Incorporation of Indigenous Priorities in Sea Level Rise Adaptation

A Case Study of the Rock Bay Site, Victoria, Canada

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Executive Summary

Indigenous peoples have been sustainably stewarding their traditional lands since time immemorial. While some of the lands and knowledge have been lost through the violent effects of colonization, many nations are working to restore and regain their lands and traditional knowledge (OECD, 2019). The Songhees and Esquimalt Nations, through Matullia Holdings Limited Partnership (Matullia), repurchased 7.5 acres of land adjacent to Rock Bay (Site) in the Victoria Harbour to reclaim part of their traditional territory and share in the economic benefits of their traditional lands.

Climate change and its associated impacts are critical components of planning for the future that Matullia must consider. This paper discusses potential sea level rise (SLR) adaptation measures, focusing on Indigenous values and priorities pertaining to the Rock Bay Site in Victoria, BC. The paper is prepared for Matullia with support from their sub-consultants responsible for creating a Master Plan. At the Site area, BC Guidelines recommend designing for an SLR increase of 0.5 m by 2050, 1 m by 2100, and 2 m by 2200 (Capital Region District, 2021). This paper analyzes SLR adaptation options at the Rock Bay Site. The analysis included a preliminary evaluation of a wide range of SLR adaptation tools and a decision matrix analysis of a short list of SLR adaptation tools. The decision matrix included the following weighted criteria that align with the three Matullia priorities:

1. Generate wealth for the Nations – Cost (35%)
2. Think to the future (200+ years) – Effectiveness (20%) & Durability (10%)
3. Make Rock Bay a source of pride – Indigenous values (15%), environmental benefits (15%), and opportunities for social opportunity (5%)

The highest ranked SLR adaptation tools for the Rock Bay Site based on the preliminary evaluation and decision matrix are the following:

1. Soft shorelines: Incorporate natural features in the shoreline, which is currently riprap with a vegetative bench. The natural features can include vegetated riprap or a gentle slope at the crest with natural vegetation.
2. Structural elevation: Place fill to raise the land to the flood construction level. This can likely be completed concurrently with geotechnical stabilization to reduce costs. A gentle slope with space for natural vegetation can be considered.
3. Emergency preparedness: Create a plan that documents the steps to be taken in case of a flood. This can lead to increased resiliency and reduced damage.

4. Wet floodproofing: Construct buildings that allow for the safe passage of water while designing electrical outlets and other critical equipment above the flood construction level.
5. Oyster beds: Create oyster beds along the shoreline that help dissipate wave energy.

It is recommended to achieve flood resiliency through various SLR adaptation measures. Soft shorelines are moderately expensive and effective but provide high environmental benefits and alignment with Indigenous values. The shoreline can be softened during all phases of the development. Emergency preparedness and wet floodproofing increase flood resiliency and can be implemented in the near term due to their low cost. Structural elevation is highly effective and should be strongly considered further during Phase 2 of the development. Completing structural elevation in the future offers two benefits: cost sharing with the geotechnical stabilization project and additional time for improved SLR projections. Lastly, although oyster beds are not recommended as the site has minimal wave effects, they are relatively low cost. They can be incorporated with the soft shorelines if they are of cultural value to the Nations.

The Songhees and Esquimalt Nations can reap economic benefits in the present without negatively impacting the future. Sustainable Indigenous-led management of the Rock Bay Site, which is located near downtown Victoria can be a significant source of pride for the Nations. To achieve Indigenous priorities and advance Indigenous values, Matullia LP is already planning to daylight a creek, increase public access to green space, and create a healthy native habitat along the mouth of the creek. Improving coastal flood resiliency through careful planning can reduce potential damage to the Site while creating a model for other Indigenous-led partnerships in reclaiming lands and improving resiliency to the effects of climate change.

Contents

1. Introduction **1**
1.1 Positionality 2
1.2 Indigenous Land Management 2
Generate wealth for the Nations. 3
Think to the future (200+ years) and align with the Sacred Trust 4
Make Rock Bay a source of pride 5
2. Methods **5**
3. Site Background **6**
3.1 Location 6
3.2 History 7
3.3 Ownership and Future Plans 7
3.4 Creek Daylighting – Example of Indigenous Land Management Values 9
4. Sea Level Rise **11**
4.1 Site Context 11
4.2 Mitigation and Adaptation 14
5. SLR Adaptation Tools **15**
5.1 Hard Protection 15
Dikes 15
Scour Protection 16
Structural Elevation 17
Wet Floodproofing 17
5.2 Soft Armouring 18
Coastal Wetlands 18
Dune Building 19
5.3 Other 20
Oyster Beds 20
Soft Shorelines 20
Living Dikes 21
Emergency Preparedness 22
6. Feasibility Study **23**
6.1 Decision Matrix 23
6.2 Limitations and Data Gaps 26
7. Discussion **26**
8. Conclusion **29**
9. References **31**

Table index

Table 1 Information regarding dikes (The Arlington Group Inc et al., 2013) 16
Table 2 Information regarding scour protection (The Arlington Group Inc et al., 2013) 16

Table 3	Information regarding structural elevation (C40 Knowledge Group & C40 Cities Climate Leadership Group, 2022; The Arlington Group Inc et al., 2013)	17
Table 4	Information regarding wet floodproofing (FEMA, 2021; The Arlington Group Inc et al., 2013)	18
Table 5	Information regarding coastal wetlands (NOAA Fisheries, 2022b; The Arlington Group Inc et al., 2013)	19
Table 6	Information regarding dune building (The Arlington Group Inc et al., 2013)	19
Table 7	Information regarding oyster beds (NOAA Fisheries, 2022a; Walles et al., 2016)	20
Table 8	Information regarding soft shorelines (NOAA Fisheries, 2022c)	21
Table 9	Information regarding living dikes (Living with Water, 2022; The Arlington Group Inc et al., 2013)	22
Table 10	Information regarding emergency preparedness (PreparedBC, 2023; UNISDR, 2015)	23
Table 11	Decision Matrix to evaluate SLR adaptation tools using Indigenous priorities	25

Figure index

Figure 1	MFA's Understanding of Songhees and Esquimalt Nations' Priorities for Rock Bay (MacLeod Farley & Associates, 2022)	3
Figure 2	The Sacred Trust (MacLeod Farley & Associates, 2022)	4
Figure 3	Site Location (Formline Architecture + Urbanism & PFS Studio, 2023)	6
Figure 4	Conceptual sketch showing development principles for Rock Bay (City of Victoria, 2017)	8
Figure 5	Geotechnical understanding of the on-site quality and stability (Ryzuk Geotechnical, 2020)	9
Figure 6	Finlayson Falls near Rock Bay, captured in 1860 (BC Archives, 1998)	10
Figure 7	Sea Level Rise (City of Vancouver, 2018)	11
Figure 9	Rock Bay Flood Construction Level Model (Associated Engineering, 2021)	12
Figure 10	Flood Construction Levels Inputs (FCLs) (Associated Engineering, 2021)	13

1. Introduction

Indigenous peoples, including the peoples of the Songhees and Esquimalt Nations of present-day Victoria, have lived in North America since immemorial and have a history of land management in foreshore harbours. They are the original stewards of these lands and have sustainably lived in North America for centuries. Indigenous peoples have a wealth of knowledge due to their close relationships with the land (OECD, 2019). However, Indigenous knowledge and connection with place have been largely under threat due to colonization and the consequent theft of their traditional lands (Armao, 2021). This close relationship also uniquely positions Indigenous peoples to manage lands sustainably while planning for climate change impacts. Indigenous land reclamation has been a significant strategy in Indigenous peoples recovering their lands and exerting their traditional rights to act as stewards.

The ways in which the impacts of climate change are being felt around the globe are frequently discussed in the news, academia, and social media. These impacts include decreased biodiversity and food and increased temperatures, severe storms, drought, ocean temperature, and sea levels (United Nations, n.d.). Indigenous peoples are also disproportionately sensitive to the effects of climate change (National Collaborating Centre for Indigenous Health (NCCIH), 2022). Climate change is leading to increased human displacement due to the significant impacts on human rights, such as food and land for shelter. Climate change impacts associated with sea level rise (SLR), such as coastal flooding, are also particularly applicable to coastal cities such as Victoria in British Columbia. Global SLR has increased by 0.2m from 1901 to 2018, and the rate of rise is only accelerating (Marshall et al., 2021). An estimated 360 million people globally live in areas below the high-tide level of the future, even if humans make a monumental lifestyle change to stop greenhouse gas emissions (Marshall et al., 2021).

Water risks in Canada are significant, as estimated economic losses due to floods will reach $30 billion by 2050 (GHD, 2022). Sea level rise due to climate change will affect Canadian coastal cities and consequently necessitate mitigation measures. One such location that is increasingly vulnerable to coastal floods related to SLR is the Rock Bay Site (Associated Engineering, 2021). The Rock Bay Site is located within the Victoria Harbour and was recently purchased by the Songhees and Esquimalt Nations, through their Matullia Holdings Limited Partnership (Matullia), for economic development and to reclaim their traditional territory. As Indigenous peoples reclaim their lands, they face the impacts of climate change and are challenged with the task of adaptation. This report discusses potential sea level rise adaptation measures, focusing on Indigenous values and priorities, as it pertains to the Rock Bay Site in Victoria, BC.

1.1 Positionality

Within Indigenous worldviews, knowledge is considered relational, meaning that the knowledge we hold and present is shaped by our relationships with the world around us (S. Wilson, 2007). As such, I believe it is essential to briefly explain my background and how I came to this project. After immigrating from India at the age of 12, I lived on the traditional territories of many nations, including the Mississaugas of the Credit, the Anishnabeg, the Chippewa, the Haudenosaunee and the Wendat peoples (Toronto, Ontario). Although I was acutely aware of race relations in Canada based on my presence as a visible minority, I was unaware of Indigenous relations in this country until I first heard of the 2015 findings of the Truth and Reconciliation Commission (TRC) Call to Action. Additional readings and podcasts of nuanced stories about the injustices Indigenous peoples face in this country contributed to my interest in pursuing small acts of reconciliation, where possible. In this journey, I reached out to MacLeod Farley & Associates, a community development consulting firm owned by my partner's parents, for a possibility to work on one of their projects that focus on Indigenous community development. This led me to Rock Bay, a fascinating site in Victoria where Esquimalt and Songhees Nations purchased a site and are looking at ways to sustainably develop the site while looking towards the future.

