REEFOCUSING REEFUEIING WAIKIKI'S SOUTH SHORE

MEMORIAL

CORAL

NURSERY

THOMAS PLAGGEMEIER Capstone 2021 Instructors • Meg Coffee | Jim Pickel | Pamela Brief UCLA Extension Landscape Architecture Program

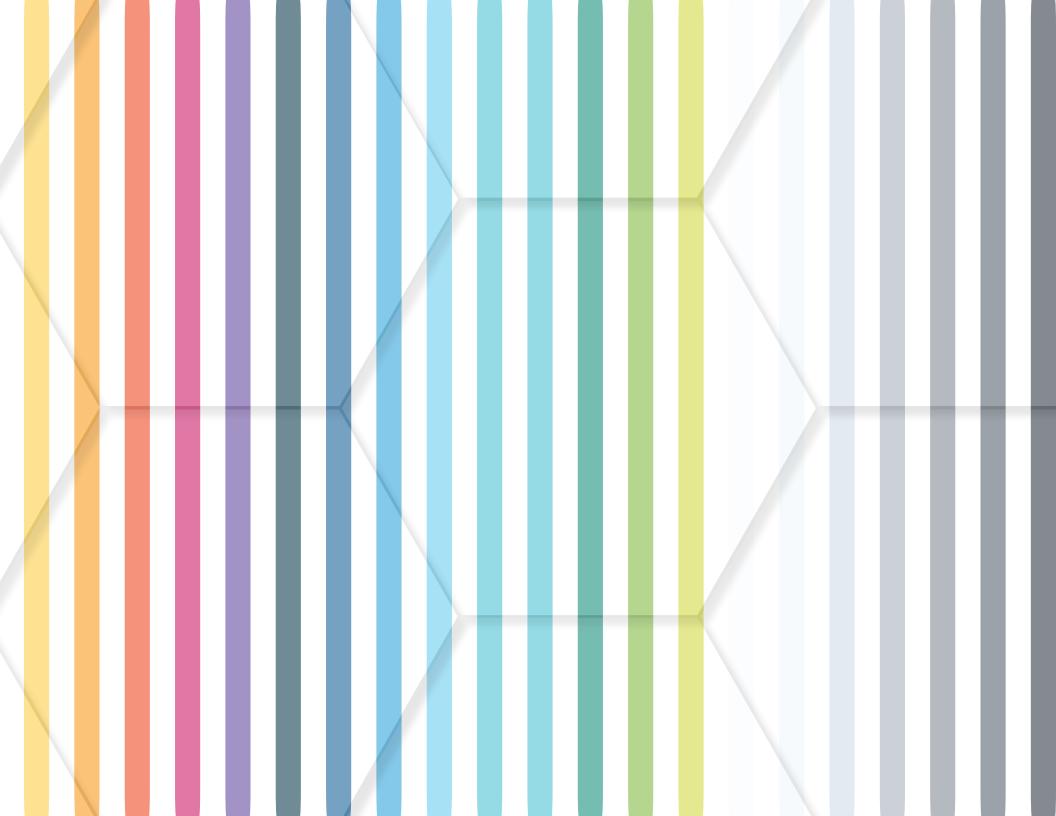


TABLE OF CONTENTS

INTRODUCTION

- 4 ACKNOWLEDGMENTS
- 5 About Me
- 6 EXECUTIVE SUMMARY

SITE SELECTION CRITERIA

- 9 PRESENTING PROBLEM
- 10 JUSTIFICATION
- 12 QUESTION (PROJECT STATEMENT)
- 13 RISK ANALYSIS (THE COST OF INACTION)

Approach

- 14 GOALS & OBJECTIVES
- 16 METHODOLOGY
- 19 Metaphor

PRECEDENT STUDIES

- 20 Yanweizhou Park
- 21 DEEP FORM OF DESIGNED NATURE
- 22 St. Pete's Pier
- 23 BARANGAROO RESERVE

Proposed Site Location

- 24 GENERAL SITE SPECS
- 26 GIS DATA

SITE ANALYSIS

- 28 LOCATION MAP
- 30 CIRCULATION
- 32 WIND & WAVES
- 33 Shade Study
- 34 CONNECTIVITY
- 35 TREE INVENTORY
- FEATURE EXISTING STRUCTURES
 - 36 The Waikiki Aquarium
 - 38 The Waikiki Natatorium War Memorial
 - 40 SEAWALLS & GROINS

