HEALING AQUASCAPES

By

Wai Van C Wong

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CONTENTS

ABSTRACT

The Healing Aquascape is a strategy to remediate the Burrard Inlet of southern BC and recover the waterway as an integral site in the development of the cultural landscape. As the ecology of the inlet is impoverished by effluent pollution there is a grand opportunity to create a rich cultural environment wherein a remediation infrastructure stages a celebration of the indigenous arts, promotes aquatic recreation, and the pursuit of knowledge of the local ecology. How might one spawn an aquatic infrastructure that restores ecological functionality and enriches the collective cultural landscape? This thesis proposes a recreational canoe circuit of remediation towers that connect an ecology research laboratory in the water with an aboriginal culture centre on the shore. The art of aquascape is a conceptual analogue at multiple scales to detangle the complexities of site and aid the investigation, development, and representation of a strategy apropos of a healing infrastructure.

ACKNOWLEDGEMENTS

I would like to express gratitude to my thesis advisor, Prof. Catherine Venart, who introduced me to critical literature on landscape, my supervisor, Prof. Talbot Sweetapple, who is a continual positive force in the search for and expression of form, Jeff Amos of Amos Woods for his time and expertise, the CNC Tech Team for their instrumental help, and the excellent Faculty and Staff at the School of Architecture at Dalhousie University.

To my family, our history and narrative inspires my dreams of continual cultural construction and moves me to edify them in the landscape.

I am ever fortunate for a constellation of friends and colleagues from East to West whose laughter, encouragement, and luminance lit a positive path for me to go forward.

Finally, I have to credit a sublime adventure surfing the Pacific for opening the door to my journey.

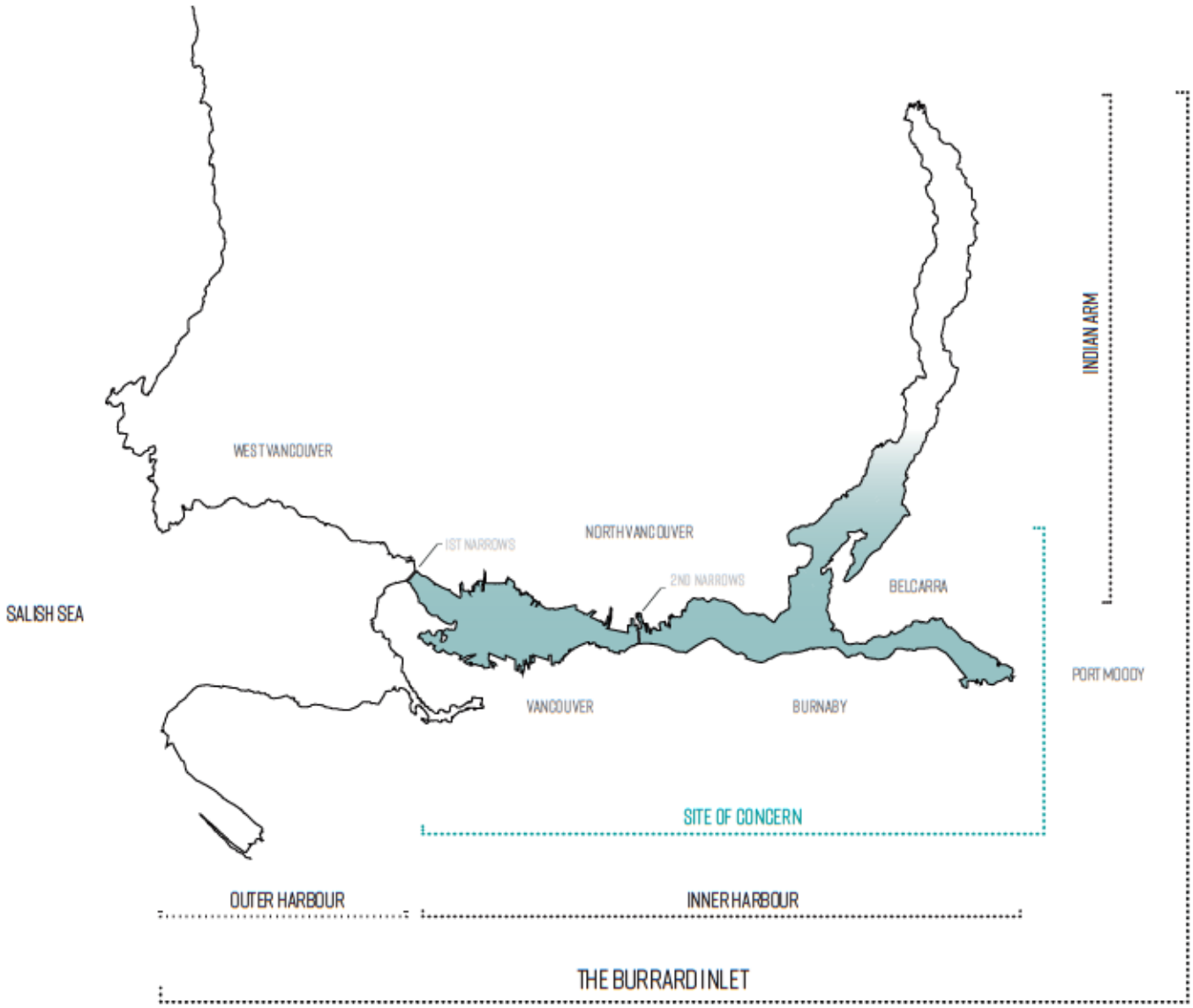
CHAPTER I: THE AQUASCAPE

Aquascape is used in this thesis as the aquatic counterpoint to landscape as a provocation against certain biases in design and design language. Etymologically, *land* is defined as dry terrain or anything that is *not water*. It is that particular division that David Leatherbarrow describes a vertical antinomy between what is dry above and wet below the level of constructed topography, one which has had great force and amplitude in the history of ideas about the nature of built sites.[1] Such biases have led to inflexible infrastructures that are ill equipped to adapt to new climate normals and many parts of the world are now confronted with the undeniable, inescapable and sometimes overwhelming presence of water. By designing strategies for reincorporating waterways into the cultural aquascape, we might yet learn better ways to coexist with and adapt to water.

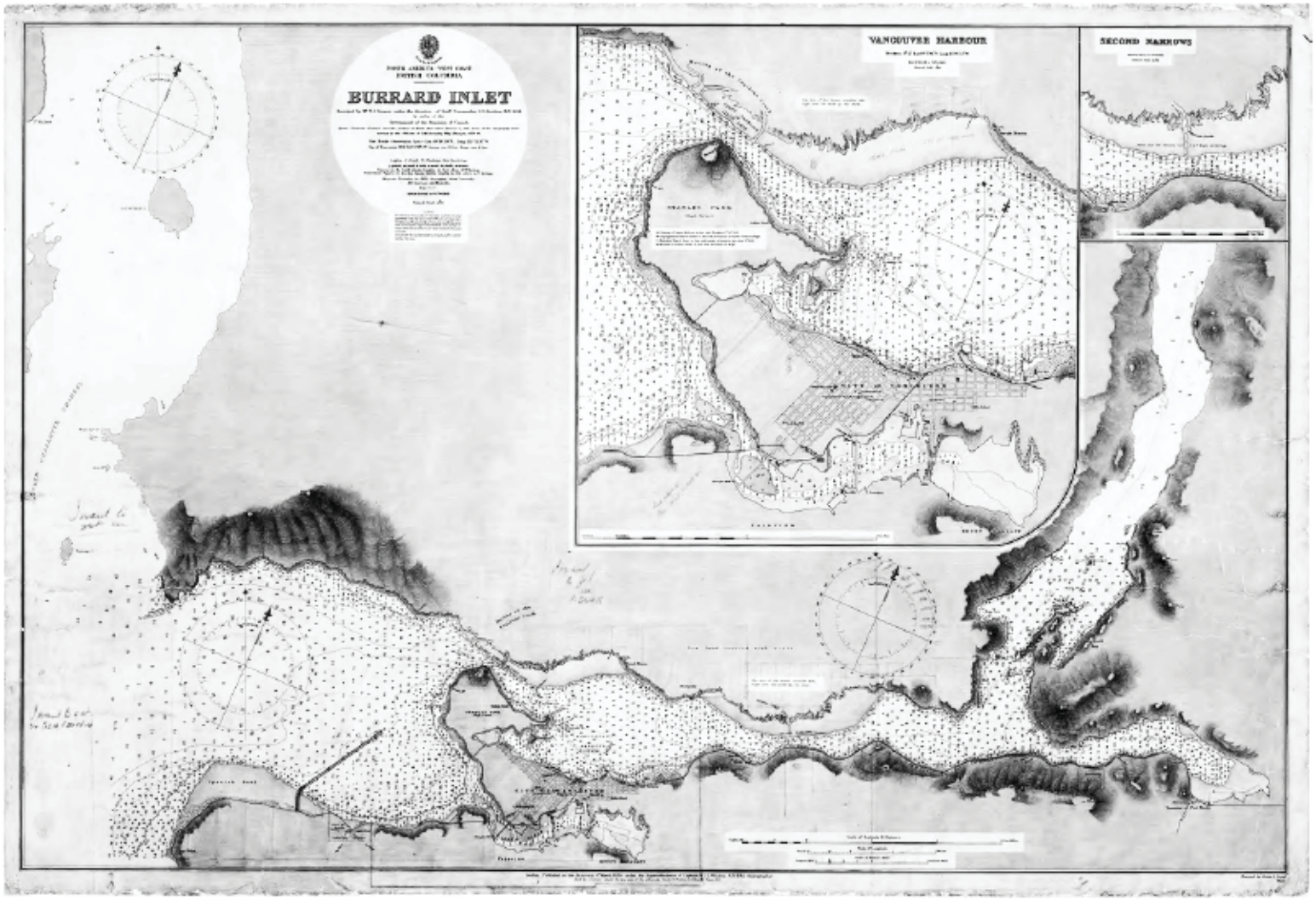
The Severance of Economy from Ecology

The Burrard Inlet is a fjord that defines the coastline of Greater Vancouver and separates the lowlands of the south from the spectacular backdrop of the Coast Mountain range to the north. The inlet stretches from the Salish Sea eastward to Port Moody and merges with the Indian Arm to a near perpendicular confluence at three quarters of the length inward. Rainfall and snowmelt from a number of river systems stream into the inlet

1. David Leatherbarrow, "Leveling the Land," in *Recovering Landscape: Essays in Contemporary Landscape Architecture*, ed. James Corner (NJ: Princeton Architectural Press, 1999), 172.



Burrard Inlet site map



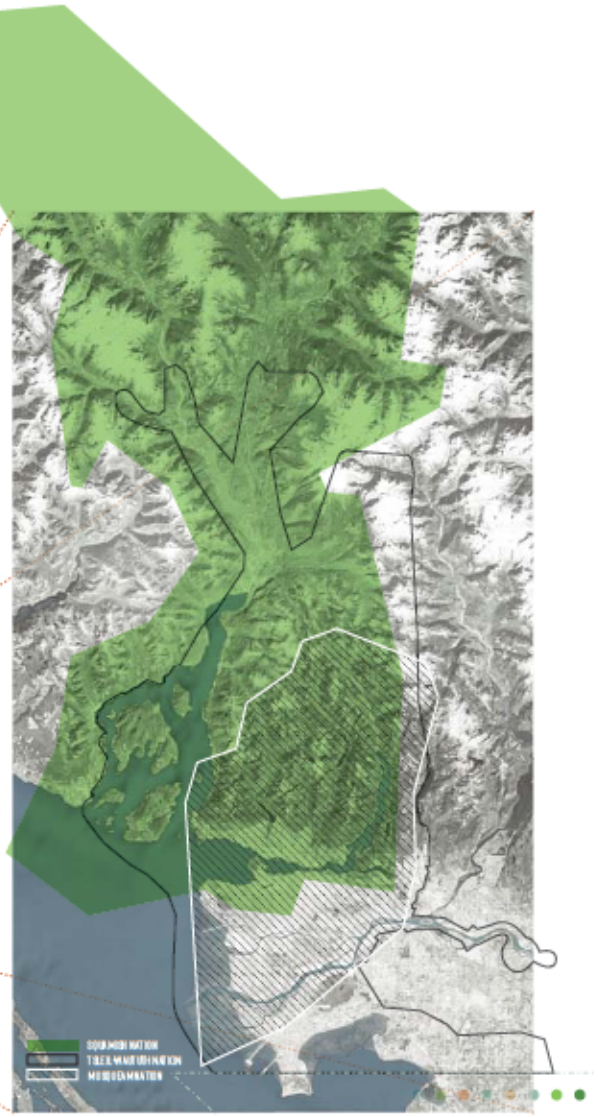
Burrard Inlet nautical chart, 1893; map by W.J. Stewart

from the north shore and mix with the inflows of brine from the Pacific. The steep mountainsides are thick with hemlock, sitka spruce, douglas fir, and cedar atop cliffs of granite. Yet the region is hardly a place of quiet idyll. It is a site of major landscape transformations that occurred within the last 150 years to become a bastion of a modern transnational industrial economy.

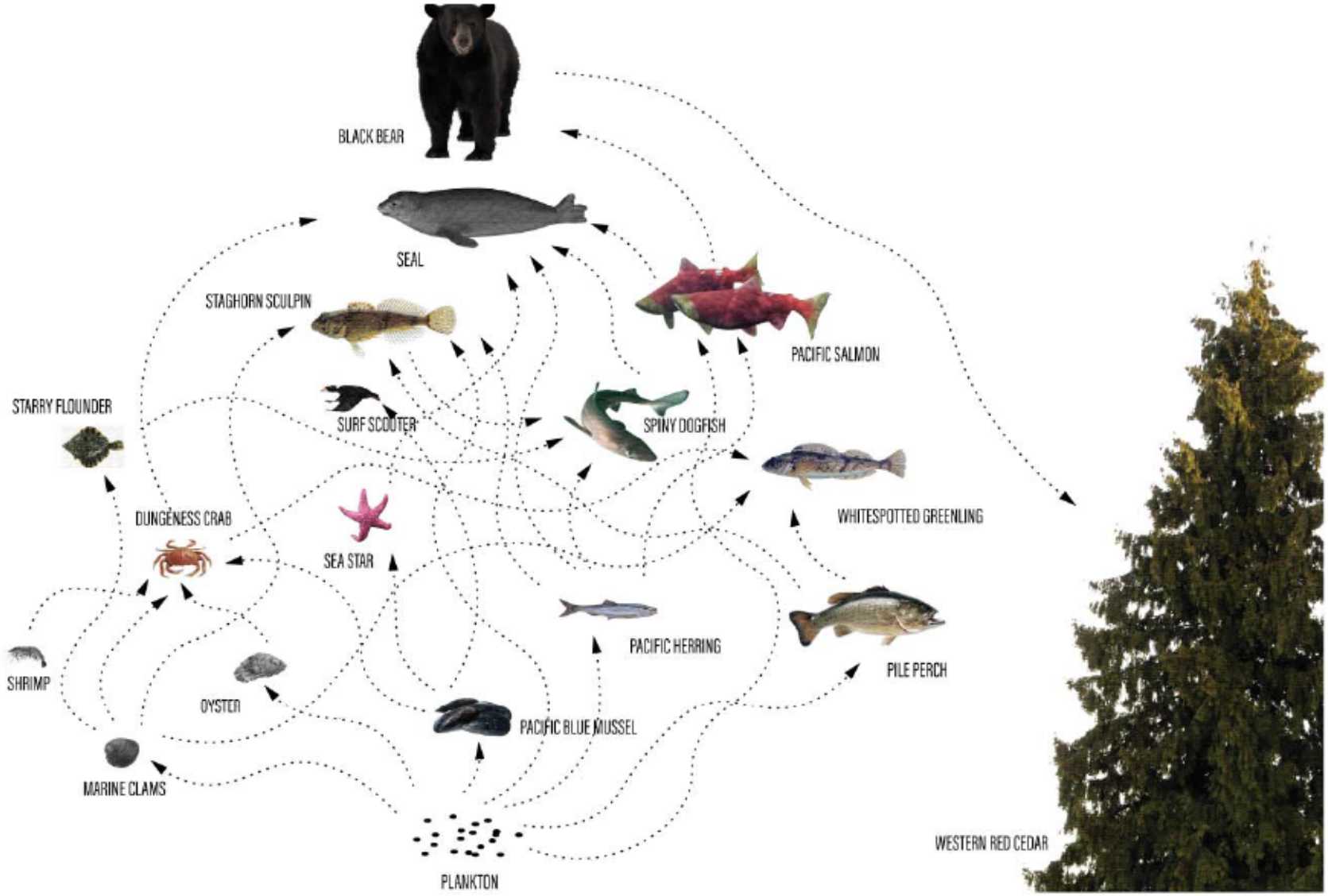
Prior to the transformations, the landscape of the inlet was the historic home of the Coast Salish tribes including the Musqueam, Squamish, and Tsleil-Waututh Nations whose ancestor's lives were inextricably tied to the inlet. The following map illustrates the territories that were historically accessed by local tribes in the context of the lands inhabited by all Coast Salish. The abundance of the inlet was the foundation of the economy and culture of the first peoples. The center of all life, the waterway was traversed by dugout canoe to move people and supplies between seasonal villages, to access and transport resources, engage in trade, and keep diplomatic relations with other tribes. From the harvest of salmon and shellfish, to the felling of cedar trees for building longhouses, the inlet supported and sustained the epic aboriginal culture for millennia. A slice of that richness is shown in the basic foodweb of the inlet. The Salish people allowed for resources to replenish after harvest and very selectively felled timber from the verdant forests. Such cultural behaviors were rooted in belief and knowledge systems that described the fundamental structures of the cosmos, the interrelationship of humans and other beings, the nature of spirit and power, and of life and death.[2] Importantly, Salish mythologies and crafts intertwined the spirit of animals with

2. Janet C. Berlo and R. B. Phillips, *Native North American Art* (Oxford University Press, 1998), 21.

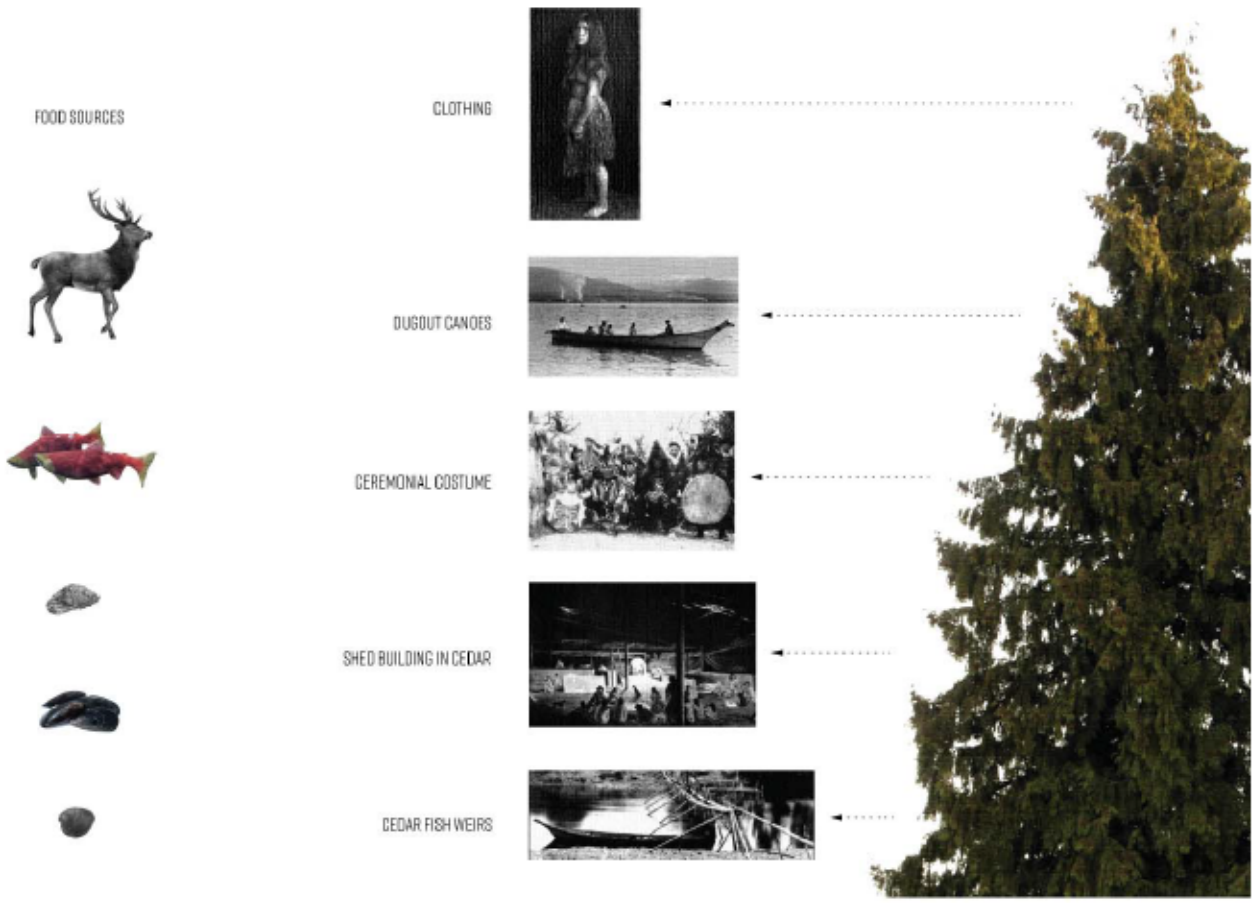
Coast Salish historic territory in British Columbia and Washington; adapted from map by Hilary Rudd, 2004



Coast Salish traditional territory in southern BC; adapted from maps from Musqueam, Squamish (BC Treaty Commission), and Tsleil-Waututh websites



Food web of the Burrard Inlet; adapted from food web map by Diego Natale, 47.



Resource uses of Coast Salish tribes

the phenomena of landscape and the cycle of creation, existence, death, and rebirth. Man was not seen as separate from, and superior to, the rest of creation but lived in a reciprocal relationship with nature.[3] However, the reverence of aboriginal man to nature, his physical movement like water in the porous landscape, is a stark contrast to how urban settlements are functionally and culturally disengaged from the inlet today.

The landscape of the inlet is one of complexity where a number of entities overlay their competing intentions. Descendent aboriginal communities are sequestered to reservations along parts of the shore bearing witness to the ecological destruction of their ancestral home. Refusing passivity, many stand in vigilance of further industrial development by taking on the mantle of stewardship over their historic territories for the longevity of the ecology and for the sake of all future generations. Meanwhile, unbridled urbanization of Greater Vancouver is expanding vertically towards the sky and east beyond the inlet fueled in part by housing shortages and an annual influx of new residents while bound by the limits of the geography from the base of the Coast Mountains to the US border in the south. The endless demand is building pressure on the existing sewage and stormwater infrastructure. Most visibly, the industries that rely on the harbour for tourism and shipment of goods dominate the landscape at the shore and in the water with the steady traffic of tankers, tug boats, and container ships. Altogether known as the Port of Vancouver, the economic industrial infrastructure has transformed and impacted the aquatic landscape dramatically.

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3. Ronald L. Wright, *Stolen Continents: The Americas through Indian eyes since 1492* (Houghton Mifflin, 1992), 34.

Burrard Inlet from the south shore

Burrard Inlet from second narrows to the east

Practically all the edges of the shore of the inlet, save for the Indian arm are hardened with concrete, asphalt decks and massive staging areas for the reception, storage, manufacture, division, sorting, and transportation of goods. Additionally, national rail networks weave through the landscape, their presence made in steel tracks and creosoted rail ties like poisoned teeth embedded in the rip rap shoreline. While the Port and the rail yards form a backbone of the national economy, physical obstacles prevent urban communities from using the inlet for a locally sourced economy. Brambled, fenced off, and razor wired, the industrial zone blocks urban access to the waterfront with the semiotics of privacy and threatened repercussions for trespass almost completely alienating the landscape from urban communities.

The physical and spiritual disconnection of the urban population from the water prevents the inlet from becoming integrated in the cultural landscape as a place of nurture and a source of meaning. A continual lack of access prevents the acquisition of empirical knowledge of ecological processes, cycles, and changes that have occurred to the inlet over time. The hardening of the landscape and dredging of the sea floor decimated coastal habitats that otherwise enabled a rich biodiversity. Compounding the effects on ecological vitality is the effluent pollution from industrial activities and sources of untreated sewage which is responsible for the destruction of aquatic and benthic habitats. Algae blooms feeding off effluents propagate, consequently hoarding the supply of oxygen, and toxifying habitats for already stressed fish populations. Meanwhile, shellfish harvest has continued to be unsafe for consumption since the early 1970's. The severance of an economy sourced from the local ecology of the inlet is near complete.