I recognize that I spent my teenage years in predominately settler communities with a Western worldview and education system. I obtained an undergraduate degree in geological engineering and have been working as an environmental engineer with GHD Limited for the past eight years. Working as an environmental engineer also provided me with experience using feasibility studies to explore potential solutions to a problem. Although we worked on projects where Indigenous peoples were included in the consultation process, their priorities and rights were not considered. That also increased my motivation to pursue this project where Indigenous priorities are at the forefront. However, it is essential to note that the format of this report and the findings are a product of my Western learnings and do not reflect Indigenous worldviews. Any mention of Indigenous values in this report is based on my minimal understanding of the wide variety of Indigenous worldviews and the priorities of Esquimalt and Songhees Nations, much of which I have learned through written reports.

1.2 Indigenous Land Management

Land is crucial for sustainable economic development. The land also holds much meaning for Indigenous peoples. The history of Indigenous lands in Canada since the arrival of Europeans is one of colonial violence and broken promises (Morin, 2020). Additionally, land sustains the present and future generations and is connected to spiritual values, traditional knowledge, and cultural reproduction.

Holding land rights is essential to reinforce nationhood and achieve self-determination (OECD, 2019). As such, the land holds special meaning to Indigenous peoples across Canada.

MacLeod Farley & Associates (MFA), a community development consulting firm, completed an Initial Findings Report in November 2022 based on meetings with shareholders and site visits to the Rock Bay Site, Songhees, and Esquimalt First Nations. The Report reflected the priorities of the site owners and provided recommendations for business ventures. The Report identified three critical priorities for the Rock Bay Site, shown in Figure 1 and described further in the following sections (MacLeod Farley & Associates, 2022).

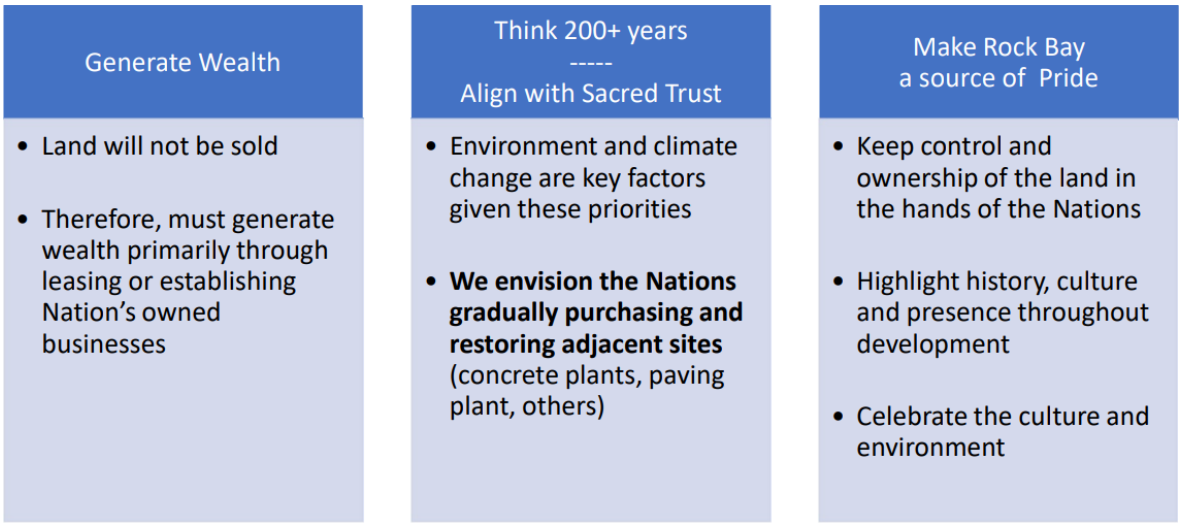

Figure 1 MFA's Understanding of Songhees and Esquimalt Nations' Priorities for Rock Bay (MacLeod Farley & Associates, 2022)

The inclusion of priority #2 and #3 above stands out as unique from settler development approaches, which place greater emphasis on wealth generation. Additionally, priority #1 wealth generation is unique, as selling the land to generate wealth is not considered.

Generate wealth for the Nations

Matullia acquired a 7.5-acre parcel along the Rock Bay waterfront, referred to in this report as the "Site," to return the land back to the Nations as land is a crucial asset for economic development, which in turn is crucial for improved well-being (Flanagan, 2019). A study completed using the community well-being index (CWIB), an index that measures socio-economic well-being for communities based on education, labour force, income, and housing, showed that First Nation communities that used land as an economic asset either through residential or commercial development generally achieved higher CWIB scores (Flanagan, 2019). Another observation from the study was the importance of leveraging lands to foster entrepreneurship and job creation rather than simply the collection of money (Flanagan, 2019). This

shows how incorporating Indigenous values that focus on factors above and beyond simple wealth generation can contribute to community well-being.

Think to the future (200+ years) and align with the Sacred Trust

One of Matullia's priorities includes thinking towards 200+ years into the future to ensure sufficient resources for future generations (MacLeod Farley & Associates, 2022). This is similar to settler views of sustainability, which generally focus on a goal to co-exist on Earth over a long time (i.e. in the future). The United Nations (UN) Brundtland Commission defined sustainability as "meeting the needs of the present without compromising the ability of future generations to meet their own needs." (World Commission on Environment and Development (WCED), 1987). With the increasing threat of climate change, looking towards the future is increasingly important to ensure that the current practices do not negatively affect future generations. Consequently, this priority also makes SLR an essential point of consideration at this Site as most of the risks associated with SLR are projected to be well into the future, with the BC Guidelines projecting 1 m and 2 m SLR in 2100 and 2200, respectively.

The Sacred Trust is passed down through ancestral oral teachings of the Songhees & Esquimalt peoples and refers to the responsibility of being protectors of the Earth (Wonders, 2010). It refers to principles guiding the relationship between land, water and resources; the Community; and the Spiritual Path(Esquimalt Nation, 2023). A visual representation of the Sacred Trust is presented in Figure 2.

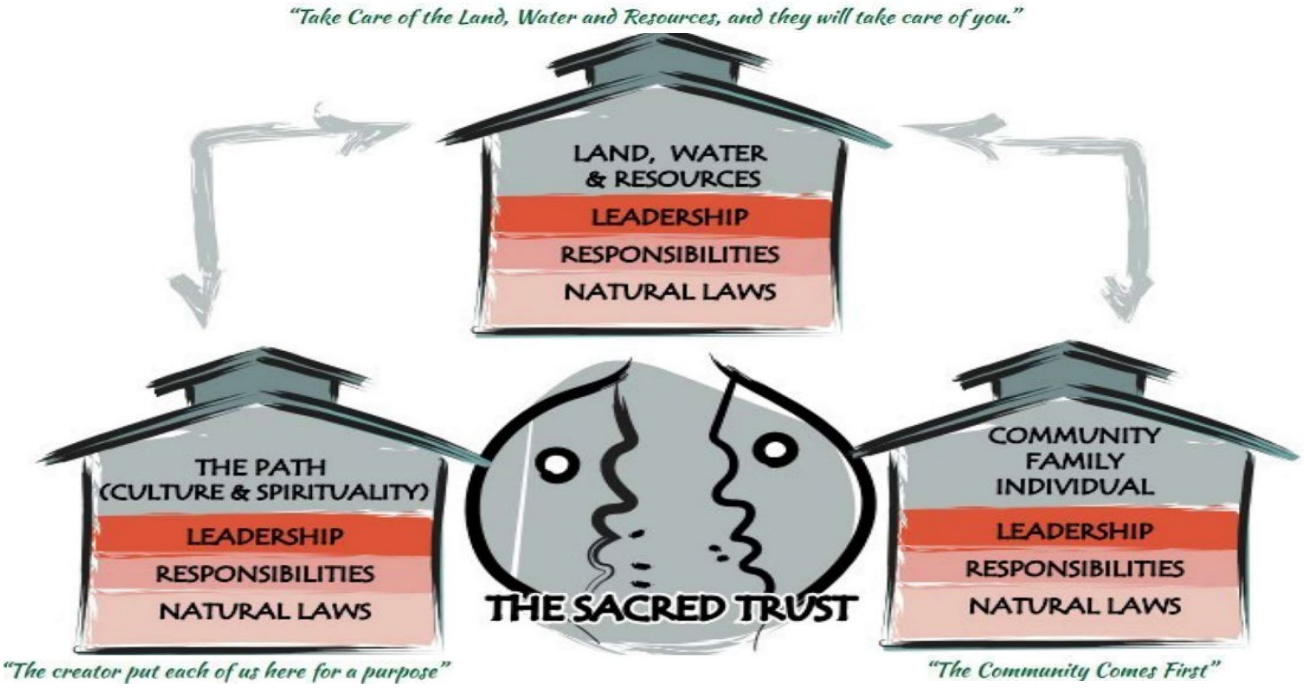

Figure 2 The Sacred Trust (MacLeod Farley & Associates, 2022)

Make Rock Bay a source of pride

The last priority is to ensure that Rock Bay is a source of pride for the First Nations (MacLeod Farley & Associates, 2022). Esquimalt Chief Robert Thomas makes this acutely evident by stating, “Piece by piece, whether we have to buy it or by hook or by crook, we are getting our land back, and that means so much to our people…” (Lindquist, 2022). As such, the Nations plan to make the Rock Bay Site a source of pride for the Nations by highlighting their presence in Victoria, celebrating their culture and their relation to the environment, and highlighting their history and culture.

2. Methods

The objectives for the project include investigating the potential harms of sea level rise associated with climate change, identifying any potential property-level solutions, and using various factors to assess the solutions to determine the best fit for the Rock Bay Site. To achieve the objectives, the methods for completing this report included getting approvals from all interested parties, engaging with the project consultants (architects and community development consultants), and completing a systematic literature review. The following steps were conducted:

1. Receive project approval through an informal consultation with Johnny Rice and Laurie Armstrong, representatives for Matullia, the site owner. Johnny and Laurie provided knowledge about Site history and a brief overview of how Indigenous values are being showcased at the Site. They also provided approval to review Site specific reports, including the MFA Initial Findings Reports, and to contact their consultants. Additional informal consultations with Jean-Gabriel Chiasson from PFS Studio, a landscape architecture firm that is part of the project’s design team, provided additional documentation regarding sea level rise and insight into the current plans for the Site.
2. A review of information obtained through a web search was completed to understand the projections and impacts of sea level rise. The October 2021 literature document *Task 2 – Sea Level Rise Modelling and Mapping* Report prepared by Associated Engineering for the Capital Regional District was reviewed in detail to understand the effects of sea level rise and associated flood construction levels in Victoria, BC.
3. A detailed review of the literature regarding SLR adaptation primers, primarily the Fall 2013 *Sea Level Rise Adaptation Primer* prepared for the BC Ministry of Environment, was completed to gain an understanding of the various recommended approaches. Additional reviews of journal

articles, case studies, and research papers from various sources were completed with a focus on additional adaptation tools that apply to the Rock Bay Site.

