URBAN ECOLOGICAL ARCHITECTURE:
AN INTEGRATED APPROACH TO ENVIRONMENTAL HEALTH IN THE CITY

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A THESIS
SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF ARCHITECTURE

UNIVERSITY OF WASHINGTON
2018

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PROGRAM AUTHORIZED TO OFFER DEGREE:
ARCHITECTURE

UNIVERSITY OF WASHINGTON

ABSTRACT

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Urban Ecological Architecture is an integrated approach to sustainable architecture that accounts for the unification of ecological systems and human-made systems in an urban environment such as a large city. "Green" or "Sustainable" Buildings today are able to internalize natural forces into building systems, however the act of internalization prevents the architecture from connecting to nature. In cities today, the need to reconnect to nature through ecological architecture stems from the need to preserve the natural environment and mitigate the detrimental effects of human dominance over nature. This thesis argues that an integrated approach such as Urban Ecological Architecture is able to unify the dichotomies of human and natural systems in a symbiotic way that results in mutually beneficial ecosystem services. This thesis applied the Ecological Design framework written by Sim van der Ryn to demonstrate an integration of architecture and landscape on Seattle's Waterfront when the Alaskan Way Viaduct is dismantled, leaving the waterfront free of the barricade. The proposed project is a Center for Environmental Health which unifies both a Tribal Cultural Center and an Ecological Science Lab to reimagine the civic waterfront and the values that connect humans to issues of the environment.

THIS THESIS IS DEDICATED TO

PROFESSOR VANDANA BAWEJA
AT THE UNIVERSITY OF FLORIDA
WHO NURTURED MY INTEREST IN SUSTAINABILITY FROM YEAR TWO,
AND CHALLENGED ME TO ASK ... "WHAT ABOUT THE BIRDS?"

"THE SQUAD"
MITCHELL CLARKE, WENDY STRADLEY, MIMI KUPIER, KIRSTEN EVANS
THANK YOU FOR THE BEST YEARS, LATEST COFFEE RUNS,
FRIENDSHIP AND SUPPORT

LAMA AL SHARIF, JAYEONG KOO, BRAD VALTMAN
FARHANA HAQUE, VIRGINIA BOSWORTH, SEEMI HASAN, WEICHENG LI
WE WILL ALWAYS HAVE SEATTLE

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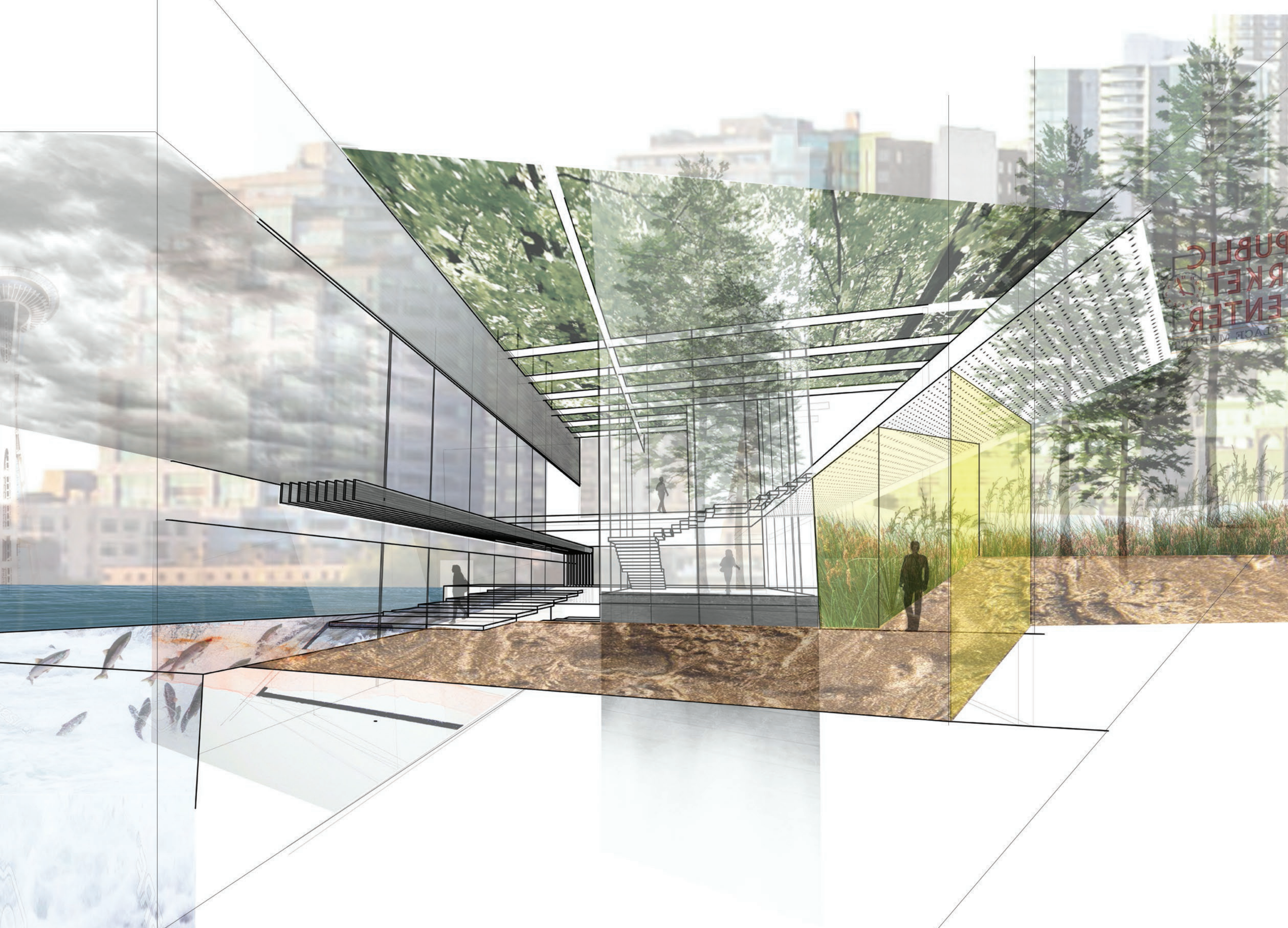
urban ecological architecture

an integrated approach to environmental health in the city



contents

preface
p. 10-15

introduction 1
p. 16-17

literature review 2
p. 18-35

context 3
p. 36-45

design 4
p. 46-87

conclusion 5
p. 88-89

bibliography
p. 90-92

list of figures
p. 93-97

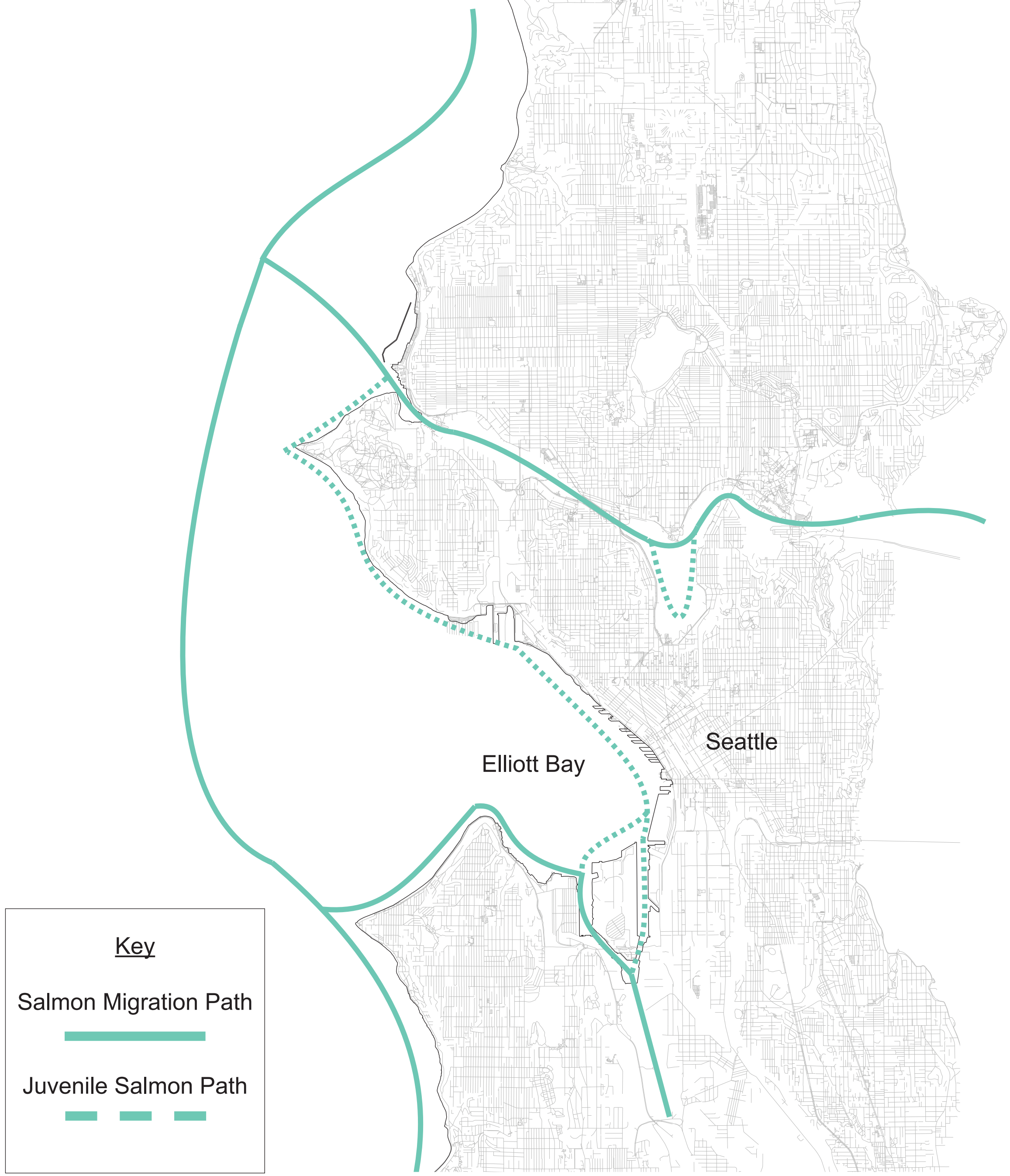


Figure 1.1 Salmon Migration Patterns in the Puget Sound.

preface

Part 1: The Life of Salmon

The Puget Sound of the Pacific Northwest is home to over 59 populations of Chinook salmon, steelhead, and bull trout (Governor's Salmon Recovery Office, 2016) who are iconic to the region because of the vital role they play as a keystone in the larger ecosystem. Keystone species by definition are depended on by other species in the ecosystem and, if removed, would cause devastating change or even collapse to the ecosystem. In the Puget Sound, salmon are not only relied upon as a major food source, but also act as an ecosystem regulator and an indicator of environmental health.

The salmon life cycle (Fig. 1.2) begins in the late fall when mature salmon migrate from the ocean to their fresh water origins to spawn. Salmon typically spend 5 to 7 years of their life in salt water. During this span, salmon will accumulate over 95% of their biomass (Schindler, et all, 2003). At the end of their life cycle, salmon instinctively return to fresh water. They are able to recognize the scent of the fresh water they hatched in and are attracted to the upstream flow that guides them back to this water source, which they famously climb to reach their destination. Then, Then, salmon will excavate a shallow fresh water stream or river bed to create a nest, known as a redd, to lay their eggs. The creation of this redd "alters the composition of sediments" and "creates substantial ridges and valleys" (Schindler, et all, 2003) in the beds that can alter water flows. The result of digging a redd, however causes a beneficial disturbance to the ecosystem: small invertebrates and algae are dislodged and sent to drift, which feeds several fish species; and silt is locally dislodged and redistributed through the stream, which reduces the shear stress in the stream (Schindler, et all, 2003) and increases oxygen flow. Most salmon species lay their eggs in the fall or winter, and subsequently the parent species perish. After, they are metabolized by the surrounding terrestrial and aquatic ecosystem in which they serve.

Salmon contribute to terrestrial* species such as bears, eagles, and other predators as primary food sources before the winter, at the time of year in which many of these species begin storing food in preparation for hibernation. If not consumed by terrestrial animals, salmon are an essential role in delivering nitrogen and nutrients to

Terrestrial: Animals that live on land and cannot breathe or survive underwater.
Riparian: Trees and vegetation that grows in the zone between water and land.

the soil which stimulate the growth of trees and riparian* vegetation (Fig. 1.3) (Schindler, et all, 2003). Salmon eggs typically spawn in the spring from their fresh water habitats until they mature enough to smolt, or adapt for life in salt water (Fig 1.2). In a nest of over 2,000 eggs, about 30 fry (juvenile salmon) survive being eaten by other aquatic species; of those, only 4 are expected to mature enough to swim to sea (The National Park Service, 2018). A salmon's body is born saltier than the water it lives in, and therefore needs to gain salt from its food source to keep the salt in. As smolting occurs, the salmon's body prepares for it

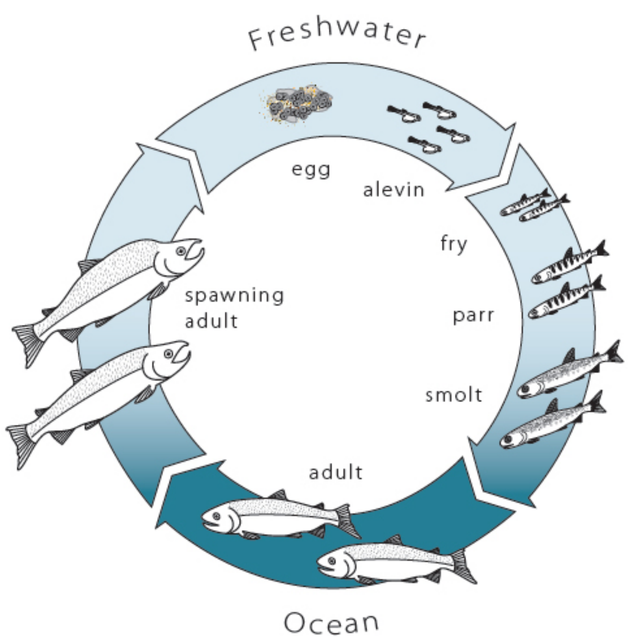


Figure 1.2 The Salmon Life Cycle.

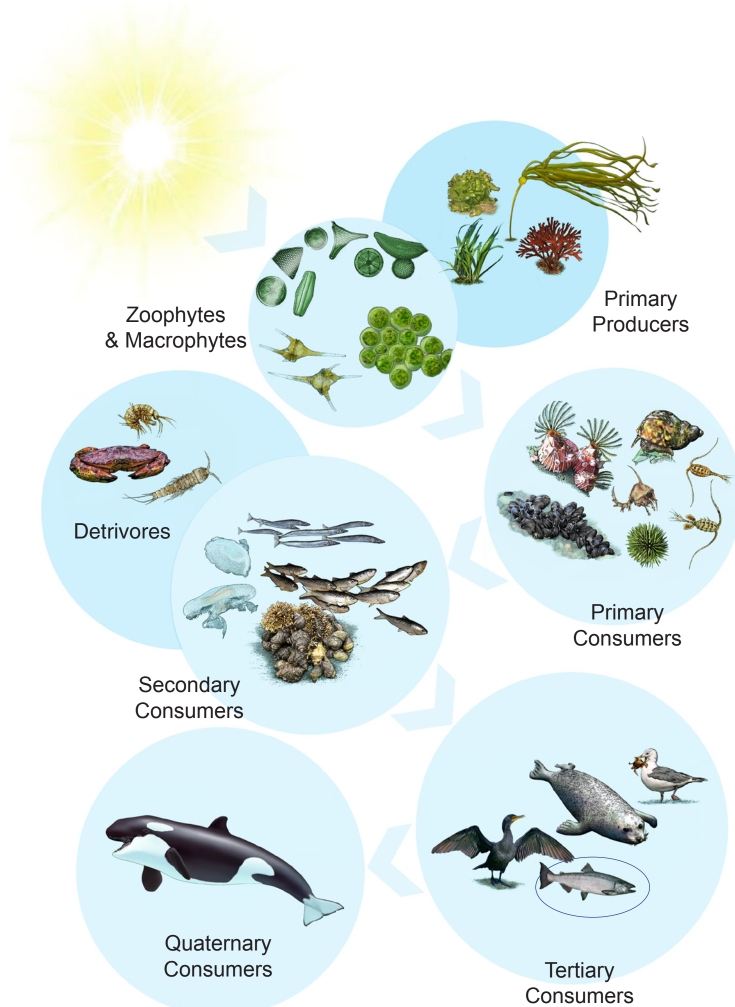


Figure 1.3. The Puget Sound Food Chain.

to live in water that is saltier than the salmon needs, and therefore adapts to its changing environment by excreting excess salt (The National Park Service, 2018). The salmon then is able to seek out the saltier water of the ocean, where it can spend up to 7 years maturing into an adult.

In the Puget Sound region, salmon follow historic migration paths to both begin life in the ocean, and return to spawn in fresh water (Fig. 1.1). These paths begin in the cold northern ocean, typically near Alaska and Russia in the Bering Sea, and they begin to make their way into the inner waterways of the Puget Sound through the Strait of Juan de Fuca, around the northern peninsula of Washington State and Victoria, B.C. Seeking their origins, salmon move through the Puget Sound into the freshwater estuaries of the major rivers of the area: the Skagit River, the Snohomish River, the Duwamish River, and Salmon Bay (Washington Department of Fish and Wildlife, n.d.). As mentioned, salmon are attracted to the fresh water source they were born in by its scent and the opposing flow of the water. Salmon will follow this scent upstream before they arrive at their destination in the fresh water locations in places such as Snohomish, Snoqualmie, Issaquah, Puyallup, and Nisqually where they begin to dig their redds.

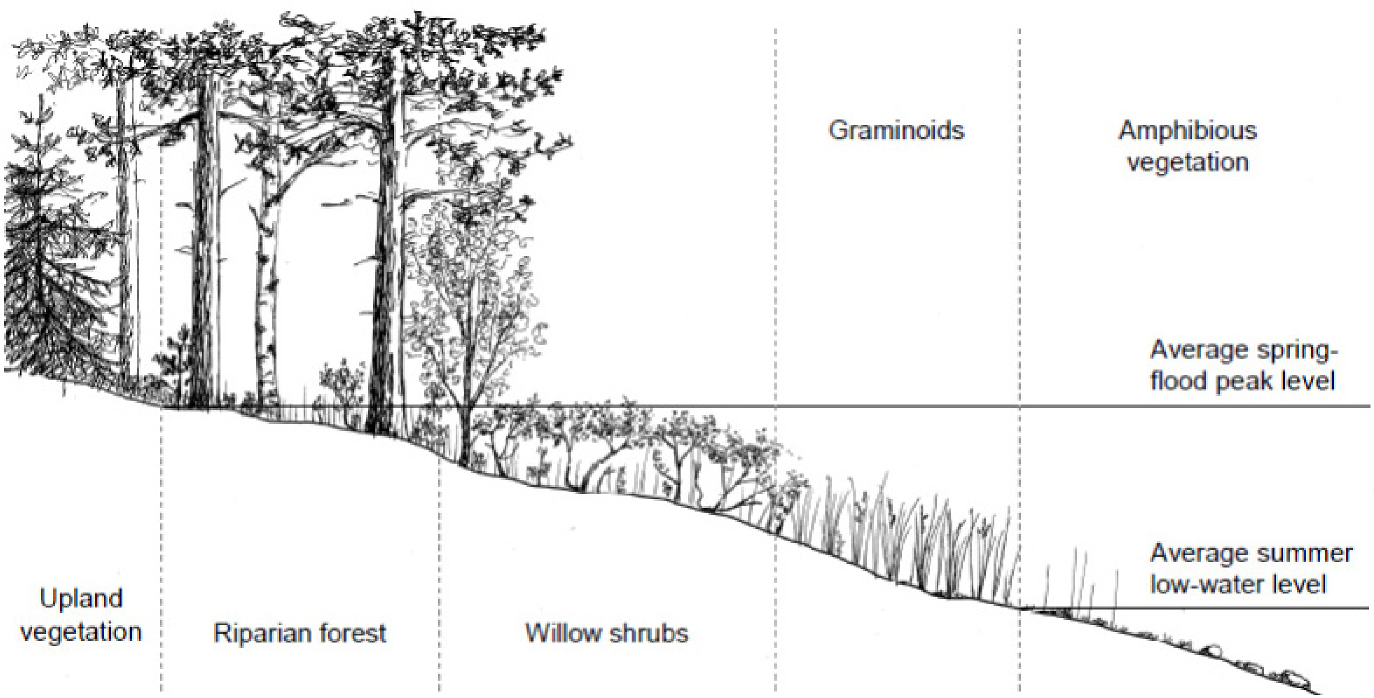


Figure 1.4. The Boreal Riparian Zone.

Figure 1.5. The Great Canoe.

Part 2: The Spirit of Salmon

In the Pacific Northwest, salmon have also been crucial to the metabolism of the human population. Historically, Native American tribes of the region such as the Duwamish, Puyallup, and Muckleshoot tribes in Seattle, have relied upon salmon as sustenance and spirituality. The culture of these tribes are what Matthew Klingle describes as "a culture or way of life rooted in the land." (Klingle, 2008) Tribes in this region were well versed in their knowledge of salmon, cycles of runs, and the best way to use the catch. To them, however, salmon were more than just food: they were a primary character in mythical storytelling (Fig. 1.7), subject of art (Fig. 1.6), and champion in sport (Fig. 1.5).

Salmon were also a primary subject of spirituality and ritual which were sacred to ensure a healthy and abundant run for the year. Because salmon provided the most prolific food resource to this region, and were key to survival, it is important to recognize that the methods of netting these fish allowed the tribes of this region more time to develop culture and art; contrasting with tribes in northern regions that spent more time acquiring larger sea mammal catches. The tribes of the Salish Sea region relied and respected salmon as an abundant resource that allowed their society to thrive, and recognized their role in assuring that the population of salmon thrived as well (Klingle, 2008).

Figure 1.6. Salish Sea Basket.

Figure 1.7. Salish Sea Salmon Artwork.

chapter 1 Introduction

Although past populations have harvested salmon as their primary source of food, humans recognized that they thrived because the salmon thrived, and ensured that they treated this species with respect for the sake of the next year's harvest. In Seattle's relatively short history of industrialization and development, the introduction of the rapidly growing built landscape has caused increasingly detrimental effects to the region's natural ecosystems which salmon once knew as home.

Between the years of 1984, when the Pacific Salmon Commission (Schindler, et all, 2003) began to record data for the 1985 Pacific Salmon Treaty, and 2010, the EPA reported that salmon populations have reduced by 60% in the Salish Sea region which includes the Puget Sound. In this area of rapidly increasing urbanization and built interface, salmon now face severe habitat loss caused by shoreline armoring, poor water quality, insufficient stream flows, impervious surfaces, and fish passage barriers (Munsch, 2017).

As a keystone species, salmon are indicators of environmental health. Considering the factors that have influenced their population decline, salmon are endangered because the built environment is in tension with the ecosystem that salmon rely upon.

This thesis investigates Urban Ecological Architecture as a method of integrating human and ecological functions into the urban context of downtown Seattle. The architectural proposal will reconnect the city's urban ecology into the built environment with a building that provides restorative functions to both human and salmon habitats.

The proposed design of a Center for Environmental Health depends heavily on its site at the Downtown Seattle waterfront using the ecological processes and human rhythms to determine the building's form and spatial functions. The methodology begins with an examination of ecological systems specific to the site to determine the best means to encourage salmon to thrive in the Elliott Bay area. Urban systems are studied to generate a response that reflects the needs of the users. This thesis will demonstrate how Urban Ecological Architecture can be used to explore the dialogue within our human habitat as both natural and human forces converge in a sustainable building.

