatively limited parcels of reserve lands, the constraints on this are of course fairly significant. The second theme grouping is tools that guide the shape of development to minimize risk where a certain level of flood hazard is a given. This includes DPAs, design guidelines, residential design plans, and other building regulations. These tools may have some drawbacks in terms of adding time and expense to the development process, but they can help ensure that buildings are adapted to their context. The third theme includes measures that work to reduce an area's vulnerability to flooding, or resist the hazard in one way or another, including nature-based solutions such as coastal and riverine restoration, and climate adaptation work. These types of tools can have significant co-benefits, such as improvements in local ecological health and community well-being, though they can have other cost, space, and capacity tradeoffs. For all tools, other important considerations are the existence of proven case-relevant examples and outside funding streams that might be able to support their implementation.

We hope that this consideration of flood risk context and collection of risk mitigation tools will be helpful for Skw̓wú7mesh Úxwumixw in considering how best to meet community goals, especially related to housing development, while keeping the community safe from flooding and related hazards into the future.

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