4. The various adaptation methods were assessed to create a short-list of methods that apply to the Rock Bay Site while considering cost, effectiveness, durability, environmental benefits, and Indigenous values.

5. Lastly, a decision matrix was created using the factors mentioned above to recommend the next steps. The factors considered were decided upon through informal consultation with Jean-Gabriel Chiasson from PFS Studio.

3. Site Background

3.1 Location

The Rock Bay Site, shown in Figure 3, is located just north of Downtown Victoria and Chinatown in the Burnside Gorge Neighbourhood in the City of Victoria. The Site is uniquely located between commercially essential areas to the south and industrial areas to the north. The Site is bordered by Government Street to the north, Pembroke Street and industrial facilities to the east, Upper Victoria Harbour to the south, and Rock Bay and industrial facilities to the west. The Site is currently zoned for M-3 Heavy Industrial District. The Site is located within Victoria's Development Permit Area (DPA) 10B, a heritage conservation area where commercial and light industrial use is encouraged (City of Victoria, 2012).

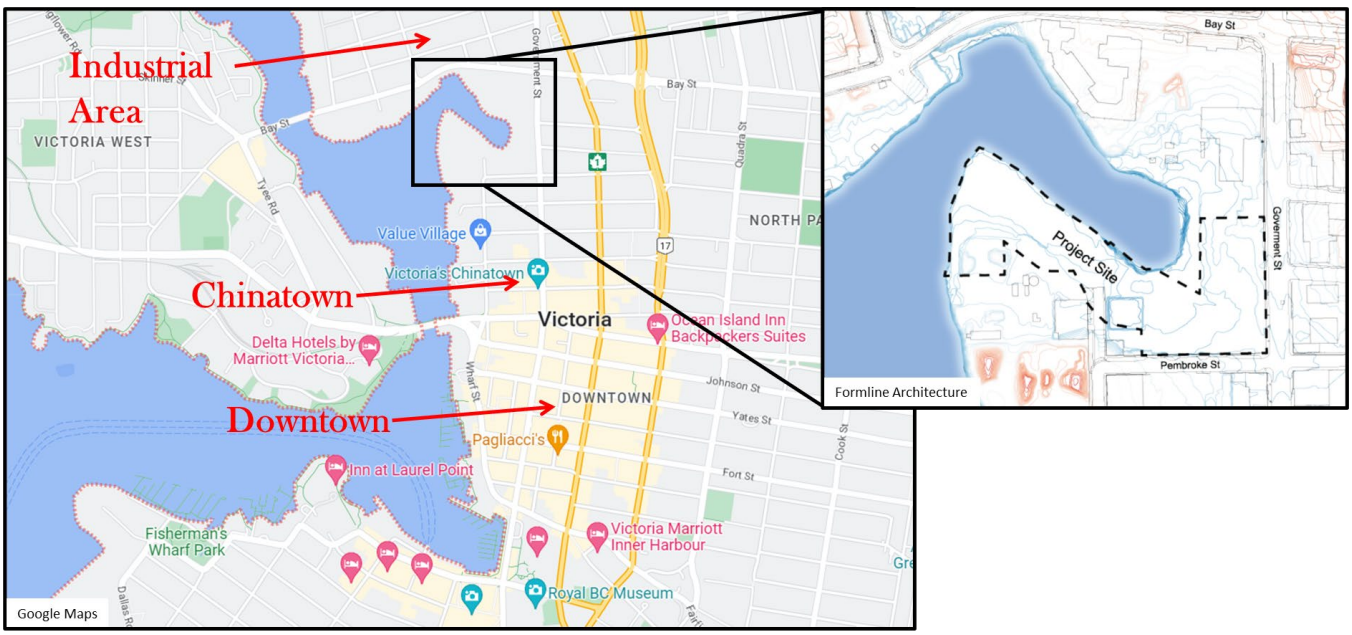

Figure 3 Site Location (Formline Architecture + Urbanism & PFS Studio, 2023)

3.2 History

The land around Rock Bay in downtown Victoria was part of the traditional territory of the Lekwungen people, including today's Esquimalt and Songhees Nations. The area was used primarily to host visiting nations and their peoples until 1855, when the Songhees Nation signed a treaty for fifty-two pounds and ten shillings sterling to the Hudson Bay Company for the area surrounding Rock Bay (Macfarlane, 2016). In 1911, settlers forced the Lekwungen peoples living in this area to their current reserve location (Kanakos, 1982). The effects of colonization, such as infilling and subsequent contamination of the land, led to a significantly altered site which has been called "one of Canada's most contaminated sites" (C. Wilson & Dedyna, 2015). The Site was impacted by decades of dumping coal tar and other chemical wastes from a coal gasification plant owned by Victoria Gas and B.C. Electric (now B.C. Hydro). By 2016, B.C. Hydro and Transport Canada had spent approximately $128 Million to clean up the Site and haul away 140,000 tonnes of contaminated soil and 88,000 tonnes of sediments (Duffy, 2022). Matullia Holdings Limited Partnership, formed in 2011 by the Esquimalt and Songhees Nations, repurchased 3 acres of land from Transport Canada in 2016 and an additional 4.5 acres from B.C. Hydro in 2022 at the Rock Bay Site (Duffy, 2022).

3.3 Ownership and Future Plans

Matullia is working with a team of consultants, led by Formline Architecture + Urbanism (Formline), on creating a Master Plan for the Site suitable for the zoning application with the City of Victoria. The Master Plan will consider types of buildings, their use, architectural design and engineering, landscaping, and other elements that will reflect the culture and values of the Songhees and Esquimalt Nations. The land reclamation completed at the Rock Bay Site presents an opportunity for Indigenous-led land stewardship of a large portion of the Rock Bay shoreline.

The City of Victoria designated the Rock Bay Site as a Special Planning Area in its 2016 Burnside Gorge Neighborhood Plan. The City planned to improve the lands to include pedestrian/cyclist connectivity, increase coastal green space, daylight a creek, and develop a gathering place (City of Victoria, 2017). The City of Victoria's vision showing fundamental principles and priorities are shown in Figure 4.

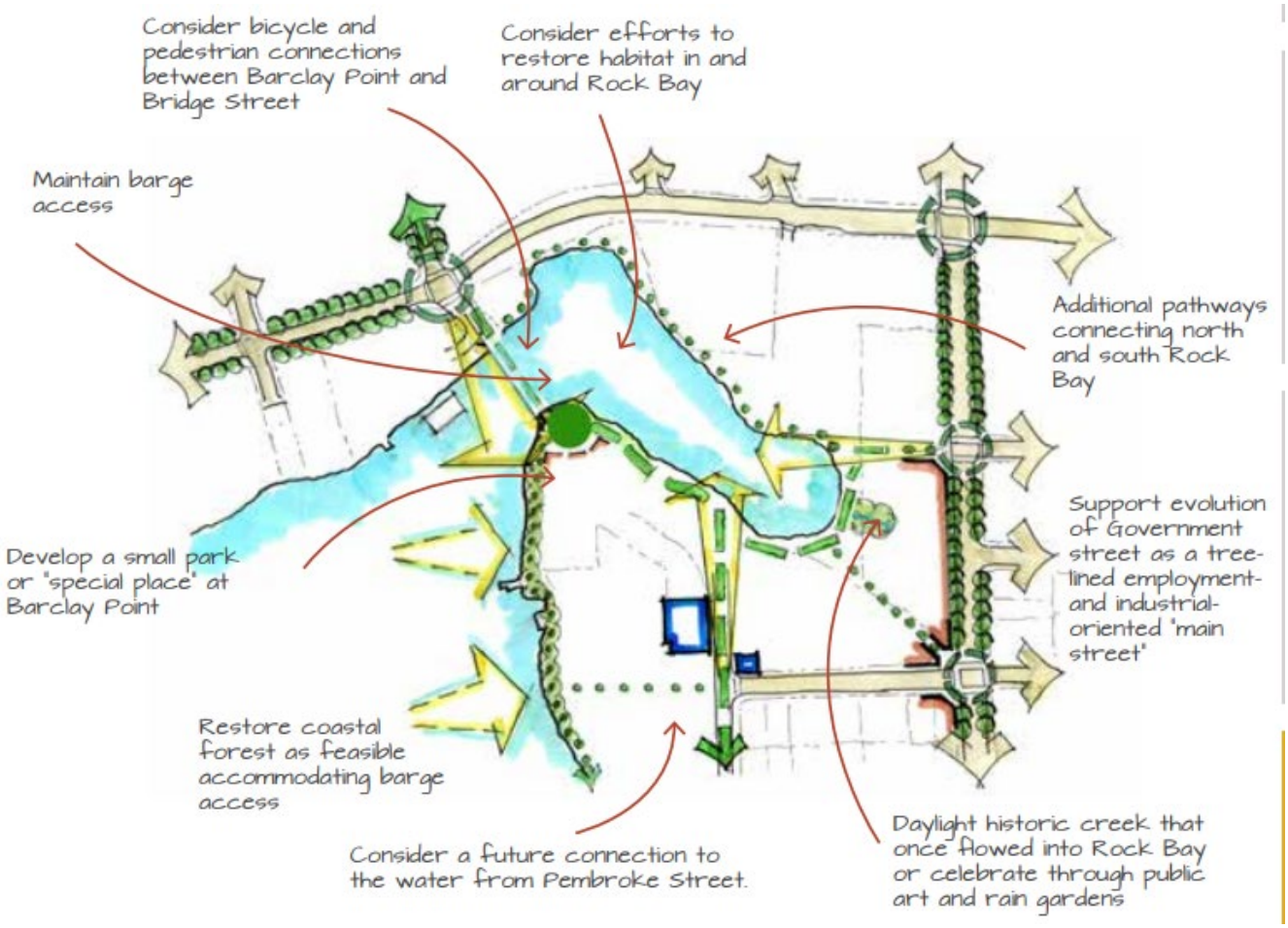

Figure 4 Conceptual sketch showing development principles for Rock Bay (City of Victoria, 2017)

The development and construction that can be completed on the Site are limited by the geotechnical conditions present. The Site can be divided into two primary geotechnical conditions, as presented in Figure 5 below:

1. Shallow Bedrock: Stable construction surface, generally at a higher elevation
2. Infilled Area: An Area historically infilled to allow for industrial operations. The infilled area's geotechnical characteristics do not allow constructing buildings taller than two storeys.