Aquascape and an Infrastructure of Healing

The landscape transformations are irreversible as preceding investments and expectations of continually growing returns from the economy moves the backhoes, cranes, ships, cargo trains, and capitalist dictates to brutishly plow on. The persistence of the negative ecological and cultural consequences could embed a sense of helplessness as to how it might all evolve. Yet the status quo and cynicism toward change stimulates the imagination of an alternate shared destiny, one in which adapting to the existing conditions and establishing a physical presence where people are forbidden, increases the level of engagement with the natural surroundings. In establishing a more tangible connection to the landscape, collective cultural values might morph into a more integrated relationship with the environment and foment demand of alternative futures as interaction with the rich, sensuous, and phenomenal world grows. How then, might one spawn an aquatic infrastructure that restores ecological functionality and enriches the collective cultural landscape that connects people to the water? It is the intent of this thesis to ignite these values by investigating a healing aquascape as a strategy to remediate polluted waters in order to revive habitats for biodiversity and to recover the waterway as an important region in the development of the grander cultural landscape.

To start with, The Healing Aquascape is a titular strategy that extends the ideas from the realm of landscape architecture to the milieu of the brackish waters and coastal environment of the Burrard Inlet. In expressing the philosophical underpinnings of the driving paradigm of contemporary landscape, James Corner elaborates that it is a synthetic

and strategic art form that aligns diverse and competing forces into newly liberating and interactive alliances.[4] It is in the weaving of the allied, divergent, and competing forces that the tapestry of landscape is able to demonstrate its potent instrumentality as a medium to enrich place with a plurality of purposes and a multitude of possibilities for novelty and individual and collective experiences. Specifically, Corner's bold vision demands an imagination in which architecture, landscape, planning, ecology, engineering, social policy, and political process are understood and coordinated as an interrelated field.[5] In this collaborative way, it is possible to fight against monotony and monopoly in the landscape. While his grand vision illuminates an apex of ideals in practice, it is insightful to look at a recent precedent to formulate a strategy envisioned for the Burrard Inlet.

LTL Architects designed Water Proving Ground to address the question of sea level rise in New York for the MOMA sponsored exhibition Rising Currents. The project proposes that major storm events and sea-level rise could be mitigated if the line between the urban and the aquatic were blurred. Existing landfill at Liberty State Park, a site that is roughly level with the sea, would be reused for a strategy of a varied topography, and a crenellated landscape of jagged fingers that, by lengthening the coast-line manyfold, allows the park to attenuate waves and serve as a natural filter of tidewater.[6] Four fingers of molded elevated landscape extend into the water as a combination of reefs, beaches, and islands that host an expansive variety of urban programs.

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4. James Corner, ed., *Recovering Landscape* (Princeton Architectural Press), 2.
5. James Corner, "Not Unlike Life Itself: Landscape Strategy Now," *Harvard Design Review*, 2004, http://www.harvarddesignmagazine.org/issues/21/not-unlike-life-itself-landscape-strategy-now, accessed Dec 2016.
6. Barry Bergdoll, *Rising Currents: Projects for New York's Waterfront* (New York: MOMA, 2011), 26.

Existing: five miles of coast

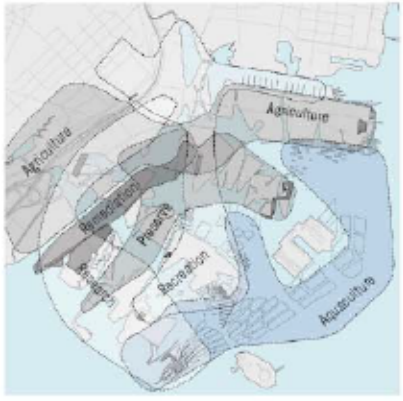
Proposed: cut and infill

Proposed: piers and crossgrain

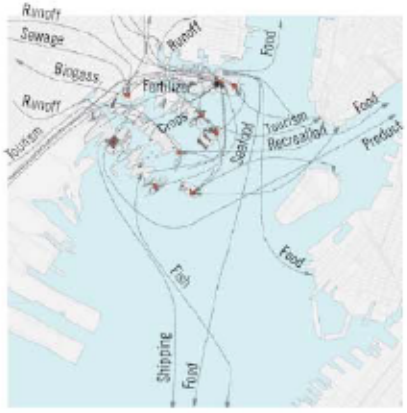
High tide: thirty five miles of coast

Low tide: forty-five miles of coast

Circulation and anchors

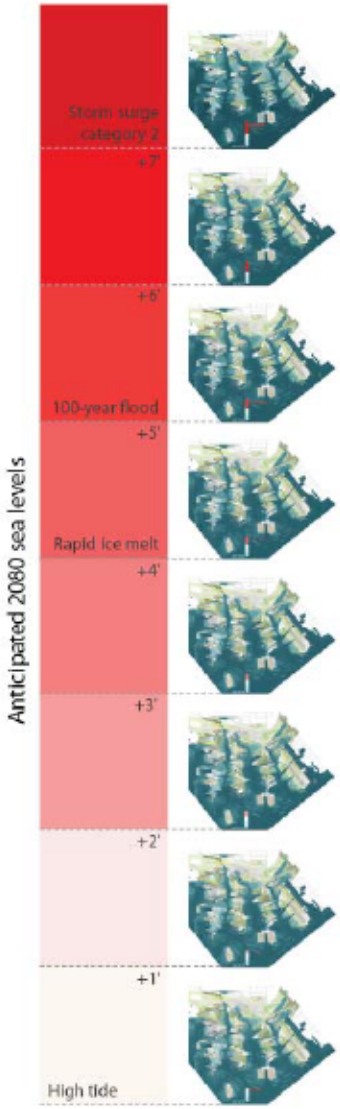


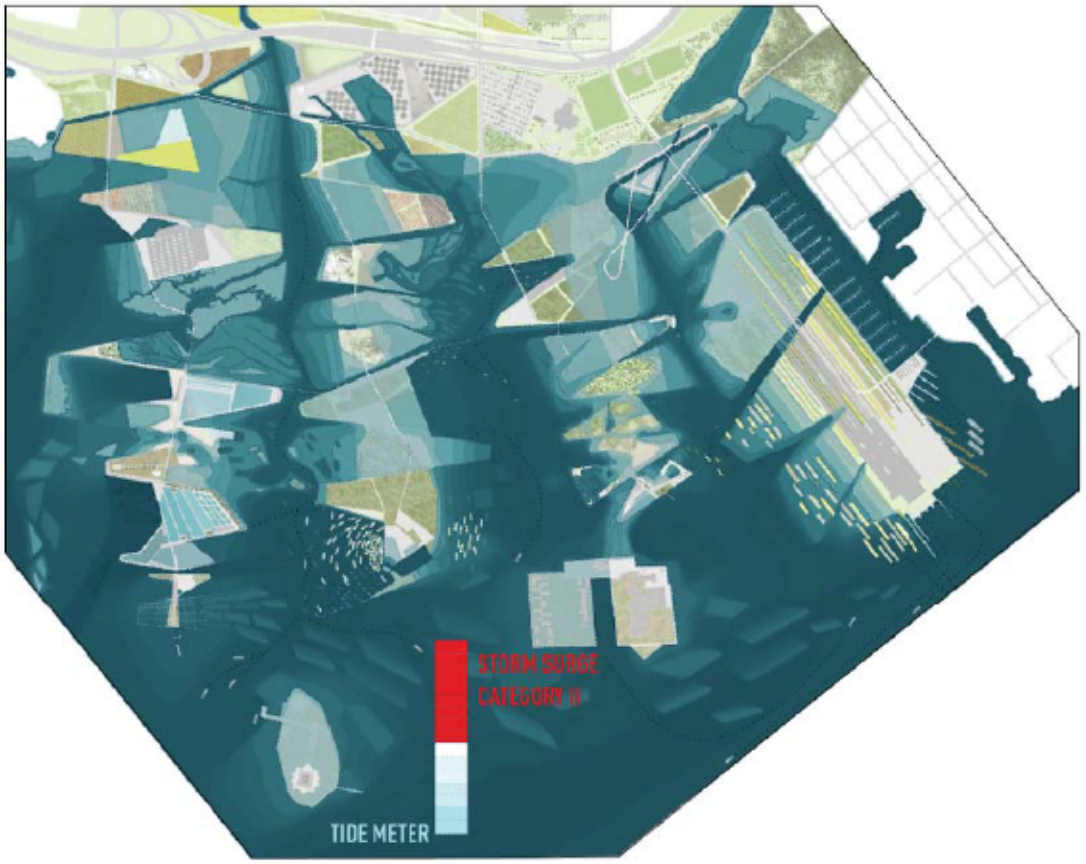
Program areas



Flows

Diagrams illustrating the landscape strategy of Water Proving Ground; LTL Architects website



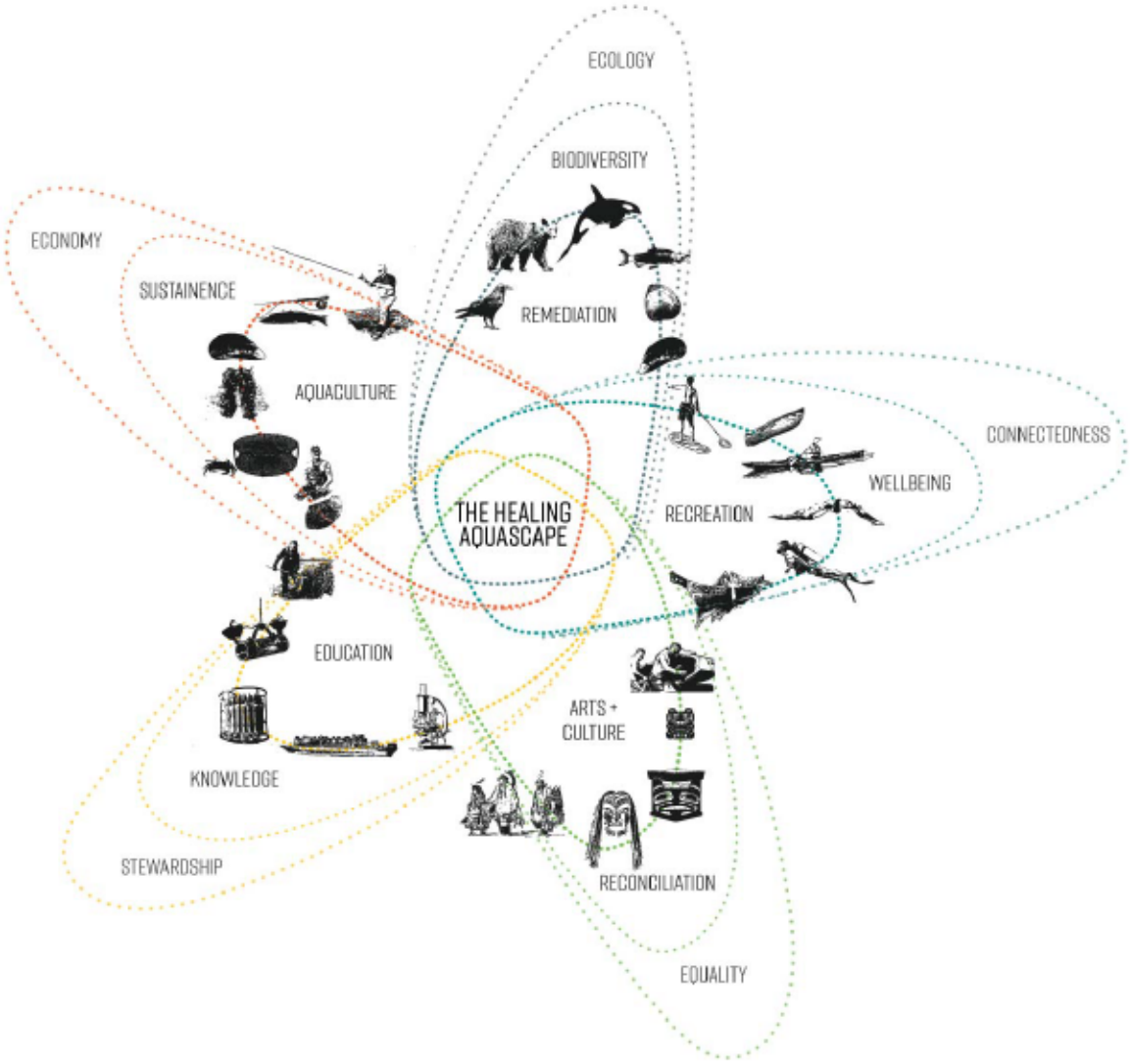


Site at category 2 storm surge

Diagrams illustrating the landscape strategy of Water Proving Ground; LTL Architects website

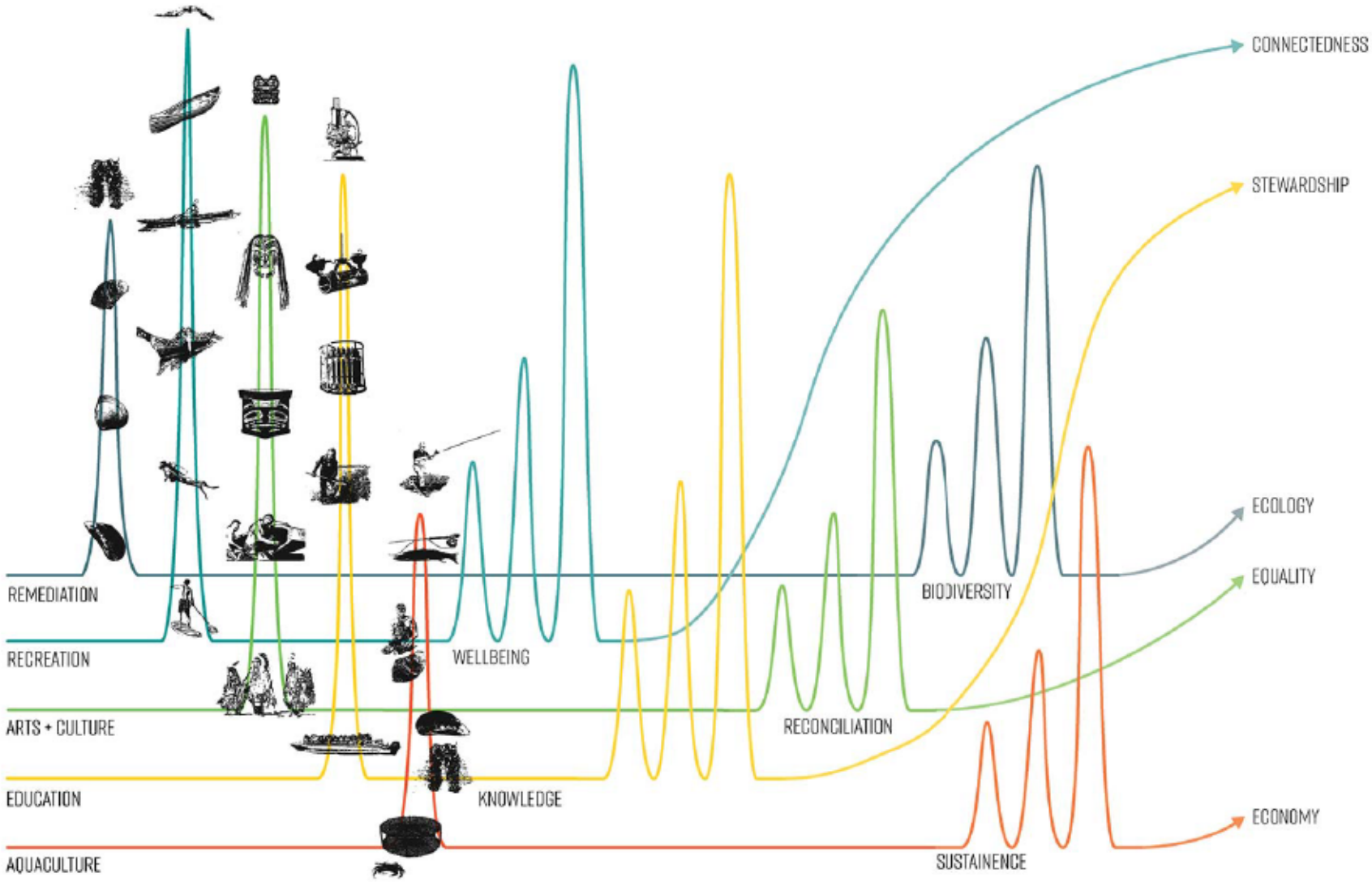
Water Proving Ground is an exemplar of James Corner's tripartite observations on the practice of landscape. The ambitious strategy manages complexity of function by serving first to physically withstand the new normals of climate change while incorporating a multitude of cultural uses. The project organizes the site on a large scale to mediate experiences through hosting functions that vary by proximity to land and water. Then in an open-ended fashion, the project demonstrates how the relationship of water to land would change over time while protecting the urban landscape from century-scale changes to sea level. While LTL's project is inherently a massive undertaking imposing intensive energy requirements to reorganize existing landscape formation, it is a demonstrably poetic proposition fusing protective topography with a mixture of ecological, recreational, and cultural land uses that activate the cultural landscape.

The Healing Aquascape is conceived from a set of five facets of a program that are knit together as an overarching framework to enrich and concentrate meaning in the landscape. In the following diagram, the underlying facets of the strategy include remediation, recreation, education, the arts and culture, and aquaculture. Each of these activities are adjusted to suit the specific narrative of site within the dimensions of space and time to form a strategic program. The following diagram illustrates the facets as interrelated, having primary positive healing impacts yet working towards and cultivating distant long-term benefits. It could possibly serve as a typological strategy for the revaluation and reclamation of polluted aquatic sites in the Pacific Northwest.



The healing aquascape framework

In the instance of the inner harbour, if the water is remediated, then we could improve the chances for biodiversity and eventually heal an ecology. If individual well-being results from improved recreational opportunities, participation and positive interaction with others in the water might engender a greater sense of connectedness to the landscape. Giving artistic and cultural voice to the indigenous communities to share with their neighboring urban settlements will showcase the compelling beauty, continuity, and longevity of an ancient culture. Activating opportunities for cultural exchange would promote reconciliation from past injustices to heal a community from persistent negative and harmful stereotypes. It might clear a path towards mutual respect and equality. A provision of educational spaces will undoubtedly improve local knowledge of the landscape and might ultimately lead to societal stewardship of the inlet. Finally, improved opportunities for aquaculture or aquatic farming might benefit with immediate sustenance and eventually go to develop a locally sourced economy as methods are continually refined, and eventually perfected. The diagram below shows how each aspect of the program might play out from implementation of strategy to when benefits might occur relative to each other, and achieve outcome possibilities in the long term. Not one of these facets of the program could individually achieve all these benefits alone. Grander than the sum of parts, positive impacts are more likely to occur when components of the program operate together in order to cultivate the Healing Aquascape as a whole.



Program implementation and expected results over time

An Ornamental Art as Analogue

A method of investigation and representation of the narrative of the aquatic landscape might be conceptualized from an ornamental art which shares the name of this thesis. As an analogue, Aquascape is the design, planning, and maintenance of aquaria or ponds. The activity involves the placement of several elements including a vessel, plants, plant materials, sand, gravel, rocks, sea creatures and importantly, water. Designs may be aesthetic, such as the freshwater aquariums created by late artist Takashi Amano, or educational in nature, re-creations of underwater environments which naturally occur in the local setting, or not. In order for an aquarium to thrive, the designer must have the technical expertise and understanding of the specific conditions of each element, how they must function together, and be maintained as a system in containment over time.

The design of aquascapes concerns a relatively small scale no larger than a pond and yet encompasses a tiny synthetic ecology that one might envision to be scalable to the level of landscape. It is a near perfect analogue. Just as in the design of aquaria, a healthy regional aquatic environment demands knowledge and understanding at a corresponding scale. What the plants represent to the botany of a region, the rocks do to the geology, as fish and other sea creatures to marine biology, while movement, volume, and type of water to hydrology, and from the interaction of those elements, an ecology. However, that is not to suggest that an actual aquarium be made in order to represent landscape. Rather, the vessel containing the minute aquascape ecology has

Aquascape by Takano Amano, Aquarium Architecture website

Aquascape by Takashi Amano, Aquarium Architecture website

a transferable equivalency with the landscape. An illustration by Jamie Mills depicts elements of nature encased in glass as if tiny bites of landscape are on display in a museum. While there is no claim to understand the artists meaning, there are a few revelatory ideas captured in the illustration.

The narrative of landscape may be communicated from its depiction as a block extraction in a two-dimensional illustration and by extension a three-dimensional model. Physical features may be isolated or layered to reveal different aspects of the landscape. One might glean from that representation its physical state, how the land is formed, and may suggest how water flows over some surfaces and pool elsewhere. It might also communicate why some parts of the landscape are used for some purposes and not others. The interplay of terrain and water in the landscape may reveal specific physical conditions to consider for design. Ultimately, it might show how the land as a vessel is physically formable and moldable, or reveals what type of structures and modifications are suitable to the site. An investigation of aquascape in the style of Ian McHarg's ecology method, where physical features are layered upon one another to determine specific values of the landscape, might enhance the outcome of the design.

Pencil illustration by Jamie Mills, 2013.

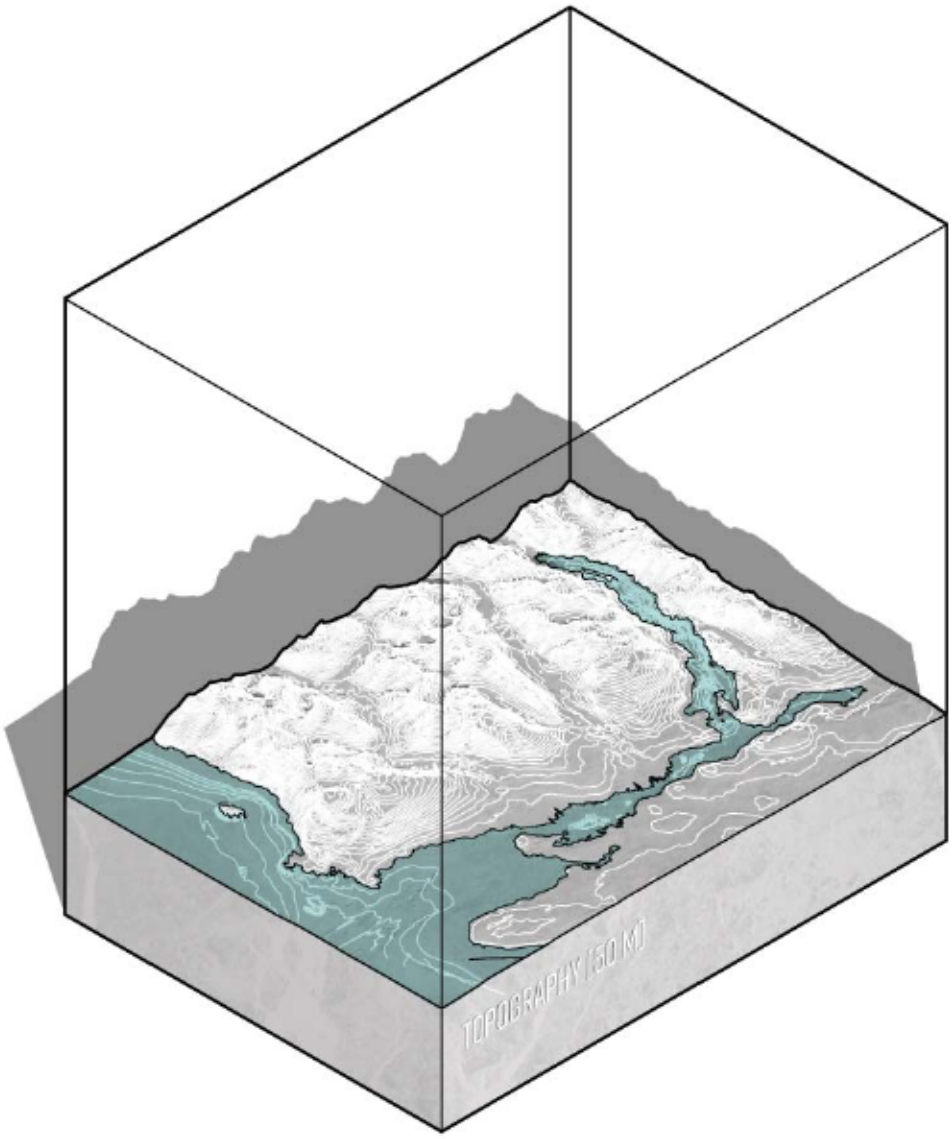
CHAPTER 2: A NARRATIVE OF COMPLEXITY

The narrative of the Burrard Inlet is one of complexity where the landscape is subject to the coexisting intentions of multiple entities. An attempt will be made to detangle the given circumstances to illustrate the story of the waterway. The specific site will be limited to the inner harbour and the lower reaches of the Indian Arm. However, overall aspects of the entire water system will be studied. An illustration of the overall picture of the inlet will assist in determining grand-scale relationships between parts of the strategy and produce a more locally responsive remediation and cultural infrastructure.