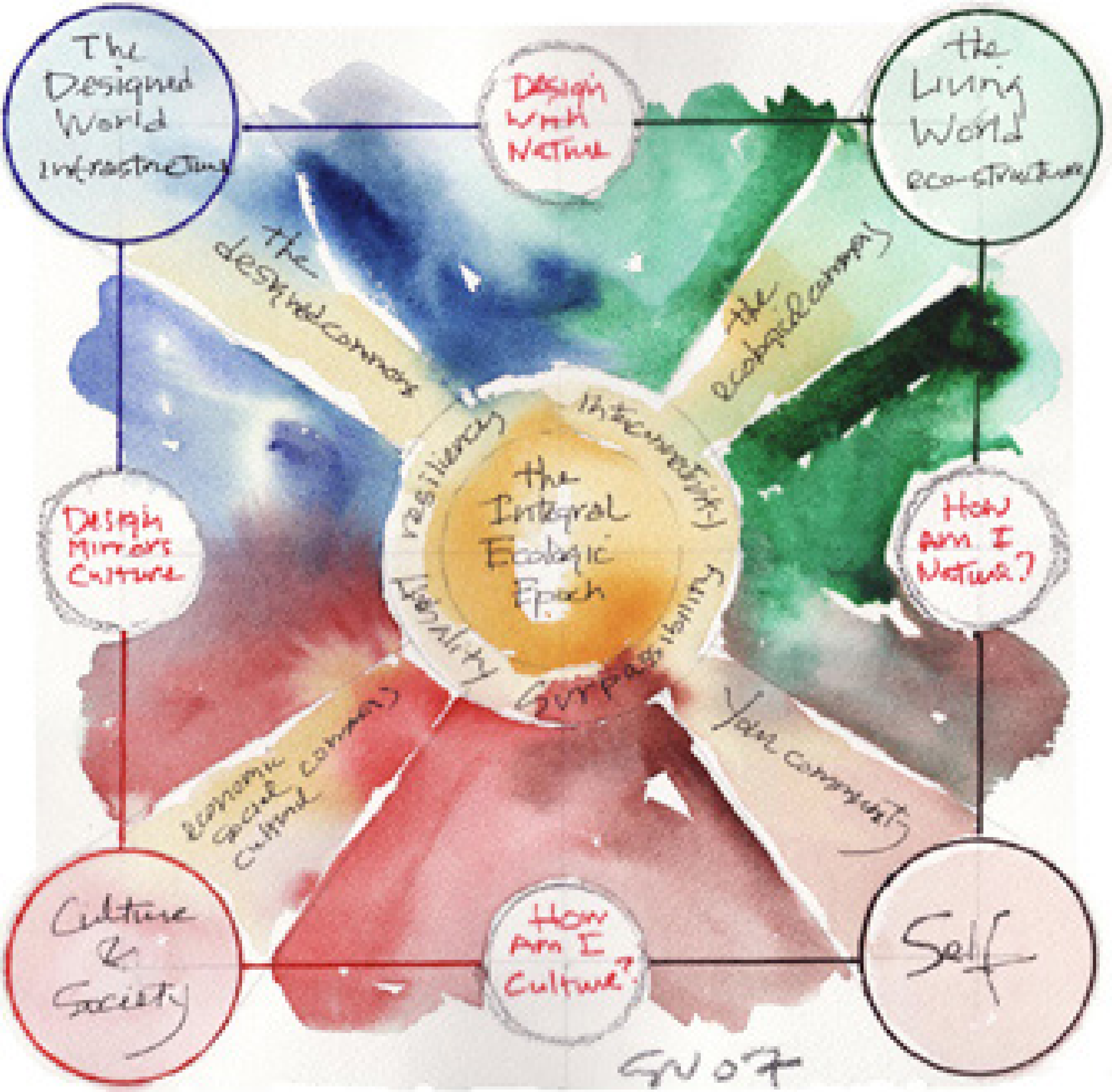


Figure 2.1. The Integral Ecologic Epoch (Van der Ryn, 2017.)

chapter 2 Literature Review

Overview of the Chapter

The urban ecology of Seattle can be defined as the relationship between systems that are both human and natural, their boundaries, and their interactions. The most often disused markers of ecology are where human and natural systems converge in the realm of sustainable buildings. However the present condition of these two systems in Seattle shows evidence of disconnect between the systems. In this chapter, a review of the meaning of Ecological Architecture in an urban context be first undertaken, in order to analyze the integration of ecological systems into the built environment.

This thesis argues that Urban Ecological Architecture addresses an evolving perspective of sustainability that is necessary for building in the city. Understanding of the way human and natural processes interrelate will give the design a deeper understanding of integrated building systems. In this way, sustainable buildings will not simply imitate these natural systems, but can integrate with them to truly embody nature in the built environment and strengthen the relationship between the urban ecosystem and natural landscape.

Urban Ecological Architecture must first be understood in relation to the urban context. Urban areas, as in cities or towns, support a diverse range of land-use activities, modes of transportation, and built systems. As Danilo Palazzo and Frederick Steiner note (Palazzo & Steiner, 2014)), urban environments also support various applications of nature. Rather, as Richard T.T. Forman argues (Forman, 2016), nature in an urban area tends to "appear in various altered or degraded forms" (Fig. 2.2) where the space has been manicured to appeal to human needs, leaving only remnants of what nature was originally present and fragments the ecological system. These small patches of nature in urban areas reveal that the need for them is much greater than provided, reflecting the fragmented condition of the ecological system.

The ecology of urban areas constitutes much more than the insertion of green space into the cityscape. Forman (Forman, 2016) observes that urban ecology encompasses the "interactions of organisms, built structures, and the natural environment where people are aggregated around a city or town." However, the study of urban ecology is also the study of "ecosystems of nature disrupted or diverted by systems of humans," as noted by Susannah Hagan (Hagan, 2015). By studying the connection of human systems, we are in fact studying the fragmentation of natural systems.

When designing ecological architecture in an urban context, it is important to establish a framework of systems that apply directly to the site within the larger context. This framework should establish the study of both human-made and ecological systems with an "emphasis on the context" as a part of the ecosystem. Palazzo and Steiner state that human systems within urban ecologies consist of human actions, social institutions, and infrastructure (Palazzo & Steiner, 2014). As urban areas develop, the access to these resources is truly important to achieving a functional society. The goal is to clearly ensure that the connectivity of these resources is effective and consistent in order to provide for the human needs of those who inhabit this area.

The human made systems of an urban area are also in a transition from independency to dependency: from open-loop systems to closed-loop systems. Susannah Hagan states that human systems began as individualistic and independent, which resulted in an open-loop metabolism that uses resources and produces waste (Hagan, 2015). Urban ecology, however, moves towards a closed loop system, where waste is recycled in order to produce new resources and prevent what William McDonough refers to as “fugitive” waste (ArchDaily, 2018).

The natural systems of an urban area include its climate, geology, water, and wildlife. Palazzo and Steiner state that these systems can be telling of the “deep context of a place” which informs the relationships between “places, solids, voids, natural, and man-made” on a given site (Palazzo & Steiner, 2015).

Although necessary to urban life, these natural systems are often disconnected and deficient in comparison to the predominate human systems. As Forman describes, disconnected natural areas in cities can take one of four forms: a natural area, a semi-natural area, an intensive-use greenspace, or a built area (Forman, 2016). Natural areas typically have significantly less activity than a built area, and therefore enabling nature to be much more preserved. The semi-natural area and intensive-use green space are much more commonly found within an ur-ban area, or within a suburban area. In semi-natural areas, there is an increase in the scale of human activity and a decrease in natural systems.

As Mohsen Mostafavi writes, the understanding of the city as an urban ecology makes it possible to develop strategies to restore incongruences and develop hybrid ecologies that are more responsive, cyclical and regenerative (Mostafavi, 2016).

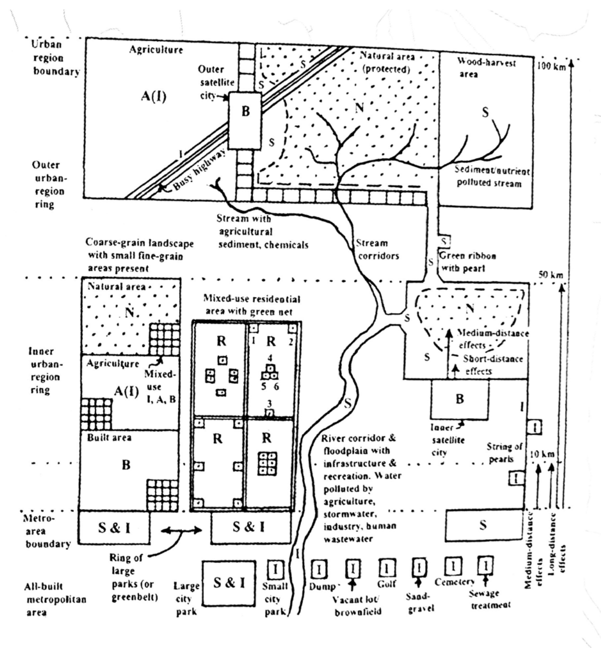


Figure 2.2. Altered Nature.

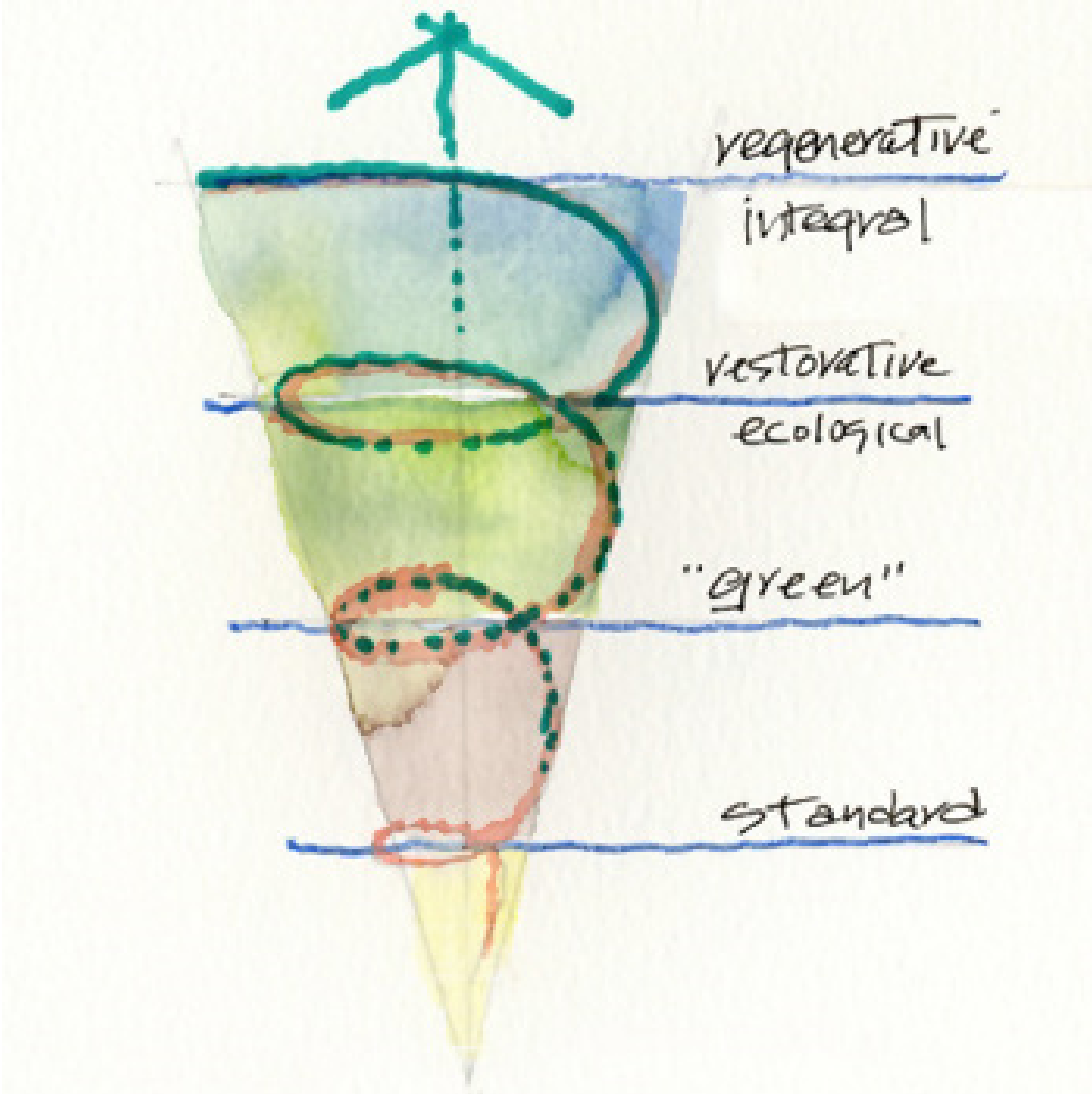


Figure 2.3. Trajectory of Ecological Design. (Van der Ryn, 2018)

As the study of Urban Ecology generates a foundation for the systems in the urban context, the concept of Ecological Architecture can also “foster integration” (Samiei, 2016) between the human and natural systems. Architecture creates the space in which these two systems can converge and mutually benefit. Relinking these systems through the design of ecological buildings can not only restore natural functions, but has the potential to also restore human functions in an urban context.

Ecological Architecture calls for thinking about the context and the building in a holistic way: meaning that the two are connected to the degree that they manifest reciprocal interactions between nature and people. The effects of humans on the natural world are undeniably detrimental, but with appropriate ecological design, people can begin to have a more positive effect on their surroundings. As Thomas Schropfer and Limin Hee state, the process of integrating natural systems into the built environment relies on a “comprehensive system” in which the building is no longer a “discrete object” (Schropher & Hee, 2012). Architecture is then able to holistically embody this comprehensive system and to both the urban and natural context .

This process has also been known as creating a “hybrid landscape,” in which architecture is involved in blending human and natural functions. Jeffrey Hou states that hybrid landscapes are a method of introducing ecological architecture to a given context and ensuring that it serves both the natural and built world. The hybrid landscape can “bridge the multiple dimensions of urban activities, structures and processes” and reconnect disrupted ecosystem functions determined by a process that “co-evolves urban and ecological processes” (Hou, 2006) If the urban context is understood as a complex ecosystem of systems, flows, and processes, architecture must fit into that framework and provide energy to the metabolism of that ecosystem. Hou argues that with this kind of “pluralistic” response the architecture itself will be symbiotic to all other systems within the space.

Ultimately, Urban Ecological Architecture is meant to integrate into the urban context rather than define itself within it. The ecological architectural response must interpret the human and natural systems in order to produce a spatial narrative that addresses the needs of the site and neighborhood that it serves.

As a model for sustainability, Sim Van der Ryn imagines that ecological design is the most holistic approach to integrate natural and human systems in the built environment (Van der Ryn, 2007). The fundamental understanding of ecology is becoming more important to reversing human impacts on the earth; the built environment is more suggestive of a relationship outside of nature rather than with nature, and this current model of detachment brings forth more evidence that it can not sustain itself.

Although Ecological Design at times must be very quantitative when it comes to ecology, this model proposes a more qualitative approach to design that echoes models for biophilia (Kellert, et all 2008). The intent is for Ecological Design to be beneficial to humans and nature, and to establish symbiotic relationships in every part of design.

Van der Ryn's model for Ecological Design follows five principles (Fig. 2.4):

1. Solutions Grow from Place
2. Ecological Accounting Informs Design
3. Design with Nature
4. Everyone is a Designer
5. Make Nature Visible

Solutions Grow from Place: The first principle stems from the essential task of site driven design. Ecological Design should have engagement with the environment, and a "place-centered" dependency. However, as Kellert proposes, it must also recognize ecological boundaries and utilize them as a design opportunity. Not only should site driven design be a physical factor, but it also requires participation. Locality of a place should consider the knowledge and culture, as well.

Ecological Accounting Informs Design: This principle suggests that there is not only a monetary accounting that must be considered to create social equity, but environmental accounting that measures flows, impacts and quantifiable uses. The design must be measurable because, typically, improvement of environmental conditions happen over longer periods of time. Measuring the design is important to not only reduce the overall impact, but to also study it.

Design with Nature: Although the third, this principle is the most important. To fulfill ecological design, the design should “regenerate rather than deplete”. The concept of symbiosis, again, lends itself to the relationship between humans and nature in the built environment. An Ecological Design promotes the coevolution of these systems which benefits both and can even be restorative. This principle also makes note that it is not the same as what we understand to be “biomimicry,” because rather than reflecting nature, Ecological Design becomes participatory in these processes; referred to by Van der Ryn as a symbolic dance partner. The result of designing with nature provides “active landscapes” which are self-organizing and able to consistently provide ecosystem benefits.

Everyone is a Designer: This principle highlights a qualitative approach to Ecological Design which takes into account people as a part of the systems. The design should consider the people it is for, and be humble enough to assume that everyone has something to bring to the table that can contribute and improve the design. In this way, we can “cultivate knowledge and design intelligence” among the community. Participation in the landscape is just as important as participation in the community, and there must be some level of the design creating an ecological literacy among those that it serves.

Make Nature Visible: Hand in hand with cultivating ecological literacy is the ability to make ecosystem processes visible to people to encourage the reclamation of ownership over natural resources. This principle discusses the infrastructure that society is unable to see although it is a part of our daily lives, such as the stormdrains below the street that carry polluted runoff into the waterways, or trash that is thrown away and never seen again. By using design to make all processes visible, not only are people able to participate in their material environment, but they can also “weave nature back into their daily lives” and “break down the dichotemies between cities and nature.” Sim Van der Ryn calls this “Visual Ecologies.” By bringing these processes to the forefront, we are then able to regain a sense of place within the world.

Figure 2.4. Ecological Design Framework

Figure 2.5 Seattle Waterfront Conceptual Plan, Field Operations, 2011.

precedent studies

The precedents analyzed are examples of ecological architecture in different forms. The projects analyzed are the Vancouver Convention Center by LMN Architects, and “The Right Way: Taking Back Seattle’s Right of Ways” by the Miller | Hull Partnership, and the Seattle Waterfront Proposal by James Corner Field Operations. These works embody an integration of ecological architecture with the urban environment and engage the concept of public revitalization by the means of access to nature. These three projects are specific to Northwest region and address urbanism in the lens of environmental conservation and restoration. These three projects embody the goals of this thesis project in their accomplishments in merging the dichotomies of urban and natural systems.

Figure 2.6. The Vancouver Convention Center West, LMN Architects, 2009.

The Vancouver Convention Center, West - LMN Architects

The vision of the Vancouver Convention Center was to integrate Vancouver's urban ecosystem with its downtown core (LMN Architects, 2009). The building was intended to become a living part of the city and north harbor. The site of the project is a former brownfield site and was restored by developing the convention center in time for the Vancouver Winter Olympics in 2010. The building is about 1 million gross square feet that sits on 14 acres of land and 8 acres of water at the edge of downtown Vancouver. Therefore, the design needed to address public access from the city and from the water.

The design of the convention center is a thoughtful public experience which provides access corridors to the water and embraces the street grid to form access "vectors" (LMN, 2009) that shape the building's landform and circulation.

The building's approach to ecology on its site is to provide an artificial reef which restores the natural shoreline and revives aquatic habitats. The topographic roof (Fig. 2.11) also forms a zone that is not publicly accessible, but collects rainwater and provides indigenous plantings that encourage pollinator species.

The building systems of the convention center primarily aim to conserve water and reduce energy consumption. The building uses a sea water heat pump system which reduces energy consumption by 60% and an on-site blackwater treatment system that returns water for irrigation of the green roof and produces greywater for other non-potable building uses.

The convention center also diversifies its public and private space by establishing indoor and outdoor connections that reflect the activity and life of the city while also extending views to the bay.

In this way, the Vancouver Convention Center connects the city to the marine environment in a layered approach (Fig. 2.12) that includes all aspects of design.

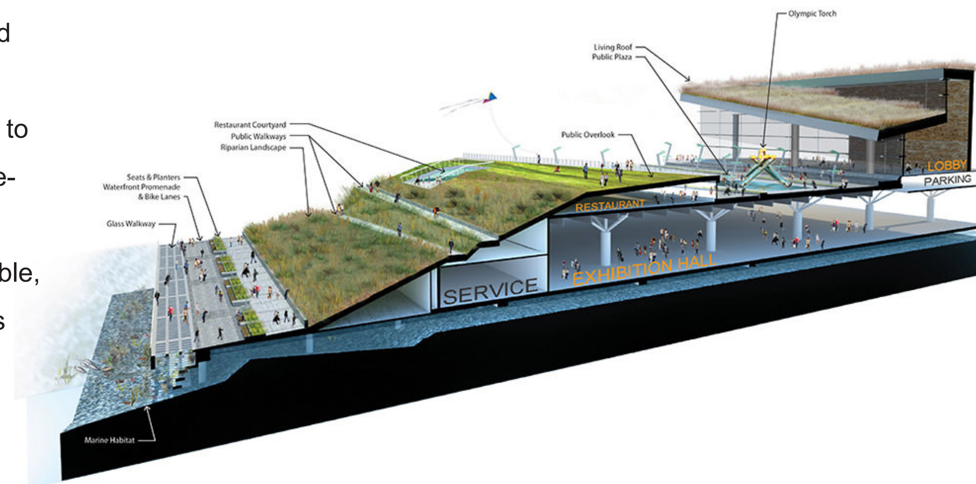


Figure 2.7. The Vancouver Convention Center West, Cross Section.

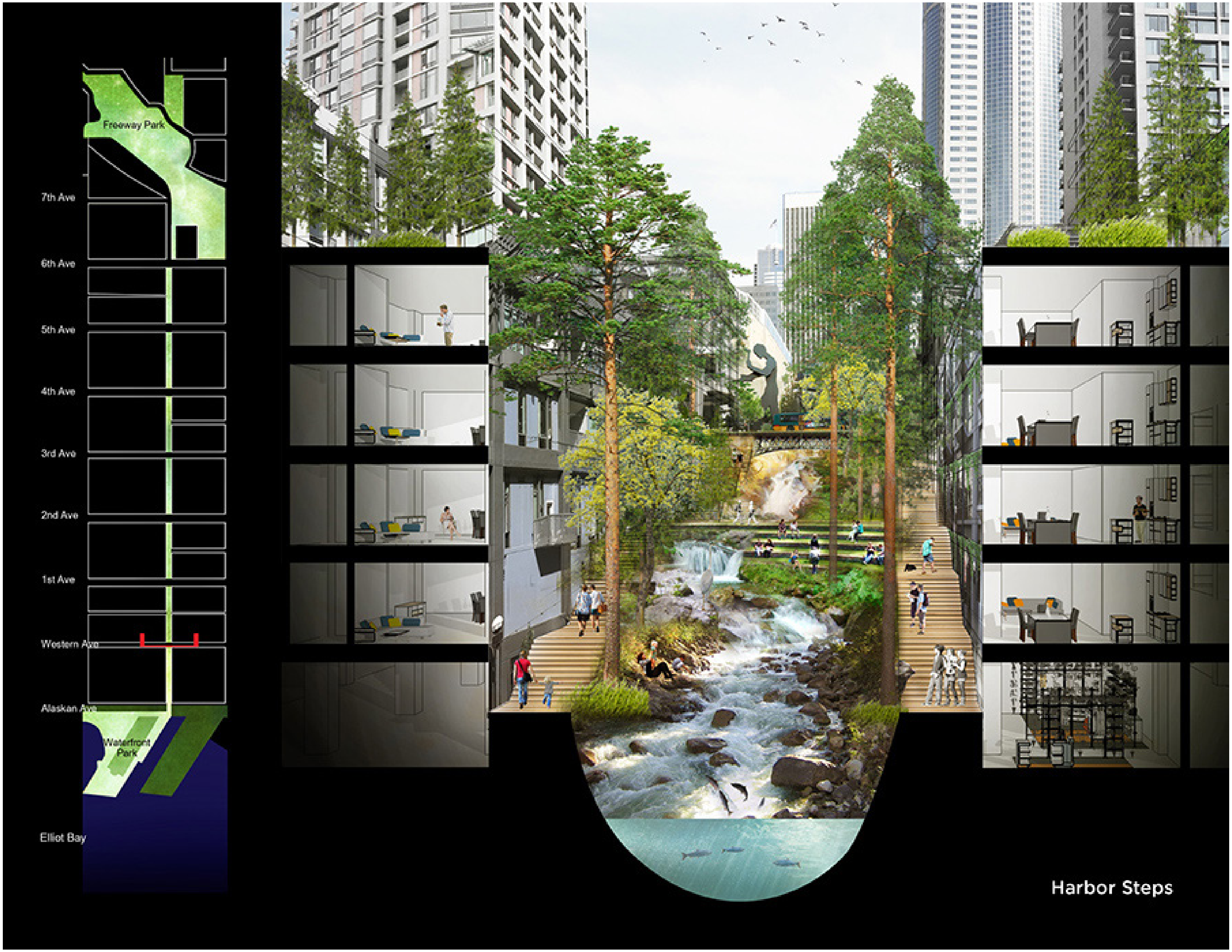


Figure 2.8. Re-envisioned Harbor Steps Park in Downtown Seattle. Miller | Hull, 2018.

“The Right Way: Taking Back Seattle’s Right of Ways” - The Miller | Hull Partnership

The proposal for this competition arose out of the changing urban landscape resulting from the Alaskan Way Viaduct demolition in downtown Seattle. The prompt for the project was to reimagine the Battery Street Tunnel as public space that better served the City of Seattle than as a traffic tunnel filled with debris from the demolition (Cole, 2018).

The approach that Miller | Hull took to reimagine this space was that of connecting the downtown ecological corridors between another bifurcating roadway (Interstate 5) and the downtown waterfront (east to west) (Fig. 2.14). This proposal removes the Battery Street Tunnel and transforms it into a ravine that connects Denny Park (north) to the waterfront (west).

The goal of this proposal was to reconnect Seattle not only to its public spaces, but to the natural environment in a way that is less artificial and more indigenous (Fig. 2.13). Each section of the project proposes a similar, but site-specific resolution that engages the needs and current conditions of the site such that it retains its character, but expresses it in a way that accepts an ecological surrounding.

The boldest intention of the project is to give natural space back to the city while performing ecosystem benefits, and challenging the way the city is planned as more human/nature-centric rather than for automobiles.

Figure 2.9. Re-envisioned Forested Streets in Downtown Seattle. Miller | Hull, 2018.