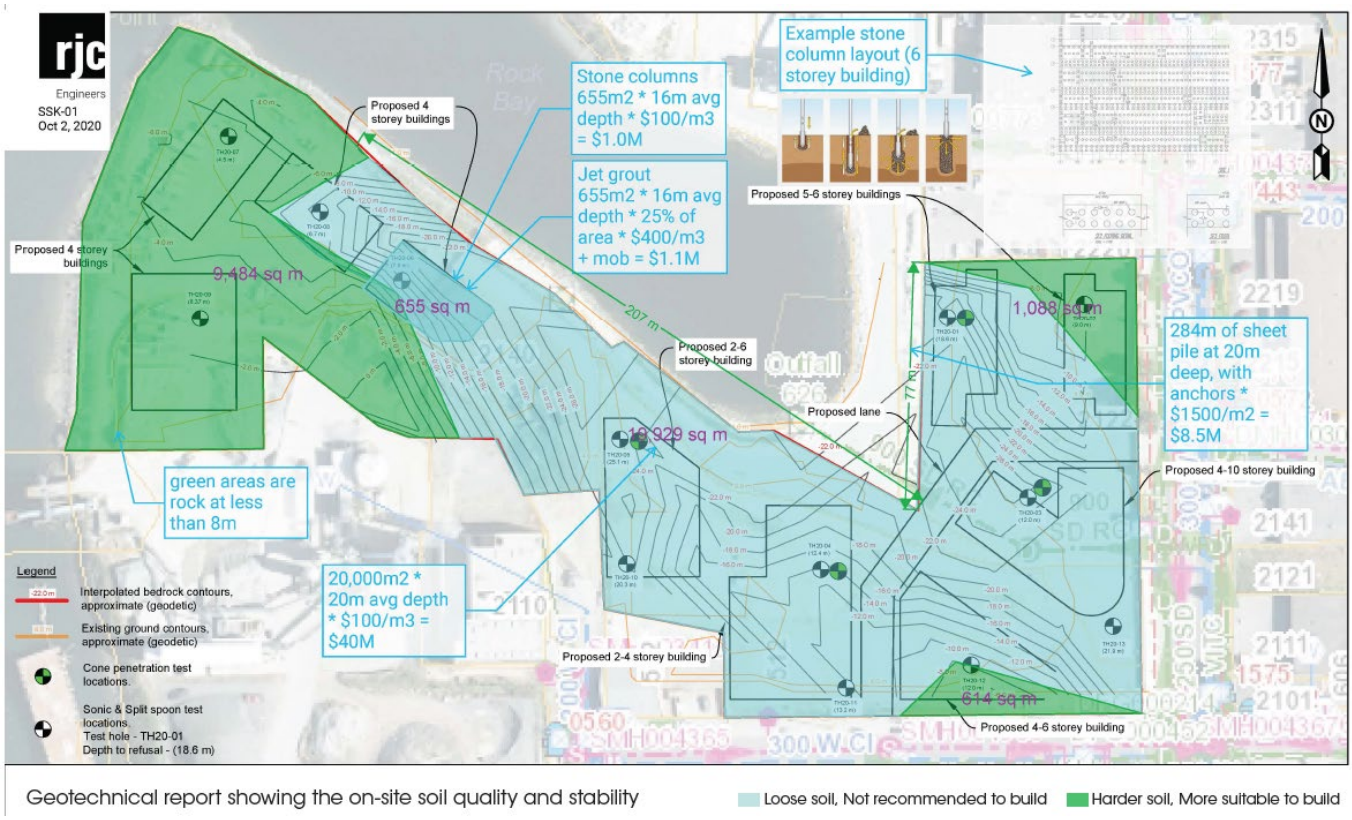

Figure 5 Geotechnical understanding of the on-site quality and stability (Ryzuk Geotechnical, 2020)

Given the geotechnical constraints, a two-phased approach to developing the Site might be necessary to contend with current site conditions that might make it difficult and costly to build. Phase 1 would include development on the western shallow bedrock portion of the land in line with Matullia's priorities while raising funds for the extensive geotechnical stabilization work necessary on the infilled areas. Phase 2 would complete the development of the infilled areas.

3.4 Creek Daylighting – Example of Indigenous Land Management Values

A Site design decision that demonstrates the Esquimalt and Songhees Nation values is their plans to daylight a creek on the Site. The Rock Bay Creek originates in the Fernwood neighbourhood and drains into Rock Bay. The creek was originally a coho salmon stream with water that would have been kept cool by the surrounding old-growth forest (Rock Bay Creek Revival, 2021). The surrounding ecosystem supported sedges, eelgrass, berry plants, eagles, and bears (Rock Bay Creek Revival, 2021). The creek cascaded down to Rock Bay as Finlayson Falls, shown in Figure 6.

The City of Victoria eventually culverted and piped the creek flow in the 1890s to support development for the increasing populations (Rock Bay Creek Revival, 2021). Matullia, with support from the Rock

Bay Creek Revival community group, plans to daylight the creek on the Site. Daylighting refers to the process of physically exposing and restoring buried waterways (Trice, 2016). Daylighting benefits include natural benefits, such as improving flood control and ecological recovery and social benefits, such as improving connection to nature (Trice, 2016). The City of Victoria policies have changed since the 1990s, and it is now supportive of daylighting the creek and increasing awareness of the waterways that once existed naturally (Rock Bay Creek Revival, 2021).

Figure 6 Finlayson Falls near Rock Bay, captured in 1860 (BC Archives, 1998)

In Rock Bay, daylighting aligns with Matullia's priorities by paying homage to the natural state (i.e., make Rock Bay a source of pride) while enhancing biodiversity and revitalizing a riparian environment for the stream (i.e., aligning with the Sacred Trust). The plans for foreshore land management as it pertains to SLR will also align with Matullia's priorities, similar to the creek daylighting project.

Although the riparian habitat of the daylighted creek will be constructed in accordance with the BC Ministry of Environment Riparian Area Regulations, Matullia has also indicated that they are willing to consider using additional land surrounding the daylighted creek to restore natural habitat at the cost of reducing some of its developable lands. This can be achieved by using the riparian habitat surrounding the daylighted creek for native vegetation and increased flood resiliency through increased carrying capacity during storm events.

4. Sea Level Rise

Matullia faces several challenges related to climate change, one of which is coastal flooding related to sea level rise. The two key factors of climate change that cause an increase in the average global sea level include (Hausfather, 2019):

1. Thermal Expansion: Since water expands as it warms, an increase in ocean temperature causes an increase in the volume of water.
2. Melting glaciers and ice sheets: The increase in global temperature causes glaciers and ice sheets to melt, which also contributes to an increase in the volume of water.

Globally, sea level rise has increased by approximately 0.15 to 0.20 metres (m) between 1993 and 2021. The global SLR is also expected to accelerate as the average loss from glaciers and ice sheets has quintupled from the equivalent of 0.17m of liquid water in the 1980s to 0.85m in the 2010s (Lindsey, 2022). It is important to note that although there is a global increase in sea levels, the sea level rise can vary regionally based on various factors such as the following (Hausfather, 2019):

- Land subsidence: decrease in land elevation due to reduced groundwater aquifers, sediment compaction, etc.
- Isostatic rebound: increased land elevation in areas weighed down under glaciers.

The factors affecting sea level rise are presented in Figure 7.

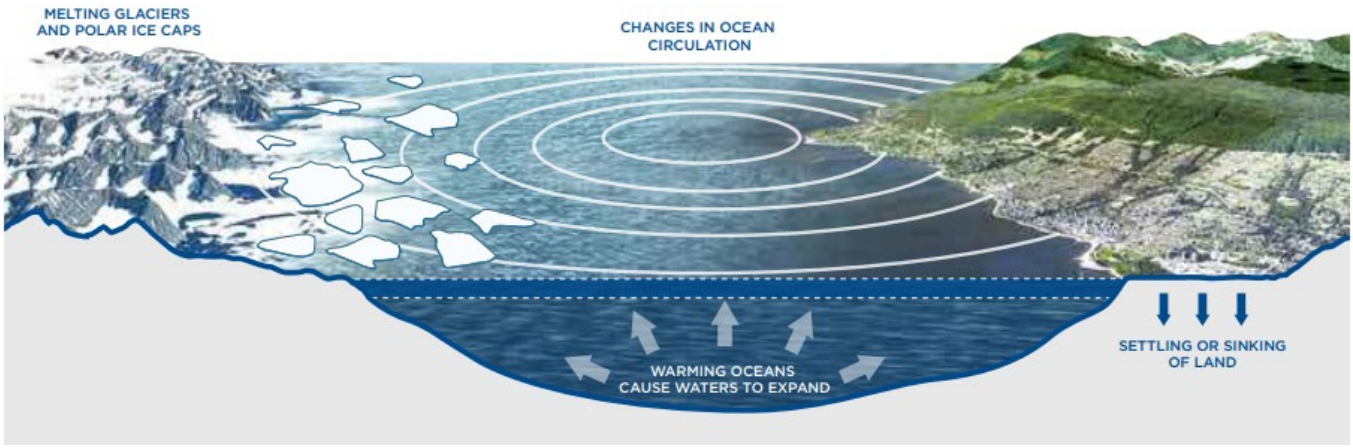

Figure 7 Sea Level Rise (City of Vancouver, 2018)

4.1 Site Context

An increase in sea level is not the only risk associated with coastal flooding, as rising seas also increase the potential for flooding related to an increase in tidal and storm surges. The Rock Bay Site is located

within the Victoria Harbour in the Capital Region District (CRD) of British Columbia. Figure 8 shows flooding risk within Rock Bay for 2200, which would capture the 200-year outlook outlined as Matullia's priorities. Note that the Figure 1 flood mapping inundation model is based on the higher high water large tide (HHWLT), 2.0m relative sea level rise (RSLR), any land uplift/subsidence, and 1.30m regional storm surge for a 500-year storm event (Associated Engineering, 2021).