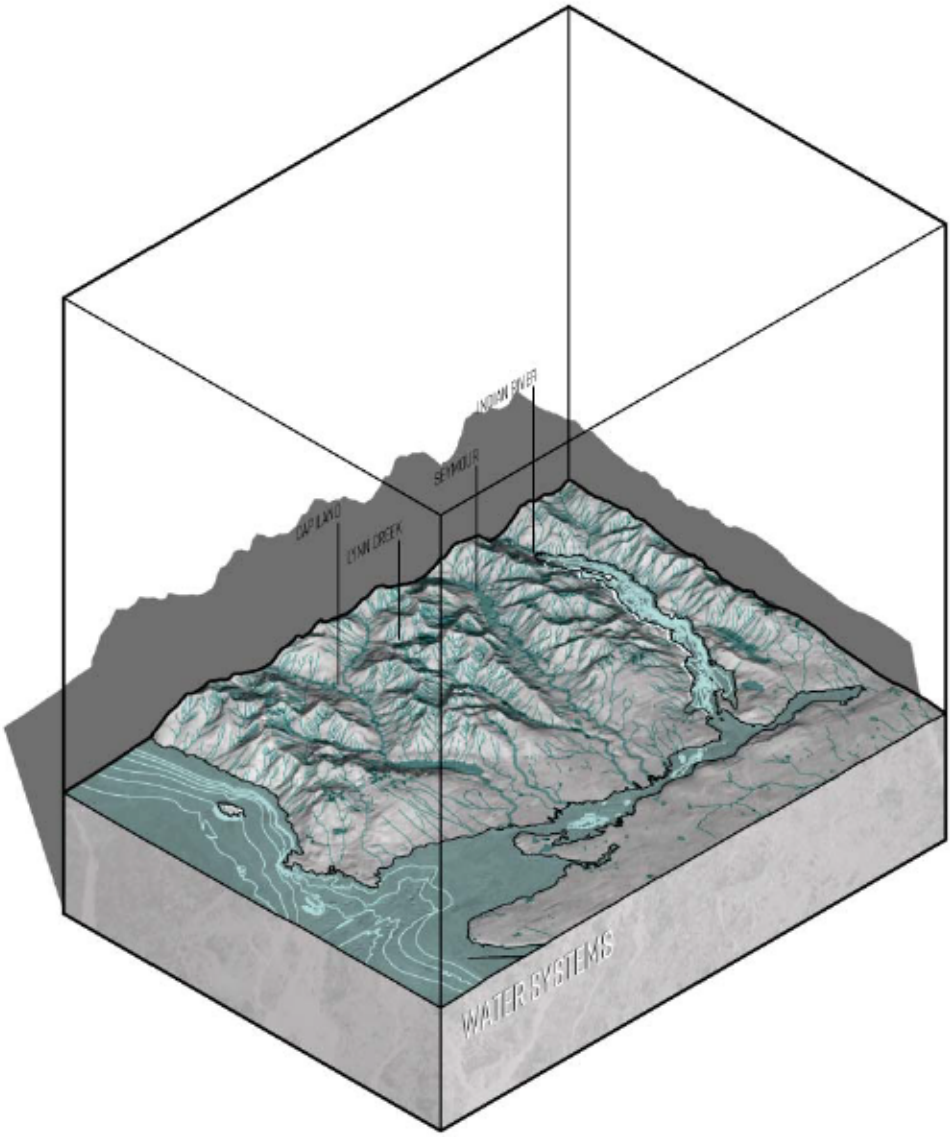
Geomorphology of Burrard Inlet

The last major natural transformation of the coastal landscape of the Burrard Inlet occurred during the Pleistocene. Periodic advances and retreat of the continental Cordilleran ice sheet scoured and clawed away sediments of the previous age and cut deep valleys into the land exposing the granitic geology of the mountains, and creating fjords that are a defining characteristic of the filigreed Pacific Northwest coastline.[7] Greater Vancouver at the south shore of the inlet features relatively flat lands made of 25m deep glacial till that stretches past the inlet and Port Moody. In contrast, the granitic makeup of the Coast Range has characteristically steep mountainsides that are undergoing natural erosion. It is a process

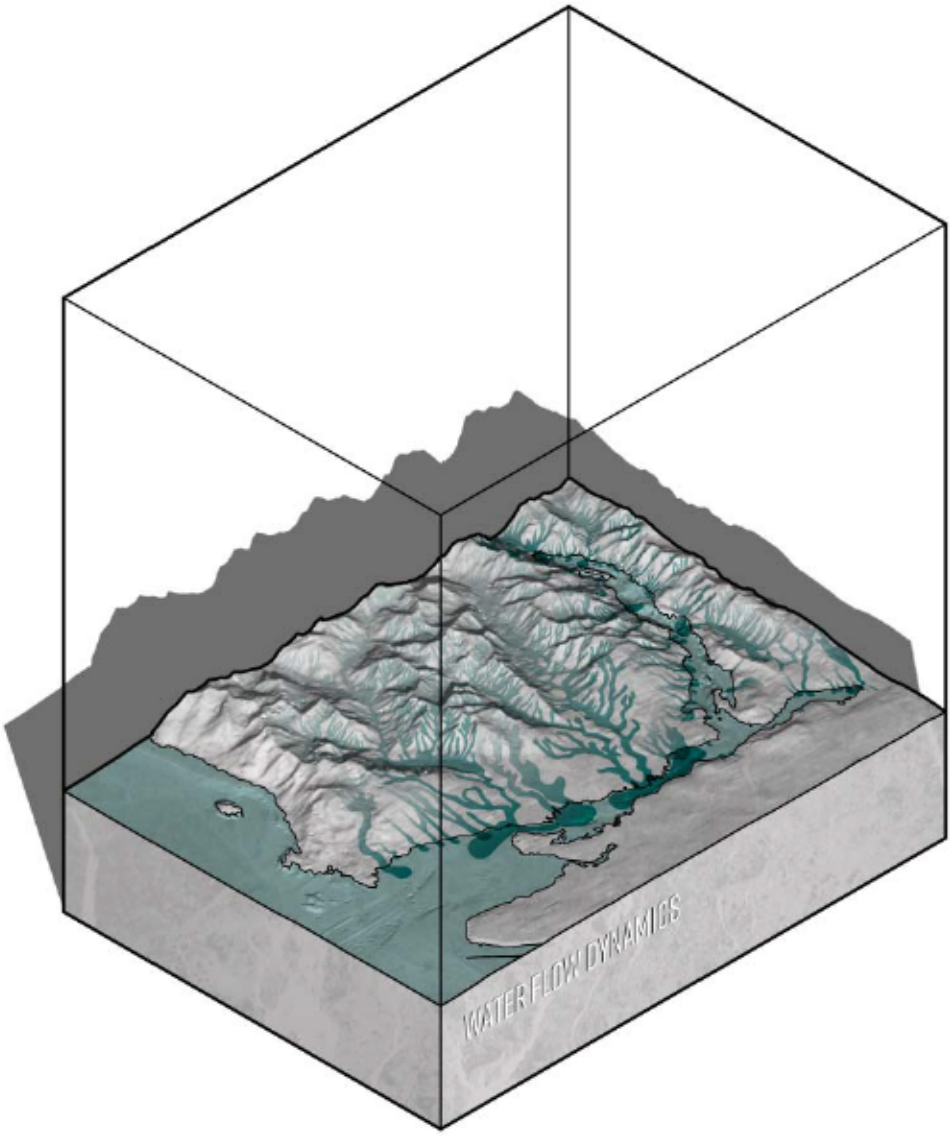
7. Sydney Cannings, Richard Cannings and JoAnne Nelson, *Geology of British Columbia: A Journey Through Time* (Vancouver: Greystone Books Ltd, 2011), 64.



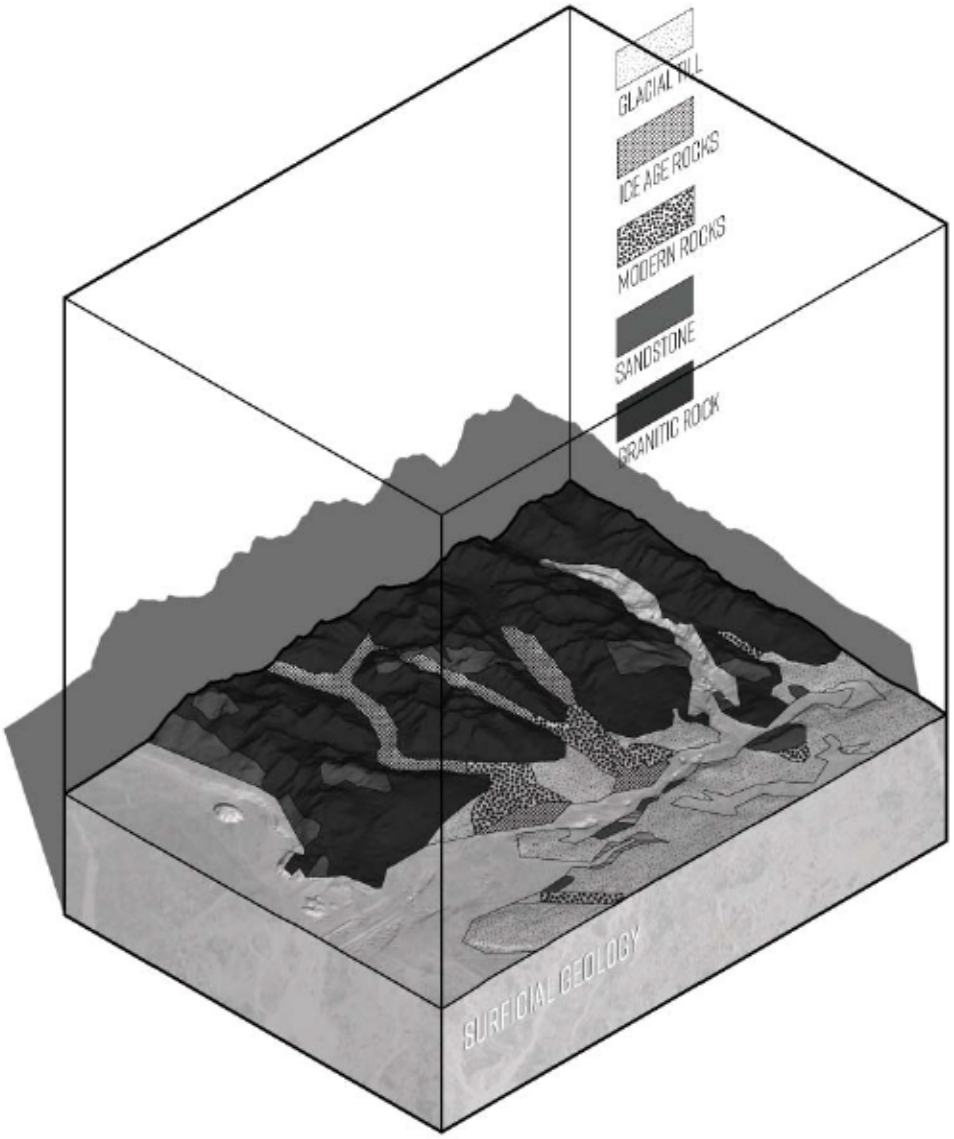
Resulting topography of southern BC from last ice age



Major river and stream systems located on the north shore



The natural path of water flows that replenish the Burrard Inlet

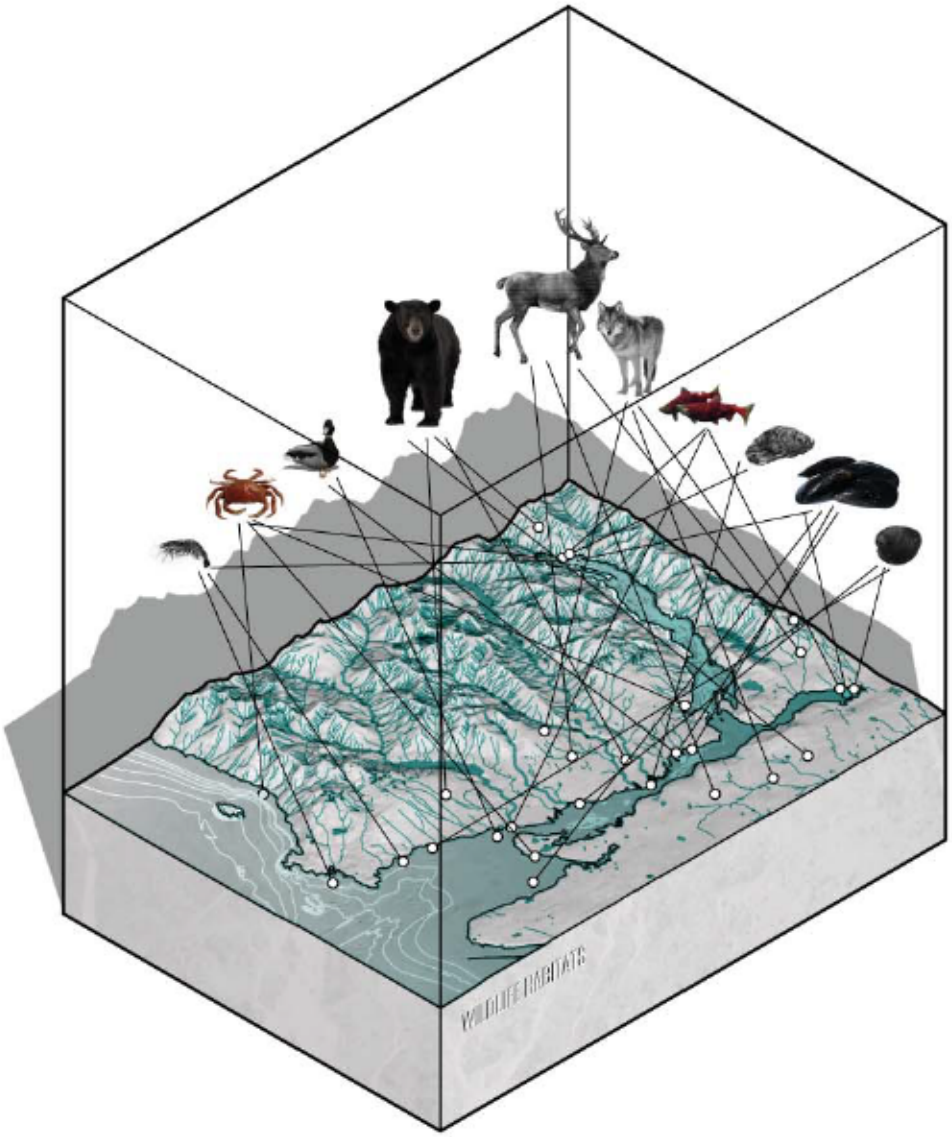


Surficial geology resulting from last ice age, climate and river systems

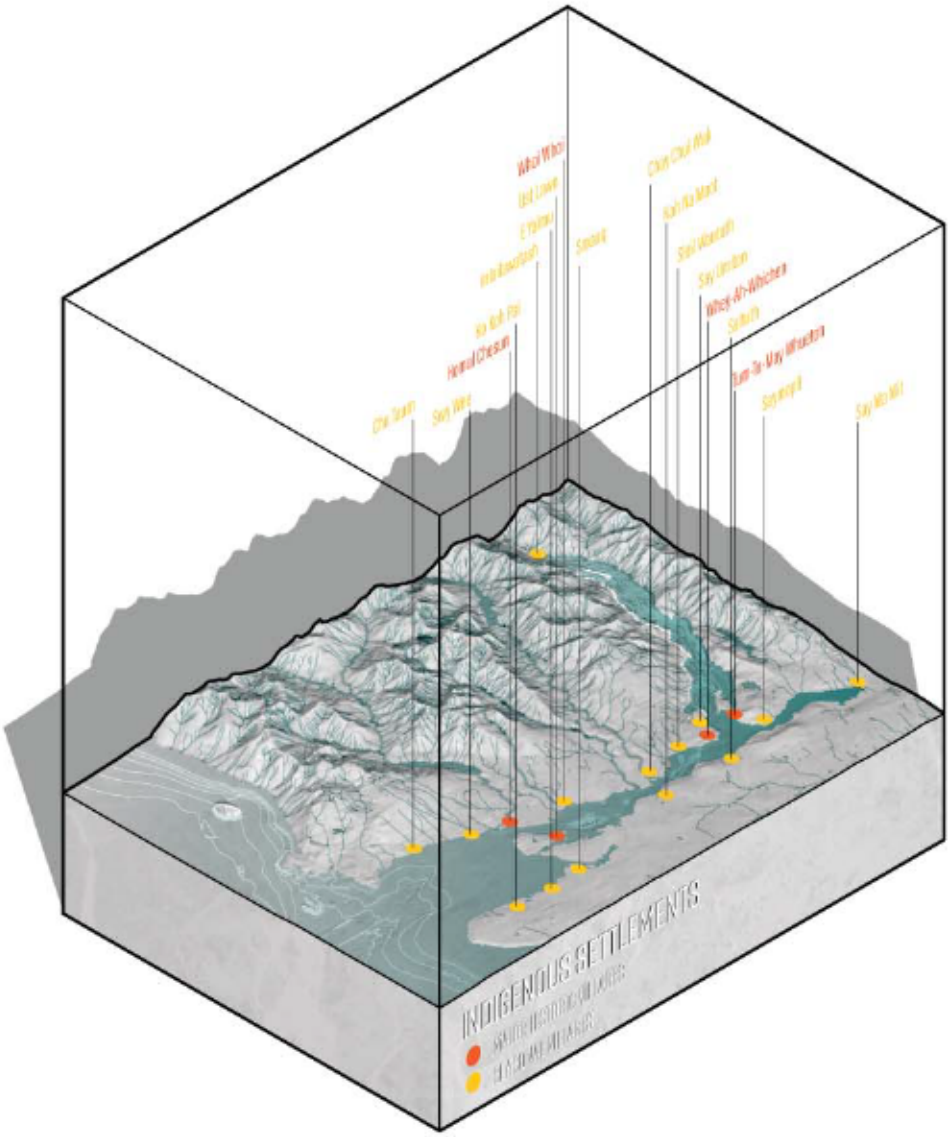
accelerated by a temperate and wet climate. Major watershed systems including the Capilano, Lynn Creek, and Seymour Rivers continually transport eroded sediments to alluvial deposits at the base of the north shore which are crucial for creating healthy benthic habitats. The buildup of the sediments in the harbour of the inlet resulted in water depths of no more than 65m and naturally created banks of rock and gravel called the first and second narrows. Meanwhile, the Indian Arm, features near vertical edges that plumb to underwater depths of over 300m in some parts. The natural landscape of the Arm is relatively vertical, treacherous, and remains mostly undeveloped for this reason. Given the geographical features of the southern portion of Burrard Inlet and the proximity of abundant natural resources, the region was a particularly excellent site for building the villages of the Coast Salish people.

The Indigenous Inlet

The natural climate cycles and flow of water that propelled the processes of erosion and deposition of sediments in the Burrard Inlet helped to create rich habitats for all types of wildlife. Salmon, an important fish in the indigenous diet, incubated and thrived in the gravelly estuaries at the bottom of every stream and river. Their return as fully grown fish from the Pacific was an important food source for black bears and the nitrogen from the detritus fertilized the cedar and hemlock forests. In addition to the iconic fish, the continually replenished benthic habitats helped shellfish to thrive all over the coast. From mussels, to oysters, and from clams to geoduck, Coast Salish villages were founded and built on



Wildlife habitats and sites of resource harvest by the Coast Salish



Historic Coast Salish villages located near shellfish beds

the shores wherever shellfish was plentiful. The evidence is in the depth of middens or shell piles that were leftover from human consumption of the staple protein and the mounds of which make the substrate under ancestral village foundations.

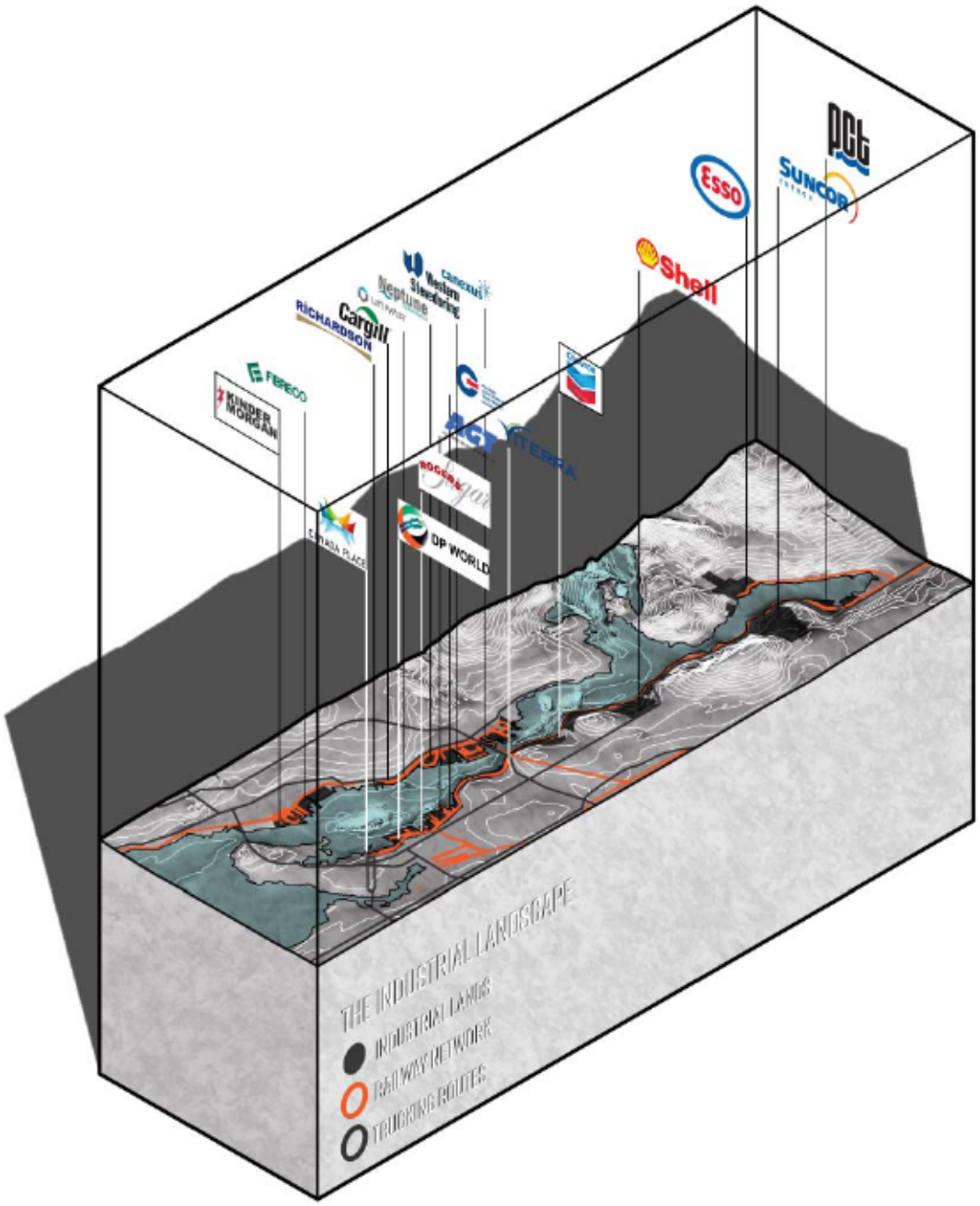
The ease of access to shellfish freed the people of the Musqueam, Squamish, and Tsleil-Waututh tribes to develop and refine a culture that was wholly defined by and integrated with the natural cycles of the coastal environment. Red cedar was prized and selectively harvested for building longhouses and carving dugout canoes, while yellow cedar was the preferred material choice for the most important woodworking in art and crafts. Yet, the dependency on the shellfish protein source required the tribes to strategically build and inhabit alternate seasonal villages to allow for the shellfish to replenish once most of the resource was consumed. Traversing the inlet by canoe was not just for accessing raw materials to create cultural artifacts but a real prerequisite for survival. It was how the Coast Salish sustained themselves for eight to 10,000 years before the arrival of western settlement.

Port of Vancouver Industrial Complex

When the first naval captains sailed past the first narrows into the Burrard Inlet, it was noted how the landscape could provide safe harbour for merchant ships. The mouth of the first narrows created a grand breakwater protecting the banks of the inner harbour against the tidal action of the Pacific Ocean. Docking in the calm waters of the inner harbour would ease the process of loading

and off-loading goods. It was a reason that a site next to the inlet was chosen as the terminus of the Canadian Pacific Railway, which connected to the national system and was completed in 1885. Global goods could now be transported from the coast to the interior provinces and national production of goods were concurrently shipped south along the Westcoast or across the Pacific Ocean to the Orient. The impetus for further industrial development in Burrard Inlet came in 1914 with the completion of the Panama Canal which reduced shipping times to other parts of the continent and beyond. Thus began an era of industrialization of the Burrard Inlet.

The industrial transformation of the waterway started when the first sawmill was built on the shore of present day North Vancouver in 1863. Nearby forests were cleared for lumber production and shipping, activities which dominated local industry until the railway made it possible for the region to diversify the economy. The railway accelerated the development of the inlet to become a marine transportation hub for numerous industries. Roger's sugar refinery, a large brick factory still in operation today, began production in 1891. Petroleum refineries were built as early as 1914 to transport oil across the country, most of which continue to ship crude for local use and export. The first massive grain elevators were built along the shore largely in the 1920's to store, sort and mill flour and are still in heavy use today. By the mid-20th century, as the export and international trade markets opened up after WWII, there was a greater reason to build container terminal infrastructure along the inlet to receive cargo ships to import and



The industrial landscape of Burrard Inlet

export commodities from around the world. Consumerism was the new world order and the Port was a means to national access of the global production of goods not otherwise available. Since 1946, 13 more terminals were built in the harbour to facilitate global trade.