Figure 2.10. Waterfront Seattle, Field Operations, 2013.

This proposal, like the previous, arises from the opportunities presented when the Alaskan Way Viaduct in downtown Seattle is demolished. On the Seattle waterfront, the roadway's removal releases about 2 miles of downtown roadway from a 50 foot high barrier that has historically bounded the city.

The Field Operations proposal is a realistic and integrated approach that meets the needs of the city from the water to the urban grid. The design proposes large public spaces and an overlay of green space that now inhabits the void which the Viaduct left (Fig. 2.15). The design focuses on programmatic zones for place-making and distinguishable identity that reflects the urban neighborhoods and needs of all user groups, including vehicular traffic (Corner, 2013).

The sustainability approach (Fig. 2.16) for this proposal balances the aspects of an urban waterfront and the needs of the ecological communities that interact with the site. The project recognizes that the waterfront plan must not only meet the needs of the human users, but the needs of the aquatic users, as well.

Visualizations of the current Seattle seawall are refreshed to reflect a sensitivity to the sealife below and human life above. The seawall now extends itself over the edge of the water with a glass block sidewalk that allows light to penetrate the surface and filter to the water below. Below this sidewalk is a zone for salmon migration where salmon are able to feed on microorganism that favor the textured seawall and habitat shelves. On larger sections of this walkway is a permeable surface that carries fallen rainwater and runoff back to a bioswale with indigenous shoreline species and stormwater gardens that filter pollutants from this water before it returns to the city's plumbing grid.

The main feature of the proposal is the Overlook Walk that connects from Pike Place Market to Pier 64/65 (Fig. 2.17) as a large gesture that crosses a 6-lane highway and connects to the pier that is envisioned as a large public park. The Overlook to the pier proposes several public space elements such as benches and sculptures (Fig. 2.18) that draw the public through the space.

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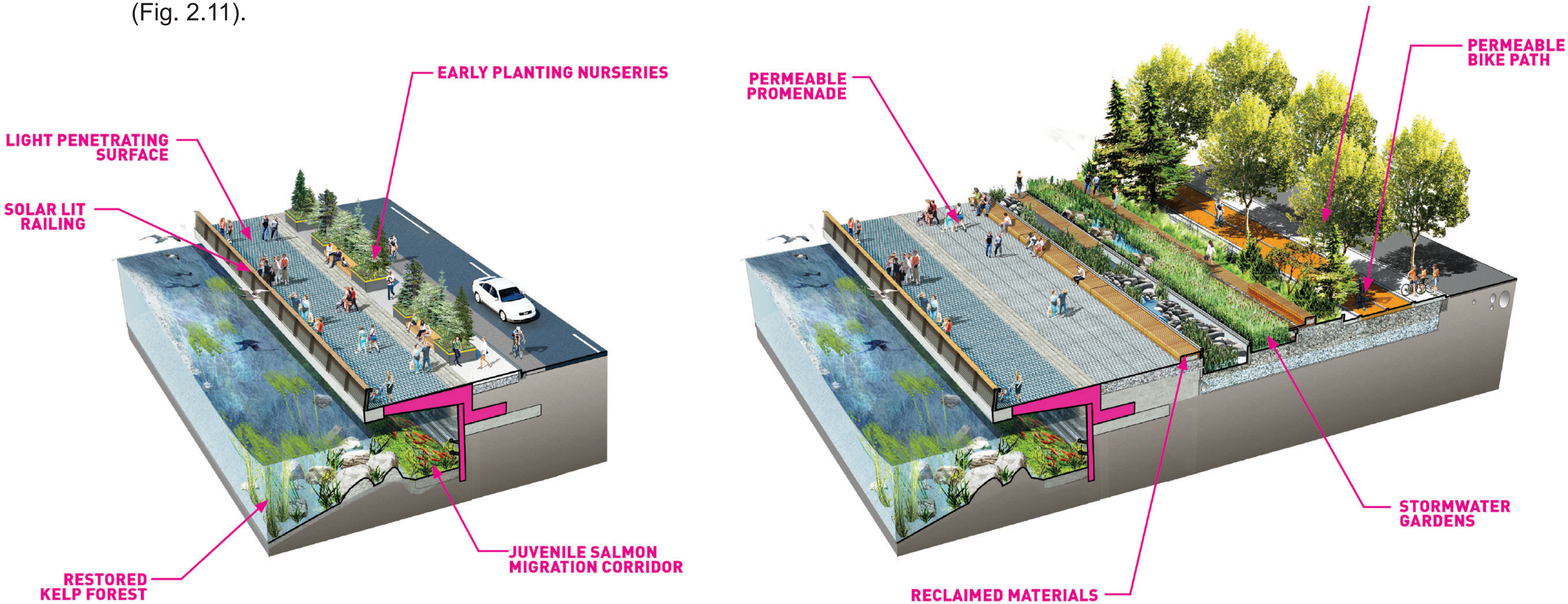

Figure 2.11. Waterfront Seattle Sustainability, Field Operations, 2013.

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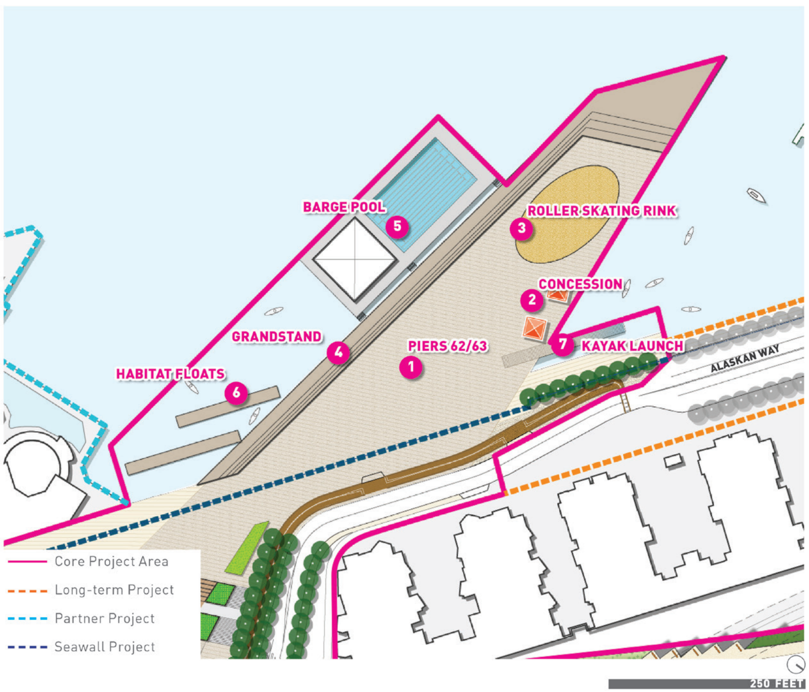


Figure 2.12. Waterfront Seattle Pier Plan, Field Operations, 2013.

VIEW OF PIER 62/63 GRANDSTAND, LOOKING WEST

Figure 2.13. Waterfront Seattle Pier Programming, Field Operations, 2013.

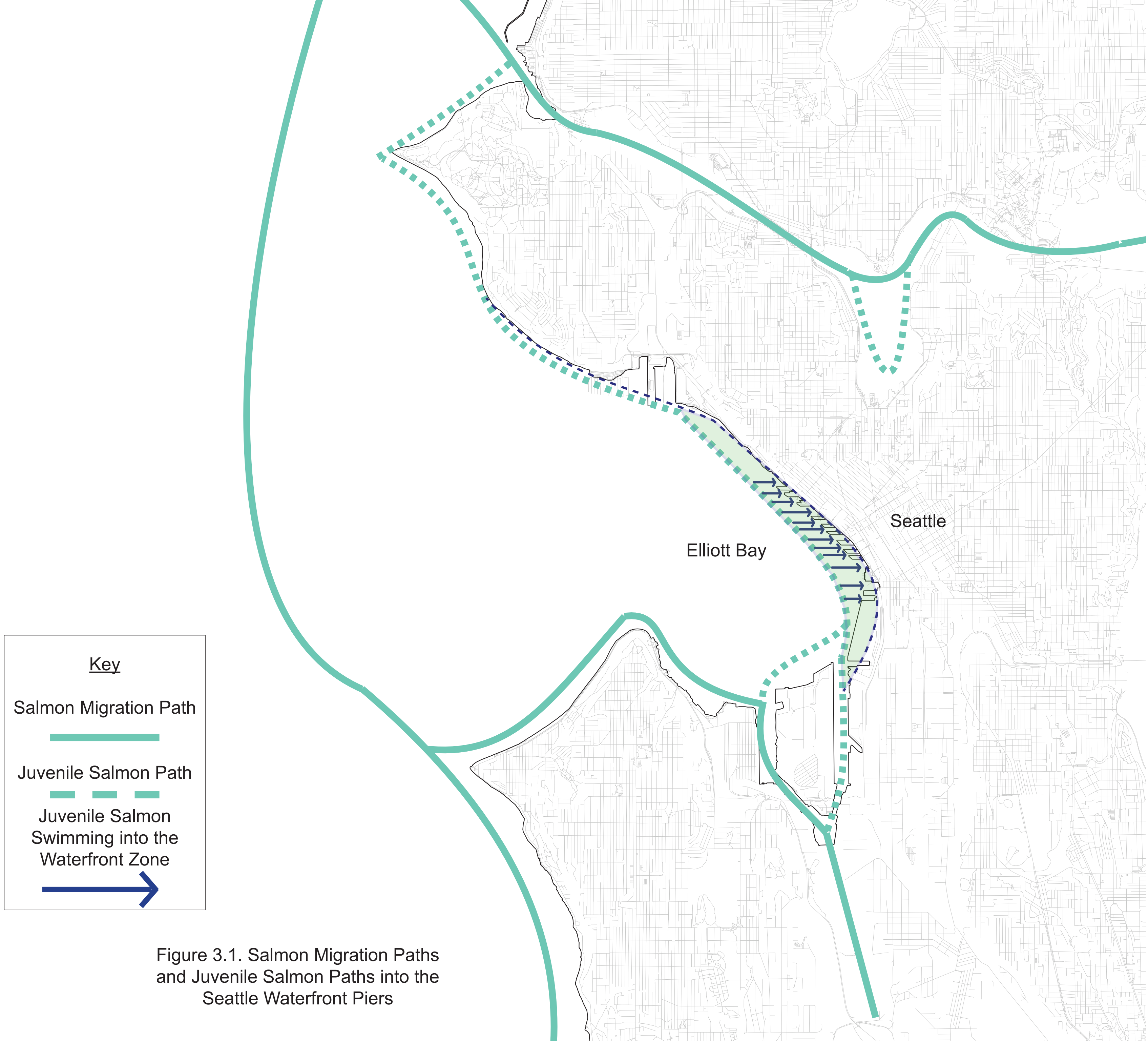


Figure 3.1. Salmon Migration Paths and Juvenile Salmon Paths into the Seattle Waterfront Piers

chapter 3 Methodology

Overview of the Chapter

By using Urban Ecological Architecture as a framework for design, this thesis will integrate architectural systems with ecological systems in the urban context of Seattle. Downtown Seattle contains a unique collection of sustainable buildings, heralded as some of the most sustainable buildings in the world. This condition calls for closer inspection of the urban and natural conditions that surround them to understand the condition of disconnection. The site analysis considers the urban context of Seattle and the natural context of Elliott Bay as two systems in tension to locate a site. The architectural design on this site reconnects these systems and architecturally creates positive impact for the urban ecosystem as a whole. The following section will investigate the city of Seattle in relation to its built (human) and natural networks to identify the most appropriate site for the project.

Most notably, of the built systems is the location and uses of sustainable buildings (Fig. 3.2). These building projects can vary in use type and size, and levels of privacy within the urban context, but are also expected to fulfill infrastructural tasks such as water catchment or energy production. Sustainable buildings overlap the human and natural systems within their architecture, but seem to primarily reflect the condition of disconnect that the city's ecological infrastructure does. The locations of sustainable buildings downtown reveal that their congregation is not typically connected to ecological infrastructure at all, but, as a building, establishes the ecological infrastructure on its own and most commonly contained to the site (Fig. 3.3). This phenomenon also implies that when establishing ecological infrastructure independently, it is not connecting back to the city's ecological infrastructure or even other sustainable buildings. Although these buildings propose a shift in values to building and designing sustainably, they cannot be seen as systematic to the greater urban context, because they do not connect on any extended level.

Natural resources such as solar and water provide energy to the city and are regenerative sources that power

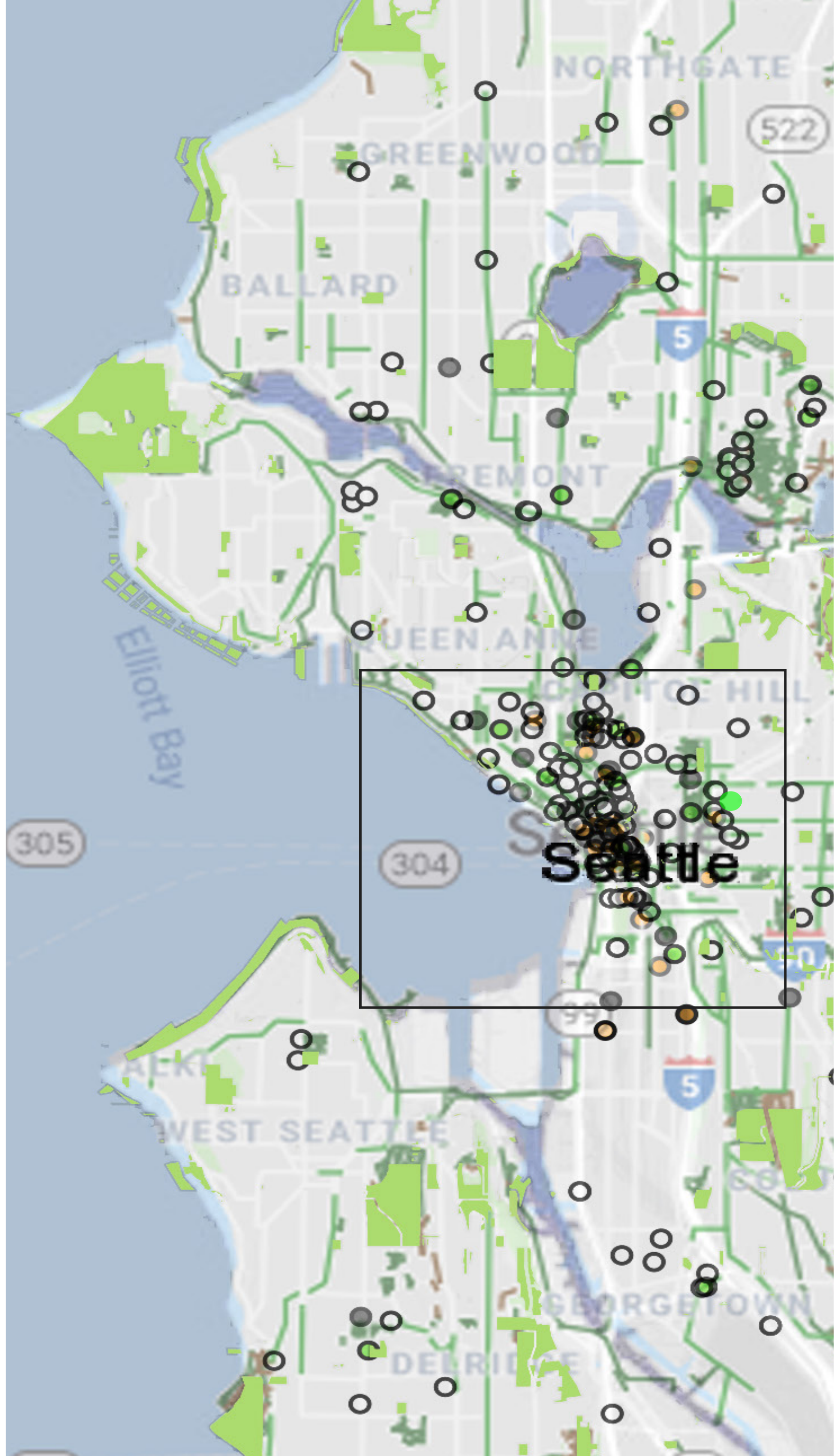


Figure 3.2. Macro Analysis of Systems in Seattle.

human activities. Seattle's electricity is primarily powered through hydroelectricity via dams and reservoirs outside of the city (U.S. Energy Information Administration, 2014). But, the city itself contains vast resources of solar and geothermal potential for energy harvesting. As shown through Google's "Project Sunroof," Seattle as a whole has high potential for solar energy harvesting through solar panels, however in the downtown area, because of tall buildings, more shade is cast on surfaces, making them less useable for solar panels (Google, 2018).

Water is another natural resources for energy generation, but overlaps systems of animal and vegetal. The downtown neighborhoods primarily interact with Elliott Bay and the Puget Sound. The Puget Sound watershed is home to several nearshore species of plants and animals (Figure 11). These species are connected to a larger complex ecosystem that includes a complex relationship to the human systems of the city. For example, salmon have a wide range of impact throughout their lifecycle, including providing nutrients for trees to grow, to larger species, and plants. It is estimated that about 135 species benefit from salmon in some way (Schindler, et all, 2003). The measurement of salmon populations is thus an important indicator of environmental health and stability.

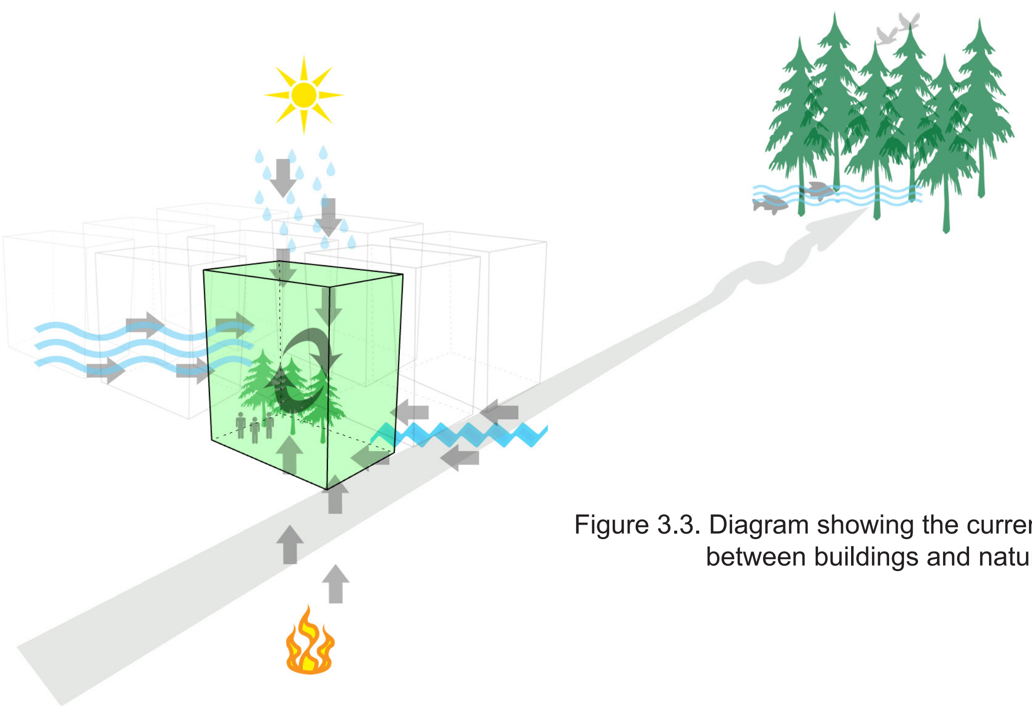


Figure 3.3. Diagram showing the current relationship between buildings and nature.

Figure 3.4. Map of the Alaskan Way Viaduct and Proposed Tunnel SR 99 Route

Salmon Perspective

Since the development of the city began circa 1850, the population of Salmon, especially in the Puget Sound, have been declining. It is expected that only 5% of original salmon population has returned to the area recently due to high impact human obstacles, such as dams (National Park Service, 2018). This effect leaves a void between migration routes (Figure 1.1) that are located at the west side of Elliott Bay and at the north mouth of the Duwamish River. Although the systems of salmon migration in the area are connected back from salt water to fresh water, the central area of the Puget Sound is widely vacated by salmon, most likely due to high boat traffic, pollutants, lack of habitat, and lack of other food sources.

Salmon, however, are a “very prolific species,” and are able to adapt relatively quickly. David Montgomery, a geomorphologist at the University of Washington notes that if a river with a clean water source became available, salmon would instinctually be attracted to the flow of the river and be able to tell that it is suitable for spawning and travel (Montgomery, 2018).

This analysis Seattle’s urban ecology informs of what disconnects in systems are opportunities for architec-

Figure 3.5 . Photo of the Alaskan Way Viaduct on Seattle's Waterfront, 1952.

-ture to intervene and reconnect them. One of the biggest disconnect occurs between Seattle's waterfront and the urban fabric, where the largest strip of land at the water's edge does not connect to the city's built systems (Fig. 3.5). This condition is largely caused by the Alaskan Way Viaduct that bifurcates the downtown condition and the waterfront area with a highway that was deemed not structurally stable after the Nisqually Earthquake in 2001 (WSDOT).

Demolition of the Viaduct is set to begin around Winter of 2018 with the replacement of the SR99 Tunnel opening in the Fall of 2018. The removal of this approximately 50 foot high structure will leave nearly two miles of expansive opportunity for revitalization. The Friends of Seattle Waterfront is an organization of professionals with who advocate for the future of the connected Seattle waterfront. This master plan imagines the waterfront primarily as a park, with few built interventions of development, to ensure the connectivity and integration of nature with the urban fabric (Friends of Seattle Waterfront). This plan inspires a variety of program types and recreational uses, and also provides a layout of intended uses that relates the site back to the neighborhood's character (Figure 2.17). Most importantly, the plan is comprehensive in that it considers the human, built and natural systems, for the new waterfront.

Because of the opportunities present when the Viaduct is fully removed, as recognized by the Friends of Waterfront Seattle Plan (Fig. 3.6) and the simultaneous connection to causes of salmon population decline, the chosen site will be on what is currently Alaskan Way between Pike Place Market and the current Aquarium (to be reconsidered), including a reinterpretation of the Overlook Walk. This site will be the most promising in the utilization of architecture to close gaps, enhance the public realm and reconnect the natural realm as if it were plugging back into the built environment.

In a proposition for the Seattle Aquarium expansion, parcels 98, 99, 100, 54 and 55 (Fig. 3.7) are in partial and full acquisition. These parcels, however, are located at a gateway point between Pike Place Market, the Pike Street Hill Climb, and the Seattle Waterfront, acting as a gateway site to a new civic landscape. This site not only offers the physical connection between city and water, but also offers a cultural and civic connection between public functions of Pike Place Market and the Waterfront.

Figure 3.6. Seattle's New Waterfront Plan, 2012.

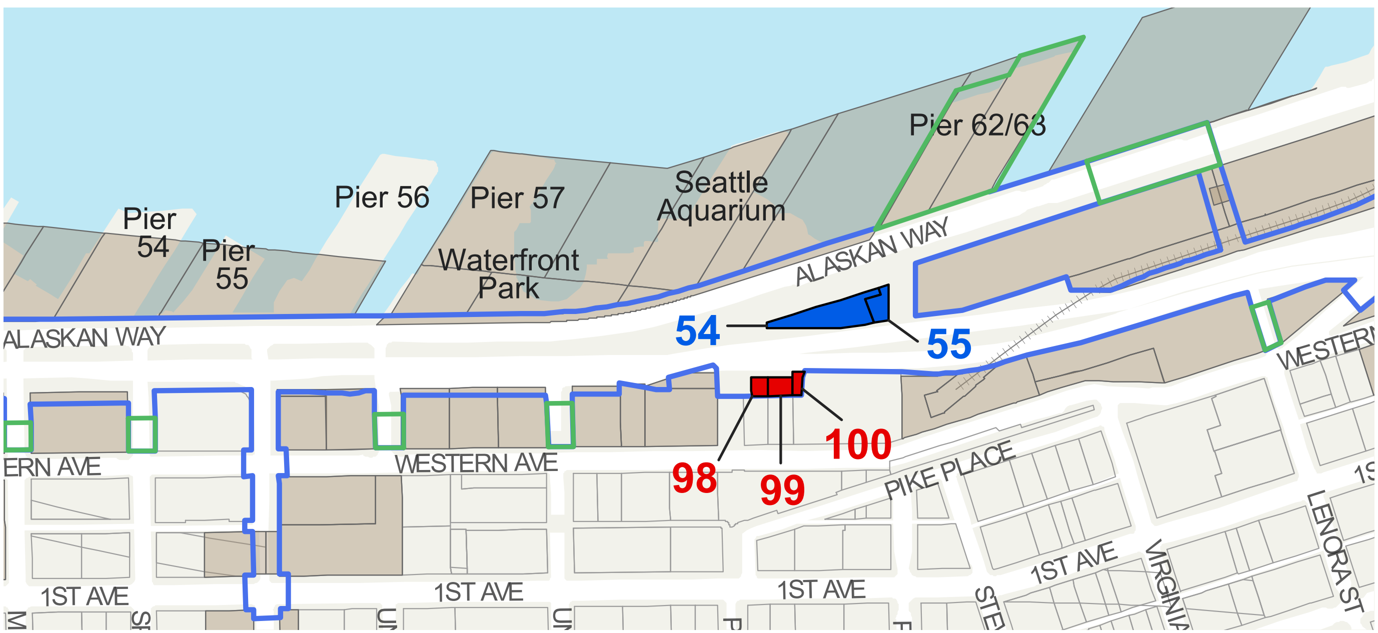


Figure 3.7. Parital and Full Acquisition Parcels on the Seattle Waterfront, 2015.