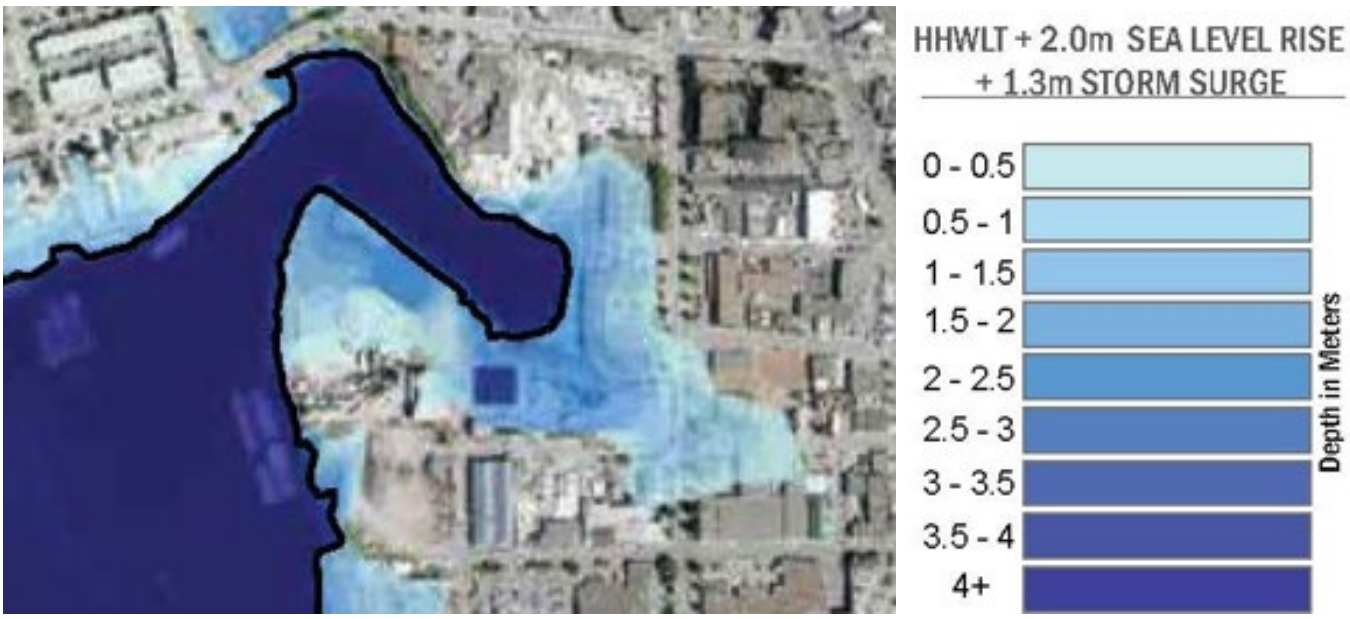

Figure 8 Rock Bay Flood Construction Level Model (Associated Engineering, 2021)

Other location-based guidelines must be considered. In Canada, the provincial government of British Columbia passed the responsibility for coastal flood management to local governments in 2004; the guidelines were amended in 2018 and stated that local governments should consider a SLR increase of 0.5 m by 2050, 1 m by 2100, and 2 m by 2200 (Capital Region District, 2021). The CRD of British Columbia, which includes lands around Victoria, completed an initial SLR study in 2015 and an expansive regional analysis in 2021, which provided appropriate flood construction levels (FCL) for the entire region (Capital Region District, 2021). The FCLs are the minimum elevation levels for habitable construction and include the effects of SLR, wave effect, storm surge, and a freeboard, as shown in Figure 9 below (Associated Engineering, 2021).

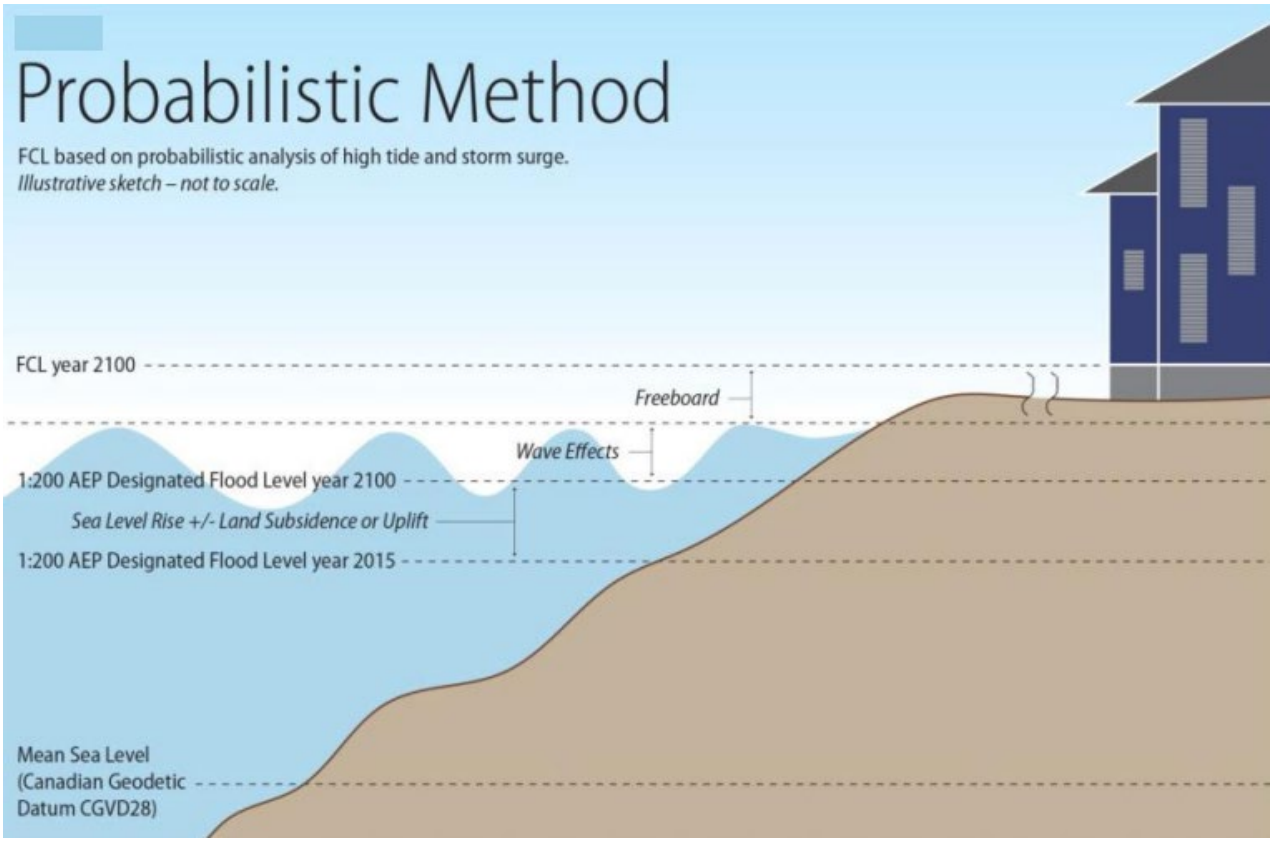

Figure 9 Flood Construction Levels Inputs (FCLs) (Associated Engineering, 2021)

The FCLs are primarily used as a guideline and are the responsibility of local governments to mandate. The City of Victoria does not currently mandate FCLs. However, it is working on its own guidelines that will address sea-level rise in future developments to help encourage adaptation strategies through rezoning and development applications.

Despite the lack of a municipally mandated FCL, the Rock Bay team is already considering designing to the FCLs by considering the 200-year outlook. Although the FCLs include wave, storm, and SLR effects, only some apply to the Site, and the adaptation measures should be chosen accordingly. Two key factors affect how coastal floods are observed at the Site (J. G. Chiasson, personal communication, June 21, 2023):

1. Rock Bay is located within the Victoria harbour around several bends and 3.6 km from the inlet at Victoria's coastal edge. Victoria's coastal edge also includes a breakwater structure designed to reduce the wave effects. Therefore, the wave effects at Rock Bay are significantly dampened as it is not exposed to the open coastal waters.
2. The Rock Bay coastline has changed as the Bay has been infilled to accommodate industrial operations. The infilled lands are generally at a lower elevation than the surrounding stable lands and, as a result, are at a higher risk of flooding due to SLR. Additionally, the infilled lands are more unstable, which could lead to increased damage during coastal floods.

4.2 Mitigation and Adaptation

Solutions to climate change induced sea level rise include both mitigation and adaptation measures. Mitigation measures refer to reducing the causes of climate change (NASA's Global Climate Change, n.d.). Since the increase in temperature is, in turn, caused by the increase in greenhouse gas emissions. As such, most climate change mitigation measures focus on reducing or stabilizing greenhouse gas emissions (NASA's Global Climate Change, n.d.). Some common mitigation examples include reducing carbon sources such as power plants, industrial plants, transportation, and food systems while preserving carbon sinks such as forests, oceans, and healthy soils (NASA's Global Climate Change, n.d.). It is essential to consider that there is a lag between a change in greenhouse gas levels and the corresponding impacts. Humanity will observe the effects of climate change even if greenhouse gas emissions are drastically reduced, which does not seem to be the case as global emissions are still increasing, albeit at a slower rate (Ritchie, 2022). One of the most successful examples of climate change mitigation includes the implementation of the 1987 Montreal Protocol, an environmental treaty aimed at reducing emissions of ozone-depleting substances. A 2023 study studied how the Montreal Protocol, which entered into effect 34 years ago in 1989, averted 0.5°C of global warming, 0.88°C of Arctic warming and consequently reduced sea ice loss and delayed projections of the first "ice-free" Arctic summer by approximately 15 years (England & Polvani, 2023).

Adaptation measures refer to measures taken to reduce the impacts of climate change. According to a 2013 Sea Level Rise Adaptation Primer prepared for the Province of BC, SLR adaptation tools are generally divided into five categories (The Arlington Group Inc et al., 2013).

1. Planning: creating government planning and management policies to adapt to SLR.
2. Regulatory: creating government regulations such as subdivision, building, development, and land use regulations to adapt to SLR.
3. Land use: use strategies such as foreshore land acquisition, easements, and land trusts, to manage the foreshore land.
4. Structural: constructing hard engineering structures such as dikes, scour protection, building elevation, floodproofing, etc., to protect from coastal floods.
5. Non-Structural: constructing soft engineering nature-based structures such as coastal wetlands, dunes, beaches, etc., to lessen the impacts of coastal floods.

Both mitigation and adaptation are beneficial approaches in creating communities resilient to climate change. However, mitigation is primarily achieved through government regulations and mass public

uptake while individual property owners can complete adaptation. The design tools incorporated by Matullia should therefore focus on SLR adaptation instead of mitigation.

5. SLR Adaptation Tools

There are several adaptation measures as discussed in the previous section. Most of the adaptation measures, particularly the ones about planning, regulatory, and land use are large-scale and therefore the responsibility of government bodies. The above policy-based measures are generally removed from the various owners of the coastal properties. On the other hand, structural (traditional hard engineering) and non-structural (nature-based soft engineering) methods can be completed on multiple scales, including property scale, which is more applicable to the current project. A short description of the various adaptation measures and their applicability to the Rock Bay Site is discussed in the following sections. Most SLR adaptation tools were adapted through the Sea Level Rise Adaptation Primer prepared by Arlington Group et al. for the Government of BC. Adaptation tools that are particularly applicable to the Site are retained for further consideration as detailed in the Feasibility Study conducted in Section 6. Note that any mention of Indigenous values refers to the Songhees & Esquimalt priorities described in Section 1.1.