Today, the edge of the inner harbour between the narrows is dominated by marine container terminals, while petroleum refinement and chemical manufacture occupies the coastal landscape east of the second narrows. The consortium of terminals and industries came to simply be known as the Port of Vancouver. One must appreciate that as an industrial backbone of the national economy, shipping activities at the Port contributed direct and indirect benefits of $9.7 billion to Canada's GDP in 2012.[8] The direct impact on communities around the inlet including Vancouver, Burnaby, Port Moody, and North and West Vancouver totalled $1.35 billion not accounting for any indirect benefits to the local economy.[9] While the prosperity brought on by the Port and the industrialization of the inlet has immediate benefits, there are major long term ecological consequences and cultural costs that will never be accounted for in business management reports on quarterly profits.

8. Intervistas Consulting, 2012 Port Metro Vancouver Economic Impact Study, last modified July 15, 2016, http://www.portvancouver.com/wp-content/uploads/2015/03/2012-port-metro-vancouver-economic-impact-study2.pdf, 50.

9. Ibid, 48.

Urbanization of the Inlet

The growth of settlements dovetailed with the industrial development of the Port as the population of Greater Vancouver began to rapidly ascend following the completion of the railways. The railroads were not just a conduit for commodities, but were the first means of mass transportation of settlers. The railroad served commuters and migrants until the 1960's when car and air travel became the transportation modes of choice. By the time the railways fell from favour, the population of the region ballooned from 1,000 in 1881 to that of nearly 800,000 by 1961.[10]

Like many major North American cities, Metro Vancouver became a conglomerate of sprawling suburbs by steadily and rapidly implementing mid-century planning principles around automobile transport and the single family detached housing typology. Disparate communities would connect to functions of the city by car. The low density of the housing typology and the service of a vast road network would completely transform the permeable layer of glacial till to a paved and hardened sprawl. That the spread of the suburbs is constrained by an Urban Containment Boundary, new development must involve the densification of the existing housing stock within.

The urban landscape adjacent to the inlet is currently dominated by single family detached housing, but it is set to change. Density is illustrated in the following diagram showing higher density to the west while there is medium to low density towards the east.

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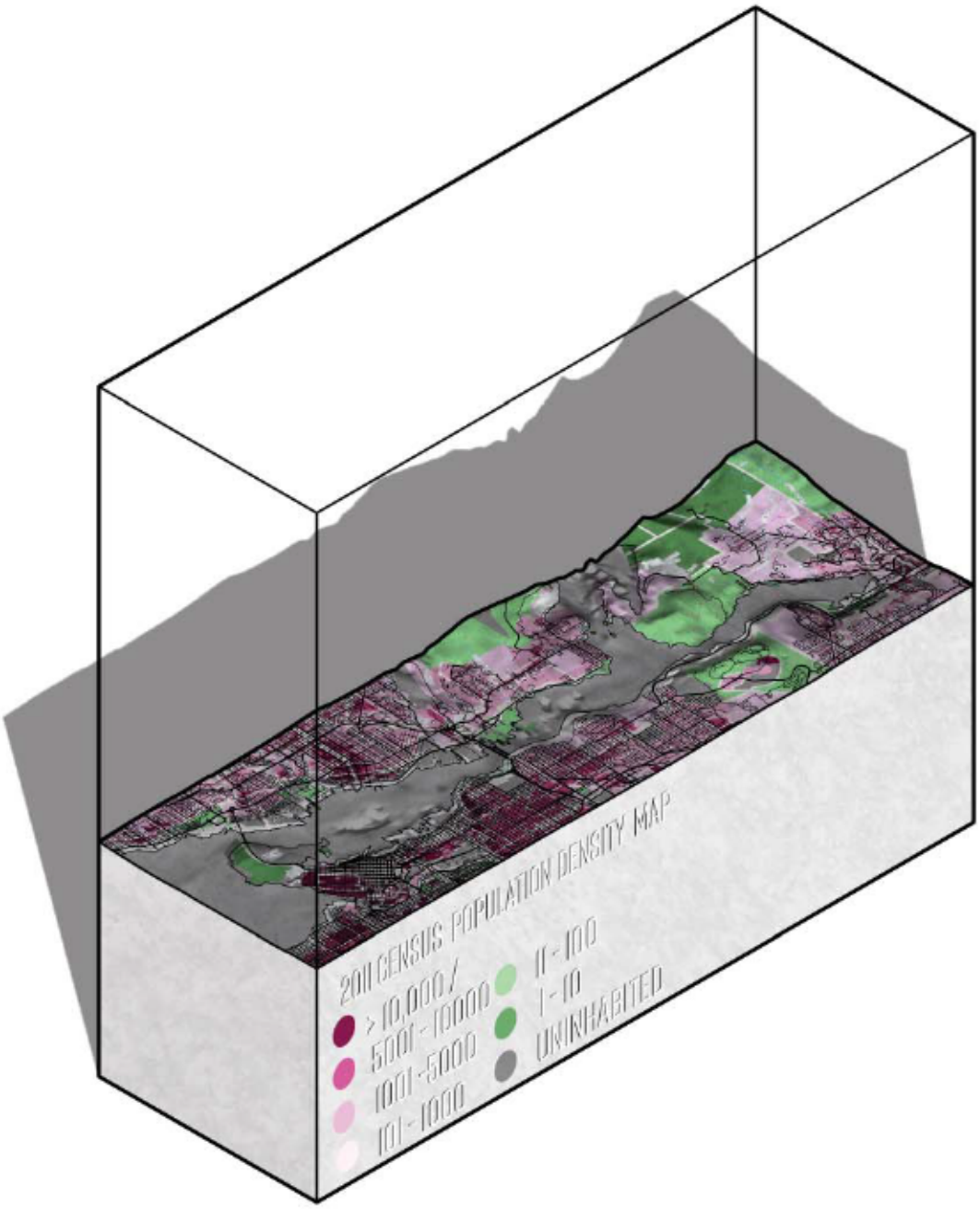
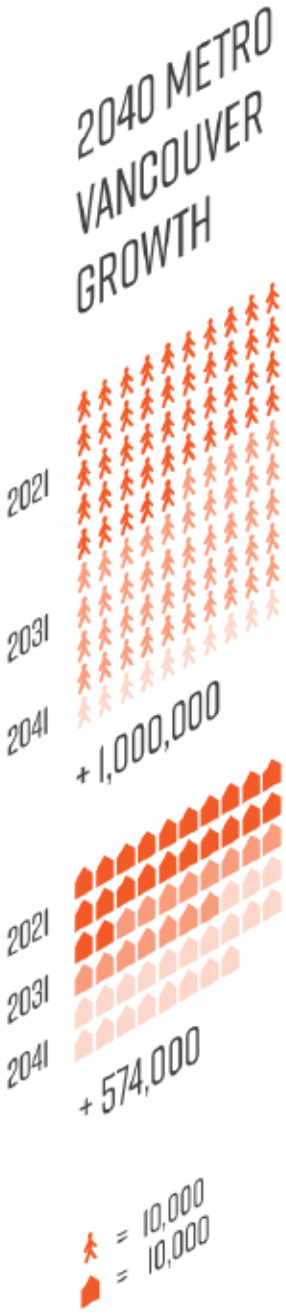
10. Vancouver Public Library, *City of Vancouver Population*, last modified April 29, 201, http://www.vpl.ca/branches/LibrarySquare/soc/pdfs/QF_Population_BC_Vancouver.pdf (discontinued, accessed on Internet Archive)



2011 census population density of Metro Vancouver; adapted using map by Anthony N. Smith

Yet growth is expected to expand eastward as there are fewer opportunities to provide new housing in the city core. Out of a regional population of 2.4 million in Metro Vancouver, 1.1 million live in the cities that extend from the coastline of the inlet as of 2016.[11] The metropolitan region is expected to grow to 3.2 million by 2041 requiring an additional 574,000 dwelling units to accommodate the growth.[12] If the projections are correct, then the urban typology near the inlet will find the city allowing the existing stock of detached housing to be replaced by dense typologies where they were previously forbidden. Densification has implications on an increased sewage load which will have adverse ecological consequences on the inlet.



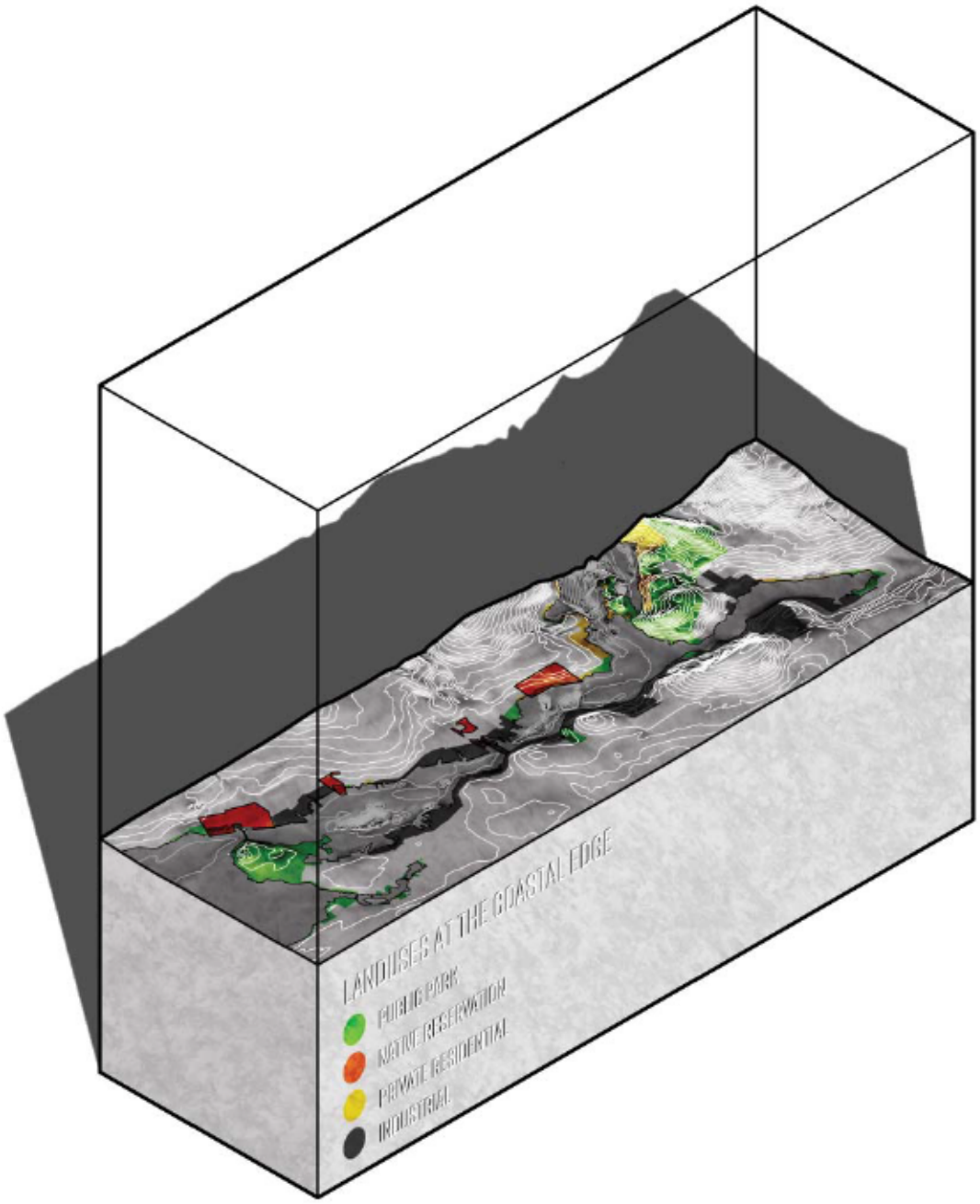
Expected growth of Metro Vancouver; from Metro Vancouver website

A Disappearance of Habitat and Limits to Access

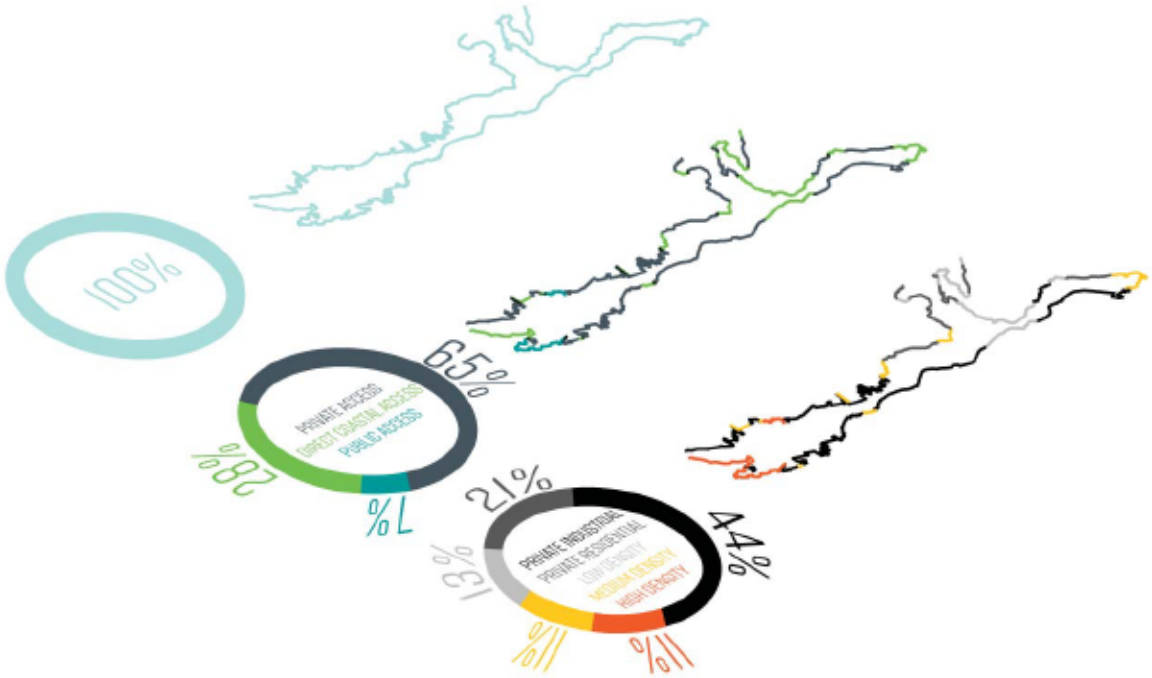
The industrial and transport infrastructure, and peripheral housing that was built along the rail line irreparably altered the nature of the coast, not only hardening the edge between land and sea, but taking over the habitats that once supported a healthy thriving ecology. Where there were wetlands, sandbanks, tidal marshes, estuaries, and access to the porous and nutrient rich glacial till, there is now landfill, concrete, and rip rap to shore up the industrial coastline. What was once a place of nurture for clams, salmon

11. Metro Vancouver, *Municipalities and Population*, last modified January 30, 2017, http://www.metrovancouver.org/about/PublishingImages/MetroVancouver-Municipalities-Population.jpg.

12. Metro Vancouver, *2001 Population Density and the Metro 2040 Growth Model*, last modified February 27, 2017, http://www.metrovancouver.org/services/regional-planning/PlanningPublications/140509_RPA_Density_and_Urban_Growth.pdf.



Landuses and accessibility at the coastal edge



Private vs Public access relative to urban density; from the City of Vancouver and District of North Vancouver open data websites

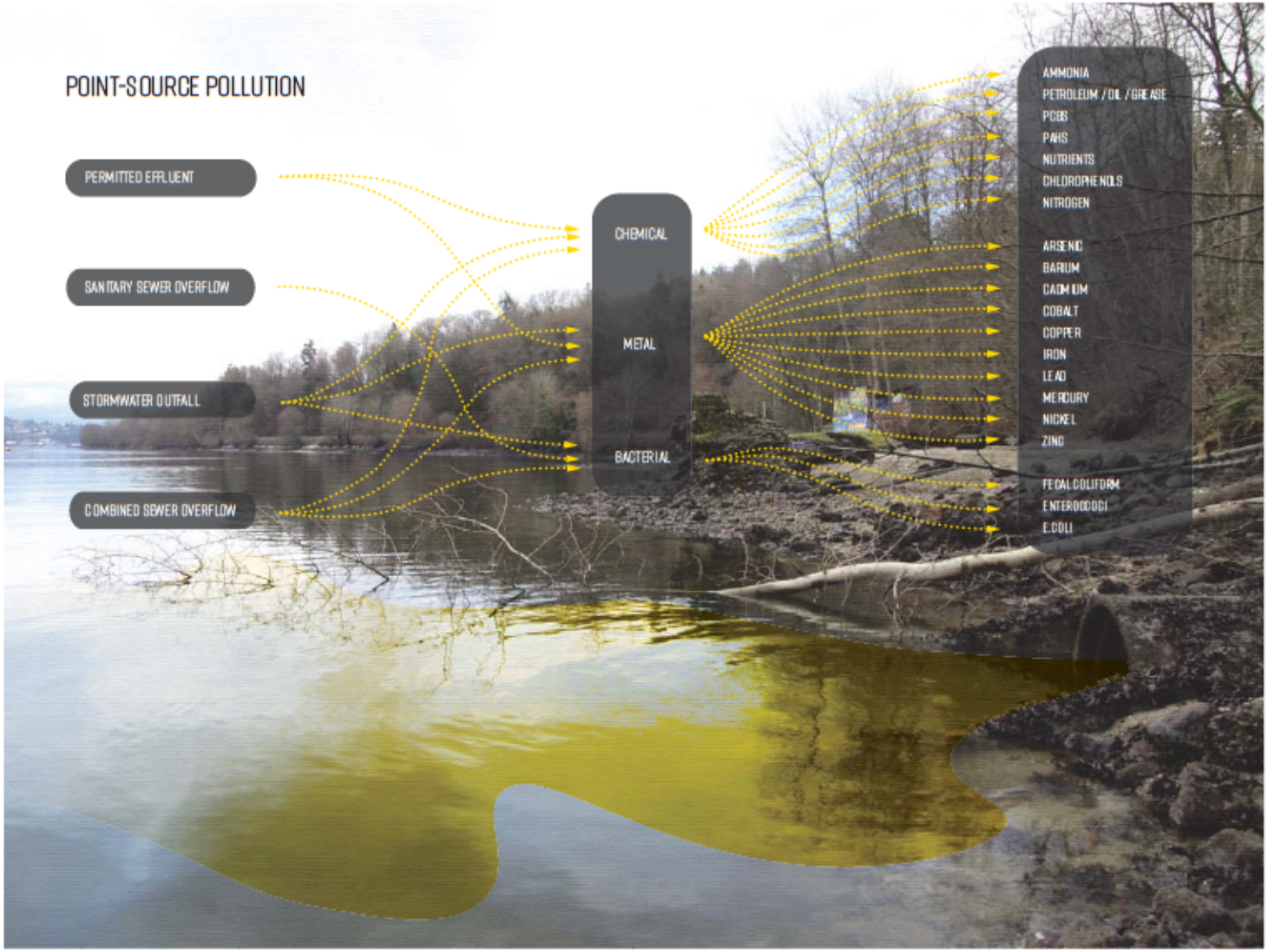
smolts, waterfowl, and other animal species with plentiful seagrasses, mud, and sand in the wetlands and marshes to hide from predators, there is a denuded coast stripped bare of habitat and nutrition.

The altered ecology and the effects of pollution are not truly known by the public because there are few places where people are able to properly access the coast and water. 65% of shoreline is industrialized or privatized preventing major parts of the inlet from general access.[13] Of the remaining 35% of coastline that is accessible, 22% is located near medium to high urban density conditions but is distributed to the far east or the far west of the Inlet requiring a majority of the population to travel greater than walkable distances for accessing the coast.[14] The few urban parks along the shore are an afterthought since they are difficult to access due to obstructions such as road and rail overpasses, and some only occupy slivers of land between container terminals. The most substantial urban parks are located in the eastern parts of the Inlet where there is the least urban density. The lack of access to vast stretches of the coastal edge of the Inlet prevents the ability to empirically know the inlet and hides the insidious impacts of pollution on the ecology.

Ecological Impoverishment by Pollution

The misfortune of the industrial and urban land uses that surround the Burrard Inlet, is that the waterway receives effluent pollution loads that adversely affect the ecology. Viable aquatic habitats are toxified by a continuous flow of heavy metals, chemicals, and bacterial effluents that are broken down in the following diagram. According to the Burrard Inlet Environment Action Program, destructive

13. Derived from open data available from the City of Vancouver and District of North Vancouver.
14. Ibid.



Point-source pollution inflows into Burrard Inlet

sources of effluent disposals enter the water in concentrated form through point-sources such as sanitary sewer overflows, stormwater outfalls, permitted effluent outfalls from industrial actors and combined sewer overflows.[15] The most toxifying sources, however, are the latter two with their locations revealed in subsequent maps. Permitted effluent outfalls are a source of industrial chemicals and metals that are pumped regularly into the inlet. Combined sewer overflows dangerously allow untreated sewage to pour into the inlet whenever there is a storm that imposes a larger load than the stormwater infrastructure is capable of handling. In a climate where the average annual precipitation at North Vancouver 2nd Narrows was 1830.8mm between 1981 and 2010, there is a mean of 173.5 days of rain per annum.[16] It cannot be underestimated the amount of raw sewage that makes its way into the harbour. The following diagrams illustrate the locations of effluent relative to their source type.

The impact on the ecology might be scientifically quantified in a number of ways but one of the most clear indicators is the health of shellfish colonies. Since shellfish are filter feeders, they are the first in the line of defense of the environment by immediately absorbing whatever substances that drain into the inlet. Thus it should be no surprise that toxified habitats lead to toxic shellfish affecting the entire food chain. A ban on harvest became the new order in 1972 by the Department of Fisheries and Oceans when they deemed shellfish unsafe for consumption. Of the most inexpensive, sustainable, and easily grown proteins, Vancouverites do not know the pleasure of the backyard harvest