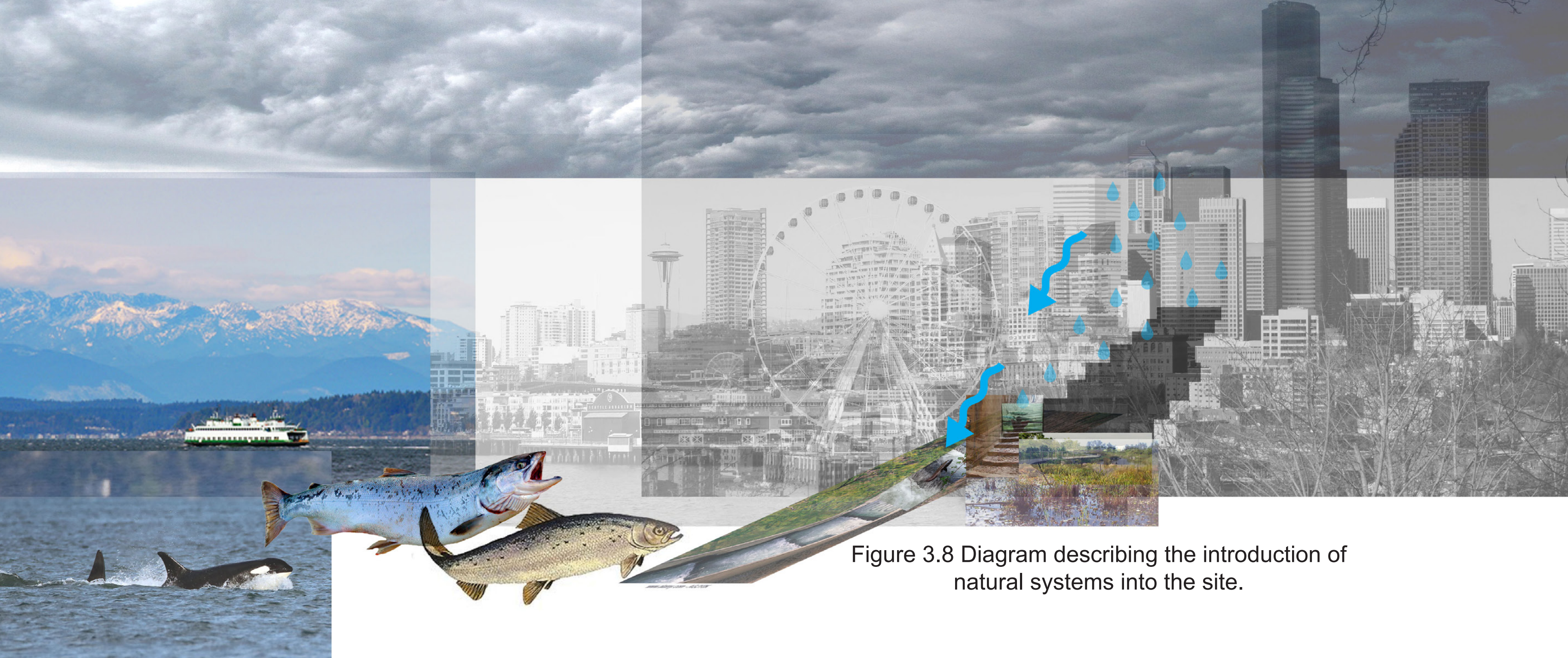


Figure 3.8 Diagram describing the introduction of natural systems into the site.

Proposed Program

The proposed program for the thesis project is a Center for Environmental Health. This space will contain scientific and education spaces that center around salmon research, habitat restoration, tribal art and cultural space. The proposed project in the downtown area is intended to reconnect the void of salmon population in Elliott Bay to the urban interface, aspiring to assist in the growth of salmon population, and reconnect natural systems with the built systems of downtown.

While there are salmon hatcheries in Issaquah and Auburn, Washington, Seattle and the greater area does not currently have an institution that monitors the health of the environment based upon salmon. This public and civic institution that monitors salmon would also have the capacity to translate the data retrieved by scientists into effective solutions to maintain the health of the ecosystem. This would include information such as the effect of salmon decline on forest health and tree population, or the impact of pollution on salmon mirgration behavior.

The human systems of the intervention will house educational, scientific, and cultural spaces that connect to social institutions important to the community such as

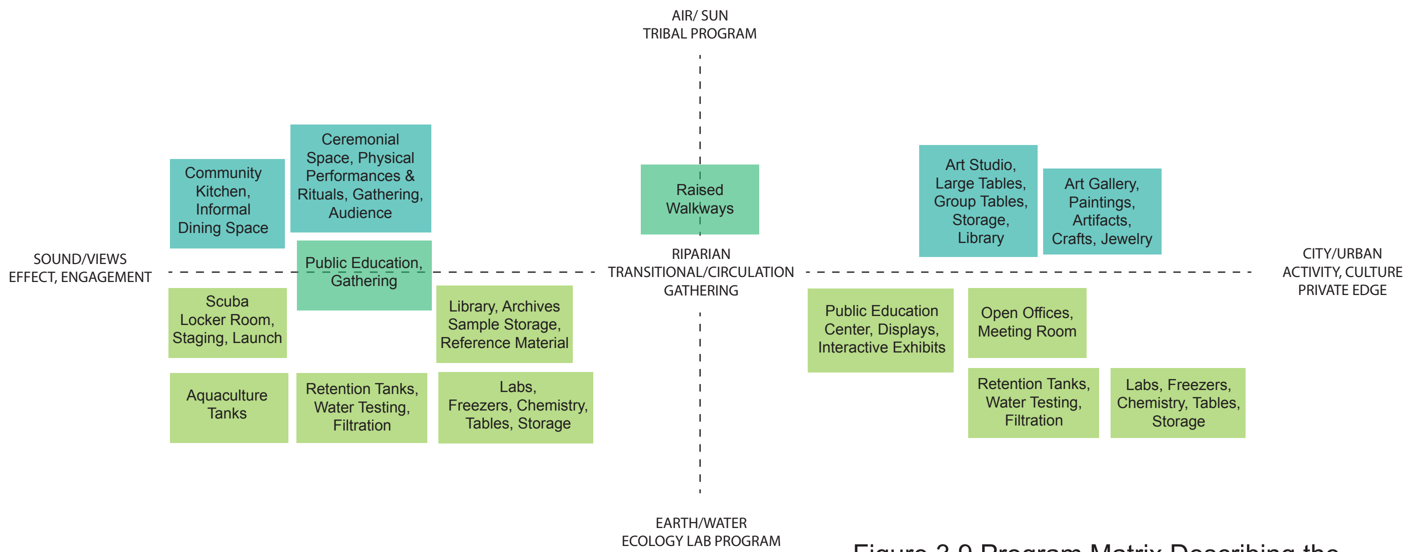


Figure 3.9 Program Matrix Describing the Arrangement of Programmatic Elements.

the visibility and understanding of wild salmon, reverence to their habitat, behavior and migration, and where they can contribute to aquaponic farming. The natural systems in the site will integrate with the human systems as though they weave through the spaces. Natural systems include rainwater catchment and filtration through the green roof with native plants that supplies water to experimentation tanks, an aquaponic farm, and a hydroponic farm. Plant life within the building will both integrate a small urban hydroponic farm with plant life that is available on the site.

The proposed Center for Environmental Health will support monitoring and education of the urban ecosystem of Seattle. By examining the urban context from a large scale to a small scale, we can better understand the macrocosm and microcosm of urban ecology and the effects that a single architectural intervention can have on the improvement of the whole system. In this way, this sustainable project seeks to show how the convergence of social and scientific program can merge with natural systems and be engaging through architecture.

Figure 4.1 Project & Site Aerial Rendering

chapter 4 Design

Project Overview

The Center for Environmental Health aims to merge the dichotomies of urban human-made systems with those of the natural environment. The setting in which the architecture is situated in downtown Seattle creates a unique opportunity to reimagine the context at a larger scale, and weave the architecture within it. The layers of the urban environment cascade toward Seattle's civic waterfront, but are currently blocked by the Alaskan Way Viaduct. In 2019, when the Viaduct is demolished, its scar meets the urban grain and the opportunity arises to explore the position of stitching them together.

The project proposes both a contextual reinterpretation and an architectural response to the new context to explore the inherent connections between urban and ecological systems. The Center for Environmental Health becomes both a Tribal Cultural Center to use for art, ceremony, gathering, and cooking. This program takes place on the second floor of the building and establishes its urban and cultural connection with the city; opening its doors to the public to engage on the level of cultural understanding the reverence to nature and the water. The first floor is an Ecological Science Laboratory which connects to the ground and water physically, and to the landing point of the Pike Street Hill Climb. This part of the program is also open to the public and generates access to information, public education, visualizing environmental issues, and engaging with the solutions to them.

The site which the Viaduct is removed from transforms with an ecological lens. In place of the Viaduct is a proposed constructed wetland, a Marine Riparian Zone, infilled with native phytoremediators for urban runoff. The Marine Riparian Zone acts as a large-scale filter that absorbs pollutants from the runoff and allows clean water to return to the atmosphere and ground. This zone also sequesters carbon and encourages biodiversity that partially relinks ecological zones in the region.

Figure 4.2 Site & Context Re-envisionment

Re-envisioned Context

In Elliott Bay, juvenile salmon (fry) that are physically preparing themselves to adapt to salt water, and adult salmon returning to the fresh water of the Duwamish River (south) are afflicted by the built conditions imposed on their environment. Currently, ocean acidification, overwater structures and shoreline armoring are the most interfering conditions to the smolting salmon. Respectively, pollution from urban runoff adds to ocean acidification and reduces the population of microorganisms that juvenile salmon feed on, overwater structures cast dark shadows that allow their predators to go unseen while their eyes adjust to the darkness (Munsch, 2017); the seawall creates artificial and inappropriate depths for juvenile salmon to feed in while their food source would be found in much shallower waters.

To mitigate the causes of salmon population decline, the solutions must be more far reaching than editing the shoreline. The proposal for an ecological and holistic response to waterfront redevelopment when the Alaskan Way Viaduct is demolished is dedicated to restoring salmon population in the most appropriate way possible and re-envisioning how the urban waterfront merges with the natural environment to form a symbiotic relationship rather than a separate and parasitic dichotomy.

Figure 4.3 Site Topographic & Bathymetric Plan with Project Placement.

Four major changes must take place to enact this ecological mitigation of the downtown waterfront. The first is to infill the shoreline at the water's edge to develop softer slopes and appropriate shallow water for juvenile salmon to adjust to light levels and to find the appropriate microorganisms who thrive in the shallows. The second is to remove all non-essential piers. Historically, the piers at the Seattle waterfront have been used for maritime and industrial purposes such as logging and exports. Now, these piers and overwater structures are used for retail and attractions, restaurants, and privatized boating. The removal of these piers will not displace the thriving retail and culinary experience in Seattle in the downtown neighborhood, nor would it disrupt the ability for boat traffic to reach this region as there are both cruise ship and ferry terminals provided in the Interbay area, Colman Dock, and marinas such as Shilshole Bay. The piers that I have chosen to remain are Colman Dock, which is home to the Bainbridge Island and Bremerton Ferries. This pier is essential to public transportation between the Kitsap Peninsula and Islands and downtown. The sole other pier that will remain is the pier that supports the Edgewater Hotel, which is a historic building and symbolizes Seattle's maritime culture. The removal of the piers will reduce the amount of shaded water and allow more sunlight to

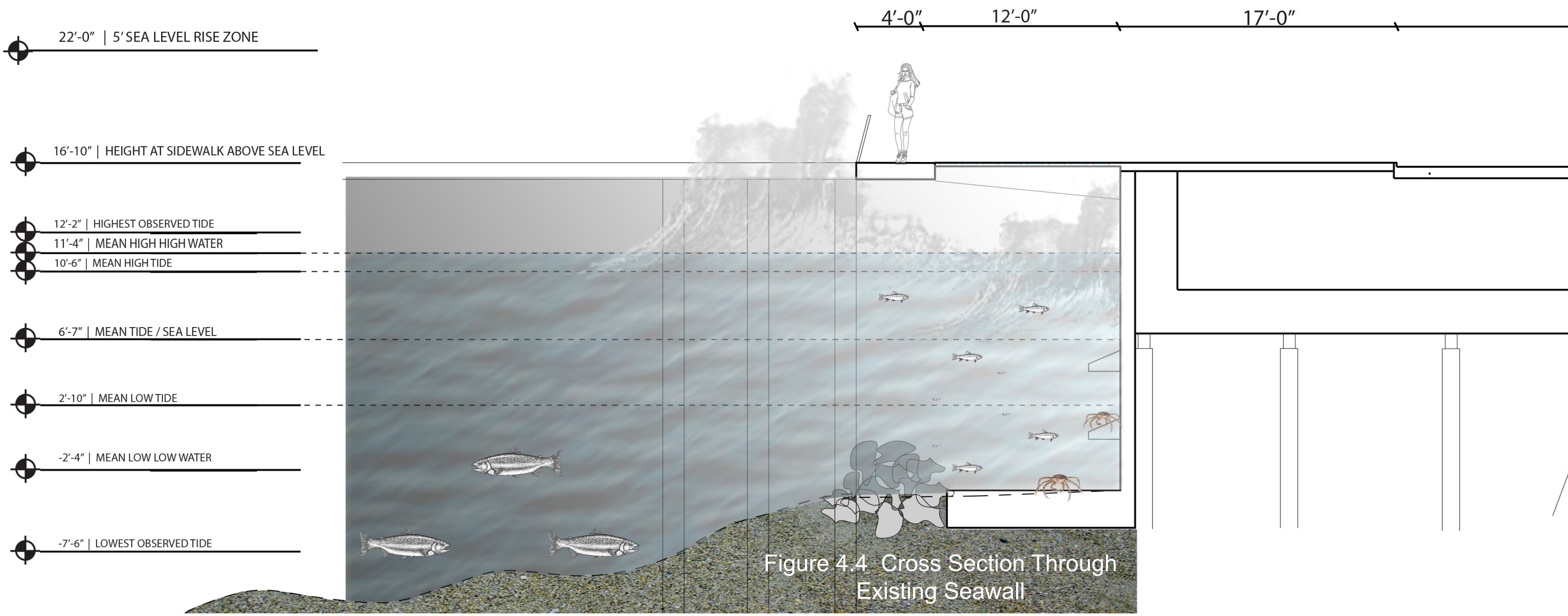


Figure 4.4 Cross Section Through Existing Seawall

penetrate the surface. This will allow more eelgrass to grow, more oxygen to be produced for underwater species to breathe, more places to generate microorganisms as primary food sources, and more pollutants from the water to be sequestered in the plants biomass. This additional sunlight will also help the salmon's young eyes to adjust to the lighting levels more quickly to avoid getting lost and for the ability to locate food sources in more appropriate waters. The third change is to infill and reduce the current seawall condition. Softening the slope of the water in combination with removing the piers guarantees much lower wave energy swelling to the shore and upland, natural tidal energy with less dramatic surges, a comfortable and more familiar landscape for fauna, and an embedded structure failsafe. The fourth change that must occur is the addition of the Marine Riparian Zone between water's edge and the urban environment. The Marine Riparian Zone serves several purposes for both the shoreline and upland zone. A Riparian Zone, as mentioned, is where vegetation grows that can live both partially on land and in water (Fleenor & Gaines, 2017). In the marine version of this zone, plantings are able to adapt to a mixture of fresh and salt water and filter accordingly. The addition of this landscape is imperative to the filtration of the water from the urban environment. Because impermeable surfaces shed polluted water

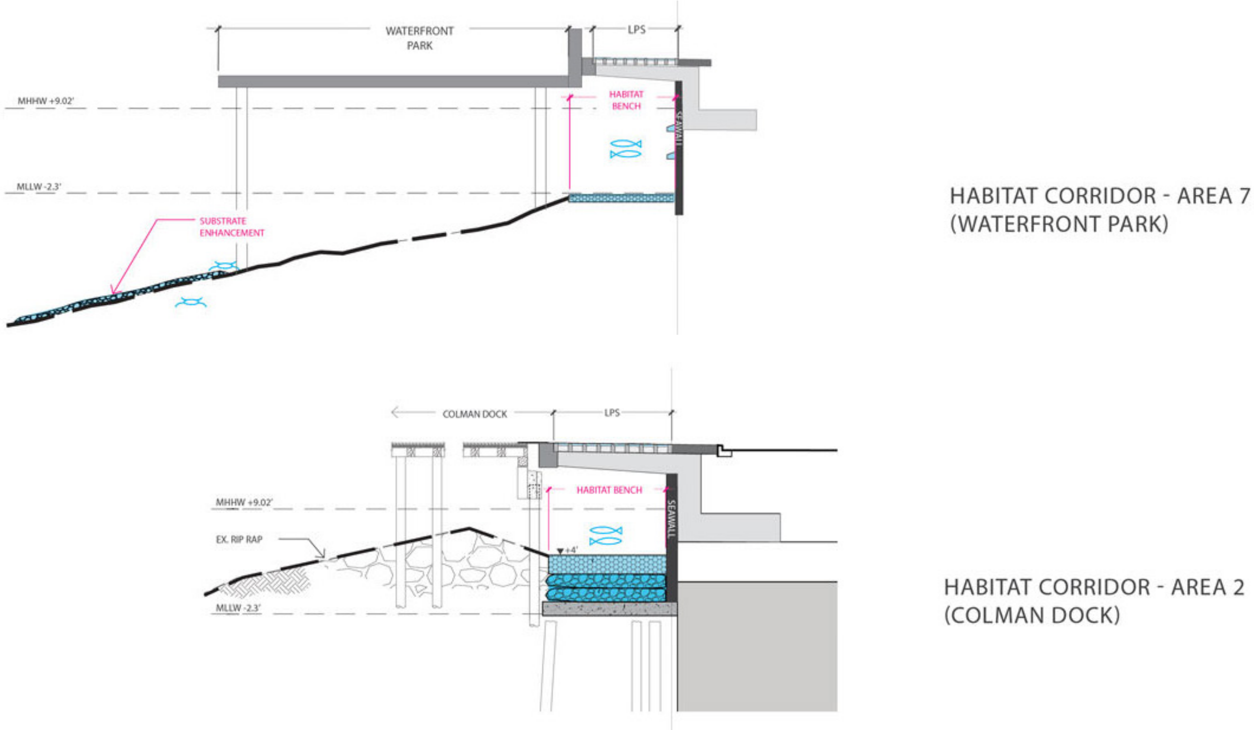


Figure 4.5 Cross Sections Through Proposed Seawall

down the steep topography of Seattle, the Marine Riparian Zone is able to capture this water along the stretch of the waterfront and filter it in a relatively short period of time before it reaches Elliott Bay. This application serves to limit or stop the source of pollution before it crosses the ecological boundary of the shoreline so that shoreline mitigation strategies will be more effective. The plantings in this zone are native species to the Puget Sound area such as wheatgrass, violets, willow trees, and maple trees. These species are natural phytoremediators* that are able to filter pollutants through the uptake of water through their root systems. These species are able to hold pollutants such as chemicals, oils, and metals in their biomass, all of which are found in urban runoff that mixes with storm water.

*Phytoremediation: The process of using plants for the removal or containment of pollutants in the soil or water. (Merriam-Webster)

Figure 4.6 Site Photograph, Between the Alaskan Way Viaduct and the Fix/Madore Buildings

Figure 4.7 Site Photograph, Between the Alaskan Way Viaduct and the Seattle Aquarium.

Current Site Conditions

The site in which the architecture lands is both a gateway and a transition from the waterfront to the urban realm. Currently, the site is defined by the boundary of the existing Alaskan Way Viaduct. The space is divided into three zones: east, under, and west. The zone east of the viaduct (Fig. 4.6) is residual space that allows residents of The Fix lofts to park, and pedestrians to access two small retail storefronts. The space is consistently in the shadow of the roadway. The zone under the Viaduct is a threshold to the waterfront. Pedestrians move through it via the Pike Street Hill Climb, several may find parking, and the city's homeless seek refuge underneath it. This zone is characterized as a threshold because of the massive overhead condition it creates and perpendicular pathways that cross underneath it. It is as if it is a doorway to the waterfront. The west zone (Fig. 4.7) is the civic waterfront which releases itself from the boundary and creates connections between sky and water. The waterfront is a much more active space, both pedestrian and vehicular. At this site, there is a triangularly-shaped parking lot, a small "professional building", and direct access to the Seattle Aquarium. At the pedestrian level, views to the city become obscured in this zone--blocked by the Viaduct, and pedestrian pathways such as the Elliott Bay Trail are less accessible due to the construction and re-routing of traffic on Alaskan Way through this area.

The alterations to the context are evident in several prominent locations other than the location of the Center for Environmental Health. The waterfront is a civic landscape for humans to access nature from the city and thus the extension of pedestrian access must continue from the urban grid to the shoreline in a way that prevents the disruption of wetland functions and enhances the connection to nature and the city for Seattleites. Two major areas of study are where the effects of overwater structure and urban landscape are the most detrimental to salmon habitat: the Cruise Ship Terminal in the Belltown neighborhood north of the site, and at Pier 48 in the Pioneer Square neighborhood south of the site. These two sites were chosen to exhibit the strongest contrast between the interference of human activity on the shoreline to the reimagined symbiotic relationship between humans and nature.

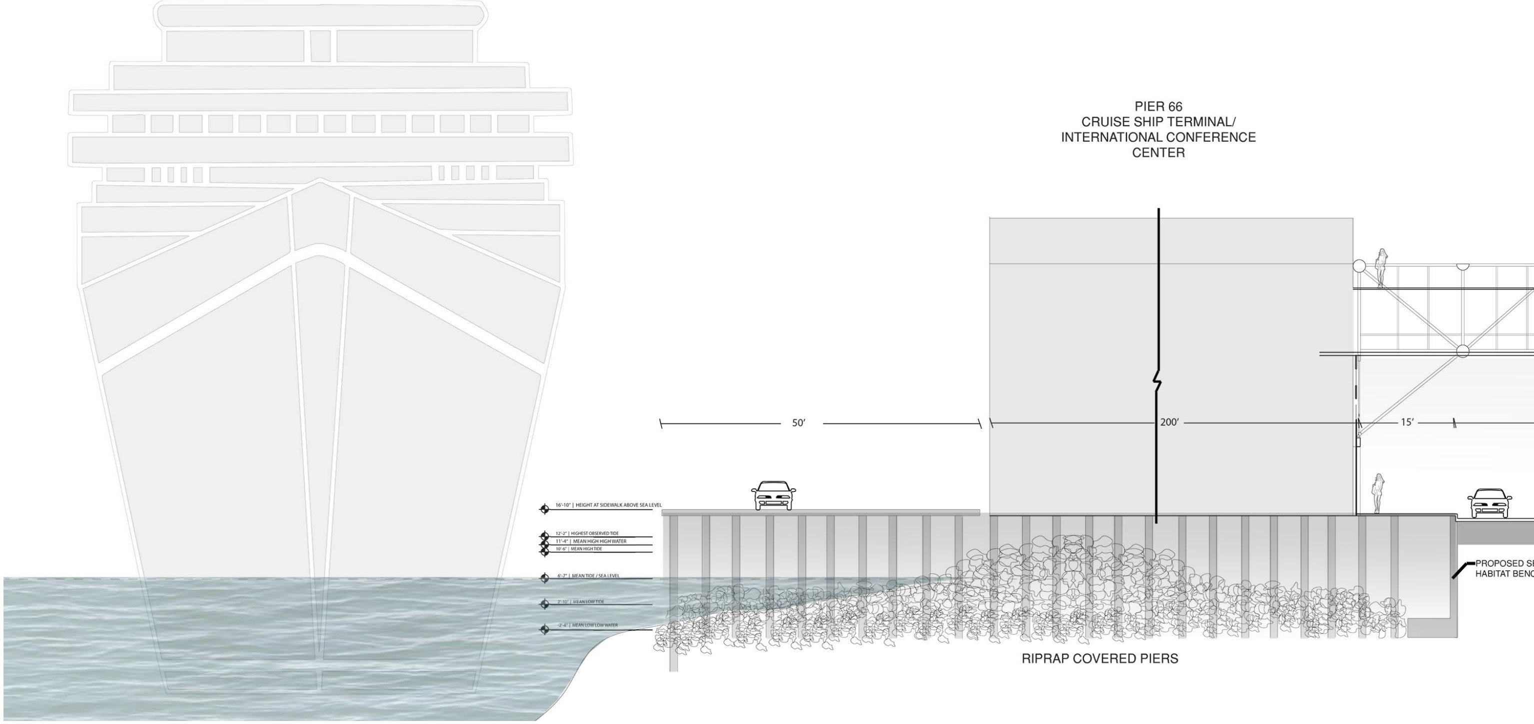
Before & After: Belltown Cruise Ship Terminal

At the Cruise Ship Terminal, the condition from east to west connects visitors to the city to a large scale mode of transportation. The Bell Street Bridge (Fig. 2.8) assists people in crossing the steep landscape, train tracks, and Alaskan Way overhead. The bridge connects to the upper floor of the terminal. At the street level (Fig 2.8), the cruise ship terminal creates a large walled zone that blocks views to the water; and additionally creates congestion with a pick-up zone for tour busses that transport tourists. The pedestrian and vehicular experience ized by density and contraction, where the edges of the overhead bridge and walled building seem to confine the space and limit civic engagement in a historic, residential neighborhood. The cruise ship arriving to the terminal over the water creates high wake and water displacement in this zone (Fig 4.10). Not yet fortified by the concrete seawall, the overwater structure raises itself much higher to allow for the transport of passengers on and off the ship. However, underwater, the disruption of the ship's arrival makes a difficult landscape for salmon and many other creatures that dwell in the bay. Erosion caused by swiftly moving water also makes underwater vegetation difficult to grow there, leaving this area destitute of habitability.