5.1 Hard Protection

Dikes

A dike is a linear earthen embankment structure intended to prevent coastal flooding by acting as a physical barrier. Sea dikes typically have a steep gradient on the landward side and a gentle gradient on the seaward side to dissipate wave energy (The Arlington Group Inc et al., 2013). A sea dike also commonly includes toe scour protection to prevent erosion at the structure's base. Dikes are typically part of a broader municipal strategy to protect areas with dense populations, high cultural value, or crucial infrastructure (The Arlington Group Inc et al., 2013).

Traditional dikes align less with Matullia's priorities for the Rock Bay Site as they are high cost (i.e. anti-wealth generation), unnatural in appearance (i.e. no sense of pride), and have high environmental and social impact (i.e. do not align with the Sacred Trust). Additionally, they are primarily a tool used by the various government bodies on the neighbourhood-scale, not property-scale. Therefore, dikes will not be retained for further discussion. Additional relevant details regarding dikes are presented in Table 1.

Category	Rating	Comments
Cost	High	Capital, maintenance, and upgrading costs
Effectiveness	High	Provides a physical impermeable barrier between the sea and land
Durability	Medium	Requires ongoing maintenance
Environmental Benefits	None	Loss of natural land used to construct the dike
Indigenous Values	Low	Loss of land for creating traditional infrastructure that does not align with Sacred Trust

Table 1 Information regarding dikes (The Arlington Group Inc et al., 2013)

Scour Protection

Scour protection is a property-specific tool that protects structures from erosion or damage due to moving water. Scour protection can include structural elements such as riprap designed to withstand wave action. It can be used along a building or a structural element foundation such as transmission towers, bridge foundations, highways, etc. (The Arlington Group Inc et al., 2013).

As there are no essential coastal buildings or structures at the Site, scour protection will not be necessary and is therefore not retained for further discussion. Additional relevant details regarding scour protection are presented in Table 2 below.

Category	Rating	Comments
Cost	High	Design, transportation, and maintenance costs
Effectiveness	High	Protects crucial structural elements
Durability	Medium	Requires ongoing maintenance
Environmental Benefits	None	Some effects on the marine environments in the intertidal zones
Indigenous Values	Low	Harsh unnatural appearance.

Table 2 Information regarding scour protection (The Arlington Group Inc et al., 2013)

Structural Elevation

Structural elevation is a property-specific tool that aims to protect structures by elevating them in various ways, including raising the ground elevation, raising the building elevation, or raising the useable areas of the building. Raising the structural elevation can be achieved in multiple ways depending on preference (The Arlington Group Inc et al., 2013).

The structural elevation tool does not increase environmental impacts and offers some flexibility in the ways it can be achieved. Therefore, the structural elevation tool might be of value at Rock Bay and will be retained for further consideration. Additional relevant details regarding structural elevation are presented in Table 3.

Category	Rating	Comments
Cost	High	High costs associated with the fill requirements and additional building costs
Effectiveness	High	Increases elevation to the recommended FCL
Durability	High	The constructed elevation provides flood protection for the design period
Environmental Benefits	Low	No additional environmental benefits
Indigenous Values	Medium	No change to the appearance and the area with raised slopes can be utilized as desired

Table 3 Information regarding structural elevation (C40 Knowledge Group & C40 Cities Climate Leadership Group, 2022; The Arlington Group Inc et al., 2013)

Wet Floodproofing

Wet floodproofing is a tool that implements a “living with nature” approach by allowing water inside a building with minimal harm. Wet floodproofing has limited applicability as it is only applicable for uses where flood-resistant materials can be used, structural equipment can be placed at higher elevations, and temporary losses of useable land are acceptable (The Arlington Group Inc et al., 2013).

Wet floodproofing, although limited in use, could be an effective tool as it is low cost, does not lead to any significant land use changes, and can fit in with Indigenous values. Therefore, wet floodproofing will be retained for further consideration. Additional relevant details regarding wet floodproofing are presented in Table 4.

Category	Rating	Comments
Cost	Low	Costs include planning and tweaks to the electrical, mechanical, heating, and ventilation construction
Effectiveness	Medium	Allows for water to infiltrate the bottom of the building but severely reduces the damages
Durability	Medium	Requires post-flood cleanup and associated maintenance
Environmental Benefits	Low	No additional environmental benefits as it naturally allows for a small coastal flood
Indigenous Values	Medium	No change to the land use except for the temporary loss of useable land

Table 4 Information regarding wet floodproofing (FEMA, 2021; The Arlington Group Inc et al., 2013)

5.2 Soft Armouring

Coastal Wetlands

Coastal wetlands are ecologically important habitats found in the intertidal zones and have characteristics of both the sea and land (The Arlington Group Inc et al., 2013). Coastal wetlands are often adaptable salt marshes that provide productive ecosystems with rich flora and fauna. Wetlands help reduce coastal floods by dissipating wave and tidal energy and reducing erosion (The Arlington Group Inc et al., 2013).

Although wetlands are highly beneficial, they require significant land area for gentle sloping and increased water carrying capacity. Therefore, they have not been retained for further discussion. Additional relevant details regarding coastal wetlands are presented in Table 5.

Category	Rating	Comments
Cost	Medium	Constructing engineered wetlands requires less cost than hard protection tools
Effectiveness	Medium	Reduces the effects of coastal floods through wave and tidal dissipation but does not account for SLR
Durability	Medium	Wetlands require some maintenance but are also equipped for self-adaptation

Category	Rating	Comments
Environmental Benefits	High	Provides environmental benefits such as improved biodiversity, water retention, and water purification
Indigenous Values	Medium	Reduces the land use but provides environmental benefits that could be a source of pride

Table 5 Information regarding coastal wetlands (NOAA Fisheries, 2022b; The Arlington Group Inc et al., 2013)

Dune Building

Dunes are wind-formed sand deposits just upward of the foreshore. Artificial dunes aim to mimic natural dunes and can be stabilized through vegetation. Dunes provide a natural recreational habitat and reduce coastal floods as they dissipate wave and tidal energy (The Arlington Group Inc et al., 2013). Dunes are typically used as an adaptation tool, specifically in beach environments.

Dunes are similar to wetlands in that they require considerable land area and provide ecosystem benefits that could provide biodiversity to the area and become a source of pride. However, the Rock Bay Site is not large enough, and the location is not ideal for dune building. Therefore, dunes will not be discussed further. Additional relevant details regarding dunes are presented in Table 6.

Category	Rating	Comments
Cost	Medium	Costs associated with artificial dunes include sand, equipment, maintenance, and land costs
Effectiveness	Medium	Reduces the effects of coastal floods through wave and tidal dissipation but does not account for SLR
Durability	Medium	Dunes require some maintenance but are also equipped for self-adaptation
Environmental Benefits	High	Provides environmental benefits such as increased natural habitat
Indigenous Values	Medium	Reduces the land use but provides environmental benefits that could be a source of pride

Table 6 Information regarding dune building (The Arlington Group Inc et al., 2013)

5.3 Other

The following adaptation tools include ones not explicitly discussed in the BC Primer. These adaptation tools were selected through informal conversations with consultants and literature research into alternative adaptation tools.

Oyster Beds

Oyster beds refer to large dense communities of oysters that were once common in estuaries across coastal communities in North America (NOAA Fisheries, 2022a). Although oyster beds have deteriorated since colonization, they protect against coastal floods by dissipating wave and tidal energy (Brandon et al., 2016).

Indigenous peoples have a history of sustainably harvesting oyster beds for over 5,000 years (Reeder-Myers et al., 2022). They can therefore create a sense of pride for the community while aligning with the Sacred Trust. Although the industrial nature and water quality surrounding the Site may not be ideal at present due to the historical contamination of Rock Bay, oyster beds are retained for further discussion due to their high potential of alignment with Indigenous values. Additional relevant details regarding oyster beds are presented in Table 7.

Category	Rating	Comments
Cost	Medium	Costs primarily include restoration costs
Effectiveness	Medium	Reduces the effects of coastal floods through wave and tidal dissipation but does not account for SLR
Durability	Medium	Can self-sustain if well designed
Environmental Benefits	High	Provides environmental benefits, including food sources, healthy coastal habitats, and water purification
Indigenous Values	High	Provides a way to restore the coastal waters to pre-colonization conditions while providing a sustainable food source

Table 7 Information regarding oyster beds (NOAA Fisheries, 2022a; Walles et al., 2016)

Soft Shorelines

Soft shorelines, sometimes called living shorelines, refer to a soft armouring tool that naturalizes shorelines to prevent erosion and dissipate wave and tidal energy. Some methods to create soft shorelines incorporate native vegetation, anchored logs, vegetative mats, gentler slopes, etc. (NOAA Fisheries,

2022c). Soft shorelines may also include oyster beds and coastal wetlands, an adaptation tool discussed above. For this report, soft shorelines will refer to smaller measures such as native vegetation, anchored logs, etc., instead of coastal wetlands, which are discussed separately. Two shorelines on Site can be modified to varying degrees, the coastal shoreline along the edge of Rock Bay and the shoreline of the daylighted creek.

Soft shorelines can create a source of pride as there is some flexibility to incorporate art and nature into the design. They will therefore be retained for further consideration as they are also moderately effective while being environmentally beneficial. Additional relevant details regarding soft shorelines are presented in Table 8.

Category	Rating	Comments
Cost	Medium	Costs include the design and installation of vegetative structures
Effectiveness	Medium	Reduces the effects of coastal floods through wave and tidal dissipation but does not directly address SLR outside of minor land elevation increases due to sedimentation.
Durability	Medium	Requires operation and maintenance
Environmental Benefits	High	Provides environmental benefits, including increased biodiversity and healthy habitats
Indigenous Values	High	Provides a way to mimic nature and increase naturalized conditions

Table 8 Information regarding soft shorelines (NOAA Fisheries, 2022c)

Living Dikes

Living dikes refer to dikes (i.e. linear embankment structures) that are naturalized and designed to mimic nature by designing a gentle slope that allows natural ecosystems to flourish (Living with Water, 2022). Similar to dikes, living dikes are typically part of a broader municipal strategy to protect critical areas. The first pilot projects in BC include the Boundary Bay dike in Delta and the Mud Bay dike in Surrey (City of Surrey, 2022).

Although living dikes may align with some of Matullia's priorities, they require significant land and are generally used for larger-scale governmental adaptation policies. Therefore, they will not be retained for further discussion. Additional relevant details regarding living dikes are presented in Table 9.