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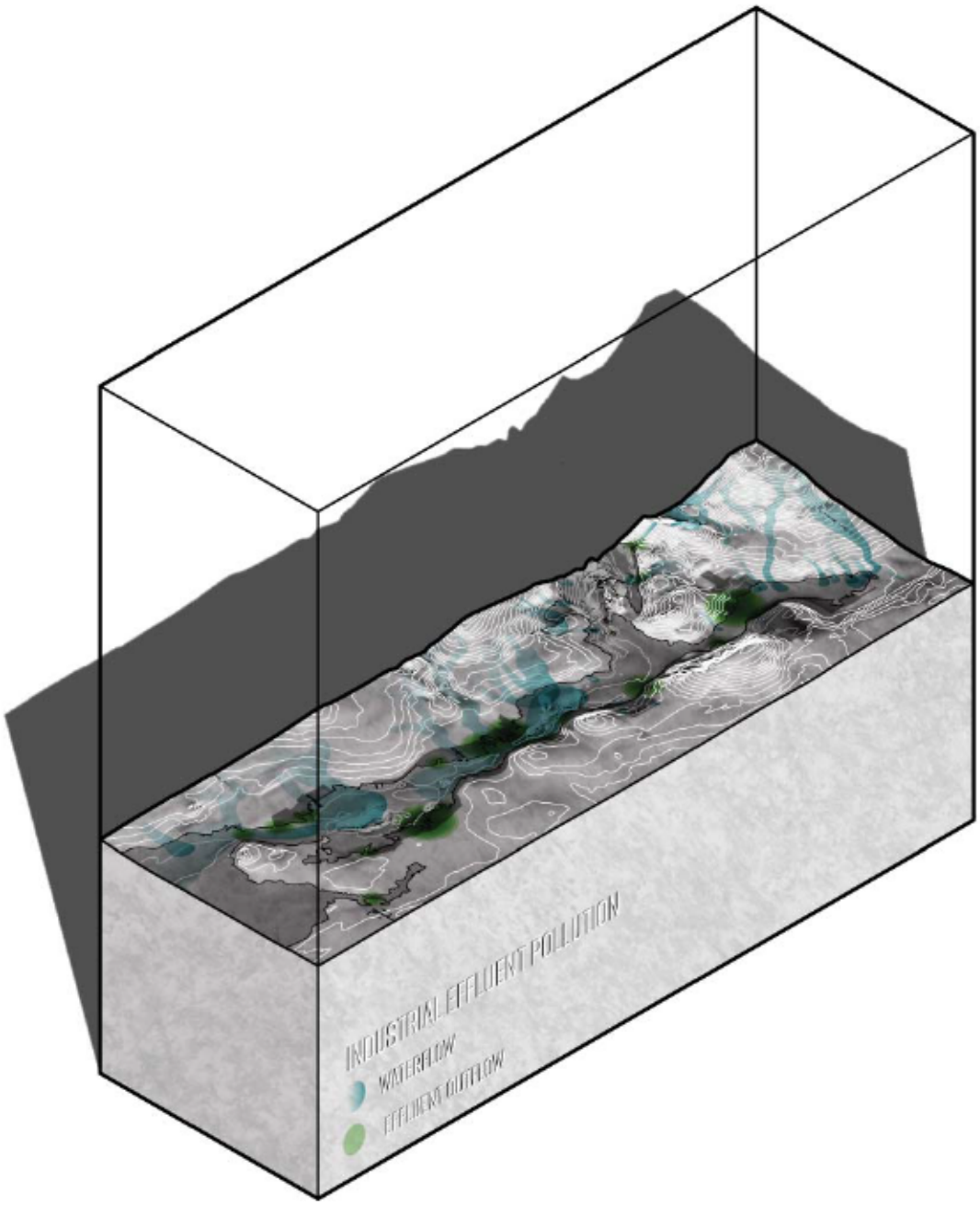
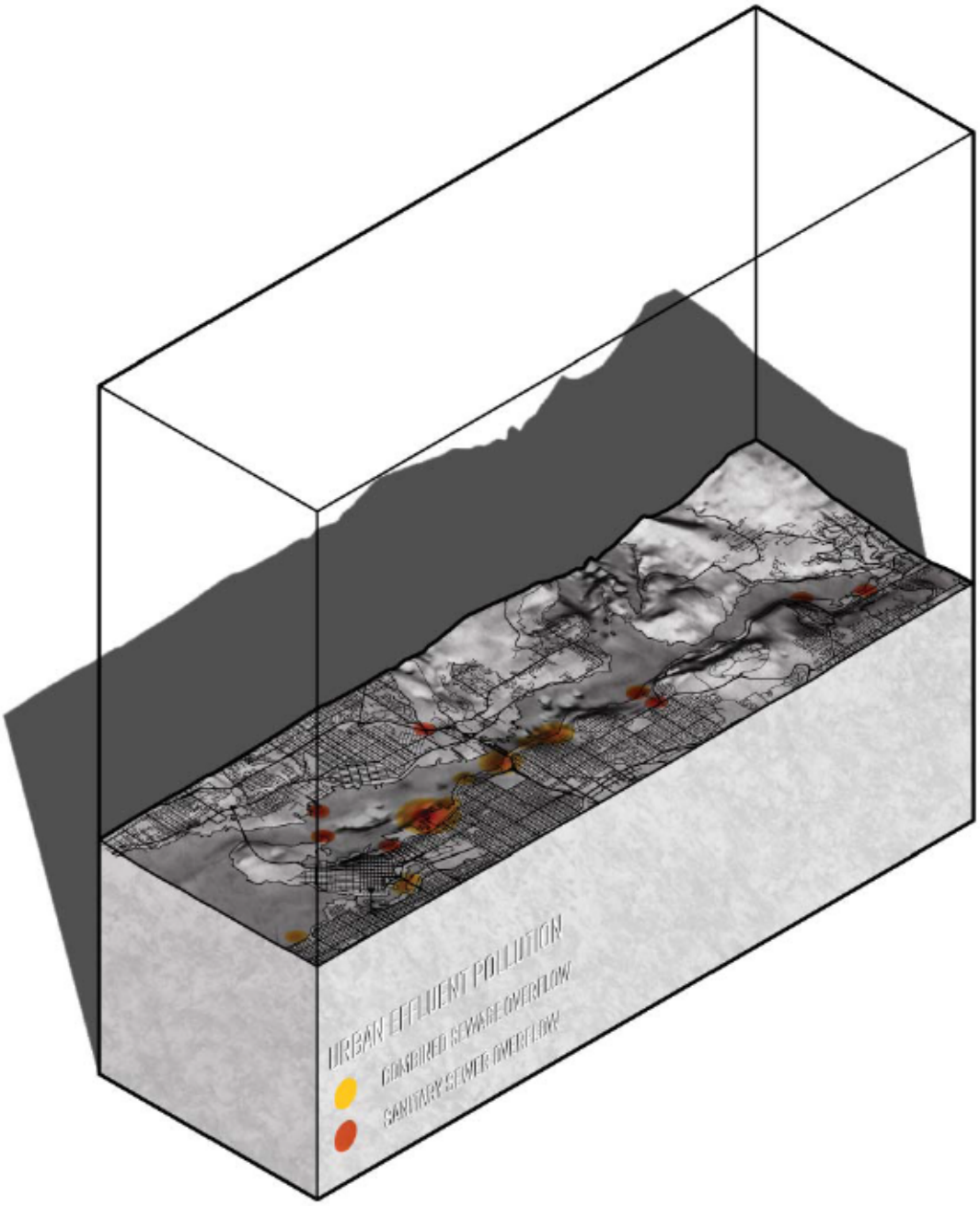
15. Whitford, Jacques for AXYS Ltd, Burrard Inlet Environmental Indicators Report, *Burrard Inlet Environmental Action Program*, Burnaby, BC (2008), 10, http://www.bieapfremp.org/pdf/burrard_inlet_environmental_indicators_feb08.pdf.

16. Environment Canada, *Canadian Climate Normals 1981-2010 Station Data: N Vancouver 2nd Narrows*, last modified January 25, 2017, http://climate.weather.gc.ca/climate_normals/index_e.html.



Industrial effluent pollution sources in the Burrard Inlet; adapted from BIEAP publication by BES Inc.



Urban effluent point sources in the Burrard Inlet; adapted from BIEAP publication by BES Inc.

of shellfish from their own shores as aboriginal communities once did. In a bid to create continuity with their ancestral practices, it is a desire of the Tsleil-Waututh people and by extension the Coast Salish of the region to safely harvest and consume shellfish from the inlet once again.[17] The safe harvest of shellfish and other wild caught foods would be a major step in the path towards affirmative cultural repair, positively rebuilding tribal and indigenous identity. Yet, a remediated inlet that permits such harvest of wild caught foods would benefit all residents and create new ways to integrate the inlet into the collective imagination of landscape. For the cleanup of the inlet to reach an ideal state of health, it would require a remediation infrastructure to be developed, cultivated, and to operate over a lengthy period of time, probably decades. Integrated with cultural programs that promote the physical, cognitive, and spiritual interaction between individuals and the landscape, the potency of the relationship might strengthen the longevity and productivity of such remediation systems. By examining the locations of the effluent outfalls as they relate spatially to culturally sensitive sites, we could begin to design the Healing Aquascape.

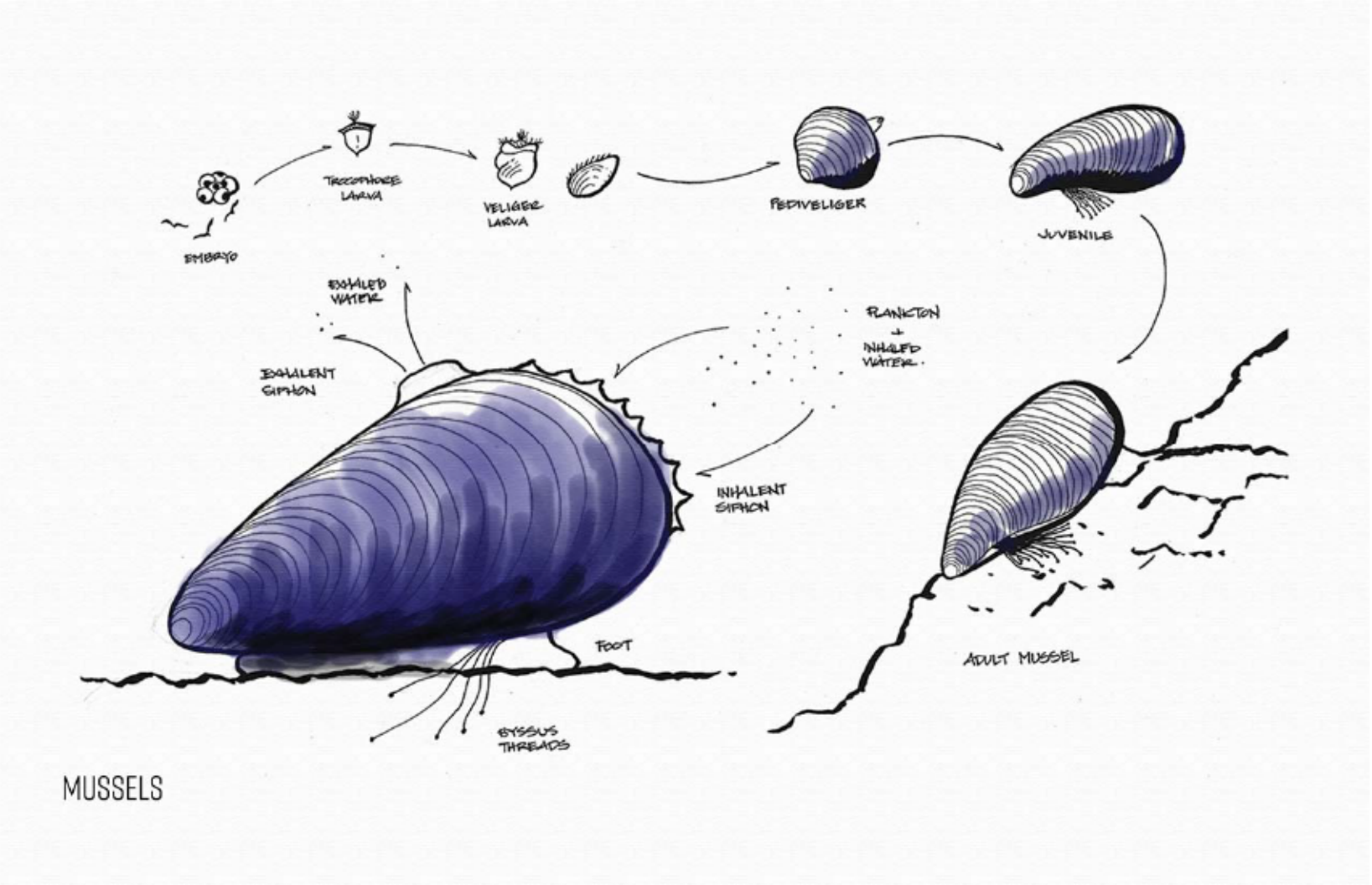
17. Jesse Morin, *Tsleil-Waututh Nation's History, Culture, and Interests in Eastern Burrard Inlet*, 335, http://twnsacredtrust.ca/wp-content/uploads/2015/05/Morin-Expert-Report-PUBLIC-VERSION-sm.pdf.

CHAPTER 3: A STRATEGY OF HEALING

In the Burrard Inlet, the healing infrastructure must be sensitive and specific to site. This thesis intends to achieve aquatic remediation of polluted waters using pacific blue mussels and other native bivalves that are appropriate for a synthetic aquaculture. The aggregate cultivation of bivalves have powers of filtration that have the potential to remediate the inlet. Structures supporting the growth of shellfish doubly serve as a canoe circuit around the inlet for all types of small recreational watercraft. The circuit is intended to connect a Coast Salish Culture Centre and Boathouse sited at the edge of an urban park to filtration pools and an Inlet Ecology Research Center located at the confluent junction. Together, these elements form an infrastructure of healing that intertwine the restoration of ecological functionality with the cultural enrichment of the aquascape.

Aquatic Remediation

The remediation of the Burrard Inlet from the industrial and urban sources of effluent pollution may occur if a system of filtration is developed using shellfish. Bivalves such as mussels and clams naturally grow in large colonies in the intertidal zone, drawing water from their immediate environment through an inhalent siphon to feed on bacteria, plankton, algae, toxins, sediments, and detritus. While the food is consumed, they expel filtered

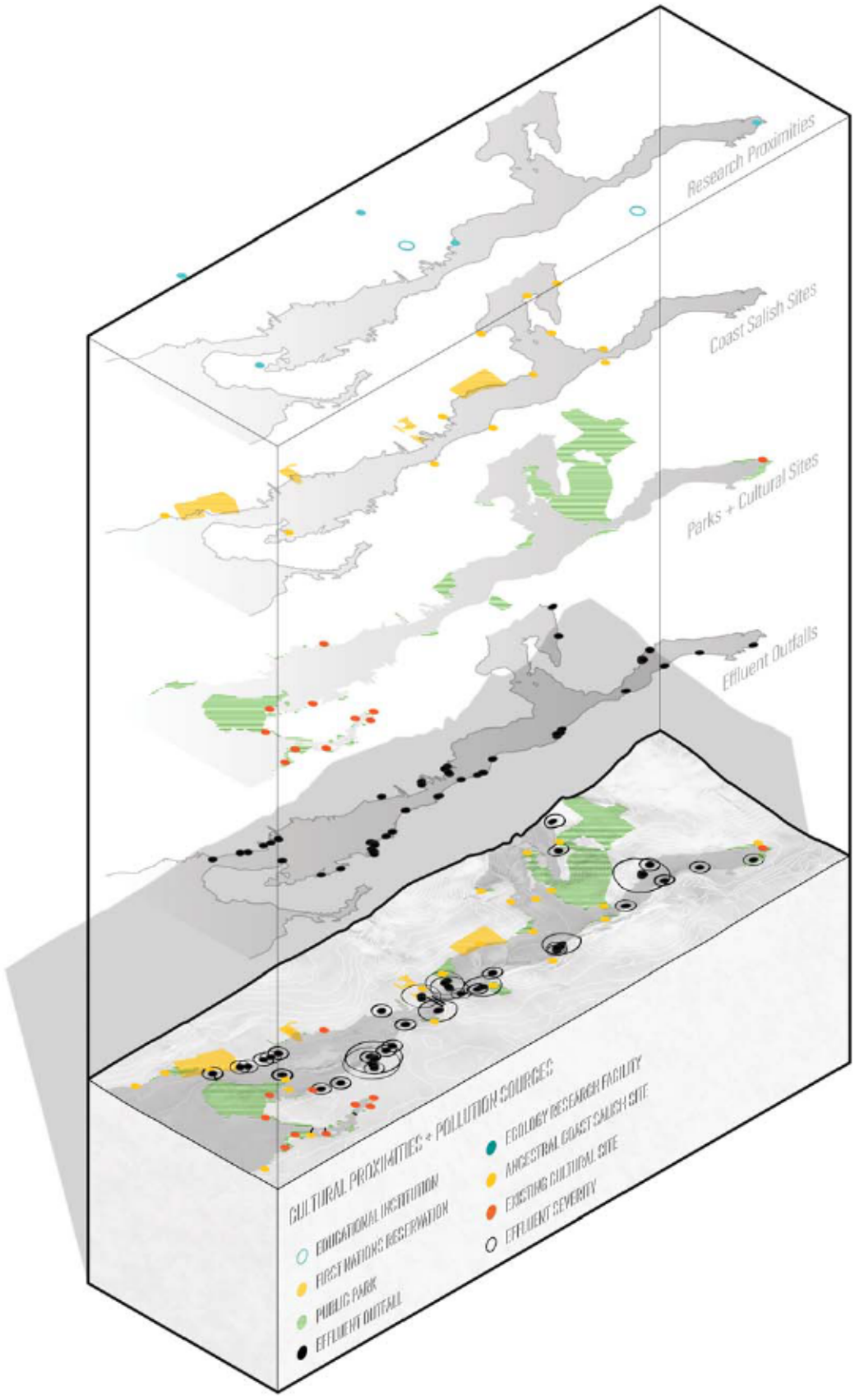


Life-cycle of a Pacific Blue Mussel

and cleansed water from an exhalent siphon back into the environment. As young shellfish grow, nutrients are converted to energy, meat protein, and layers of protective shell. Adult blue mussels, which are a common species in the Pacific Northwest, are capable of filtering water at a rate of 10 to 15 gallons per day.[18] If they are cultivated in large quantities, a system supporting and enhancing the growth of mussels to filter effluent pollution from the aquatic environment could potentially cleanse the entire inlet quickly, efficiently, without much labour effort, and naturally with the cycles of the tides.

In this scenario, mussels, clams, and other shellfish serve as keystone species that could support a robust biodiversity and promote the health of the ecology. They would function purely as a biological means of water filtration and would not be harvested for human consumption. While mussels are growing, pollution would be absorbed into the meats and become encased in the makeup of the shell as the mussels metabolize the nutrients from the surrounding water. As mussels reach maturity, the rate of water filtration grows. The consequential impact of filtered water is that benthic sediments are improved as habitats and the cleared water column permits more sunlight to reach greater depths for photosynthesis to occur. Thus, they would accelerate the growth of sea grasses in the estuarine waters of the inlet, where the growth of vegetation would give birds and fish the necessary habitats, nutrient sources and protection from predators that have disappeared along the shore. Potentially, that chain of reactions

18. C. Graham Hurlburt and Sarah W. Hurlburt, "Blue Gold: Mariculture of the Edible Blue Mussel (mytilus Edulis), *Marine Fisheries Review*, Vol.37, No.10 (Oct 1975), 10, spo.nmfs.noaa.gov/marine-fisheries-review/mfr-37-10.



Cultural proximities to pollution sources; from Cities of Vancouver and North Vancouver open data websites

could help to set off the repair of an ecology. Accumulations of organic matter would subsequently refuel the cycle of filtration and help to maintain existing and new colonies of shellfish. A remediation infrastructure using mussels and clams would be the foundation for assisting the function of the local ecology and be significantly aligned with the cultural re-integration of the inlet.

A Remediation Canoe Circuit

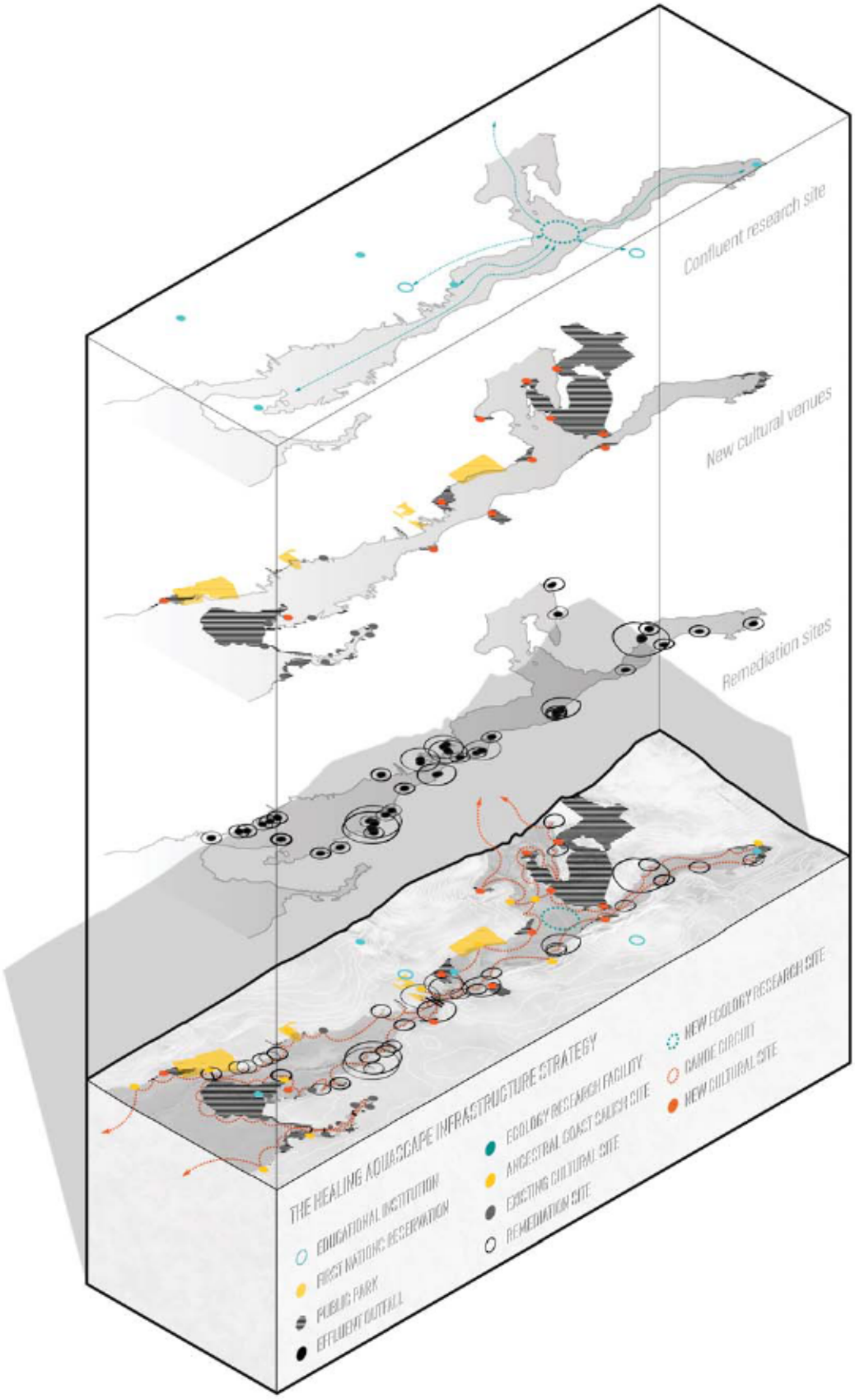
Remediation centers are simply placed where there are effluent outfalls. Structures that support the growth of mussels and clams filter the outflows immediately at the source of disposal to capture the effluent before it has an opportunity to spread across the water and penetrate the benthic layer. The more numerous the sources of effluent, the more structures supporting shellfish growth are placed to filter the water. As an entire system, the remediation centers form a means of aquatic connection to access, manage, and maintain the growth of the shellfish filtration network. Having periodic distribution at various points in the inlet, the network facilitates anchorage during various recreational activities making a canoe circuit possible. As the quality of the water improves with time, the canoe circuit revives ancient circulatory paths of travel and collective interaction with the inlet grows to open an opportunity for the culture in the aquascape to be invigorated.

The building of a remediation canoe circuit gives occasion to develop a cultural infrastructure of the inlet that would mediate one's experience between land and sea. In the following diagram, existing cultural

proximities are mapped against the locations of the effluent outfalls to reveal possible linkages between parks, significant modern and ancient Coast Salish sites, existing research facilities, and cultural venues. The mapping shows few dedicated marine ecology research facilities located on or near the coast. Additionally, it reveals an uneven distribution of cultural venues located to the west with virtually none in the central harbour. Additionally, many historic Coast Salish sites overlap with coastal parks, giving a grand opportunity to connect them across the harbour. Thus, building the remediation centers not only improves the ecological functionality of the inlet but would serve to establish an aquatic route to connect people to the physical experience of the landscape that is now open to cultural diversification and new opportunities.

Cultural Propagation

The aquascape has the potential to be culturally invigorated to promote its long term health with the establishment of the canoe circuit. As a cultural life line, constant and repeated circulation of the inlet strongly supports the propagation of a number of typological cultural venues at the shore. In the following diagram, the strategy for the healing aquascape is outlined for the immediate long term. New cultural sites are chosen for their proximity to the remediation circuit, and intersection between parks and Coast Salish sites of significance with an intent of increasing accessibility by distributing venues across the inlet evenly. Depending on the site, the cultural infrastructure may contain one, few or all architectural expressions. The architecture



Strategy for the Healing Aquascape; from Cities of Vancouver and North Vancouver open data websites

of the healing aquascape in full form would activate a culture of recreation, house a celebration of the indigenous arts, found an enriched ecological knowledge stream, and spawn a sustainable, ecologically based economy.

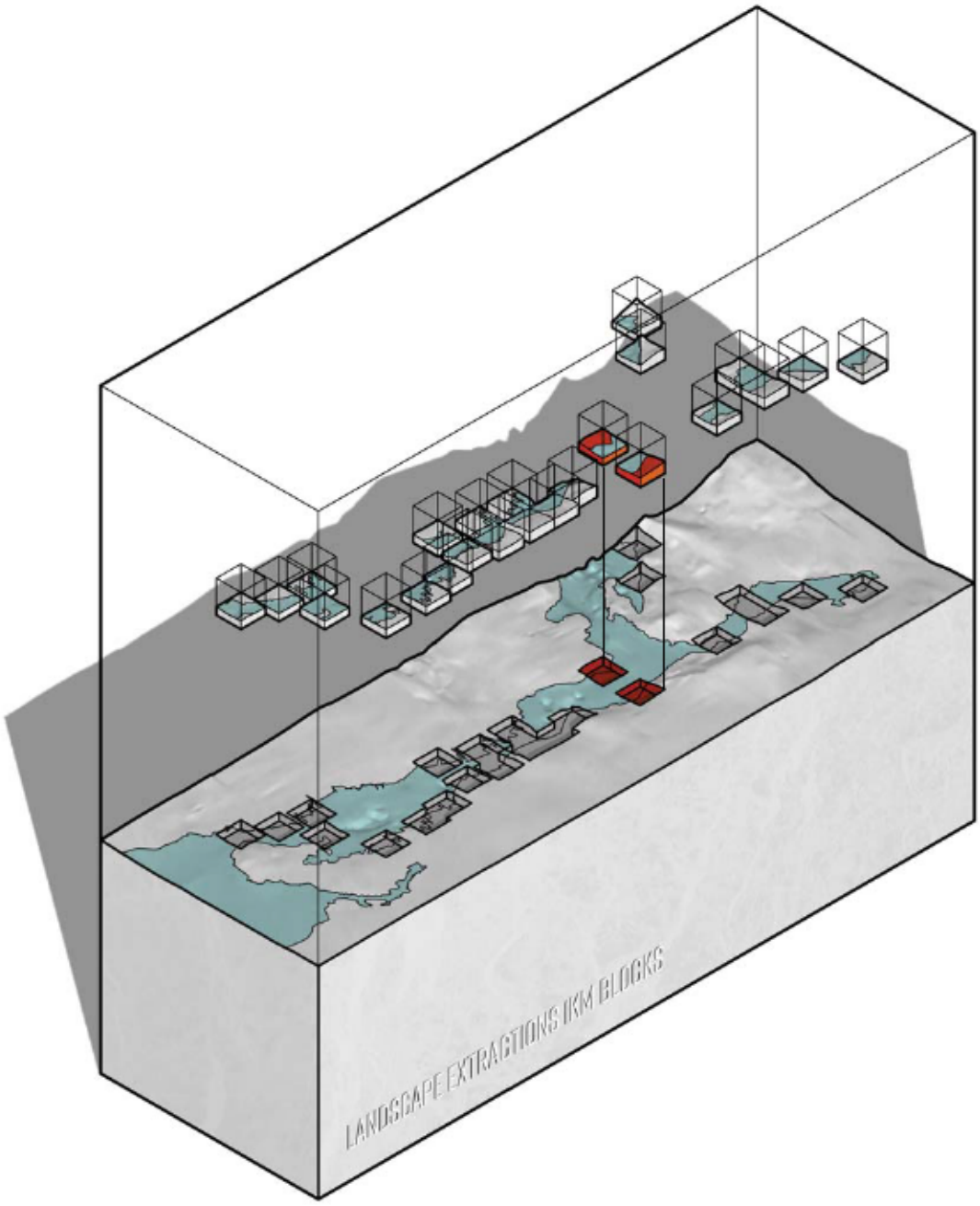
The second architectural expression after the remediation circuit, facilitates and develops an aquatic culture of marine recreation. A boathouse enables the fundamental act of storing, and accessing small watercraft and makes travelling the canoe circuit viable. Recreational activities include but are not limited to canoeing, kayaking, paddle-boarding, rowing, swimming and diving. A proliferation of boathouses across the inlet is a basic step to laying a foundation for reactivating the inlet.