FEATURE - SPECIAL CONSIDERATION

- 42 SEA LEVEL RISE
- 46 Constraints
- 47 OPPORTUNITIES
- 48 Stakeholders (Users)

50 PROSPECTIVE ELEMENTS

Initial Concepts

- 54 NATURALIZED SHORELINE
- 56 SEAWALL » BERM » PARK
- 58 SEAWALL » BERM » SEAWALL

PROJECT PROPOSAL

- 61 A BLANK SLATE
- 63 The Q*bart Stairs
- 65 A REVERSE REEF
- 67 SEAWALL & GROIN
- 69 Waikiki Ecoquarium | Coral Genome Bank | Reverse Oceanarium
- 71 LONE NUT COVE & HAWAIIAN PICNIC PUKAS
- 73 KEEPING IT TOGETHER (PLANTINGS PT 1)
- 75 Reverse Arbor Walk
- 77 MUSEUM OF THE PACIFIC & RETAIL
- 79 To & Fro (Entrances & Exits)
- 81 UP & OVER (NEW CIRCULATORY PATTERNS)
- 83 The Whole Plate Lunch (Plantings Pt 2)

Illustrative Site Plan

- 85 Illustrative Site Plan
- 86 SIGNAGE
- 88 CONCLUSION
- 89 Reference and Photo Lists

with My Undying Gratitude

First and foremost, I want to give many mahalos to my partner, JR. The completion of this project and the completion of the certificate program in Landscape Architecture at UCLA Extension would not have been possible without his encouragement, support and patience. I am wholeheartedly grateful to him for expecting me to dig deeper, find my limits, and then push through to the realm of imaginative innovation and true personal growth. Thank you for having faith in me when I wasn't finding it in myself.

A tremendous *THANK* YOU to my capstone teachers: Meg Coffee, Jim Pickel, Pamela Brief, and Eileen Alduenda for steering this ship called Capstone. Your skill at 'leaning in' and listening with a presumptive 'yes' as I shared my thoughts was both generous and instructional. For seeing through to the heart of my ideas, each of you is deserving of many muffins baskets and trees planted in your name. For righting my ship when it was foundering, a special thank you thank you thank you thank you, Meg.

To my classmates who continuously inspired me throughout the landscape architecture certificate program, thank you for sharing your insights, points of view, and, of course, your friendships. Distance learning during this pandemic was not easy and knowing that we were going through this together (over Zoom) made the last year and a half a little easier. Thanks everyone.

To Melissa Pirie and Denissia Withers who introduced me to the field of landscape architecture, showed me the value of garden-based community outreach, and taught me that educational pursuits do not always follow a linear path "... and that's OK," thank you.

To my ocean swimming family, a special thank you, too. There was a time when swimming in the open ocean terrified me. Without your teachings, encouragement, and patience, I'd likely never known the joy of open ocean swimming. Having acquired the confidence and skills to freely explore the waters and reefs around my island home doubtless inspired this capstone project. Mahalo!

To our program director, Stephanie Landregan, who keeps things running smoothly and continued our education despite the pandemic, I believe you are an invaluable advocate for students and an asset to our professional landscape. To Melissa McDonald, your mastery of the path to a successful student experience is remarkable. Thank you, both.

Lastly, a special thanks to my family, there aren't enough words (or space in this book) to express my gratitude. I love you.

About Me

I find recurrent inspiration in, at, and through interfaces, which is to say, the intersections where would-be opposing forces find instead integration: the boundary of urban and rural landscapes, inhabited coastlines, natural vs built environments. Almost daily, I see examples of mankind's attempts to intelligently manage and manipulate interfaces like these, some successes and some failures, and I find myself compelled into the field of landscape architecture as a result. It is here that I believe both my knowledge and interest are most apt to make a meaningful difference and shape the future.

I foster in myself and others authentic expression, especially that of unique perspective. Training for marathon open water swimming events has given me, I realize, a unique perspective. Splashing at the water's surface above unseen white/tiger/bull sharks, I am afforded the opportunity to observe from a questionably safe distance what my species has made of our country's shorelines ... and witness the shorelines' responses. You'll find me and my musings about life out in the ocean as often as possible ... be it the green waters of the Atlantic, the cold & dark Pacific waters off California's coast, or at home in the tropical blue around my Hawaiian island of Oahu.