Category	Rating	Comments
Cost	High	Capital, maintenance, and upgrading costs
Effectiveness	High	Provides a physical impermeable barrier between the sea and land
Durability	Medium	Requires ongoing maintenance
Environmental Benefits	High	Provides environmental benefits through healthy intertidal ecosystems such as salt marshes
Indigenous Values	Medium	Loss of land for creating nature-based infrastructure

Table 9 Information regarding living dikes (Living with Water, 2022; The Arlington Group Inc et al., 2013)

Emergency Preparedness

Emergency preparedness is a tool that refers to the procedures set in place in the event a coastal flood does occur. Emergency preparedness typically includes procedures that will be undertaken to protect people in case of an emergency. It does not protect buildings or reduce the intensity of coastal floods; emergency response planning can lead to fewer economic, environmental, and social impacts. A holistic approach to response planning can also improve the post-flood recovery and rehabilitation period (Feinberg, 2021).

Emergency preparedness is a low-cost adaptation tool that does not impact the land and water and is therefore retained for further discussion. Additional relevant details regarding emergency preparedness are presented in Table 10.

Category	Rating	Comments
Cost	Low	Labour costs associated with procedure planning
Effectiveness	Low	Does not reduce the intensity of coastal floods but reduces the potential damage.
Durability	Medium	The guide requires occasional updates
Environmental Benefits	Low	No change to Site conditions
Indigenous Values	Medium	Minimal changes to the land and water while also being proactive

Table 10 Information regarding emergency preparedness (PreparedBC, 2023; UNISDR, 2015)

6. Feasibility Study

6.1 Decision Matrix

The decision matrix tool assessed the various foreshore management options retained for further discussion. The decision matrix was chosen as the decision-making tool, incorporating various weighted criteria (ASQ, 2023). Each coastal flood adaptation tool will be evaluated against the weighted criteria. The criteria and the justification include the following:

- Cost (35%) – Approximately a third of the weight is assigned to the cost as one of three Matullia's priorities is wealth generation.
- Effectiveness (20%) & Durability (10%) – Another third of the weight is assigned to effectiveness and durability as they are essential factors in reducing the intensity or impacts of coastal floods. These also align with Matullia's priorities to think 200 years into the future.
- Indigenous values (15%) & Environmental benefits (15%) – Another third of the weight is assigned to indigenous values and environmental impacts as those factors closely tie in with Matullia's priorities of aligning with the Sacred Trust and making Rock Bay a source of pride for the Nations.
- Opportunities for Social Activity (5%) – Lastly, the Site is part of the City of Victoria/Burnside Gorge neighbourhood community, and as such, a small portion of the weight is assigned to social benefits. This ties in with Matullia's intention to manage a Site that aligns with some aspects of the neighbourhood/city vision.

The decision matrix is presented in Table 11. The Table includes the various adaptation tools as rows and the criteria as columns. Each adaptation tool is assessed with a score between 1-5 (1 for lowest benefit and 5 for highest) for each criterion. For example, a high cost would be given a score of 1 (i.e. low benefit), while the high environmental benefits would be given a score of 5 (i.e. high benefit). Finally, a cumulative weighted score will be calculated to determine the adaptation tools that benefit the Site most significantly. Note that the scores are based on my understanding of the various tools and how they fit the Site. A short justification for each score is provided in the Table. The justification provided is my understanding of the information already presented and cited in Section 5.

Several scores were adjusted from what would be considered a typical score based on site factors. The scores that were adjusted include the following:

- Cost of structural elevation would typically be the highest (score of 1). However, most of the Site is infilled areas which already require significant geotechnical stabilization work before the construction of buildings greater than two storeys. Incorporating the cost of structural elevation into the cost of geotechnical stabilization should result in some savings. Therefore, the cost score of structural elevation has been changed to 3.
- Effectiveness of oyster beds would typically be medium (score of 2-3) as they attenuate wave effects that impact coastal floods. However, as there are minimal wave effects at Rock Bay, the effectiveness score of oyster beds has been adjusted to 1. Similarly, the effectiveness score of soft shorelines has been adjusted from 4 to 3.

Criteria:	Cost		Effectiveness		Durability		Indigenous values		Environmental		Social benefits		Score
Weight:	**35%**		**20%**		**10%**		**15%**		**15%**		**5%**		
Structural Elevation	Typically high cost, but ability to pair with geotechnical stabilization reduces the costs	3	Increases the shoreline elevation, preventing any flooding	5	Requires no additional work as Site has been elevated according to design	5	Flexibility in how to utilize the space allows for creating an environment that is a source of pride	3	Flexibility on how to use the space that is elevated allows for some environmental benefits	2	Provides flexibility around how to structure the public spaces	3	3.45
Wet Floodproofing	Low costs associated with installation of flood vents and minor design changes	4	Allows for water infiltration but severely limits the damage	3	Requires some operation and maintenance	4	Ability to use a solution that allows to live with nature by allowing structures to flood	3	Does not affect the current site conditions and allows for natural conditions to exist	2	No connection to the neighbourhood or the city	1	3.20
Oyster Beds	Typically medium costs associated with design and construction	3	Dissipates wave energy effectively which is not a consideration for the Site	1	Requires no aditional maintenance once constructed	4	Invisible structure with some precolonial history that can create a source of pride	4	Provides ecosystem services such as increased biodiversity and water filtration	4	Invisible to the public but provides benefits to and can be expanded across the larger shoreline	3	3.00
Soft Shorelines	Typically medium costs associated with design and construction.	3	Dissipates wave energy effectively but that is not a major consideration for the Site	4	Requires some operation and maintenance	4	Flexibility in how to utilize the visible shoreline allows can create an environment that is a source of pride	4	Provides ecosystem services such as healthy habitats, increased biodiversity, and water filtration	4	Provides some natural attractions for the public walkway	4	3.65
Emergency Preparedness	Only costs related to creating the emergency preparedness document	5	No protection against floods but addresses the steps to follow in case of a flood	2	The plan requires minor revisions based on any lessons learned	4	Ability to use a solution that allows to live with nature but does not provide any benefit	2	Does not affect the current site conditions and allows for natural conditions to exist	2	Potential tie-in to the latest municipal and provincial flood protection guidelines	3	3.30

Table 11 Decision Matrix to evaluate SLR adaptation tools using Indigenous priorities

Most of the scores were close in range, which is to be expected as the adaptation tools that were the least applicable to the Site were not considered in the decision matrix as described in Section 5. A benefit of the decision matrix tool is that the weight of each criterion can be easily changed if the priorities change. On the other hand, a downside is that it is more challenging to assess partial or combined solutions. The decision matrix is presented in Table 11.

6.2 Limitations and Data Gaps

Some of the limitations of the analysis and discussion completed in this paper include:

- The site is early in the development process as the Master Plan is currently being developed. Consequently, several engineering, cost, and regulatory considerations cannot be assessed until the design process commences.
- Most nature-based approaches to shoreline management focus on large areas where wetland reclamation is possible. Less data is currently available regarding property-level novel adaptation measures in industrial areas where the priority is wealth generation and environmental considerations.
- The understanding of Indigenous values comes from my interpretation of one informal consultation with the Matullia LP representatives and a report generated by their community consultants. The paper does not reflect the depth and breadth of Indigenous values and approaches to foreshore land management.
- This paper is intended as a comprehensive overview of SLR adaptation tools that could be incorporated at the Rock Bay Site and is not intended to support the engineering design process.

7. Discussion

Addressing coastal floods is a complex issue that requires multiple approaches to be effective. Some of the tools observed can also be completed concurrently. For example, soft shorelines can include some aspect of wetland vegetation, structural elevation allows for a host of shoreline options as the land is elevated, and emergency preparedness is a critical component of wed floodproofing to ensure effective evacuation and recovery procedures. Additionally, Matullia is considering a two-phased approach to Site development based on geotechnical conditions and funding requirements. The phased approach would also be a good fit for adapting to SLR. Therefore, a combination of SLR adaptation tools should be discussed further.

Rank #1 – Soft Shorelines

The decision matrix and various Site factors suggest that soft shorelines are the best high-cost, high-effectiveness option. Soft shorelines provide a range of benefits that extensively address Matullia's priority #2 (plan for 200 years and align with Sacred Trust) and #3 (source of pride):

- Soft shorelines can potentially adapt to SLR as the plants trap sediments and naturally increase their elevation over time (NOAA Fisheries, 2022c). This ties in with Matullia's priorities of thinking about 200 years ahead.
- Soft shorelines provide other environmental benefits such as improved biodiversity, water retention, and water purification (NOAA Fisheries, 2022c). This ties in with Matullia's priorities of aligning with the Sacred Trust.
- Soft shorelines are visible natural habitats that can create a sense of pride for the community by connecting with some natural aspects. The design of coastal wetlands also allows for some flexibility in the design, where Indigenous history can be included by selecting design elements such as flora and fauna. This can create a source of pride for the Nations by designing a nature-based solution that aligns with the lands' history.

Soft shorelines are therefore, one of the best options to address coastal floods related to sea level rise at the Rock Bay Site. There are two locations where soft shorelines can be adapted at the Site: the coastal shoreline and the daylighted creek. The major drawback of soft shorelines is that it requires a considerable land area to be effective due to their gentle slope compared to the steep grading of a hard shoreline. From my understanding, Matullia is willing to lose some land that can be used for wealth generation in exchange for addressing other priorities.

The current coastal shoreline is a hybrid shoreline that incorporates a steep grade lined with riprap and a bench with a vegetative mat allowing native vegetation to grow. Matullia does not wish to significantly alter the current shoreline as it was reconstructed during the remediation processes recently in 2016. However, several measures can be completed to soften the two shorelines further:

- Create a vegetated riprap by increasing vegetation along the riprap slope and at the bank crest. This can be achieved by planting native vegetation between the joints of the riprap structure and at the crest. Benefits of the deep-rooted vegetation include soil stabilization, further reducing erosion risk, protection against surface runoff, slowing of floodwaters, and pollutant and excess nutrient filtration leading to improved water quality (The Natural Edge, 2022). Note that although this method is best achieved during the construction of the riprap bank, it can also be completed post-construction with careful planning of riprap relocation to allow for joints (Juneau Watershed

Partnership, n.d.). Joint planting can be completed using live stakes and pole plantings or also branched cuttings (Juneau Watershed Partnership, n.d.).

- Construct a gentle grade at the top of the bank wherever possible while completing structural elevation to increase the ground elevation to match the FCLs. The gentle slope is more suitable to allow for vegetation and absorb the energy of the waves, consequently reducing erosion risk (The Natural Edge, 2022).
- Incorporate multiple soft shorelines principles along the daylighted creek. In addition to the importance of vegetation and gentle slopes mentioned above, other tools that may be used are logs and root wads for erosion protection, aquatic vegetation for stabilizing sediments, and incorporating a variety of materials for improved biodiversity and to mimic a natural shoreline (NYS Dept. of Environmental Conservation, 2010).