A third means to integrate the inlet is to develop inclusive cultural venues that are a showcase for arts and culture. In this particular instance, the venues are a display and propagation of indigenous art for the advancement of affirmative cultural repair. Such venues may celebrate and strengthen the arts by providing spaces for teaching, learning, art and craft making, displaying, performing, and social gathering. Importantly, the indigenous voice is given a place to safely express and amplify to an audience, no longer isolated nor silenced. Activities would include handicraft, mask making, canoe carving, weaving, dancing, acting, performance, making music, and hosting special community events such as potlatch. Building the cultural connections offers a greater opportunity to engage, interact, and relate with others to increase the sense of connection and community.

The educational program of the aquascape takes on a few forms to develop the knowledge streams of the ecology and local environment. Founding an ecological education builds a sense of place and connection to the water serving latent benefits to the growth of an alternate economy. The first architectural expression takes the form of a library at the edge of the seascape while the second are facilities for ecological research located in the water. A library of local ecology, natural resources, and ethnobotany supplements the experiential and phenomenological aspect of repeated interaction in the inlet with access to a rich resource of information. Concurrently locating a research facility within the inlet at the confluent junction takes advantage of a strategic geographic proximity as a means to access all arms of the inlet and existing facilities transforming the site to a possible hub of ecological research and information sharing. The new knowledge streams and space for experimental application would support the foundation of an ecologically aware economy.

A viable economy based on the aquaculture of mussels, oysters and other shellfish would be an ideal way to reintegrate the ecology into the economy. Yet, in the immediate long-term, it is not achievable in the Port of Vancouver's southern harbour. Realistically, it would take many years, if not, decades of remediation and a long process of de-industrialization for that particular portion of inlet to be a safe habitat from which to harvest healthy mussels. However, it would be possible to develop a system of aquaculture in the upper reaches of the Indian Arm distant from the sources of pollution at the Port. With little residential development and virtually no

industrial conversions of the coastal landscape, it would be possible to cultivate such an alternative economy. While it is an interest of this thesis to reconnect the ecology to the economy, the strategies explored for the southern portion of the inlet will lay the groundwork for developing those systems in the future. The following diagram illustrates particular polluted sites as 1km block extractions. The specific sites highlighted are to be studied as a model for the entire strategy in the inlet. They include Way-Ah-Whichen Park on the north shore, a historically significant site of a Tsleil-Waututh village, and directly across from it to the south, a petroleum marine terminal owned by Kinder Morgan.



Extractions of landscape at effluent outfalls

CHAPTER 4: THE HEALING AQUASCAPE

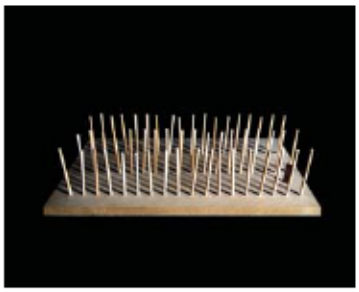
The design of the Healing Aquascape is dependent on understanding the behaviour of water, the form of the land as a vessel for its containment, and how they affect one another over time. Modelling the vessel using topographic and bathymetric data is paramount to the process of devising and forming a physically responsive strategy. Not only should the results seek to fulfil their functional promise through their appropriateness for the water and to the form of the land, but that very appropriateness of the strategy has the potential to elevate one's cosmic knowledge, experience, and relationship with the landscape and its contents. Various architectural elements of the Healing Aquascape differ in their relationships with the land and water. They were studied, modelled, and designed with that in mind.

The Remediation Canoe Circuit

The architectural investigations of the remediation structures began with a look at typological techniques from the mussel aquaculture industry whose aim is of maximal output. Each strategy responds to a geographically specific condition in the aquascape to permit varying production outputs balanced with ease of access and maintenance. The techniques are varied in their response to land with increasing immersion in water, requisite modes of access, and dependency on built structure. Their study

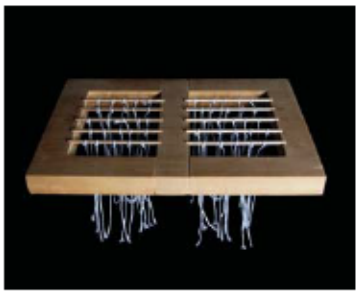
will help to inform what techniques are appropriate for the various topographies in the shore zone and water of the inlet.

The following model at the top demonstrates a traditional French strategy of wooden piles driven into the sand called bouchots. Rope is wrapped around the bouchot like a spiral to separate mussel growth from the wood and to increase the surface area where mussel spats are spread and cultivated. The technique is appropriate for long flat stretches of the intertidal zone where they are accessed by a small boat or by foot when the tide is out.



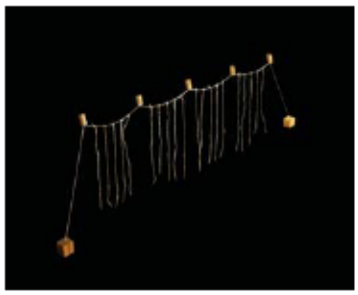
The French bouchot technique

Where there are deep water conditions exceeding 3m, mussels might be cultivated using a technique that originated in Spain. Old boats were converted to decks upon which wooden beams were arrayed and supported by suspension from the mast. From the beams, lengths of rope were suspended into the water to grow the mussels. The modern version of the technique is shown in the second model where new constructions lay beams on wooden decking that serves as a walkway. While the mussels are ever suspended in the water without the tides affecting their exposure to air, continual submersion in the water causes mussels to persistently consume twice as much food. This technique grows mussels twice as fast as the bouchots while reducing the amount of necessary structure.



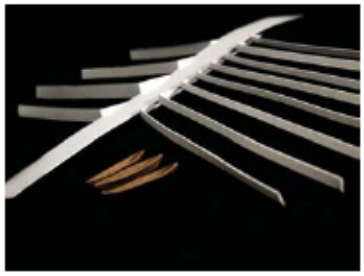
The Spanish deck technique

Modern commercial mass producers may employ the long line method which is appropriate for open ocean conditions. The technique shown in the adjacent model, anchors a rope line to the bottom of the ocean. Periodically, the main rope line is tied to buoys



Modern longline technique

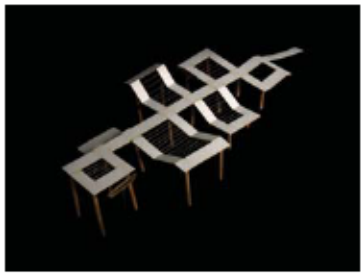
to keep the line lofted in the water. With the main rope divided into sections, netted nylon *socks* which protect the mussels from birds and other predators are suspended in the water as long as 20ft or more. As mussels grow, weighing down the line, the dropping level of the buoys indicate when the mussels are ready for harvest. As in the deck technique, mussels in this instance grow the fastest and the largest except with the least amount of structure per output. While these techniques are specific to mussels, the Coast Salish employed a highly productive method for harvesting clams.



Model of a modern clam garden

Intertidal rock walled clam gardens were an ancient technique invented and maintained by Coast Salish peoples for the cultivation of clams which burrow in marine sediments for habitat. Rock walls were terraced laterally to the shore and contained sand and sediments where clams were cultivated with protection from predators and the tidal action of the ocean. This technique was recently deployed in a study in still existing clam gardens that produced four times as many butter clams than in natural conditions.[19] The clam garden is most appropriate for near shore zones. The top model illustrates the technique as a potentially functional landscape solution for the entire coastal edge of the inner harbour. Not only would it be appropriate to grow clams but it could contain and be interspersed with new vegetation for a rich and graduated experience of the fore shore and coastal edge.

Wall variant for recreation



Deck variant for docking and procession

Other models were investigated as other potential solutions for hosting mussel growth and developing the recreational aspects

19. Amy S Grosbeck, K. Rowell, D. Lepofsky, and A.K. Salomon. "Ancient Clam Gardens Increased Shellfish Production: Adaptive Strategies From the Past Can Inform Food Security Today," *PLoS ONE* 9, no. 3 (2014): e91235, last updated March 11, 2014. http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0091235

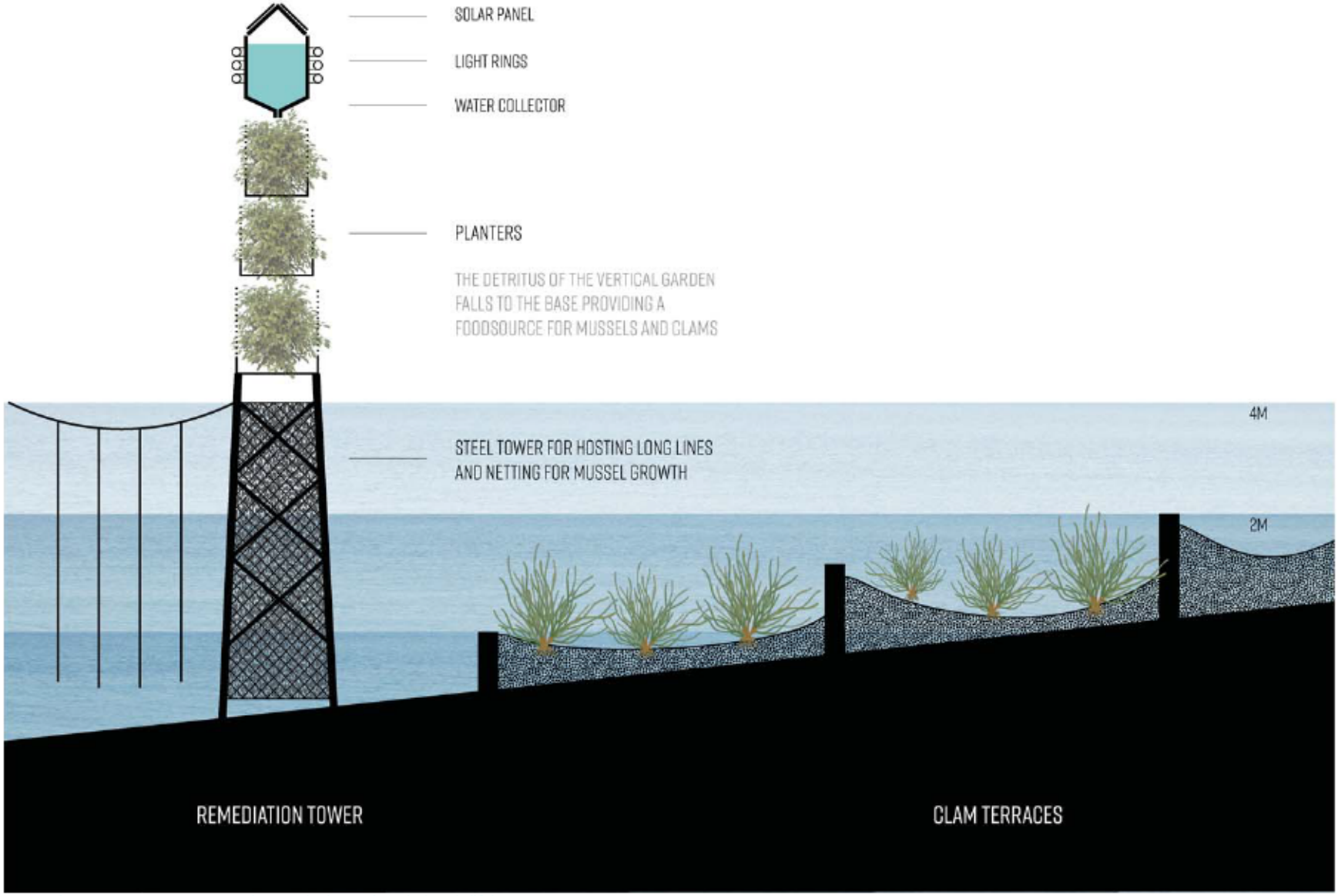
of the circuit. For novelty, the second model illustrates remediation walls that serve as an obstacle course for small watercraft. Limited to the intertidal zone, the walls would be accessible by foot at low tide. This type of structure favours novelty and recreation while exposing mussels more easily to predation. The probable low remediation value prioritizes other strategies.

The bottom model above is an iteration of the deck type of structure for hosting the growth of mussels that invites the public to be observers or actors in their cultivation. The decking simultaneously serves as a landing for canoes and kayaks creating an interface between the land and sea. While this strategy relies heavily on structure, it is a familiar typology that would have much success in drawing people to the water.

For a greater break from the land, the following model proposes greater distances from the shore to beckon visitation via canoe. The possibility is of creating a sense of place with sheltered viewing platforms that give an opportunity for landing, rest, and observation within the inlet. The splayed structure permits hanging netting to cultivate mussels. While architectural formality is not necessary for remediation, building familiar forms would help to attract more casual visitors and promote the inlet as a place of recreation, social engagement and cultural space.

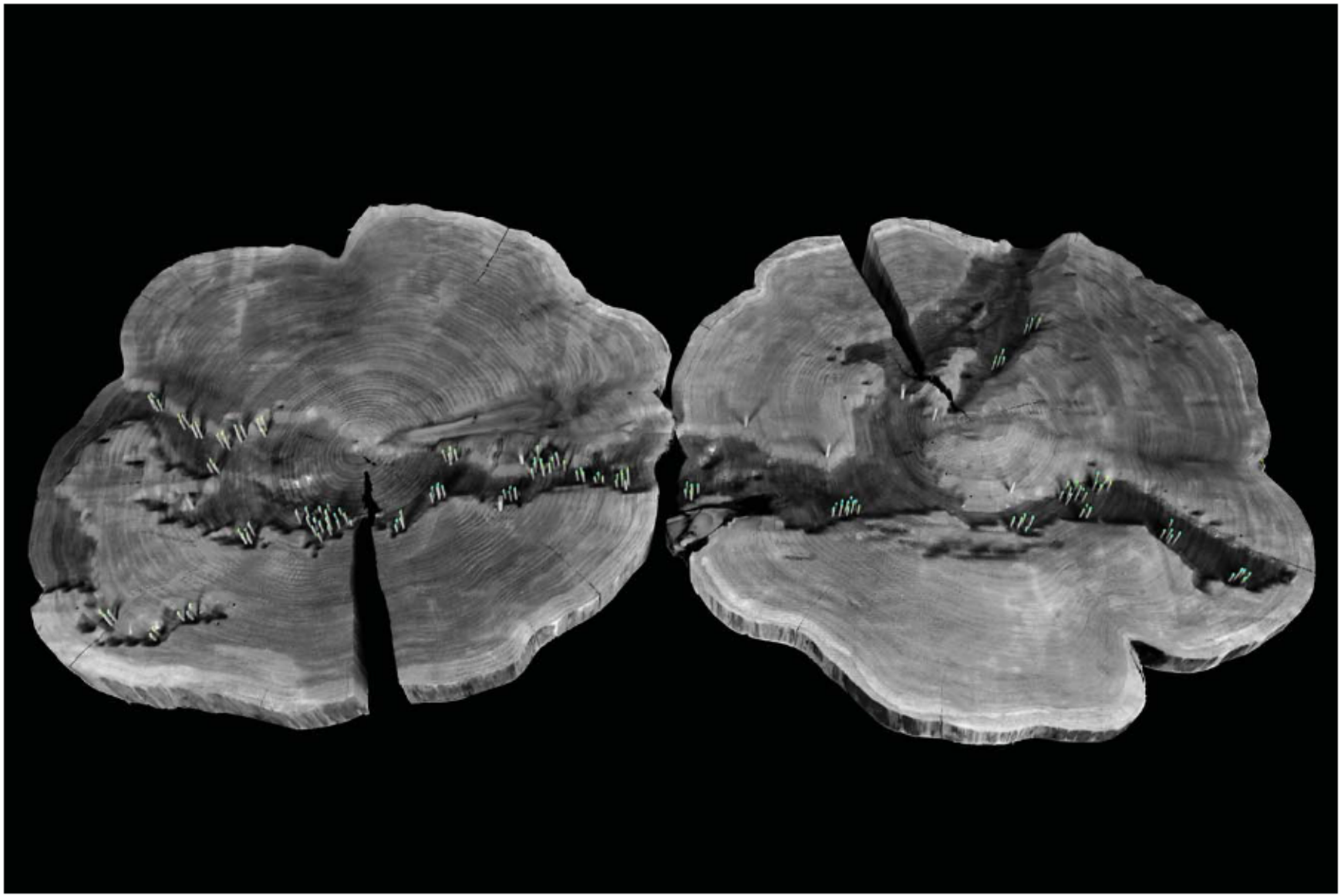
There is a veritable menu of techniques from which we could draw from to formulate the canoe circuit with a plurality of novel experiences to engage people with the inlet. With time, those alternate strategies help to further diversify the experiential

Inlet structures that create a sense of place while hosting mussel aquaculture



Concept for tower structures to support the growth of mussels and other shellfish

aspects of the circuit. For the purpose of remediating the inlet effectively, clam terraces and multifunctional towers that support long line aquaculture are a strategy of choice. The priority of remediation is met by the high productivity of these structures. The section diagram above illustrates how the remediation system works relative to the land and shifting tides. The clam terraces mediate the transition from terra firma to the aquatic by acting as a buffer zone that laterally contains marine sediments, and vegetation that is descends into the water. Further from the shore the tower is a hybrid that combines the structural support of long lines with its function as a lighthouse to guide watercraft and a water tower to feed a vertical garden from which dead leaves and soil particulates fall below to provide a passive yet proximal source of nutrition for the growing shellfish. While the terraces help to create a transitional space at the shore and provide a place for canoes to land, the towers and long lines emphasize the circuit as a temporal recreational infrastructure that is intended for travel. Like the railways did for industry, the canoe circuit will help to diversify the cultural functionality of the inlet. The model below, carved from a red cedar trunk illustrates the remediation canoe circuit serving as a visceral reminder of the land as a container for water and the cosmic ideals that are embodied in that representation.

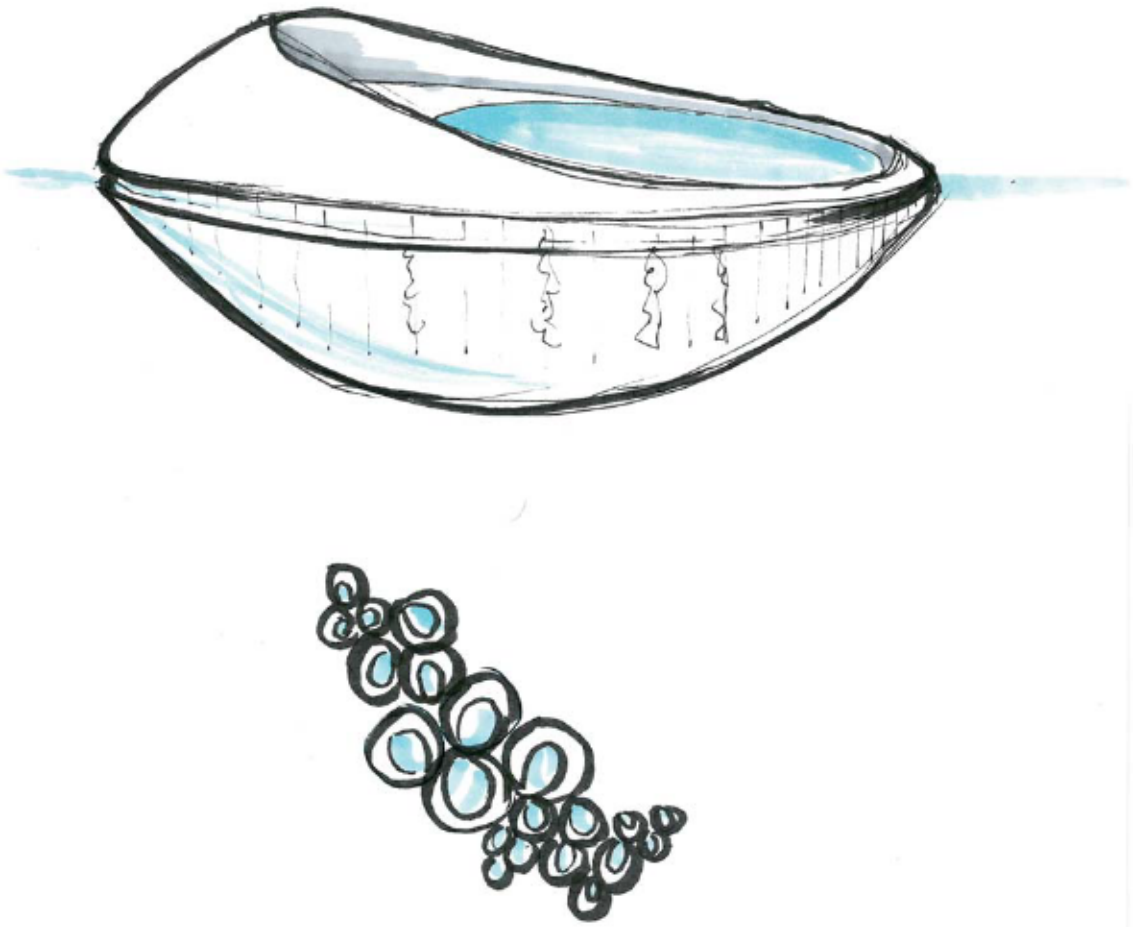


The Healing Aquascape Canoe Circuit

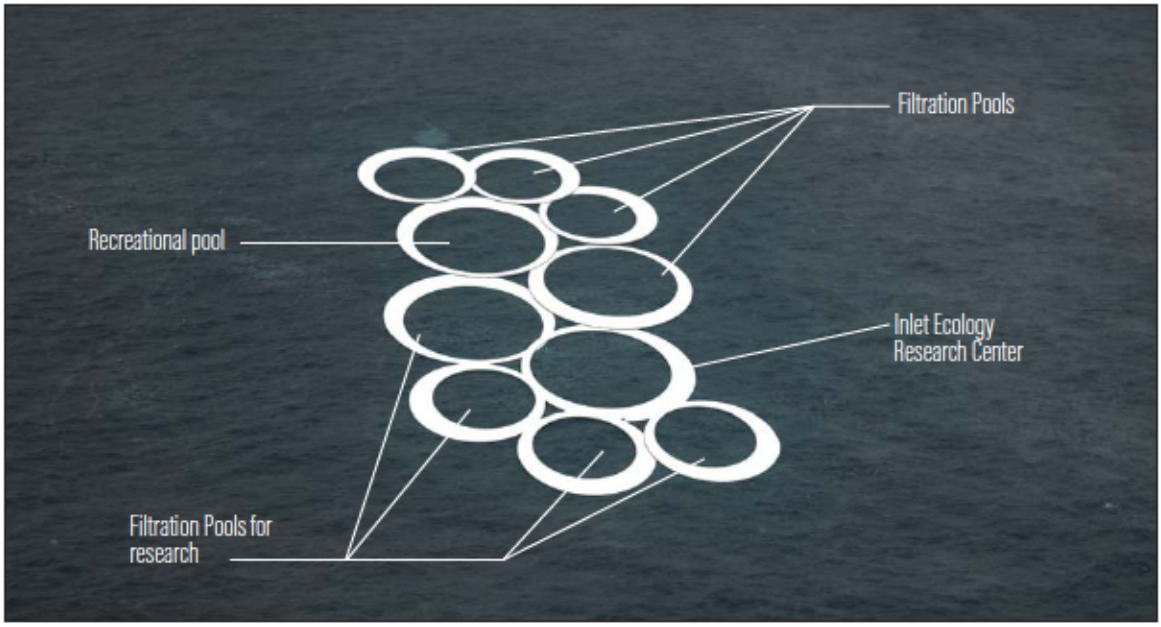
Remediation Pools and the Inlet Ecology Research Center

A second line of defense of the health of the inlet is imagined as a set of filtration pools. Autonomous vessels that are anchored to the sea floor at the confluent junction of the inlet are part of the strategy to further the task of remediation. Surrounded by industrial neighbours that manufacture chemicals and refine petroleum, the junction is a prime location to protect all arms from pollution that escape the remediation circuit and mitigate one-time spill events that occur unpredictably. The pools are intended to be programmed either passively or mechanically to receive water from the inlet. The water is to be filtered and exhaled back in as it becomes displaced by new unfiltered water that enters the pool. A conceptual drawing below illustrates the pool as having a morphology resembling a barnacle with a platform that suspends ropes of mussels from its underside.