To adapt this area as an ecological zone, a similar approach to the site was taken (4.11). The removal of the cruise ship terminal and narrowing of Alaskan Way gives preference to pedestrian activity and opens the area to expand the space. The shoreline habitat is infilled and sloped to provide appropriate depths for juvenile salmon, eelgrass, and microorganisms to thrive. The vegetation of the Marine Riparian Zone also extends toward the shoreline to establish root structure that prevents erosion from wave energy now reaching the edge of the city. The Bell Street Bridge remains intact and extends slightly to connect pedestrians from Belltown to the waterfront. Visitors may access on foot via the stairway or elevator. Traffic on Alaskan Way is no longer intended to allow through-traffic, and narrows for vehicular access to waterfront buildings that are not connected to the city's grid.

Figure 4.8 Photo of the Bell Street Bridge seen from the Alaskan Way.

Figure 4.9 Photo of the Bell Street Bridge from the top of the bridge.


PIER 66
CRUISE SHIP TERMINAL/
INTERNATIONAL CONFERENCE
CENTER
50'
200'
15'
16'-10" | HEIGHT AT SIDEWALK ABOVE SEA LEVEL
12'-2" | HIGHEST OBSERVED TIDE
11'-4" | MEAN HIGH HIGH WATER
10'-6" | MEAN HIGH TIDE
6'-7" | MEAN TIDE / SEA LEVEL
2'-10" | MEAN LOW TIDE
-2'-4" | MEAN LOW LOW WATER
RIPRAP COVERED PIERS


1':20 SLOPE
100'
16'-10" | HEIGHT AT SIDEWALK ABOVE SEA LEVEL
12'-2" | HIGHEST OBSERVED TIDE
11'-4" | MEAN HIGH HIGH WATER
10'-6" | MEAN HIGH TIDE
6'-7" | MEAN TIDE / SEA LEVEL
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-2'-4" | MEAN LOW LOW WATER

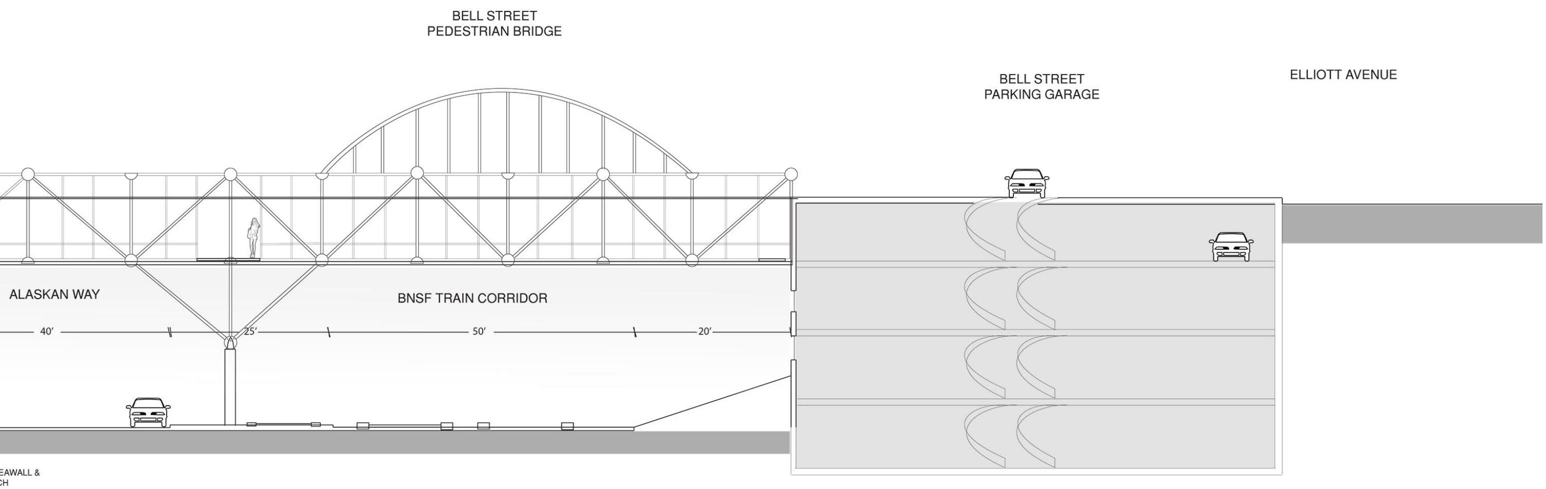


Figure 4.10 Cross Section between Elliott Avenue and the Cruise Ship Terminal in Belltown, Before Context Changes Are Made.

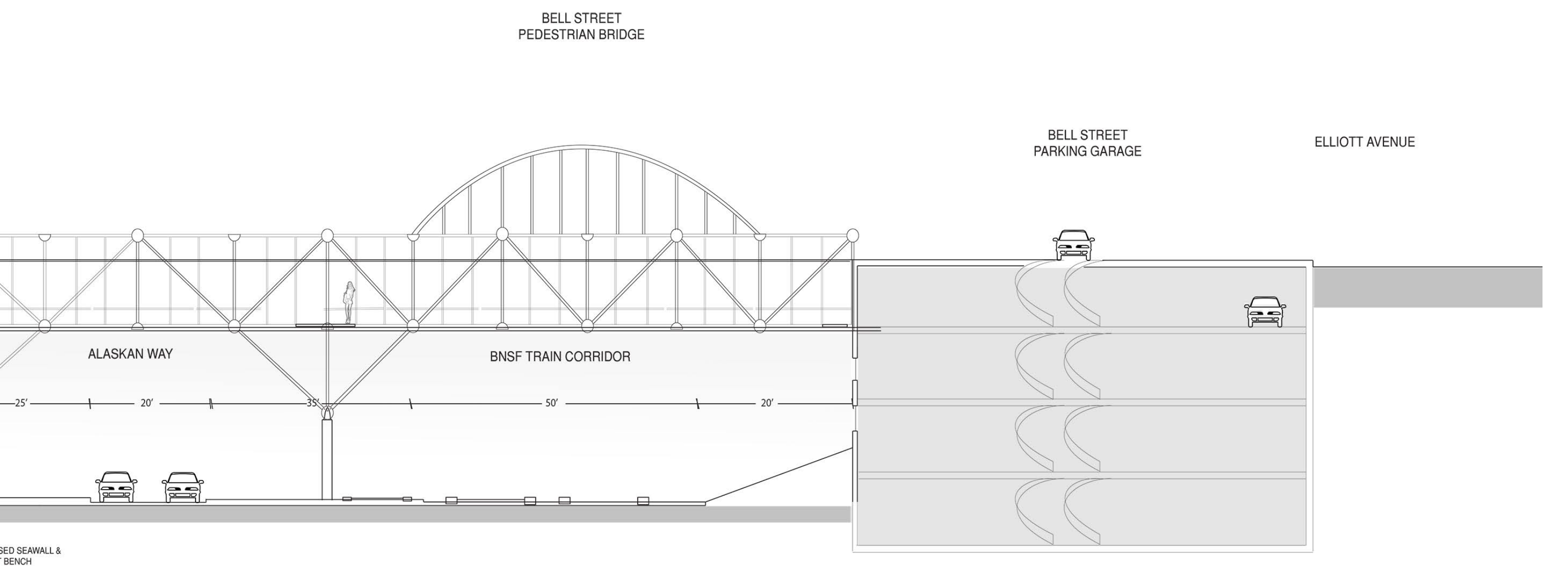


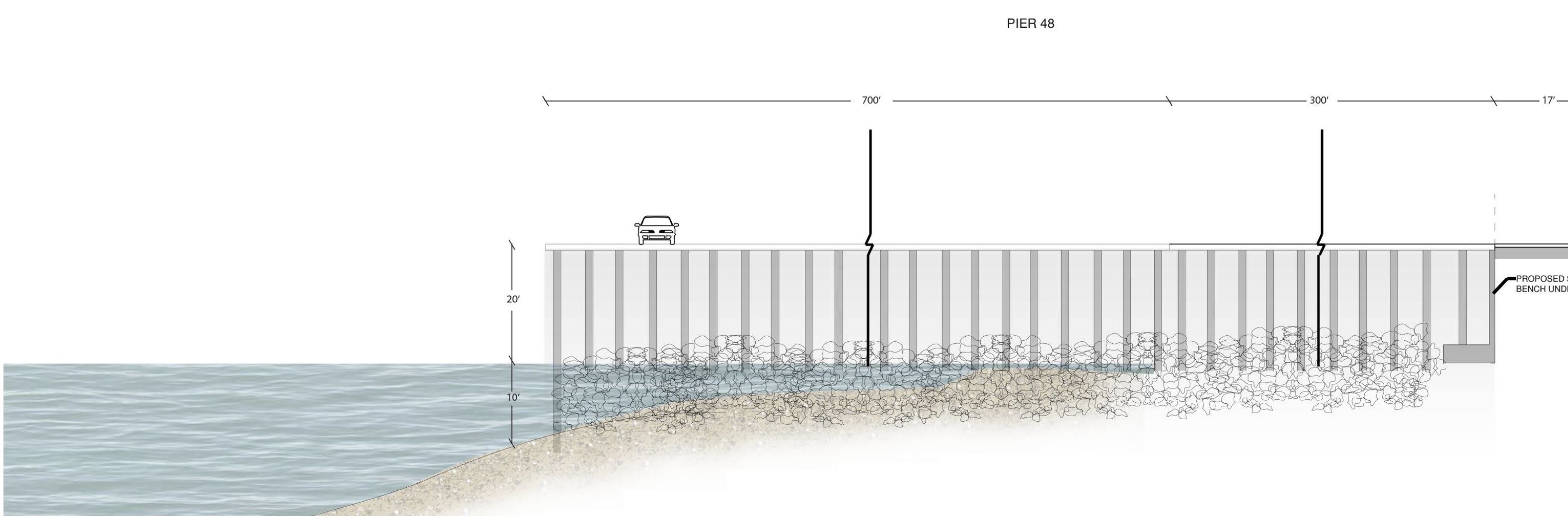
Figure 4.11 Cross Section between Elliott Avenue and the Cruise Ship Terminal in Belltown, After Context Changes Are Made.

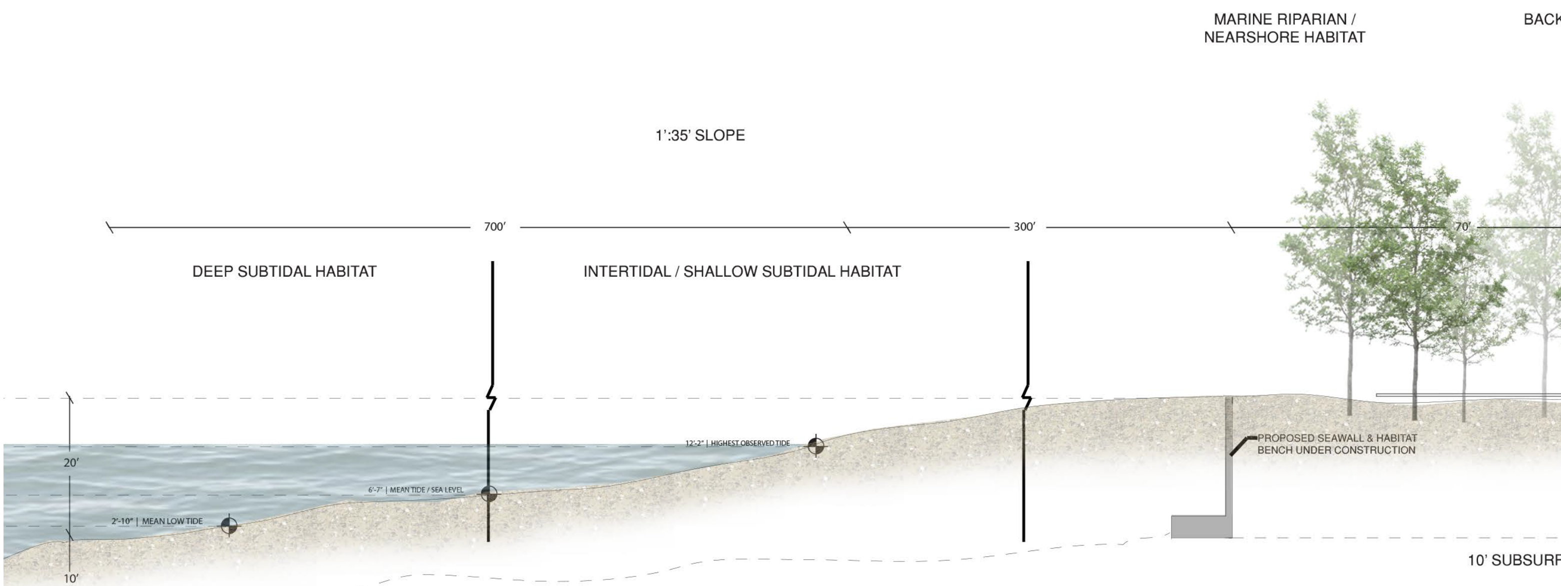
Before & After: Pier 48

Pier 48 is the largest pier on the waterfront and is currently in a state of disrepair. The pier used to support warehouses and maritime shipping industry, however with the addition of Harbor Island and expansion of the Industrial District, Pier 48 had fallen into disuse (Fig 4.12). The existence of this pier blocks an important connection to the Pioneer Square Historic District from the waterfront and covers over 800 lineal feet of surface area of nearshore water. This area, similarly to the site, is bounded by the Viaduct and disrupts continuity between the city and the civic waterfront. Historic buildings at the edge of Pioneer Square are masked by the roadway and seen in selective windows provided by the layering of traffic above and below.

The removal of the Viaduct will unlock this area and allow for it to be celebrated as a vital connection to Seattle's community, as well as reconnecting a larger portion of the shoreline environment to the Marine Riparian Zone (Fig 4.14). As with the Belltown transect, the removal of Pier 48 and filling of the shoreline bathymetry will create an appropriate landscape for salmon, eelgrass, and microorganisms. Because of the proximity to Coleman Dock, aquatic species may now seek refuge adjacent to frequent ferry traffic without disruption of their habitat. The Marine Riparian Zone will extend to this southern location and also develop root structure to prevent erosion while allowing access to the ferry terminal at Coleman Dock. While this landscape begins to dissolve, the connection to Pioneer Square serves as an instance where past and future can coexist. At the end of Main Street and Washington Street, the Marine Riparian Zone connects to the pedestrian experience from Occidental Square. The civic space in this park traverses down to the waterfront and establishes a relationship and pedestrian connection to the new waterfront from the landmarked location.

Figure 4.12 Photograph of partial Pier 48 and the Alaskan Way Viaduct near Occidental Square.


PIER 48
700'
300'
17'
20'
10'


MARINE RIPARIAN /
NEARSHORE HABITAT
1':35' SLOPE
700'
300'
70'
DEEP SUBTIDAL HABITAT
INTERTIDAL / SHALLOW SUBTIDAL HABITAT
12'-2" | HIGHEST OBSERVED TIDE
6'-7" | MEAN TIDE / SEA LEVEL
2'-10" | MEAN LOW TIDE
20'
10'
PROPOSED SEAWALL & HABITAT
BENCH UNDER CONSTRUCTION

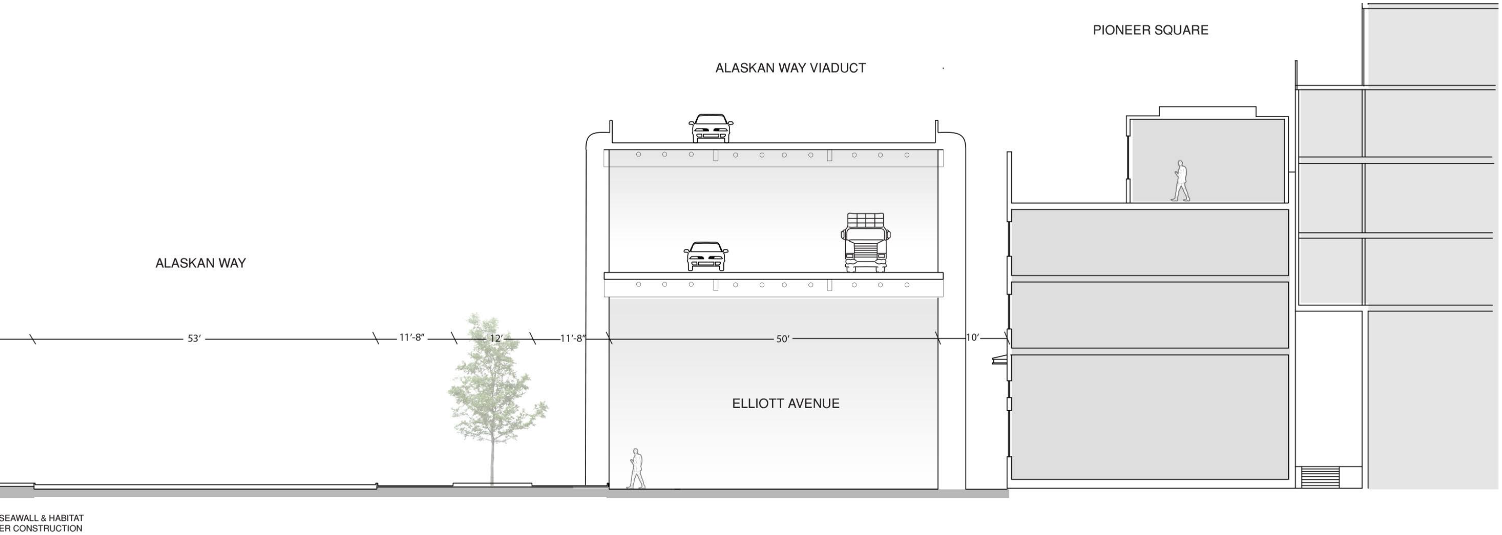


Figure 4.13 Cross Section between South Main Street and Pier 48 in Pioneer Square, Seattle, Before Context Changes.

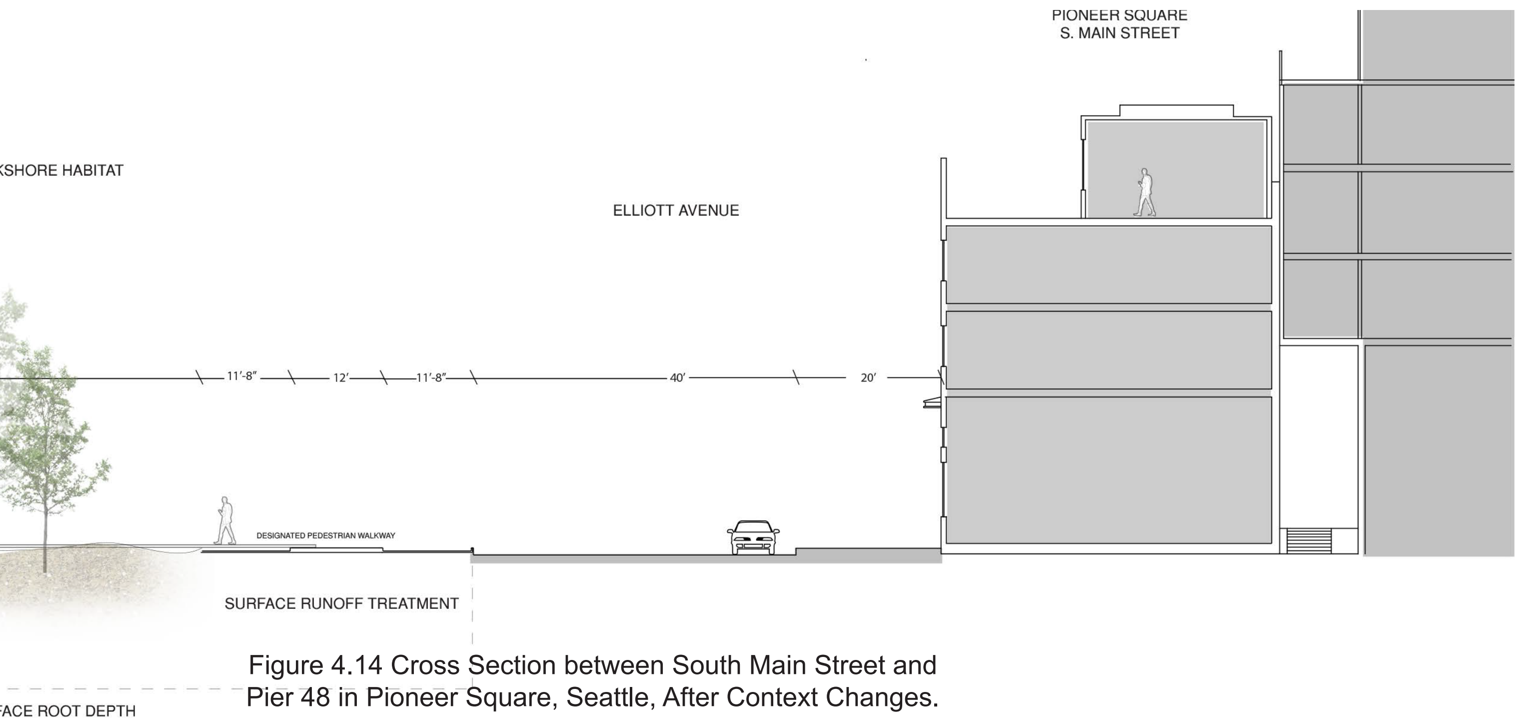


Figure 4.14 Cross Section between South Main Street and Pier 48 in Pioneer Square, Seattle, After Context Changes.

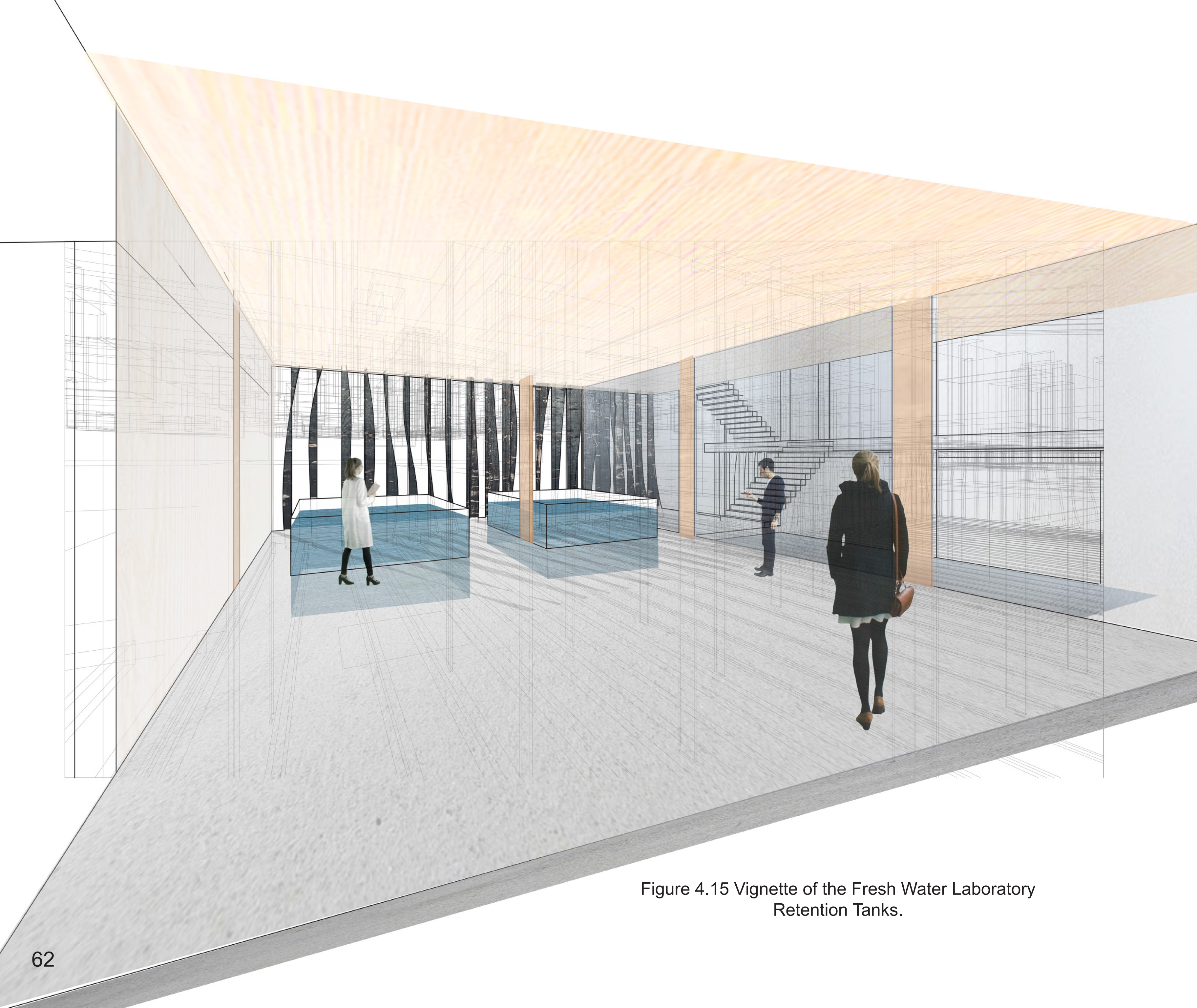


Figure 4.15 Vignette of the Fresh Water Laboratory Retention Tanks.