Rank #2 – Structural Elevation

The other high-cost high-effectiveness option, structural elevation, also warrants further consideration in Phase 2 of Site development. An advantage of holding off on significant changes till Phase 2 is the improvements in SLR projections that will likely occur over the years as the effects of the global response to climate change will be better understood. The most significant advantage of structural elevation is that it essentially protects the site from SLR and coastal floods due to the increased elevation. A significant downside of structural elevation by adding fill to raise the property elevation is the construction cost associated with sourcing the fill and achieving enough geotechnical stability. However, as the Rock Bay Site already requires some structural stabilization in the infilled areas, structural elevation can be a part of the stabilization construction design to split some construction costs among the development and structural elevation projects. Consequently, structural elevation addresses SLR impacts by raising the land but does not particularly address the shoreline. A soft shoreline should also be considered when the structural elevation is completed.

Ranks #3 & #4 – Wet-Floodproofing and Emergency Preparedness

Two of the three lowest scores in the decision matrix are attributed to the low-cost low-effectiveness options as they are ineffective against SLR or coastal floods and do not provide any added environmental benefits or align with Indigenous values. However, although they do not reduce any impacts of SLR or coastal floods, they should be considered as they are both low-cost methods to improve the Site's resiliency against SLR and coastal floods. Both wet-floodproofing and associated emergency preparedness prepare the Site to reduce the impacts of coastal floods without reducing their intensity. The Sendai Framework for Disaster Reduction is a renowned international holistic framework which

promotes proactively understanding risk and investing in preparedness to ensure that any damage from disasters is reduced through careful planning and implementation prior to the occurrence (UNISDR, 2015). The importance of being proactive through emergency preparedness was also highlighted by Indigenous peoples of the lower mainland region of BC (Feinberg, 2021). Wet-floodproofing is an excellent low-cost measure that can be implemented in Phase 1 by designing buildings with flood vents that allow for the safe passage of water and elevated electrical wiring. Factors to consider would be the fact that the actual businesses on Site will have to familiarize themselves with the wet-floodproofing methods and the associated emergency preparedness measures. This may reduce the type of businesses that can occupy the buildings.

Rank #5 – Oyster Beds

Oyster beds are the lowest-score medium-cost option that should not be considered further as their effectiveness is primarily tied to dissipating wave energy which is not a big concern at the Site. However, oyster beds and oyster harvesting may hold some value to coastal Indigenous peoples as the Coast Salish peoples have used the native Olympia oyster as a traditional source of food (Kuhnlein & Humphries, 2017). Indigenous peoples also have a history of sustainably harvesting oyster fisheries before their collapse due to various impacts of colonization (Reeder-Myers et al., 2022). If Matullia wants to incorporate oyster beds into the design to pay homage to a traditional food source, oyster beds can be incorporated into other SLR adaptation tools, such as soft shorelines.

8. Conclusion

Climate change impacts such as coastal floods related to sea level rise are one of the challenges faced by coastal communities and properties globally, including the Rock Bay site in present-day Victoria, BC. The Rock Bay Site is at an exciting crossroads as the Indigenous site owners determine how to utilize the land best to achieve their three key priorities: 1) generate wealth for the Nations; 2) think 200+ years to the future and align with the Sacred Trust, and 3) make Rock Bay a source of pride (MacLeod Farley & Associates, 2022). The Site includes two distinct geotechnical conditions: a stable area where construction can occur immediately and a less stable area where stabilization is necessary before construction. This paper completed an analysis of various sea level rise adaptation measures as they pertain to the Rock Bay Site. A review of various adaptation tools was completed, and a shortlist of tools was selected for assessment using a decision matrix. Dikes, scour protection, coastal wetlands, dune building, and living dikes were not included in the decision matrix as they require a significant area of land or align less with the site's Indigenous priorities. The decision matrix criteria included cost, effectiveness, durability, Indigenous values, environmental and social benefits.

A combination of SLR adaptation measures is recommended based on the close scores of the decision matrix and the two-phase development approach necessary at the Site due to the geotechnical conditions. Soft shorelines received the highest score in the decision matrix due to their medium cost, medium effectiveness, high environmental benefits, and high alignment with Indigenous values. The current shoreline can be softened using vegetated riprap or a gentle slope with native vegetation at the crest. Wet floodproofing and emergency preparedness are two short-term low-cost SLR adaptation measures that can be completed in the initial construction phase. Structural elevation (i.e. raising the land to the FCL by placing fill) is an effective long-term high-cost adaptation measure which can be completed alongside geotechnical stabilization. Using a combination of adaptation tools can adequately create a Site that aligns with Indigenous priorities while also being resilient to coastal floods related to SLR.

The Esquimalt and Songhees Nations have a unique opportunity to manage the Rock Bay Site in alignment with their priorities while showcasing sustainable Indigenous stewardship by thinking 200+ years in the future while generating wealth for the Nations. The Nations are planning to daylight a creek, build at a human scale, create space for public access, and increase green space and natural vegetation on the Site. As Indigenous peoples reclaim the lands that were stolen during colonization, they can demonstrate how Indigenous-led management can lead to sustainable stewardship of the land by considering impacts of climate change, such as coastal floods due to sea level rise. The Nations are already ahead of the curve by planning for 200+ years in the future and considering flood construction levels that the government does not yet mandate. With Rock Bay, they can rehabilitate a Site and make it a massive source of pride by achieving both economic gains and environmental benefits while balancing the needs of the present and the future.

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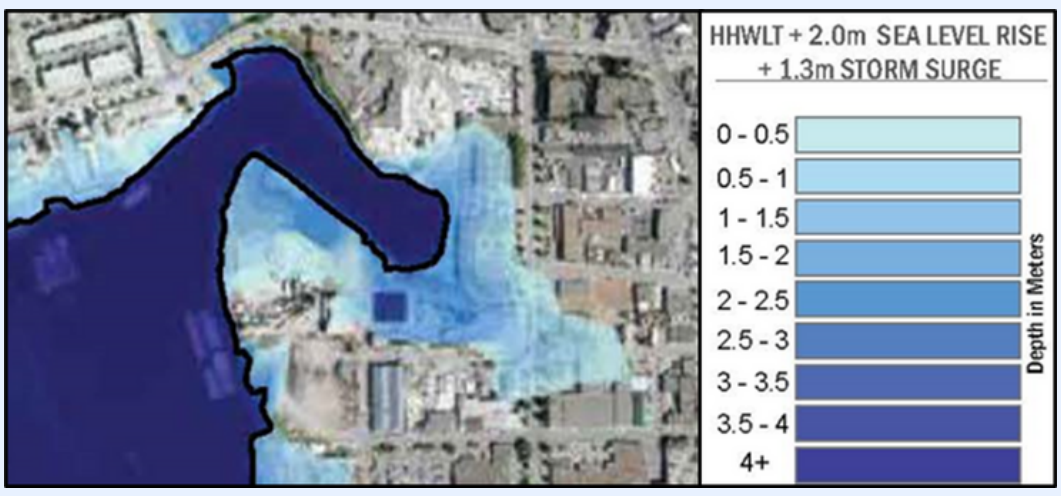
Appendix A

LWS 548 – Rock Bay SLR Adaptation Infographic

Sea Level Rise Adaptation

Incorporating Indigenous Priorities at Rock Bay, Victoria, BC

A MLWS Major Project by Tirath Dave, B.A.Sc., P.Eng (ON)



Land: 7.5 acres in Rock Bay, Victoria
Owners: Songhees & Esquimalt Nations
Shoreline: Riprap with vegetated bench

Site

Methods

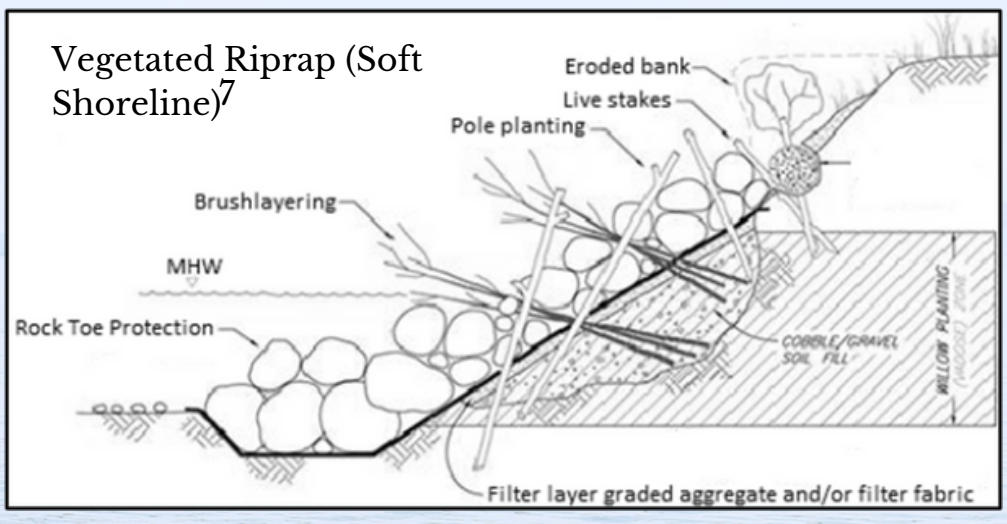
Use **Short-List** of tools
Use a **Decision Matrix** using 5 factors: Cost, Effectiveness, Durability, Indigenous Values, Environmental Benefits & Social Benefits

Context

Indigenous Priorities[1]**:**

1. Generate wealth for the Nations
2. Think to the future (200+ years) and align with Sacred Trust
3. Make Rock Bay a source of pride

Coastal Floods[2] = SLR + wave + storm + freeboard
BC Guidelines[2] = 2.0m of SLR by 2200



Vegetated Riprap (Soft Shoreline)[7]

Results

1. **Soft Shorelines** - Vegetation, salt marsh, etc.[3]
2. **Structural Elevation** - Add fill to elevate site[4]
3. **Emergency Preparedness** - Create a plan for emergencies[5]
4. **Wet Floodproofing** - Allow water to infiltrate buildings[6]
5. **Oyster Beds** - Construct oyster beds to reduce wave effects

Recommendations

- Incorporate soft shoreline principles during various construction stages.
- Use structural elevation with geotechnical work to reduce costs
- Adopt low-cost measures (emergency preparedness and wet floodproofing) as soon as possible for small immediate benefits
- Use oyster beds if important to highlight Indigenous history if desired
- Combine multiple adaptation tools in a Comprehensive Plan to achieve flood resiliency
- Showcase Indigenous presence by successfully adapting for SLR

Access the full report at https://mlws.landfood.ubc.ca/student-projects/

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