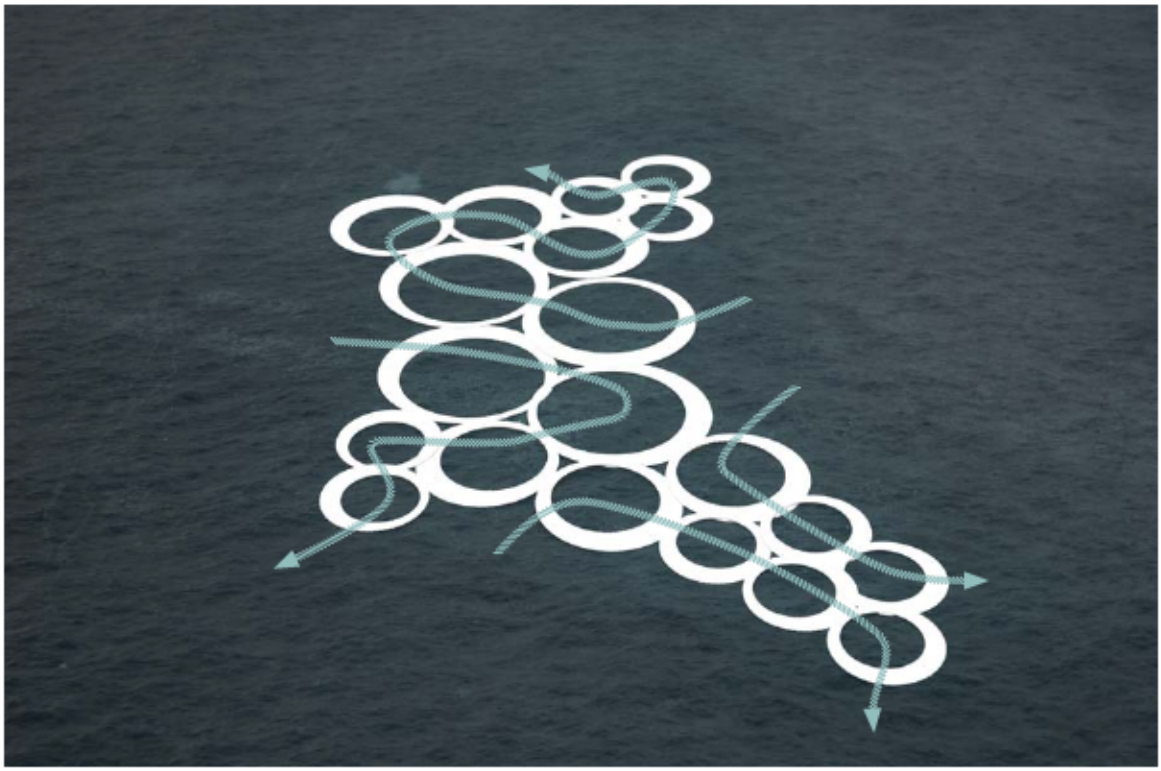
The pools have a morphology that is conducive to being clustered, scaled, and even diversified. The latter illustration shows how the pools could grow over time, change in size, and have alternate functions. From this basic form, a series of pool clusters could create an aggregate filtration system whereby polluted water passes through multiple pools to assure complete filtration before it is ready to be reintroduced into the inlet. The typology is also scalable for different purposes and suggest a possibility for cross-programming. There could be pools for recreation that would benefit from receiving filtered water so that bathers and swimmers will not develop rashes from excessive bacteria counts. Recreational pool water could subsequently be refiltered in a new



Conceptual drawing of a remediation pool



Formal growth of filtration pools with additional functions



Formal growth of filtration pools showing potential paths of water filtration and travel

cluster before it is discharged back into the inlet. The platforms are also imaginable as a social space that recreationists arrive at and land small watercraft. The pools would serve a novel means to interact with others and to feel a sense of connection to community and the aquascape.

To make the most of the geographic advantages of the confluent junction of site, an inlet ecology research center is imagined as an important part of a research and educational infrastructure. With a few marine research facilities that already exist along the shore, they are connected by the research center within the inlet that has the possibility for marine scientists to study pollution in situ of the pools. The models below reuse the single form of the inlet shelter oriented in circular fashion to approximate a structure for the research facilities. Stripped of a facade, each bay is effectively an enormous light well that reflects natural light into the spaces. The angle of the structure may change altering the overall aperture towards the sky and thus altering its form.

Ecology Pool Structure Type 1

Ecology Pool Structure Type 2

The aggregate of architectural form presents a visually compelling morphology not unlike that of a cluster of barnacles. The following model demonstrates how the aggregate is situated in the Aquascape providing a tangible vision to create a remediation system that combines research with cultural uses. The aggregate form has a proximity to Way-Ah-Whichen Park, the site of the Coast Salish Culture Center.

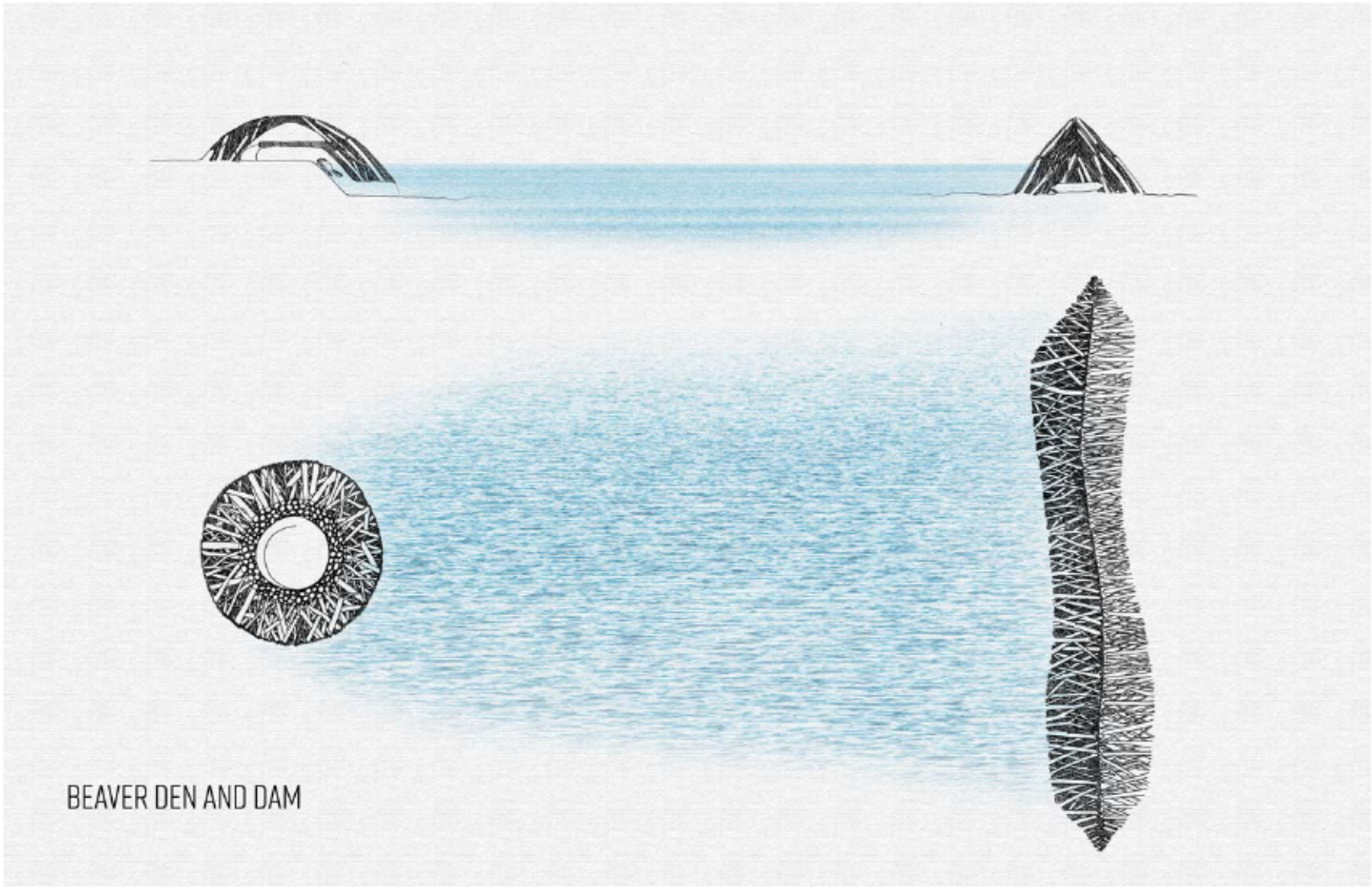
Typological pool formations to host water filtration in the inlet

The Coast Salish Culture Center

The aboriginal people of the Coast Salish First Nations are known for their reverence of nature that permeates every aspect of their rich culture. Abstractions of animals are familiar memes and are iconic of indigenous art and craft. Especially compelling are the retold histories and current practices of indigenous people who invoke communion with animal spirits as a means to understand and adapt to the immediate environment, using the wisdom of nature to guide their decision-making. A desire to enrich and infuse modern culture with that ancient reverence for the landscape and its creatures inspires thinking about architecture like an animal.

For the design of the Coast Salish Culture Center, that inspiration was drawn from the beaver. Its behavioral relationship to the landscape is primarily determined by its instincts for survival yet has a startling effect on the ecology. Chief architect of its home, the nocturnal beaver locates an appropriate stream and site to build a dam. Molding the earth around the stream, the dam is constructed of twigs, mud and rock to inhibit the flow of water and create a meter deep pool. Within the water or situated at the edge of the stream, a dome-like den is built using the same materials and technique. During the day, the beaver accesses the second floor by ramp and burrows in the spacious den to sleep. The den is accessed via a passage dug out below the level of the water line. The pool and passage are evidence of an evolutionary intellect and are a trick of survival against predation. The den and dam are illustrated in plan and section in the latter diagram revealing their

Thinking and building like animals



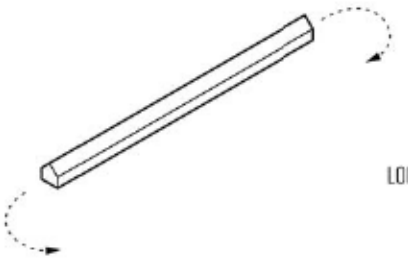
Plan and section of a beaver den and dam

construction.

The beaver's building behavior has an incredible impact on the landscape by single-handedly creating a node in the ecology for wildlife habitats and new vegetation. As the dam stills the water, the pool is favorable to waterfowl and fish drawing other animals into the food web. By molding the landscape to create its own living space, the beaver is responsible for effecting a local biodiversity and ecological richness. It is not a wonder then, why indigenous people sought to understand and emulate the wisdom of animals.

In devising a scheme for the Culture Center, the aspect of molding the land to shape its effect on water and drawing a diversity of people to the shore are considered. The following set of diagrams illustrate the architectural strategy. The longhouse, a typological indigenous example of architecture, is re-imagined as a circular roundhouse form. However, its formal rigidity is not suitable to the steep topography of the North shore. The form is thus broken up programmatically into arc fragments that are pulled apart. The fragments are then situated in the landscape and descend towards the water. The arcs naturally orient towards a circular exterior space giving an opportunity to create a correspondence between the interior and exterior activities. A dialog of respite and activity is created by the flow of spaces which are divided between connecting platforms. Finally, the fragments are reconnected from hilltop to water by a series of exterior ramps.

The multitude of functions imagined for the Culture Center create a novel experience in the landscape that will facilitate the



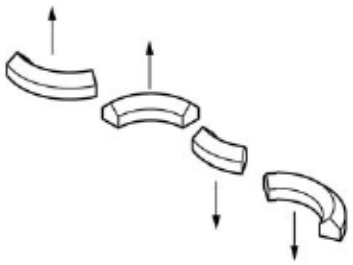
LONG HOUSE

ROUNDHOUSE

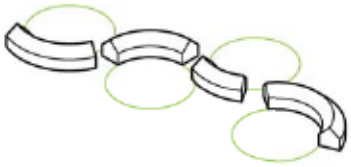
PROGRAM DIVISIONS

FRAGMENTS

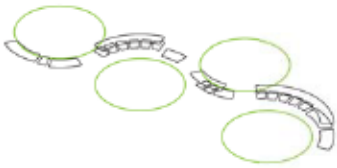
Formal strategy of the Coast Salish Culture Center and Boathouse



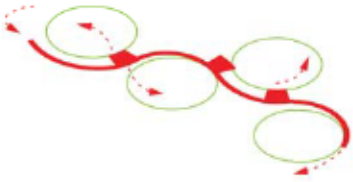
LANDSCAPE ORIENTATION



LANDSCAPE CORRESPONDENCE



FLOW OF SPACE



FLOW OF PEOPLE

Formal strategy of the Coast Salish Culture Center and Boathouse

cultural reintegration of the inlet. Efficaciously commanding the landscape, the architecture links specific correspondent functions while organizing them in an alternating fashion. More than a mere squiggle in the landscape, the parti suggests the poetic management of people like droplets of water flowing in a cultural stream. From West to East, the architecture and landscapes correspond as follows:

Performance Hall <---------> Amphitheater

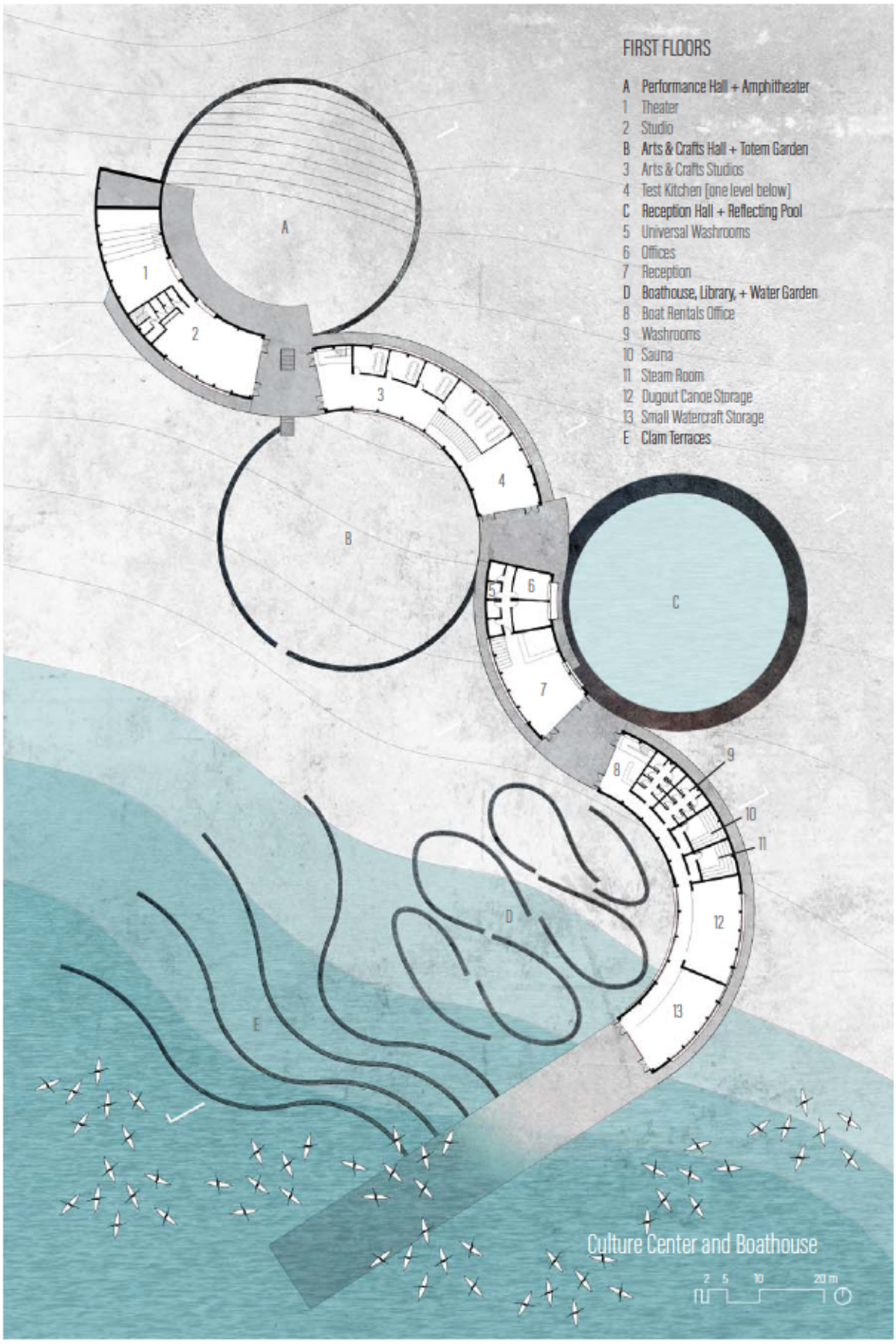
Totem Garden <---------> Arts + Crafts Hall

Reception Hall <---------> Reflecting Pool

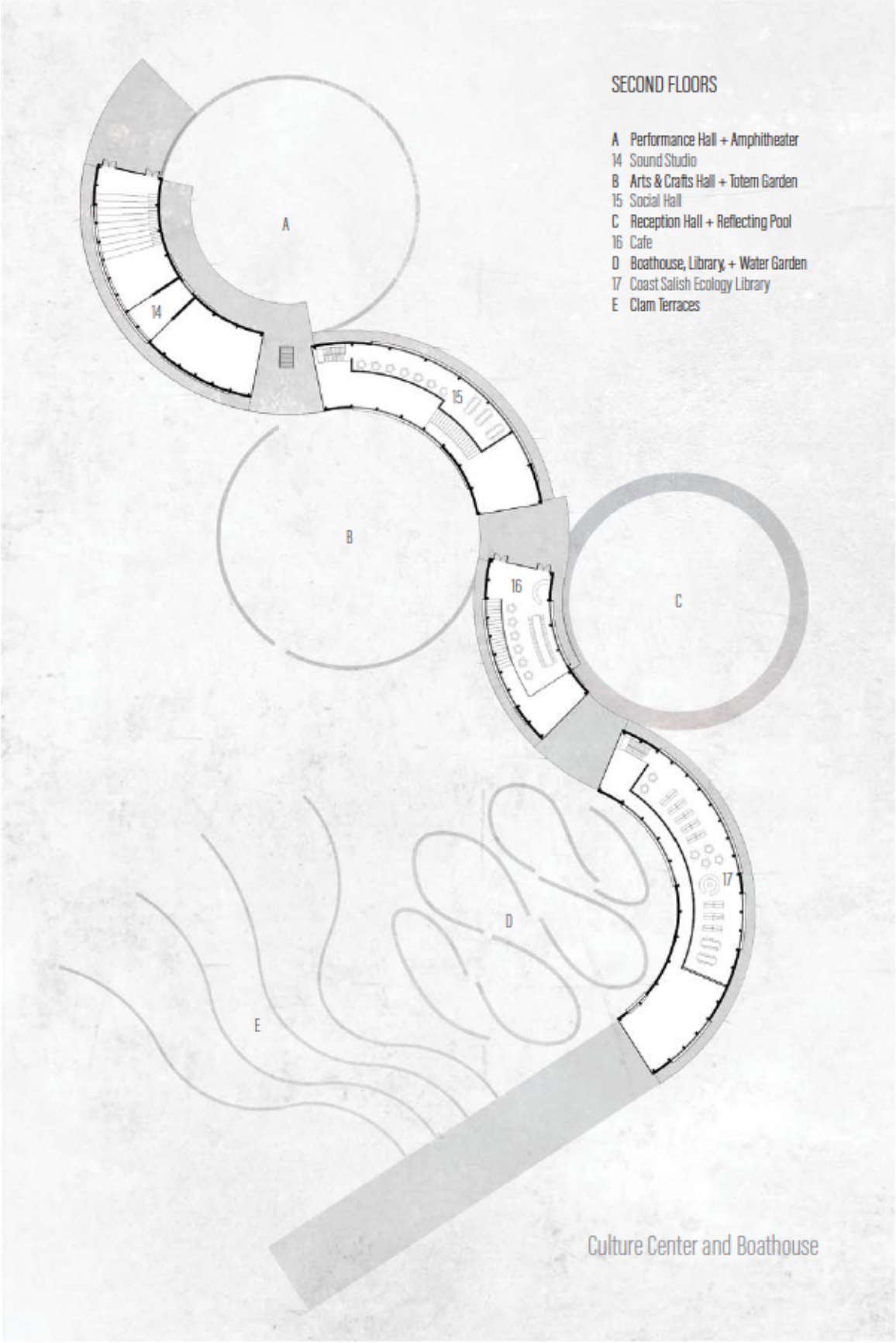
Water + Clam Gardens <---------> Boathouse + Ecology Library

The resultant architecture and interplay of landscape is revealed in the following set of drawings in plan and section. Formally, the architecture mediates one's experiences by helping to transition from its urban context and social connection of landedness to its gradual descent into the water and integration with the life aquatic.