Proposed Program

The Center for Environmental Health proposes two programs of two typologies, respectively: a Tribal Cultural Center and an Ecological Sciences Laboratory, that apply to a Fresh Water and Salt Water category (Fig. 3.9).

The Fresh Water Building is located on the east side of the site, and develops the closest relationship with the urban environment. This building has two primary entryways: one on the ground floor that follows the Pike Street Hill Climb, and one on the second floor that follows the Pike Place Market Expansion overlook. On the ground floor is the fresh water Ecological Science Laboratory. This floor has an archive/library which houses records, references and samples needed to conduct scientific analysis of water quality; a freshwater testing room with small scale tanks that retains water for testing of various measures that indicate water quality; a public education and viewing space for visitors to engage with scientists about the effect of pollution and urban runoff on the storm water entering Elliott Bay; and an open laboratory for chemistry with storage for safely retaining experiments. Because this building is testing fresh water, a small hydroponic garden lab is able to support itself and test the viability of water purification through the means of urban agriculture. The upper floor of the building gives space for tribal arts and craftwork. As visitors and artists enter through the Pike Place Expansion connection on the north side of the building, a gallery is open to the public as a space to display and sell artwork created by tribespeople of the region.

The space serves as a mixing space where conversations can be generated about the recognition and importance of tribal culture to the culture of Seattle as a whole. After passing through this space, visitors can choose to circulate downstairs to the Ecological Labs, or across either one of two bridges that connect them to a Tribal Ceremonial and Gathering space. Artists will continue to circulate to the south end of the building to access a large art studio that contains large-project tables, storage, individual work spaces, and an archive/library to retain records, research and to store artworks. The green roof above is angled down toward the west to open a clerestory for eastern light and to shed fresh rainwater through the plantings and down to the Marine Riparian Zone.

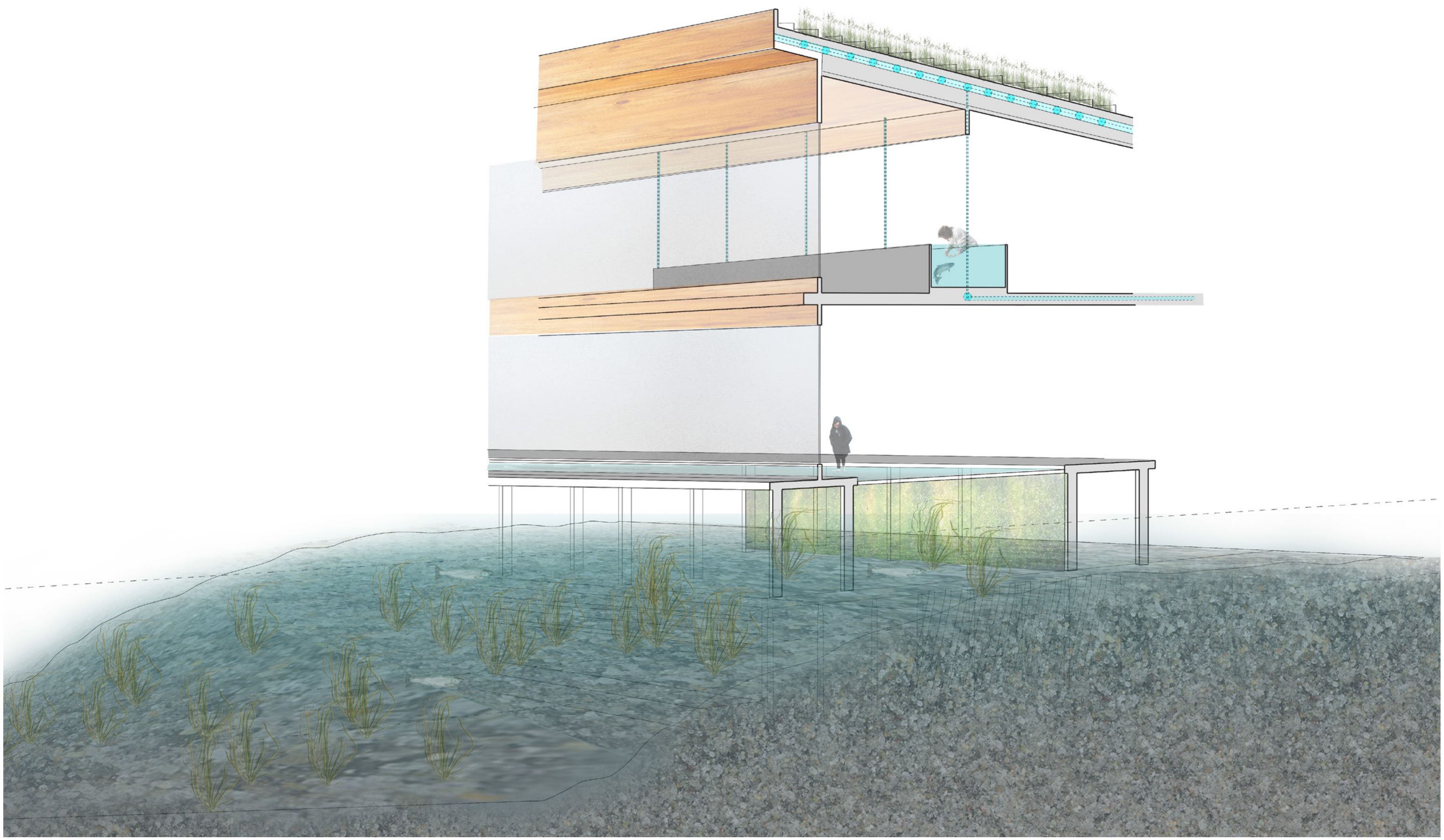


Figure 4.16 Parital Cross Section of the Salt Water Building
showing water movement below the building.

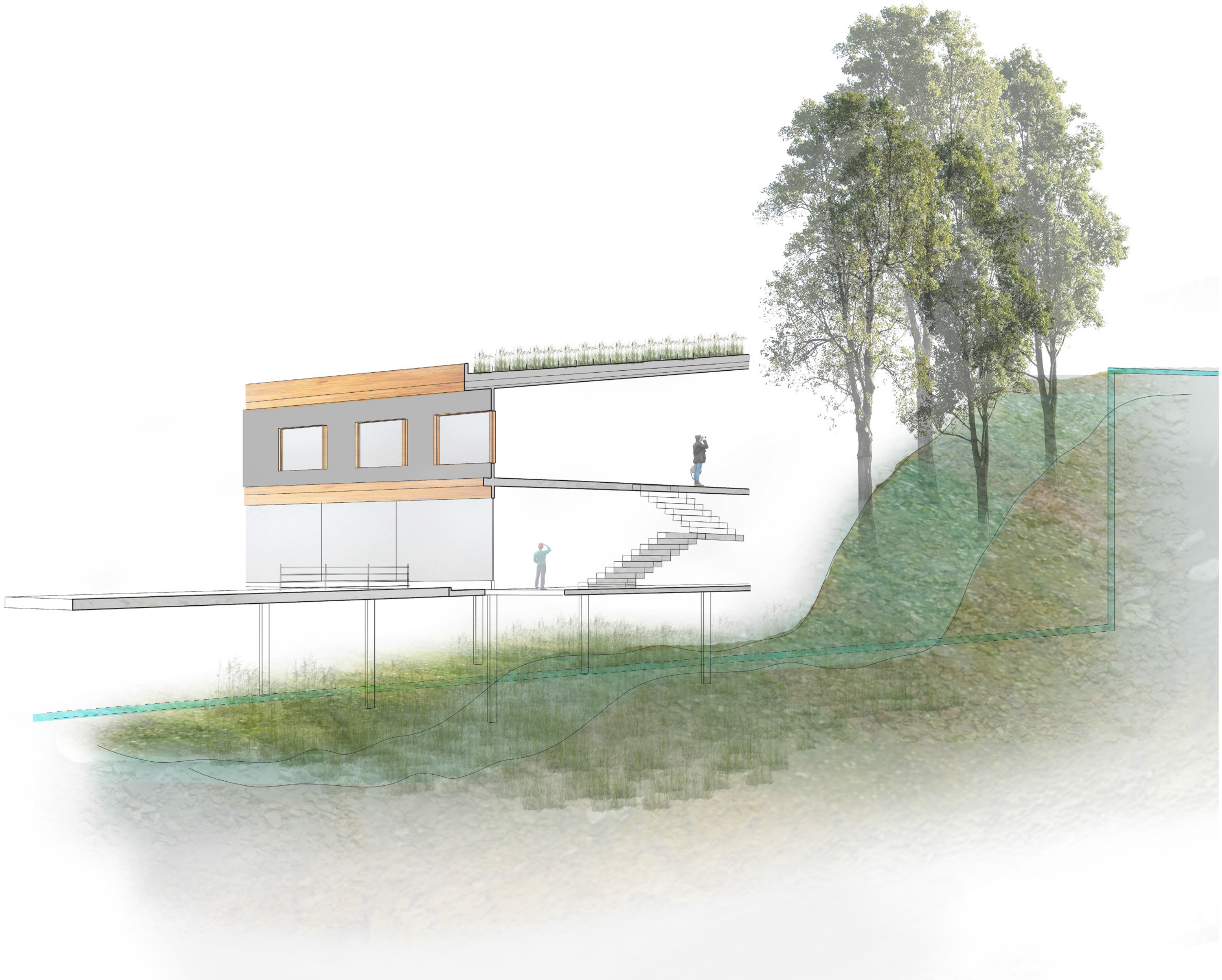


Figure 4.17 Parital Cross Section of the Fresh Water Building showing water movement below circulation.

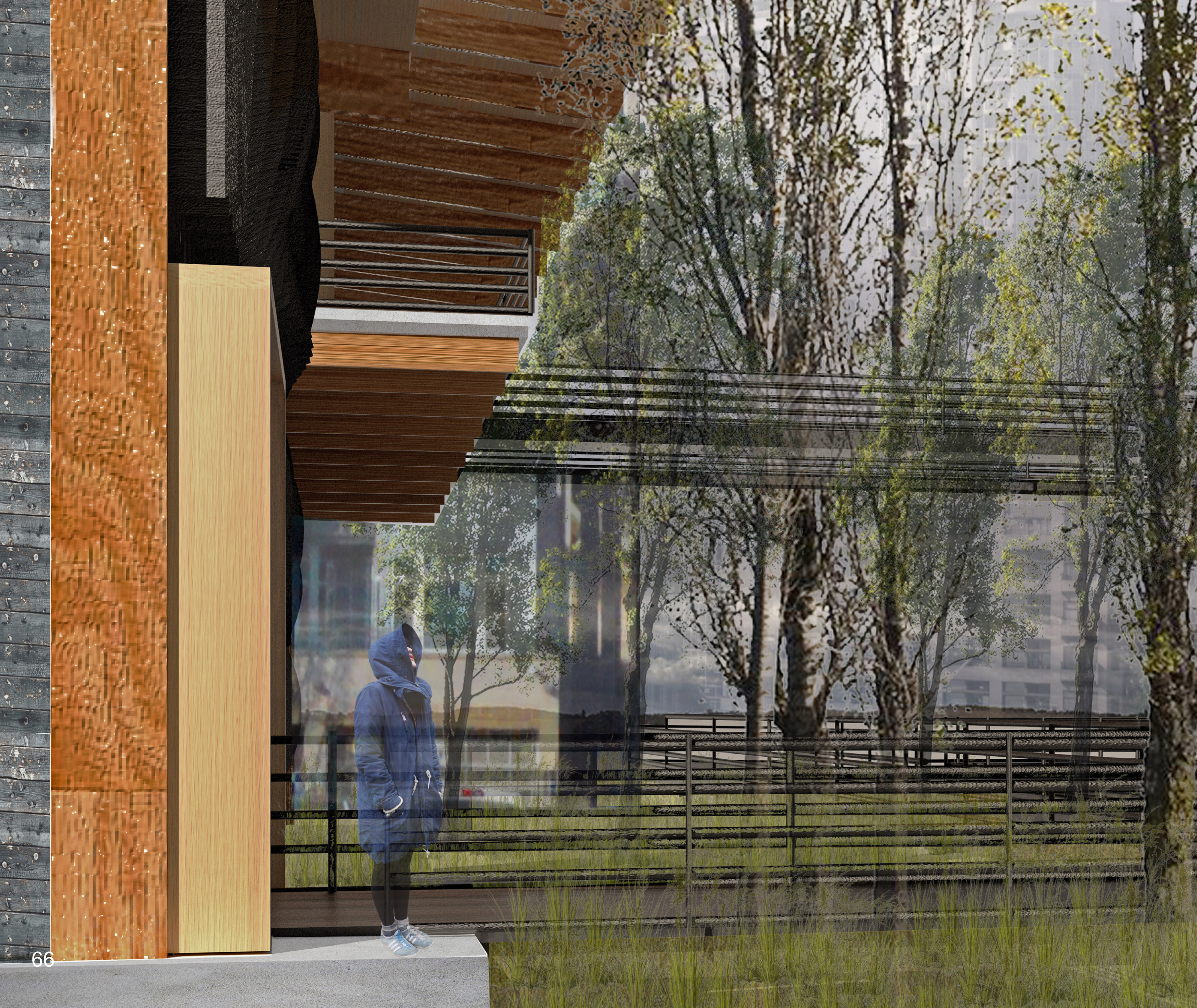


Figure 4.18 Rendering of the Marine Riparian Zone between the Fresh Water & Salt Water Buildings.

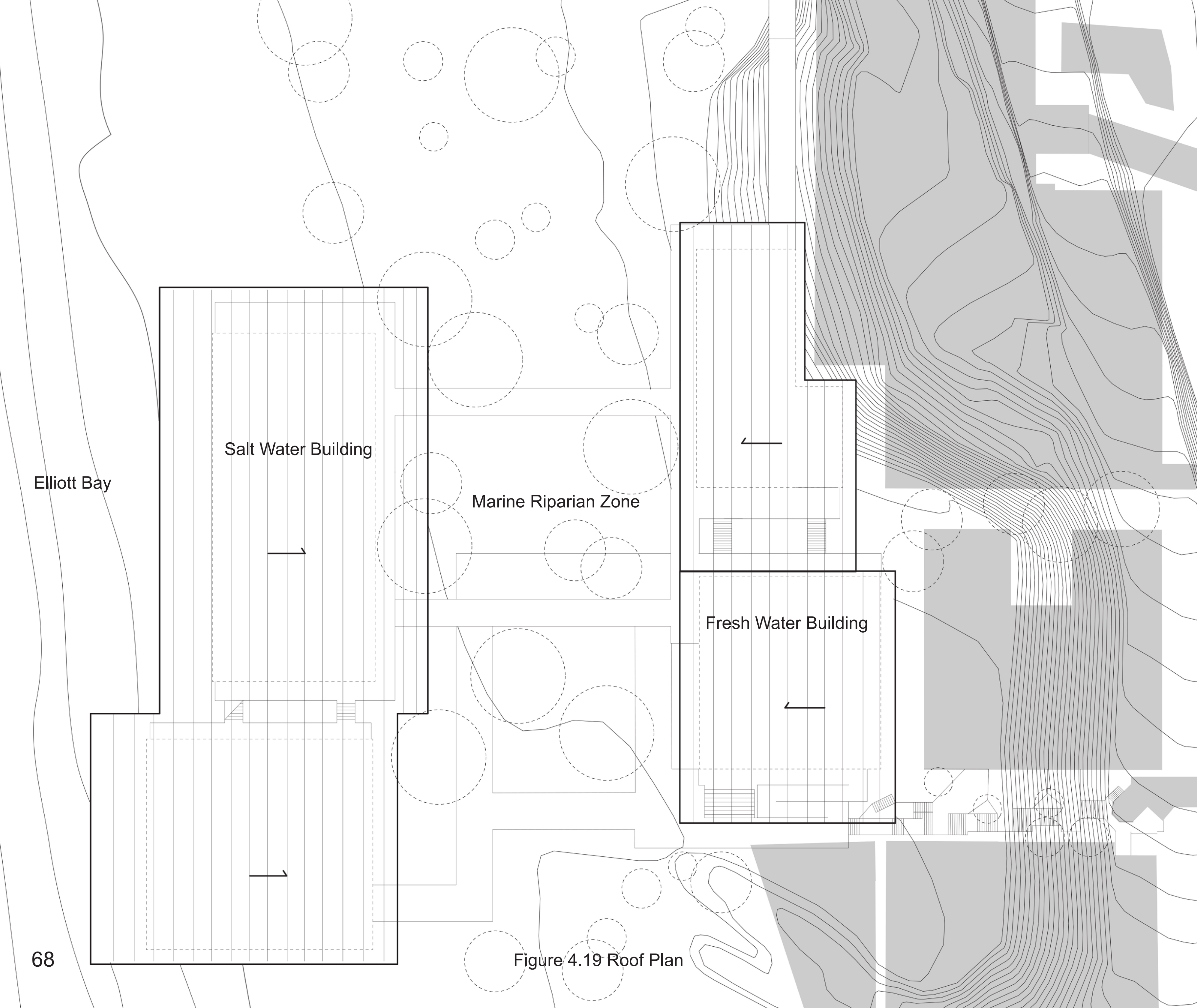


Figure 4.19 Roof Plan

The Marine Riparian Zone is an interstitial space between the Fresh Water and Salt Water Buildings that is an additional program element. Though uncapped, the Marine Riparian Zone acts as outdoor classroom, where visitors pass through and physically encounter the natural environment. Walkways between buildings are elevated off the ground to prevent foot traffic from stressing the plantings and to mitigate the encounters with pollutants that are passing through this zone. To access shifting elements of the program, visitors and long-term occupants are circulated outside through this zone or exterior, covered stairways that emphasize the mixing of programs and develop a dynamic itinerary through the revitalized context.

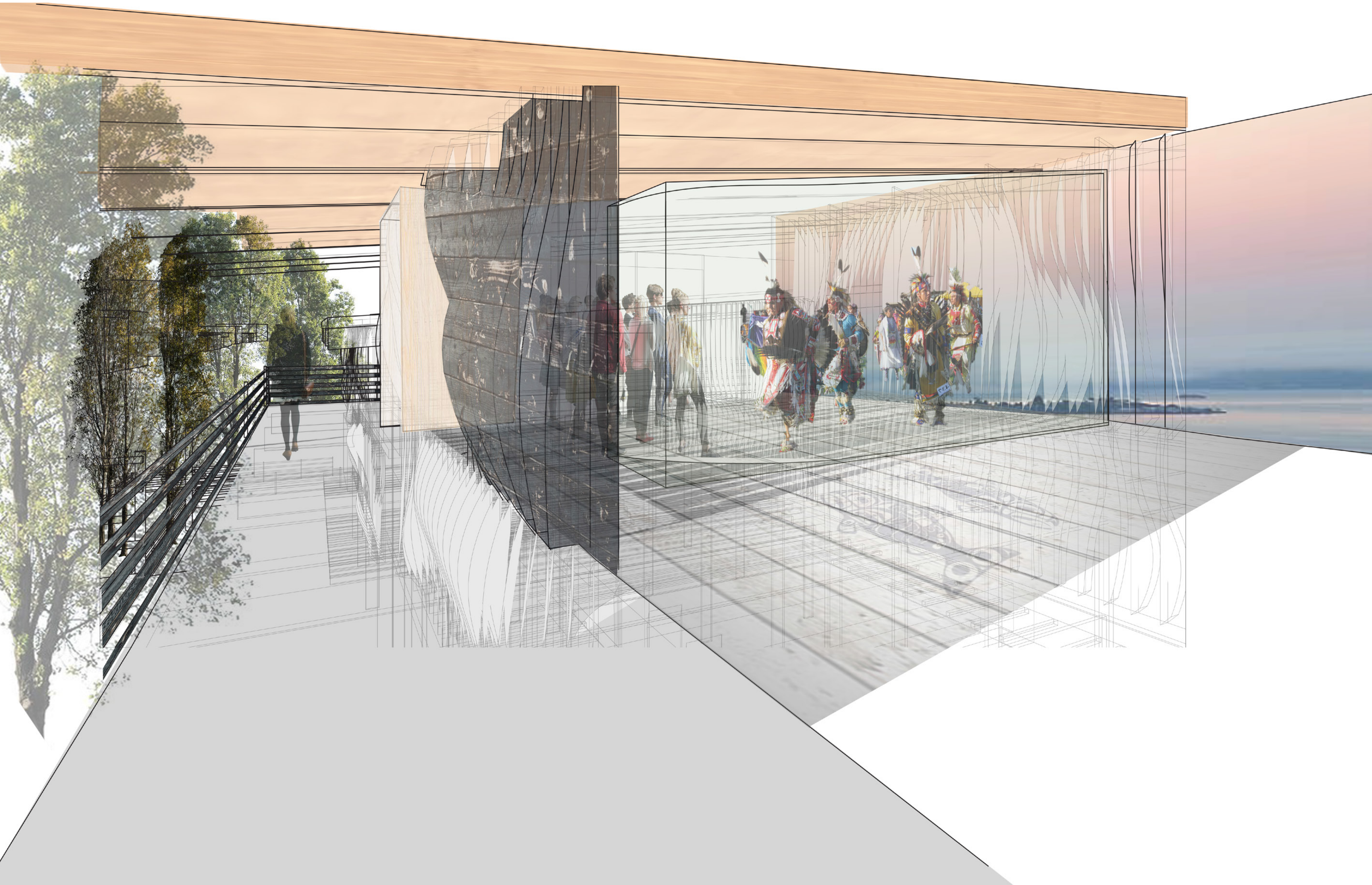
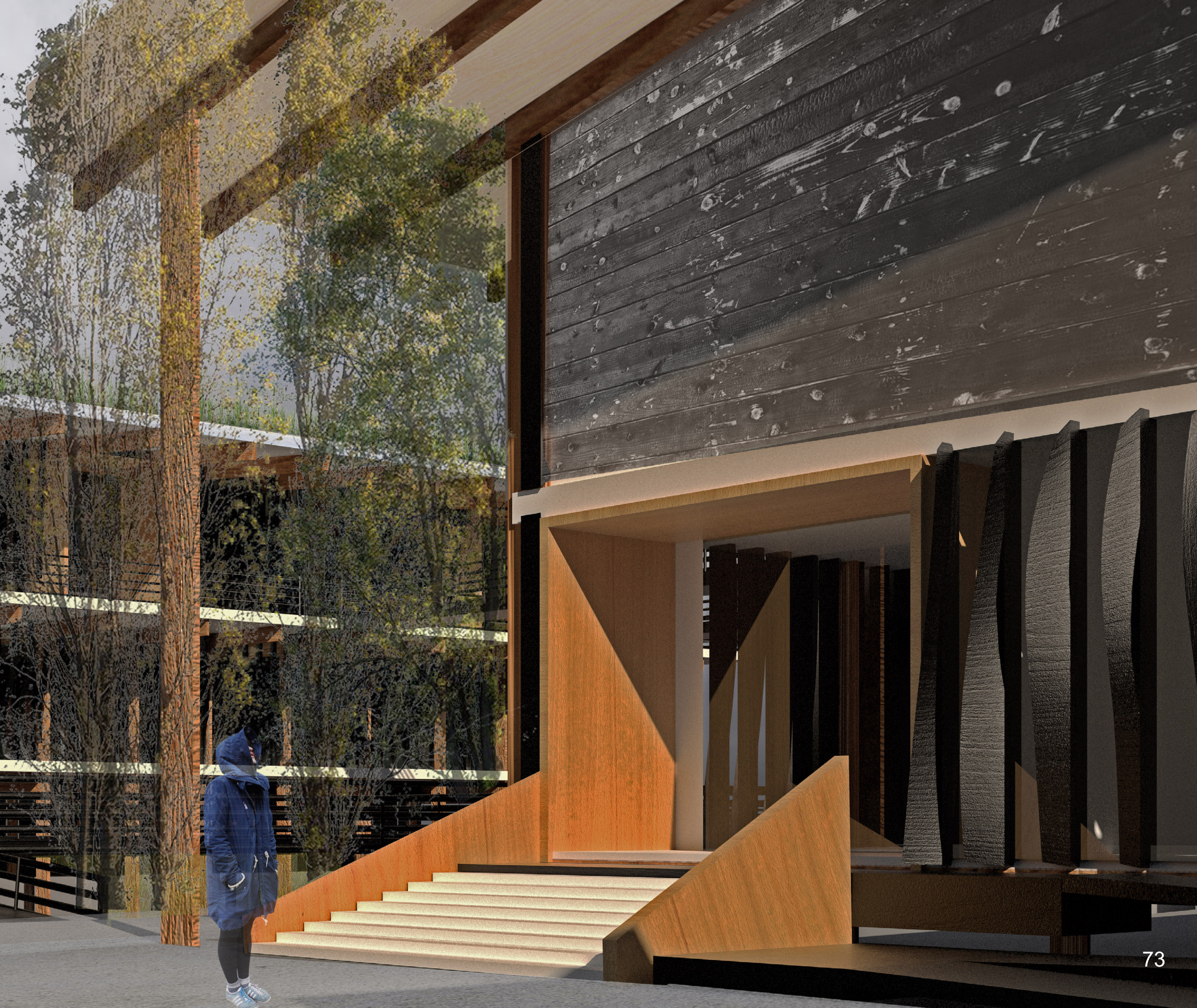


Figure 4.20 Vignette of the Tribal Cultural Center in the Salt Water Building.

The Salt Water Building can be accessed on the ground floor or second floor, and also be accessed by water. At the ground level, an exterior walkway connects from the Pike Street Hill Climb, to the Fresh Water Building, and crosses over the Marine Riparian Zone to the entry of the Salt Water Building (Fig 4.22). The ground floor of this building mirrors that of the Fresh Water Building by providing salt water Ecological Science Laboratories. As visitors enter this building, they first encounter a Visitor's Center and Public Education space. This space is highlighted by a portion of glass floor in which visitors can stand on and visually connect to the changing tides and flows of water moving underneath the building. There is also a large gathering space for group tours and for scientists to generate social interactions with the public. Scientists are able to continue to the north portion of the building where there is a large scale ecological laboratory for salt water. This lab has three large scale detention tanks which hold and release water from Elliott Bay for testing, purifying with UV and mineralization, and releasing. The space also holds a large scale chemistry lab, storage, meeting and individual work stations. Visitors can circulate to the second floor via the exterior staircase between the north and south parts of the building to access the Tribal Cultural Center; Scientists are able to access an Aquaponics Laboratory at the south side of the building where there is space for small scale, short term, catch-and-release aquaponic food growing in which adult salmon are captured to provide nutrients to the water that supports vegetable growth.

Visitors can access the Tribal Cultural Center on the north side of the building (Fig. 4.20) which provides space for ceremony, music, gathering, meals, and community cooking. This space is meant to be more informal for the mixing of activities to encourage public engagement with rituals and to connect cultural understanding to nature. The upper floor connects back to the Fresh Water Building by way of connecting bridges and circulates outdoors to blend the experience of gathering and community with the new context. Because the building traverses the water's edge (Fig. 4.16), it is able to also be accessed by canoes at a slender over-water pier with a permeable grate. This small pier extends itself to both programs: for scientists to research the shoreline environment for juvenile salmon by scuba diving, and for tribes to arrive to the Cultural Center by boat, as a ceremonial ritual and a nod to historic modes of transportation by canoe.

Figure 4.21 Rendering of the Entry to the Fresh Water Building from the bottom of the Pike Street Hill Climb.



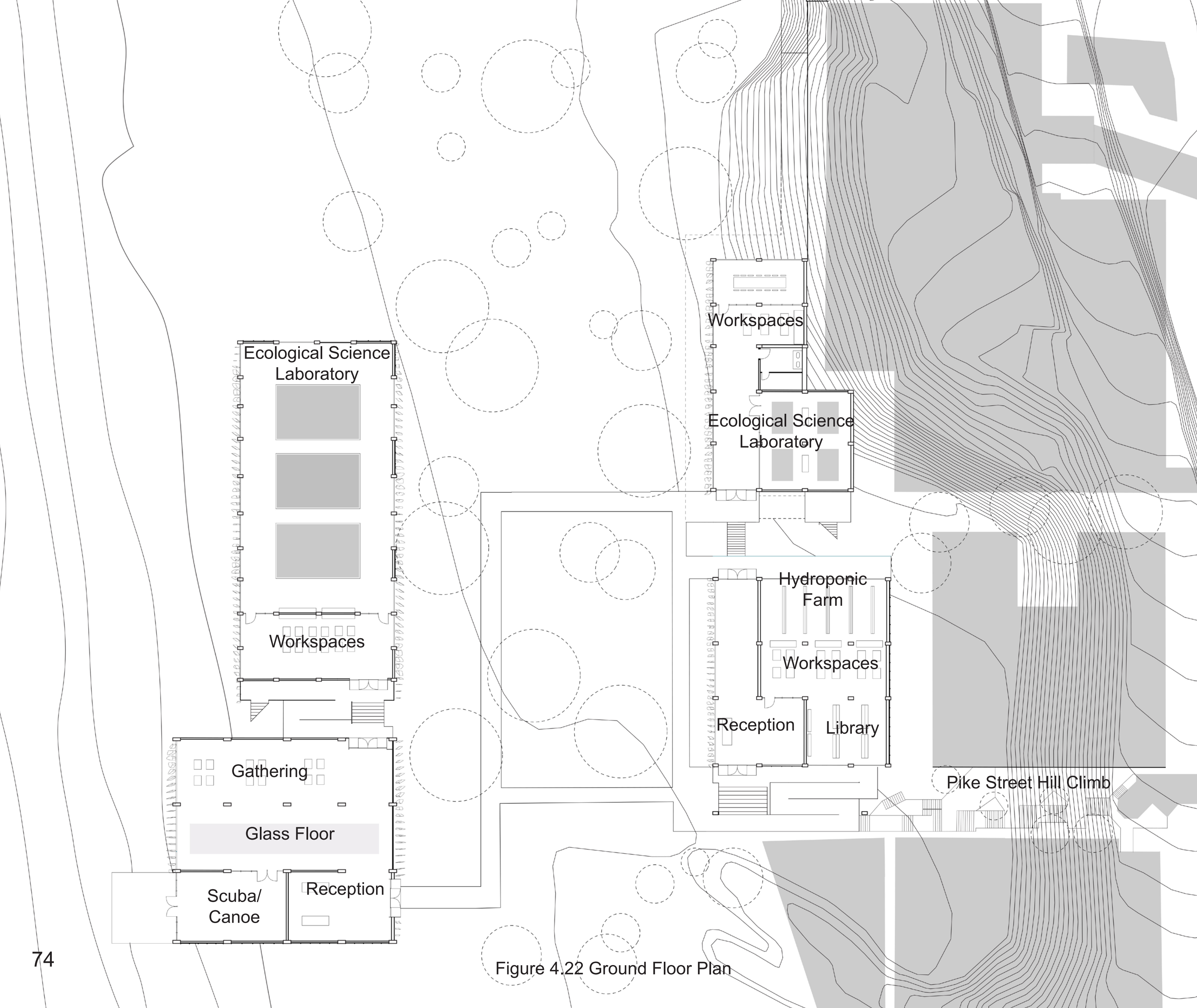


Figure 4.22 Ground Floor Plan

Program Layering

The simultaneous layering occurs throughout the transect between Pike Place and the waterfront in this proposal. From the Upland zone and urban environment, layers of local business, retail, and culinary experiences intensify as they culminate at Pike Place Market (Fig 4.24). There, these layers mix with new layers of pedestrian activity and itinerary diversity, artwork, and cultural space. These layers now meet with new program introduced by the Center for Environmental Health: cultural, education, scientific, and natural. The system of program layers shifts into one less involved with human activity and more involved with natural occurrences and thus this density of activities begins to dissolve with the introduction of a new landscape. The edges and boundaries are blurred and now can mix with eachother to merge dichotomies of human and natural systems in the built environment while introducing an alternative interpretation of urban nature. These layers react to the ecotones between urban, riparian and aquatic habitats (Fig 4.25) and shift their behavior to accommodate natural and urban systems that must now coexist.

The architectural response to addressing these ecotones is to raise the architecture above the ground plane. The supporting foundational structure is stilted with thin slabs oriented north and south sitting upon them. The structure at grade is wide flange concrete columns to provide enough support and stability in a now wet ground foundation. Above grade, heavy timber structure is utilized for its strength, durability and effectiveness in carbon sequestration. The roof structure is also vegetated and slanted either east or west to create a butterfly roof condition that drains to the Marine Riparian Zone. Precipitation is collected and filtered from the roof's vegetation and released into the wetland through a series of downspouts that carry the water to distributed points that avoid flooding. The long facades of the building are oriented east and west to extend the views to the sound and to emphasize the blending of space between building and natural environment. These facades (Fig 4.27 & 4.29) are transparent and tectonic in nature with heavy timber frames and an exterior vertical louver skin consisting of Shou Sugi Ban, a durable charred wood, that shades the interior and extends the landscape simultaneously. The louvers twist and open in select locations to address programmatic needs of daylight. Because the facility is open

Figure 4.23 Second Floor Plan

during daytime hours, the need for comfortable daylight in the east and shading from the west determines the extent of depth the louvers are and varies the need for openings. For program such as the ceremonial center, openings are provided for dramatic sunlight casting on performances, while for programs such as the library or art studio, the louvers gain depth to prevent uncomfortable solar incidence on the work plane. On the east façade of the Fresh Water Building is a special circumstance that addresses the privacy of neighboring buildings that are residential and commercial office. This façade drapes the vertical louver skin over varied instances of glass curtainwall and solid cross-laminated timber (CLT) panels. The panels are located primarily on the upper floor and limit a visual connection between residential apartments and civic program, however the sloped roof allows for the façade to raise to a clerestory in which eastern daylight can illuminate the space simultaneously.

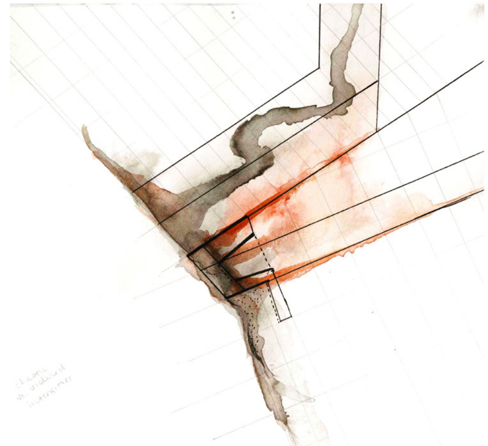


Figure 4.24 Collection & Intensities

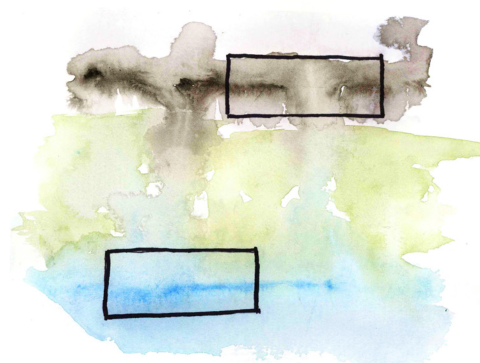


Figure 4.25 Ecotones

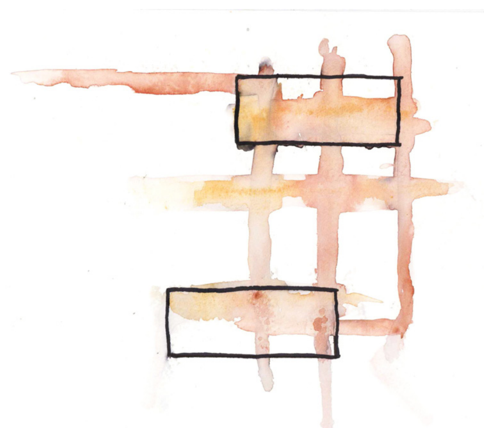


Figure 4.26 Filtration

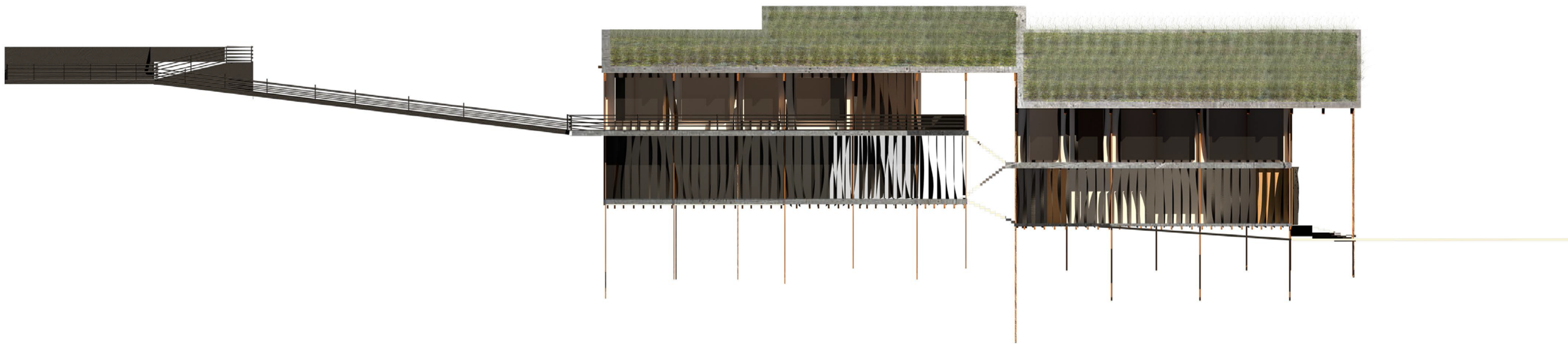


Figure 4.27 Fresh Water Building West Elevation

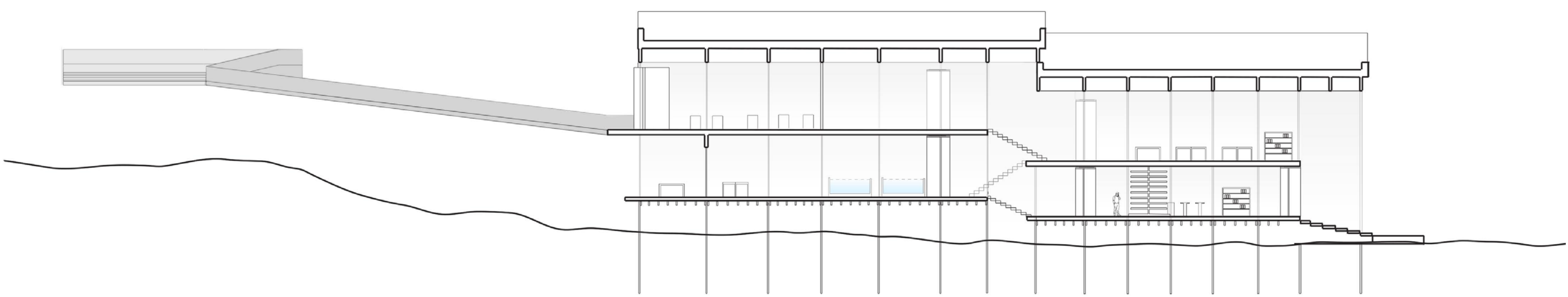


Figure 4.28 Fresh Wate Building Longitudinal Section

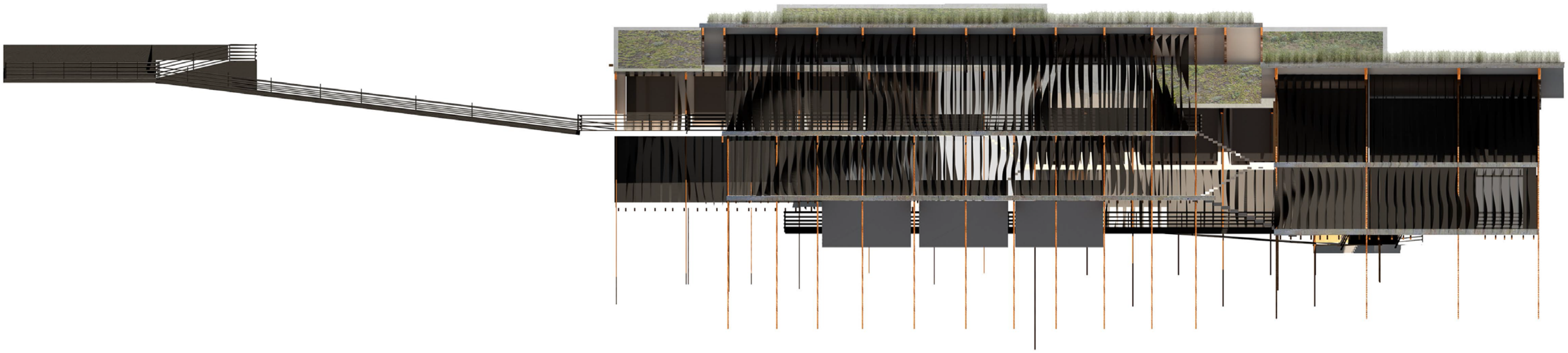


Figure 4.29 Salt Water Building West Elevation

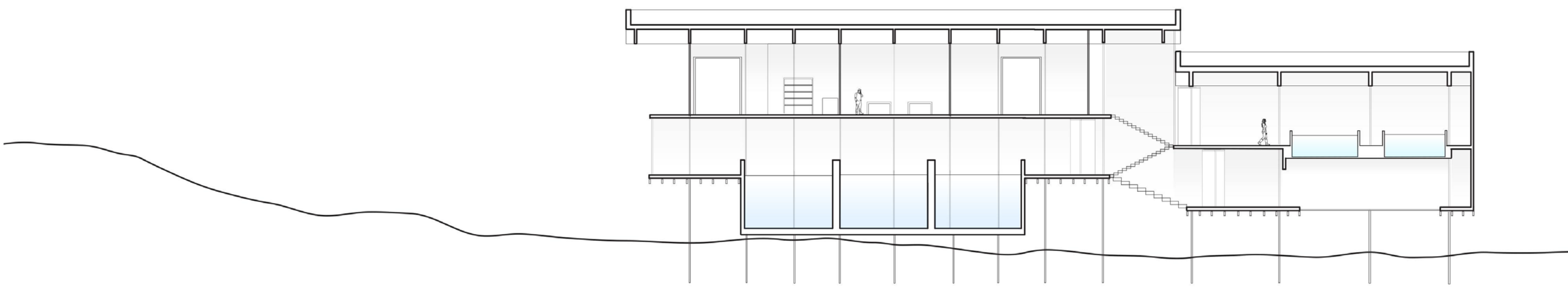
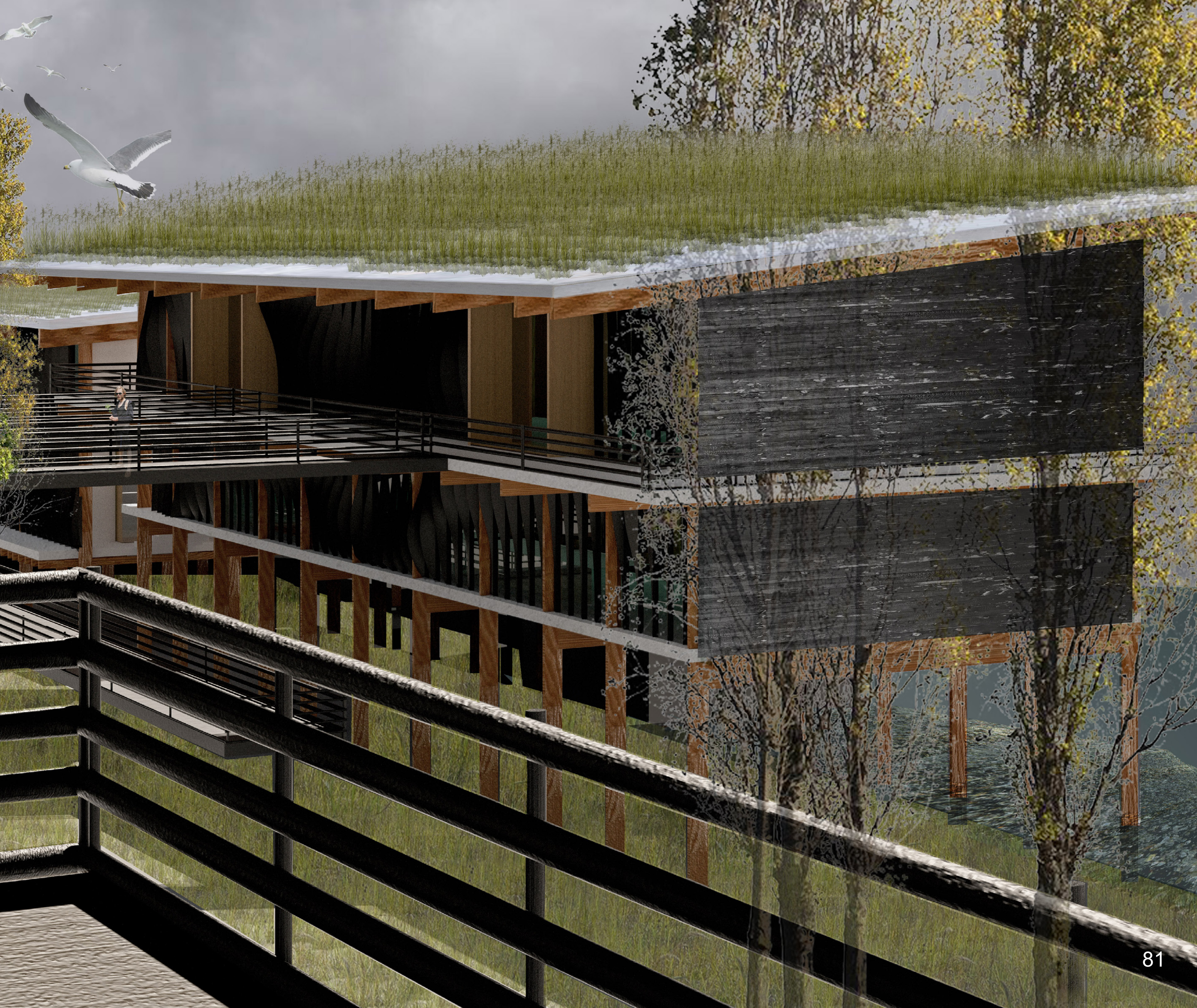
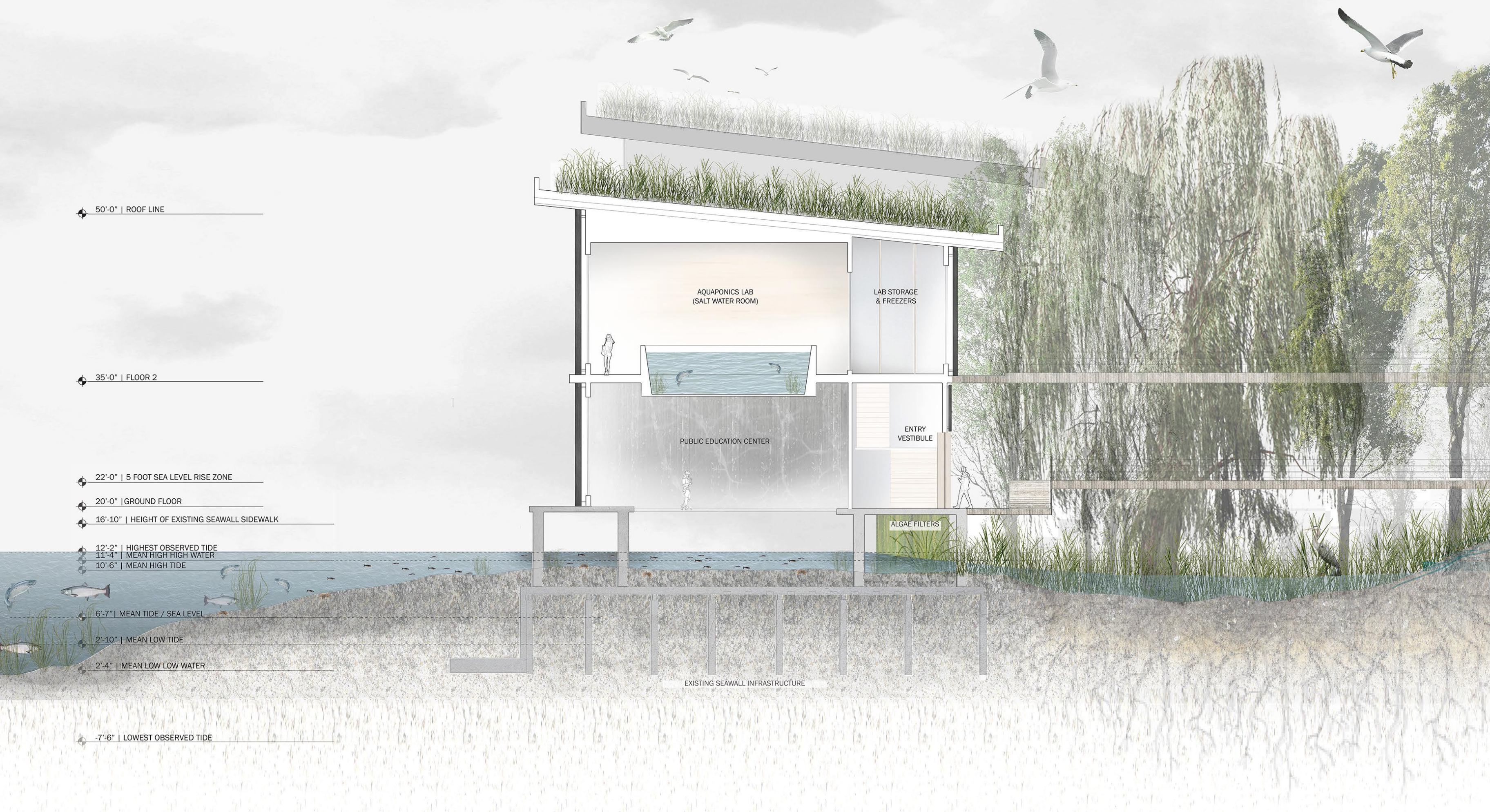


Figure 4.30 Salt Water Building Longitudinal Section

Figure 4.31 Rendering of the Entry to the Fresh Water Building from the bottom of the Pike Place Market Expansion.