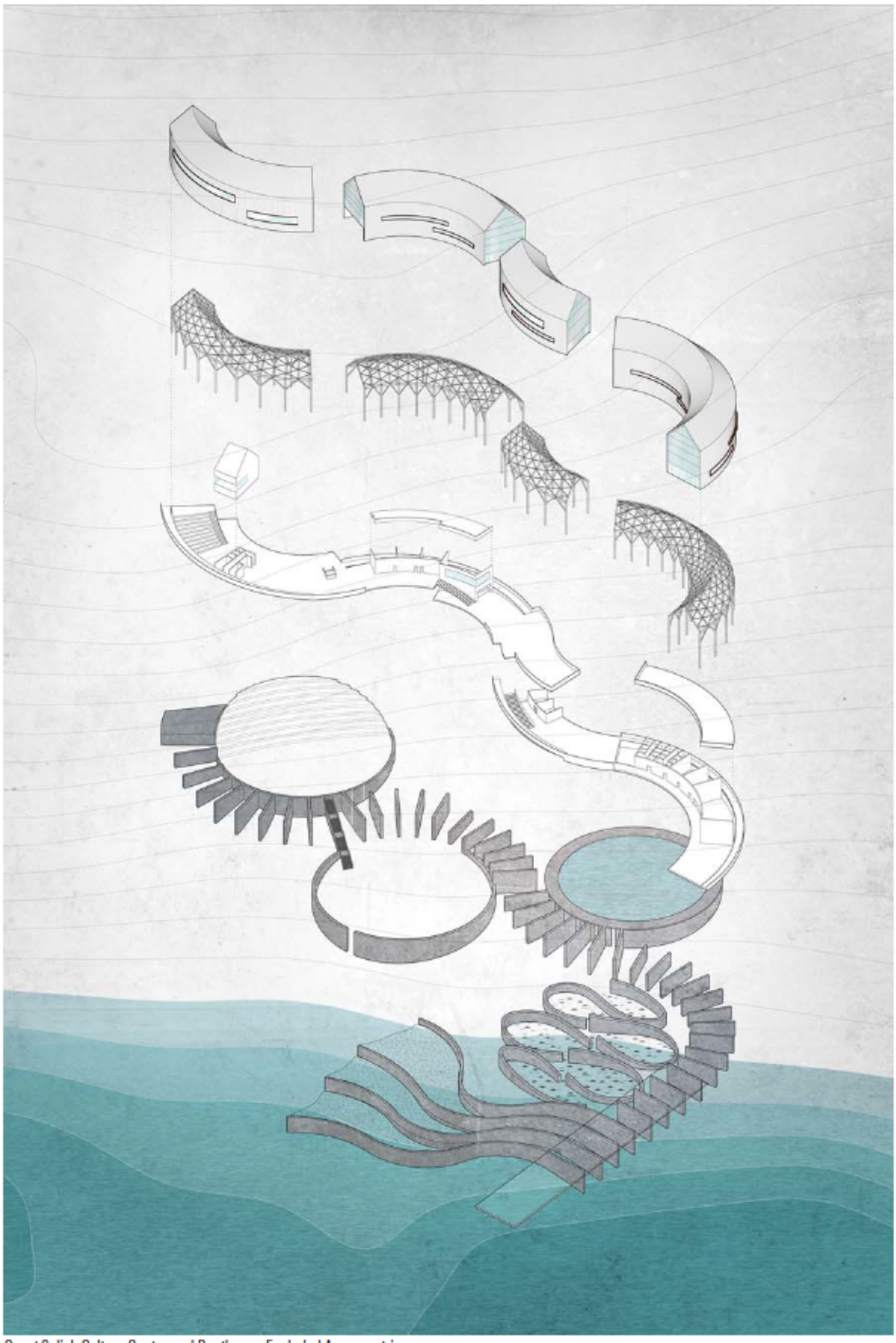
The axonometric drawing at the latter end of the set reveals the general intended construction of the architecture that seeks to blend with the landscape. The fragmented forms sit on platforms atop structural fin foundations of rammed earth rising from the middens like sculpture. From the fins, structural columns bearing a latticework canopy, all in red cedar, support the roof and facade of wooden slats. Cor-ten steel window boxes project horizontally



Culture Center and Boathouse



Culture Center and Boathouse



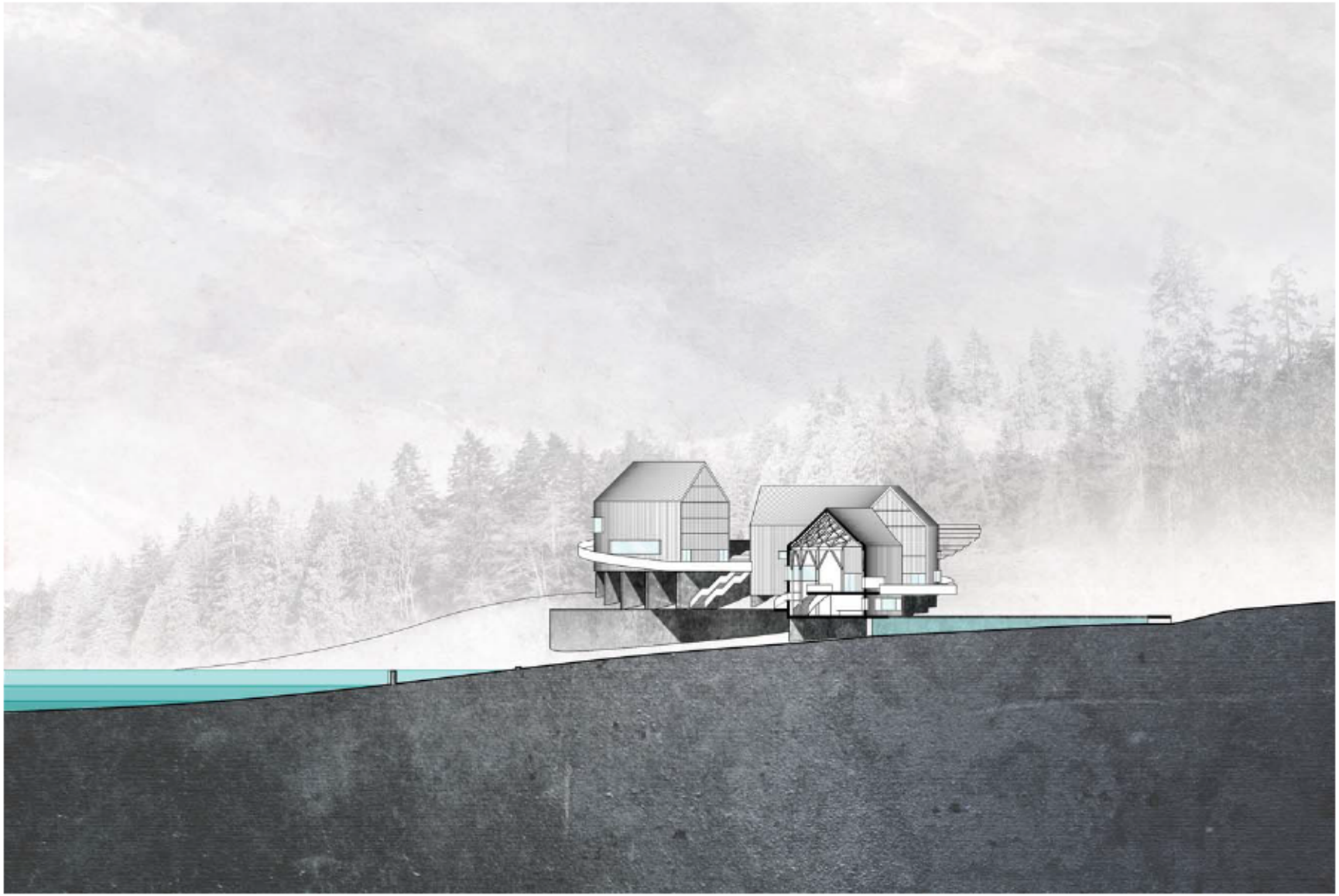
Coast Salish Culture Center and Boathouse Exploded Axonometric

from the facade along the length of the architecture while the ends are fully bookended by light. The exterior landform containers, also of rammed earth are a visual and textural connection to the foundations that invites touch. Openings in the landform containers between the fins permit the flow of rain water and snow melt to permeate the land and eventually drift to their natural destination of the inlet.

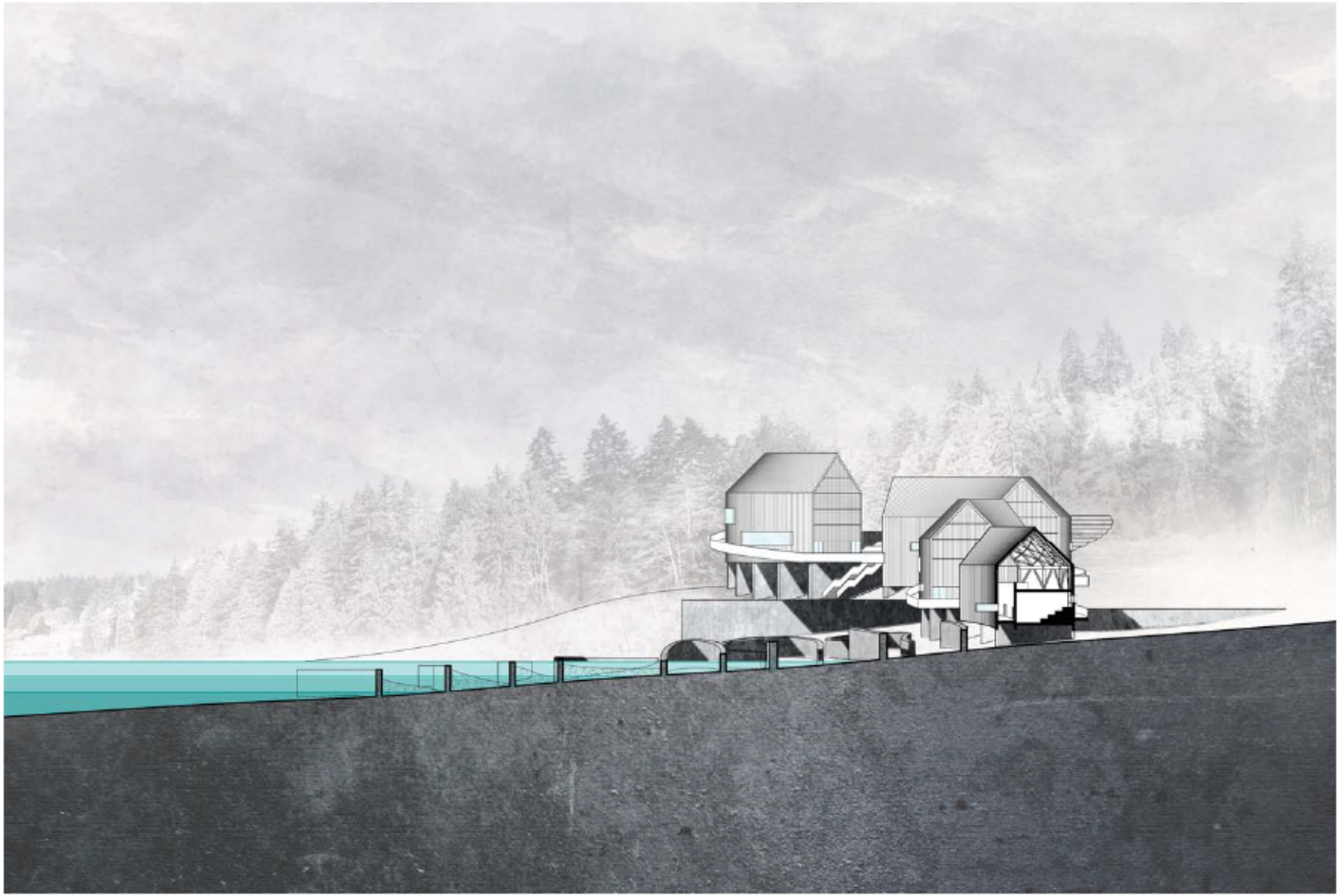
From the axonometric and section drawings, there is an explicit hydrologic connection between the reflecting pool, the water garden, and clam terraces below. Rainwater is collected in the reflecting pool that is intended to release trickles of water into the garden where plants are hydrated and the sediments filter the excess. The water passes through the clam terraces with the natural deposition of organic matter and detritus for their food source. As the water is filter fed by the clams there should be a release of clean water into the inlet.

Performance Center and Amphitheater Section

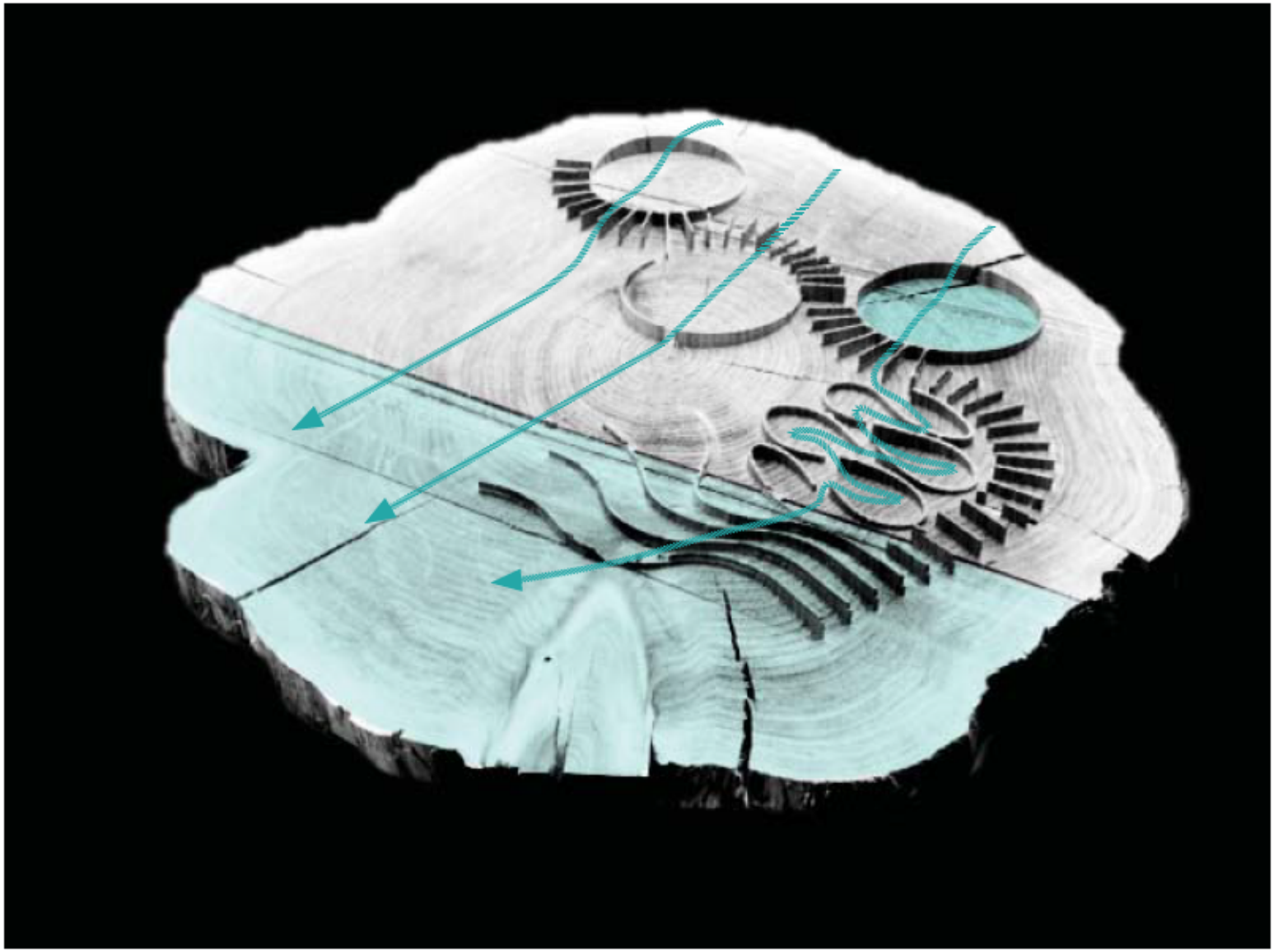
Arts and Crafts Hall and Artist Garden Section



Reception Hall and Reflecting Pool Section



Clam Terraces, water garden, and Boathouse Section



Coast Salish Culture Center Model - Water Flow

Coast Salish Culture Center Model - South View

Coast Salish Culture Center Model - Bird's Eye View

Coast Salish Culture Center Model - West View

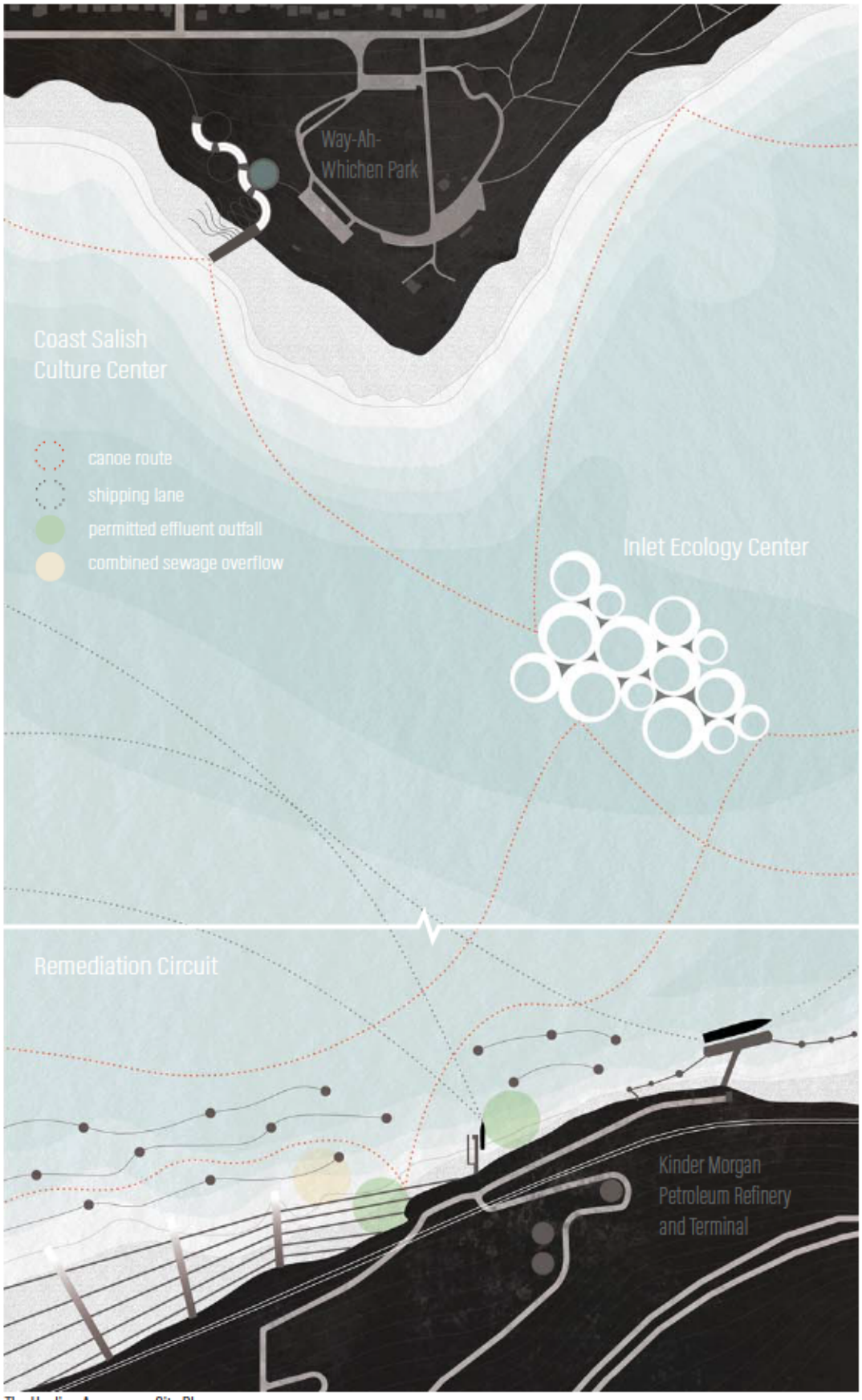
Coast Salish Culture Center - Reception hall

Coast Salish Culture Center - Boathouse

CHAPTER 5: CONCLUSION

The Healing Aquascape is formulated as a strategy to heal the aquatic ecology of the Burrard Inlet and to reincorporate the waterway as an integral region of the cultural landscape. In order to reach a strategy, a framework of functions helped to elaborate a desirable long term vision for developing a new healing culture. In defining the Healing Aquascape, the goal is to cultivate a remediation infrastructure to heal the ecology, to establish a positive long-term relationship between people and the landscape through recreation and interaction, to promote indigenous reconciliation by giving stage to aboriginal art and culture, to develop education and research networks that improve local knowledge of the ecology, and through those efforts to reconnect the economy to the ecology by way of shellfish aquaculture.

As a matter of first importance, the story of the landscape formation was studied and illustrated by observing how it changed with time. From it's geomorphology, to its first inhabitants, to the global transport infrastructure, and the urban evolution of Metro Vancouver, the layered history gave a greater understanding of its present condition. Through those layers a number of significant locations were sifted from the mound of information to identify sites to locate three major components of the Healing Aquascape. The specific site of Way-Ah-Whichen park has a particular genius loci that confronts the industry of the Kinder Morgan petroleum refinery directly south. Those sites were isolated to examine the



The Healing Aquascape Site Plan

components of the healing infrastructure.

In devising a remediation and cultural infrastructure, typologies of each component were studied to examine how remediation could be blended with recreation, education, and arts and culture. Types were then synthesized as the circuitry of a new marine culture that connects an aggregate of filtration pools and an inlet ecology research facility to the Coast Salish Culture Center located at Whey-Ah-Whichen park. The resulting strategy is illustrated above.

Clam terraces, remediation towers, and long line aquaculture form the first line of defense against point-sources of effluent pollution at the Kinder Morgan site to the south. When there is a spill event, the aggregate filtration pools might mitigate the impact of the pollution as a second line of defence. Finally, the integration of the inlet through improving its cultural quality with the Coast Salish Culture Center and its aquatic access to the Burrard Inlet serves to reconnect people physically, culturally, and spiritually to the Aquascape. While this thesis focused on a specific site and devised a strategy as a typology for the entire inlet, a future study could show how those types might spread across the inlet over different periods of time as the industrial infrastructure slowly verges towards obsolescence and is taken over by an ecological culture of longevity defining of a Healing Aquascape.

BIBLIOGRAPHY

Amano Takashi. Untitled photograph collection online, undated. Last modified October 3, 2016. http://www.aquariumarchitecture.com/archive/legendary-aquarist-takashi-amano/.

Balanced Environmental Services Inc. *Burrard Inlet Point Source Discharge Inventory*. Burrard Inlet Environmental Action Program (BIEAP), 2010. 4

BC Treaty Commission. *Statement of Intent Traditional Territory Boundary Squamish Nation*, 1993. Last modified April 20, 2017. http://www.bctreaty.ca/sites/default/files/Squamish__01__SOI__Map.pdf.

Bergdoll, Barry, and Guy Nordenson. *Rising Currents: Projects for New York's Waterfront*. New York: Museum of Modern Art, 2011.

Berlo, Janet Catherine, and Ruth Bliss Phillips. *Native North American Art*. Oxford: Oxford University Press, 1998.

Cannings, Sydney, Richard Cannings, and JoAnne Nelson. *Geology of British Columbia: A Journey Through Time*. Vancouver: Greystone Books Ltd, 2011.

City of Vancouver. *Open Data Catalogue*. Last modified March 29, 2017. http://vancouver.ca/your-government/open-data-catalogue.aspx.

Corner, James. "Not Unlike Life Itself: Landscape Strategy Now." *Harvard Design Magazine* (2004). Last modified April 22, 2016. http://www.harvarddesignmagazine.org/issues/21/not-unlike-life-itself-landscape-strategy-now.

Corner, James. *Recovering Landscape: Essays in Contemporary Landscape Theory*. Princeton: Princeton Architectural Press, 1999.

District of North Vancouver. *Open Data*. Last modified December 8, 2016. http://geoweb.dnv.org/data/.

Environment Canada. *1981 to 2010 Canadian Climate Normals Station Data: N Vancouver 2nd Narrows BC*. Last modified January 25, 2017. http://climate.weather.gc.ca/climate_normals/index_e.html.

Groesbeck, Amy S., Kirsten Rowell, Dana Lepofsky, and Anne K. Salomon. "Ancient Clam Gardens Increased Shellfish Production: Adaptive Strategies From the Past Can Inform Food Security Today." *PLoS ONE* 9, no. 3 (2014): e91235. Last updated March 11, 2014. http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0091235.

Hurlburt, C. Graham, and Sarah W. Hurlburt. "Blue Gold, Mariculture of the Edible Blue Mussel (Mytilus Edulis)." *Marine Fisheries Review*, Vol.37, No.10 (Oct 1975), 10-18. Last modified August 30, 2016. htt://spo.nmfs.noaa.gov/marine-fisheries-review/mfr-37-10.

Intervistas Consulting. *2012 Port Metro Vancouver Economic Impact Study*. Last modified July 15, 2016. http://www.portvancouver.com/wp-content/uploads/2015/03/2012-port-metro-vancouver-economic-impact-study2.pdf.

LTL Architects. *Water Proving Ground in the Rising Currents Exhibit, 2010*. Last modified January 31, 2017. http://ltlarchitects.com/water-proving-ground.

Leatherbarrow, David. "Leveling the land." *Recovering Landscape: Essays in Contemporary Landscape Architecture* (1999): 171-177.

Metro Vancouver. *Municipalities and Population*. Last modified January 30, 2017. http://www.metrovancouver.org/about/PublishingImages/MetroVancouver-Municipalities-Population.jpg.

Metro Vancouver. *2001 Population Density and the Metro 2040 Growth Model*. Last modified February 27, 2017. http://www.metrovancouver.org/services/regional-planning/PlanningPublications/140509__RPA__Density__and__Urban__Growth.pdf.

Mills, Jamie. Forest. *Tiny Pencil 1: The Forest Issue*, 2013. Last modified March 29, 2017. http://www.cargocollective.com/jamiemills/Forest.

Morin, Jesse, *Tsleil-Waututh Nation's History, Culture, and Interests in Eastern Burrard Inlet*. Last modified February 3, 2017. http://twnsacredtrust.ca/wp-content/uploads/2015/05/Morin-Expert-Report-PUBLIC-VERSION-sm.pdf.

Musqueam Indian Band. *Musqueam Declaration, 1976*. Last modified August 26, 2016. http://www.musqueam.bc.ca/sites/default/files/musqueam__declaration.pdf.

Natale, Diego Carlos Ernesto. "Development of a food web model to develop sediment target levels for selected persistent organic pollutants in Burrard Inlet." PhD diss., Simon Fraser University, 2007.

Rudd, Hilary. Map of Coast Salish Territories, 2004. Last modified December 9, 2011. https://web.uvic.ca/~bthom1/maps.html.

Smith, Anthony N. 2001 Census Population Density. Cartography and Data Visualization. UBC, 2013. Last modified August 22, 2016. https://blogs.ubc.ca/maps/2013/07/03/vancouverpopulationdensity/.

Stewart, Hilary. *Cedar: Tree of Life to the Northwest Coast Indians*. D & M Publishers, 2009.

Stewart, W.J. Map of Burrard Inlet. United Kingdom Admiralty, 1893. Last modified May 3, 2016. http://searcharchives.vancouver.ca/burrard-inlet-6.

Tsleil-Waututh Nation. Tsleil-Waututh Nation Consultation Boundary Area, 2008. Last modified February 22, 2017. http://www.twnation.ca/About%20TWN/Stewardship.aspx.

Vancouver Public Library. City of Vancouver Population. Last modified April 29, 2016. http://www.vpl.ca/branches/LibrarySquare/soc/pdfs/QF__Population__BC__Vancouver.pdf (discontinued, but original accessed from the Internet Archive, June 5, 2007).

Whitford, Jacques for AXYS Ltd. Burrard Inlet Environmental Indicators Report. *Burrard Inlet Environmental Action Program*, Burnaby, BC (2008). Last modified December 22, 2016. http://www. bieapfremp. org/pdf/burrard__inlet__environmental__indicators__feb08.pdf.

Wright, Ronald. *Stolen continents: The Americas through Indian eyes since 1492*. Houghton Mifflin, 1992.