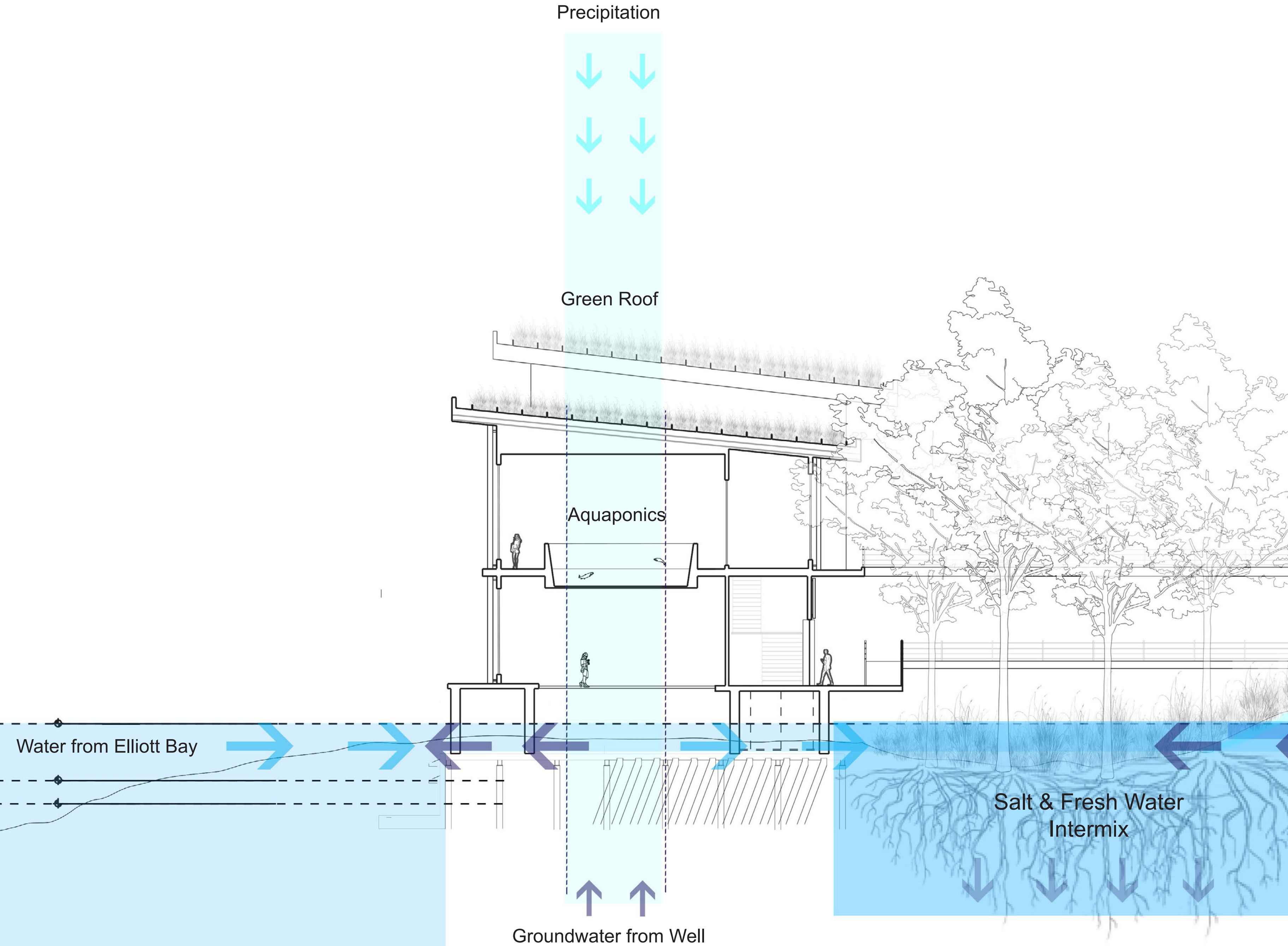
50'-0" | ROOF LINE
35'-0" | FLOOR 2
22'-0" | 5 FOOT SEA LEVEL RISE ZONE
20'-0" |GROUND FLOOR
16'-10" | HEIGHT OF EXISTING SEAWALL SIDEWALK
12'-2" | HIGHEST OBSERVED TIDE
11'-4" | MEAN HIGH HIGH WATER
10'-6" | MEAN HIGH TIDE
6'-7"| MEAN TIDE / SEA LEVEL
2'-10" | MEAN LOW TIDE
2'-4" | MEAN LOW LOW WATER
-7'-6" | LOWEST OBSERVED TIDE
AQUAPONICS LAB
(SALT WATER ROOM)
LAB STORAGE
& FREEZERS
PUBLIC EDUCATION CENTER
ENTRY
VESTIBULE
ALGAE FILTERS
EXISTING SEAWALL INFRASTRUCTURE

Figure 4.32 Cross Section of the Fresh Water and Salt Water Building from Western Avenue to Elliott Bay.

Figure 4.33 Diagram Showing Access and Circulation to the Site & Buildings

The theme of filtration applies to circulation, flows, and programmatic arrangements for this project to develop a spatial understanding that correlates to the environmental issues it addresses. Most literally, the flow of water determines how circulations occur, where they begin and end, and what they constitute. Polluted fresh water runoff and storm water gather and collect upland (Fig. 4.24), much like people do as they traverse the downtown neighborhood and move westward toward retail and restaurant corridors (Fig 4.23). These intensities of water and circulation collect along a datum on Western Avenue, where, to the west of this street, dramatic slopes to the waterfront begin to form.

At this point, filtration begins by negotiating tolerances of pedestrian and vehicular access toward the water. Various access points, such as the entryways from the Pike Place Expansion or the Pike Street Hill Climb (Fig. 4.23) allow for intentional exploration by visitors, and long-term building occupants (scientists, artists, tribespeople). The architecture of the Center for Environmental Health also acts as a filter for programmatic experiences, where visitors and occupants move throughout the building to and across the Marine Riparian Zone that varies the depth of their experience there. People are able to move across the site in a controlled pathway, while water is able to move across the site freely without unnatural limitations (Fig. 4.22). Water is then able to flow between ecotones, while the circulation of people is more constricted to conserve and protect the state of the natural resources and processes they perform. The building acts as a vessel that retains the people in the landscape while water is able to move through it. Toward Elliott Bay, an algae filter below the Salt Water Building also acts as a filter for both water and aquatic species. Algae is able to filter toxins and pollutants within the water while providing a protective barrier that prevents these species from entering the Marine Riparian Zone and becoming trapped where it is inappropriate for them to reside.



Precipitation
Green Roof
Aquaponics
Water from Elliott Bay
Salt & Fresh Water
Intermix
Groundwater from Well

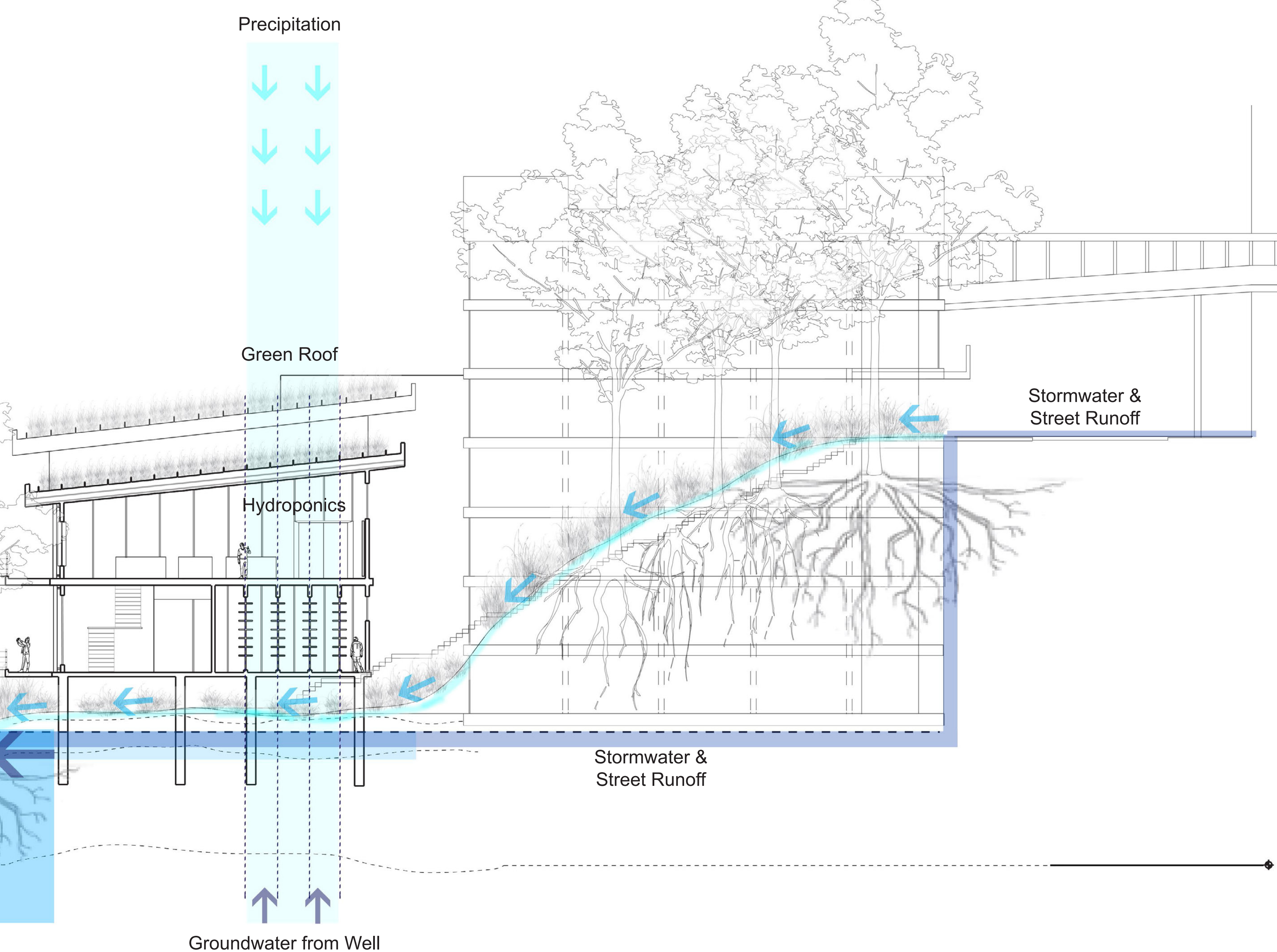


Figure 4.34 Diagram Showing the Flow of Water Through the Buildings

chapter 5 Conclusion

The implementation of ecological design in an urban environment reveals the need to design on a large scale systematically. Because the chosen site allowed the opportunity to reimagine an extensive landscape in an urban environment, the architecture was able to formulate a response to a distinct ecological condition. The development of the ecological condition as an additional layer to an already "infilled" site arose from the needs of the site and its relationship to the land. Therefore, the most appropriate response for the landscape typology was to become a Marine Riparian Zone. Its proximity to both Elliott Bay and Seattle's primary downtown district made evident that the best purpose was for it to be a buffer or a filtered zone between the two, where an ecological conservation boundary could emerge and act as a zone that united both dichotomies of human and natural systems. An architectural response, in addition to a landscape response, acts as the unifying element between human systems and natural systems, but simultaneously transforms to blur its identity with the landscape. Transparent long edges of the building as well as circulation elements that merge on the exterior of the building negotiate the indoor and outdoor spaces and create distinct physical relationships with the natural systems at work below in the Marine Riparian Zone.

The project itself was enlightening in its demonstration of ecological design as a highly integrated process which relies upon experiential qualities that reveal the systematic or technological aspects of sustainable design. Sim Van Der Ryn's framework for ecological design relied heavily upon the experiential qualities that can merge the dichotomies of human and natural systems, but that the value that humans put on a place (placemaking) and their experiences and memories in this place reinforce the sustainable systems that create its beauty. The Center for Ecological Design's' intent was to merge the human and natural systems in downtown Seattle to better represent the city's attitude toward environmental issues and to expose people to these issues in a meaningful way rather than as an attraction. As in integrated design, a cultural understanding may lead to a shift in value, a behavioral change, and then a physical change that can begin a series of actions to reverse the negative effects of humans on the environment. This project, located at a pivotal gateway in the city, not only connects people in a cultural sense, but is able to shift their values in an environmental sense.

Ecological design in urban areas demands more exploration, as climate change is more threatening and the increasing density of our cities leaves little room for truly green spaces. Human connection to nature is as equally important as an architectural connection to nature. Buildings today are more able to develop a symbiotic relationship between space, systems, and nature. Those successful in doing so, such as the examined case studies, are able to exceed baselines for sustainable development and provide ecosystem benefits on new levels in modern cities. Ecosystems thinking applied in the development of an ecological architecture offers the potential for a paradigm shift in which we can coexist with rather than dominate nature. This thesis strives to demonstrate that this relationship is possible in our urban environment, and that nature has a place in the city.

Thanks & Acknowledgements

I am so grateful for the journey this thesis has taken me on, and for all of the knowledge, support, and experience I have gained from it. After over 6 years, the adventure has just begun!

Thank you,

To my studio co-chairs, Susan Jones and Rick Mohler: your support and guidance have pushed this thesis to be more. Thank you for your time, inspiration, feedback, and challenges.

To my mentor, Chris Meek: Thank you for taking the time to meet with me and provide me with affirmation, guidance, and wisdom. Your unique insights about sustainability and Seattle's history helped to ground this thesis into what it needed to be.

To Lousia Iarocci: Thank you for your constant encouragement, time, and thoroughness. Your inquisitiveness pushed me to explore this unique idea and refined the way I will think about Ecological Architecture in the future.

To Vandana Baweja: Thank you for taking me under your wing. Your time and guidance has led me to where I am today and has matured the way I see and think about architecture. I will always remind myself to think about the birds.

To Asher Russell: I have been in graduate school since we met, and I could not have done it without you. Your support and love has helped me emerge as the person I am today, and the architect I will be. Thank you always.

To my friends at UW: Lama, Jayeong, Brad, Farhana, Seemi, Weicheng, thank you for all the fun, friendship, laughter, late nights, comeraderie, happy hours, coffee and bagels, DM runs and most of all, support and encouragement. We did it!

To my friends at UF: Mitch, Wendy, Mimi, and Kirsten: Thank you for being the backbone of my academic career, for the crazy memories and pranks, for the lessons in watercoloring, for the genuine teamwork, for the midnight roof visits, and for friendship that started in the studio that spans the country.

To my family: Thank you for your constant support and encouragement to be the first in the family with this degree, and for the unlimited guidance in navigating this new world with open doors. I will always strive to "work hard and do good things."

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List of Figures

Images by author unless otherwise noted.

Cover Image: Collage Diagram of Interstitial Space.
Page 6, 88. Salmon Ballet.
Chet Stein Photography. 2017.
https://www.chetsteinphotography.com/Seattle--Olympic-NP-2017/i-Tk84c6V

Page 14 Murkey Windows.
Ingrid Taylar Photography. 2013.
https://www.flickr.com/photos/taylar/9230221076/

Figure 1.1 Salmon Migration in the Pacific Northwest.
Diagram Adapted from Washington Department of Fish & Wildlife Salmonscape Map.
https://apps.wdfw.wa.gov/salmonscape/map.html#
Figure 1.2 The Salmon Life Cycle.
Diagram courtesy of the National Oceanic and Atmospheric Association (NOAA) & Northwest Fisheries Science Center.
https://www.nwfsc.noaa.gov/education/foreducators/handouts.cfm
Figure 1.3 The Puget Sound Food Chain.
Diagram adapted from the University of Puget Sound.
https://www.pugetsound.edu/academics/academic-resources/slater-museum/exhibits/salmon/
Figure 1.4 The Boreal Riparian Zone.
Diagram adapted from Strom, 2011.
Ström L., Jansson R., Nilsson C., Johansson M.E. & Xiong S.J. (2011) Hydrologic effects on riparian vegetation in a boreal river: an experiment testing climate change predictions. Global Change Biology, 17, 254–267.
http://www.climate-and-freshwater.info/climate_change/wetlands/cold/
Figure 1.5 The Great Canoe.
Coast Salish Collection. American Museum of Natural History, New York, New York. 2017.
Figure 1.6 Salish Sea Basket.
North American Ethnographic Collection, American Museum of Natural History, Northwest Coast. In Division of Anthropology.
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Figure 1.7 Salish Sea Salmon Artwork.
Sterritt, Neil. The Luring of Salmon at Gitanmaax. 1977. North American Ethnographic Collection. American

List of Figures, cont'd.

Images by author unless otherwise noted.

Figure 2.1 The Integral Ecologic Epoch.
van der Ryn, Sim. Sim's Philosophy. 2017.
http://simvanderryn.com/philosophy/
Figure 2.2 Altered Nature.
Forman, Richard T. T., The Arrangement of Nature, Altered Nature, and People in the Urban Region.
Ecological Urbanism, pp. 312.
Figure 2.3 Trajectory of Ecological Design
van der Ryn, Sim. Sim's Philosophy. 2017.
http://simvanderryn.com/philosophy/
Figure 2.4 Ecological Design Framework.
Diagram adapted from "Ecological Design," van der Ryn, Sim, 2007.
Figure 2.5 Seattle Waterfront Plan
Corner, James. Field Operations, Concept Proposal, 2011.
https://archpaper.com/2011/07/seattle-waterfront-park/
Figure 2.6 The Vancouver Convention Center, West.
LMN Architects, Exterior Photo, Vancouver, British Columbia, Canada, 2009.
https://lmnarchitects.com/project/vancouver-convention-centre-west
Figure 2.7 The Vancouver Convention Center, West.
LMN Architects, Cross Section Perspective, Vancouver, British Columbia, Canada, 2009.
https://lmnarchitects.com/project/vancouver-convention-centre-west
Figure 2.8 Re-envisioned Harbor Steps Park in Downtown Seattle.
The Miller | Hull Partnership, Cross Section, Seattle, Washington. 2018.
https://seattle.curbed.com/2018/10/31/18049826/downtown-seattle-biophilic-battery-street-tunnel
Figure 2.9 Re-envisioned Forested Streets in Downtown Seattle.
The Miller | Hull Partnership, Aerial Plan, Seattle, Washington. 2018.
https://seattle.curbed.com/2018/10/31/18049826/downtown-seattle-biophilic-battery-street-tunnel
Figure 2.10 Waterfront Seattle
Corner, James, Field Operations, Aerial Rendering, Seattle, Washington, 2013
https://www.asla.org/2013awards/501.html
Figure 2.11 Waterfront Seattle Sustainability
Corner, James, Field Operations, Section Perspective, Seattle, Washington, 2013
https://www.asla.org/2013awards/501.html

List of Figures, cont'd.

Images by author unless otherwise noted.

Figure 2.12 Waterfront Seattle Pier Plan.
Corner, James, Field Operations, Plan, Seattle, Washington, 2013
https://www.asla.org/2013awards/501.html
Figure 2.13 Waterfront Seattle Pier Programming.
Corner, James, Field Operations, Conceptual Rendering, Seattle, Washington, 2013
https://www.asla.org/2013awards/501.html
Figure 3.1 Salmon Migration Paths and Juvenile Salmon Paths into the Seattle Waterfront Piers.
Diagram Adapted from Washington Department of Fish & Wildlife Salmonscape Map.
https://apps.wdfw.wa.gov/salmonscape/map.html#
Figure 3.2 Map of the locations of Seattle's LEED rated buildings.
Diagram Adapted from ESRI GIS data.
Figure 3.3 Diagram showing the current relationship between buildings and nature.
Figure 3.4 Map of the Alaskan Way Viaduct and Proposed Tunnel SR 99 Route.
Washington State Department of Transportation (WSDOT), 2018.
http://www.wsdot.wa.gov/Projects/Viaduct/About
Figure 3.5 Photo of the Alaskan Way Viaduct on Seattle's Waterfront.
Seattle Municipal Archives, Seattle, Washington, 1952.
https://www.flickr.com/photos/seattlemunicipalarchives/9839028923/in/album-72157633512897548/
Figure 3.6 Seattle's New Waterfront Plan.
American Society of Landscape Architects, Friends of Seattle Waterfront, Seattle, Washington, 2012.
https://waterfrontseattle.org/design/plans.aspx
Figure 3.7 Partial and Full Acquisition Parcels on the Seattle Waterfront.
Waterfront Seattle Land Use Discipline Report, Draft Environmental Impact Statement, Appendix C, May 2015.
Figure 3.8 Diagram describing the introduction of natural systems into the site.
Figure 3.9 Program Matrix Describing the Arrangement of Programmatic Elements.
Figure 4.1 Site Aerial Rendering.
Figure 4.2 Site and Context Re-envisionment.
Figure 4.3 Site Topographic and Bathymetric Plan with Project Placement.
Waterfront, Seattle, Washingtion.
Figure 4.4 Cross Section Through Existing Seawall.
Waterfront, Seattle, Washington.
Figure 4.5 Cross Sections Through Proposed Seawall.
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List of Figures, cont'd.

Images by author unless otherwise noted.

Figure 4.6 Site Photograph, Between the Alaskan Way Viaduct and the Fix/Madore Buildings, 2018.
Figure 4.7 Site Photograph, Between the Alaskan Way Viaduct and the Seattle Aquarium, 2018.
Figure 4.8 Photo of the Bell Street Bridge seen from Alaskan Way.
Mabel, Joe. Seattle, Washington, October, 2008.
Figure 4.9 Photo of the Bell Street Bridge from the top of the bridge.
Figure 4.10 Cross Section between Elliott Avenue and the Cruise Ship Terminal in Belltown, Before Context Changes.
Figure 4.11 Cross Section between Elliott Avenue and the Cruise Ship Terminal in Belltown, After Context Changes.
Figure 4.12 Photograph of partial Pier 48 and the Alaskan Way Viaduct near Occidental Square.
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https://www.djc.com/news/en/12093429.html
Figure 4.13 Cross Section between South Main Street and Pier 48 in Pioneer Square, Seattle, Before Context Changes.
Figure 4.14 Cross Section between South Main Street and Pier 48 in Pioneer Square, Seattle, After Context Changes.
Figure 4.15 Vignette of the Fresh Water Laboratory Retention Tanks.
Figure 4.16 Parital Cross Section of the Salt Water Building showing water movement below the building.
Figure 4.17 Parital Cross Section of the Fresh Water Building showing water movement below circulation.
Figure 4.18 Rendering of the Marine Riparian Zone between the Fresh Water & Salt Water Buildings.
Figure 4.19 Roof Plan.
Figure 4.20 Vignette of the Tribal Cultural Center in the Salt Water Building.
Figure 4.21 Rendering of the Entry to the Fresh Water Building from the bottom.
Figure 4.22 Ground Floor Plan.
Figure 4.23 Second Floor Plan.
Figure 4.24 Watercolor Diagram: Collection & Intensities
Figure 4.25 Watercolor Diagram: Ecotone
Figure 4.26 Watercolor Diagram: Filtration
Figure 4.27 Fresh Water Building West Elevation.
Figure 4.28 Fresh Water Building Longitudinal Section.
Figure 4.29 Salt Water Building West Elevation.
Figure 4.30 Salt Water Building Longitudinal Section.
Figure 4.31 Rendering of the Entry to the Fresh Water Building from the bottom of the Pike Place Market Expansion.
Figure 4.32 Cross Section of the Fresh Water and Salt Water Building from Western Avenue to Elliott Bay.
Figure 4.33 Diagram Showing Access and Circulation to the Site & Buildings.
Figure 4.34 Diagram Showing the Flow of Water Through the Buildings.