My background is in sustainable urban development, landscape design, green home construction standards, and real estate resales. As such, I've found my innately adaptable nature and pension for collaboration to be great assets. That said, I'm not above a little friendly competition and you'll find me particularly persistent in overcoming obstacles. My personal motto:

When waters are rough, Check your form, Put your head down, And keep swimming.

EXECUTIVE SUMMARY

Waikiki has a problem. It's not unique to her, but she will have to solve it her own way. The evidence is both measurable and overwhelming.

In the face of global oceans rising, one of our nations treasures and a worldwide vacation destination, Waikiki Beach, in Honolulu, Hawaii is facing the real possibility of going extinct. It seem impossible but it's already happening. Twice a year, at the 'king' tide, parts of the mile long stretch of coastline take on water and that water makes it way into the city, streets, and parks on the beach's inland side. Every year it gets worse. Every year it will continue to get worse ... unless we act.



In the face of sea levels rising, and respecting the lives and property at risk, this project offers a seed of hope. A scalable solution designed to protect Waikiki now and into the foreseeable future. The design accepts that change is natural and nature is the best model we have for adapting to these changes. The project takes a hard look at real world problems; the solution is based on achievable goals and using tools we have available to us, such as, earth-working (grading), construction, and programming to fortify and rehabilitate both the coastline and the ocean floor into an ecosystem that offers protection for Waikiki's existing infrastructure, acceptance of sea levels rising, partnership with nature (especially with the coral reef part of nature, and growth in tourism ... the economic engine of Hawaii. This project offers a complete 'seed' solution intended to prove itself on the most neglected south shore of Waikiki (pictured here), then adapt and grow to protect even the biggest luxury hotels and most popular, historic parts of Waikiki, including its beaches. It's ambitious but, as a resident of Honolulu, worth it, imho.



Presenting Problem

Waikiki is being reclaimed by the Pacific Ocean.

Honolulu's primary (non-military) economic engine is Waikiki Beach and the abutting priceless resort district. However, the entirety of Waikiki sits beside the open Pacific Ocean and, essentially, at sea level. In fact, according to Honolulu Co., *all* waterfront hotels already run pumps 24/7 to remove subterranean sea water and stave off inundation ... but don't ask them about it. They're obliged to deny, deny, deny. Honolulu urgently needs an effective, scalable, and, crucially, adoptable solution to protect the city's most valuable real estate from the current and progressively worsening damage resulting from climate-driven sea level rise.

Time is of the essence.

In 2016, NOAA released its measurements and predictions regarding how SLR has and will affect our tiny island state. In the 17 years from 2000 to 2016, sea levels rose 0.5 feet at a steadily increasing rate that averaged 0.25 inches per year. NOAA predicted another 0.5 feet in the next 12 years, by or before 2029, if SLR rates remain unchanged. As of Dec 2020, the reality is worse than the predictions as sea levels have risen in Waikiki by an average of 0.285 inches per year, meaning, Waikiki will reach NOAA's next 0.5-foot marker by the middle of 2026 ... a mere 5 years from now.

There are only 2 valid solutions to global sea level rise (SLR). They are:

- 1. Retreat.
- 2. See solution #1.

However, humanity continually demonstrates its willingness to pretend nothing inconvenient, no matter how predictable, will ever happen ... again. (I'm looking at you, Miami-Dade.) Honolulu is proving to be no exception. However, I won't give up hope and believe I can offer a third valid way of addressing SLR: **3. Buy time until we realize we must retreat** (and, in the meantime, not miss a beat enjoying what we still have.) <u>BONUS</u>: More time could mean more prepared when the evidence of SLR is *literally* undeniable. So, leaving pessimism and censure behind ...

JUSTIFICATION

I believe that, in the face of global climate change and sea level rise, landscape architecture can be at the forefront of providing functional upgrades that will grow with, prepare for, and adapt to the changing needs of coastal cities. In a post-Hurricane-Katrina/Super-Storm-Sandy America, my inner boy-from-Queens, NY applauds the innovative work of renowned architecture and landscape architecture firms who've been tasked with installing or reinforcing flood barriers, but also acknowledges that these great designs underscore an undeniable reality: catastrophic loss of life and property due to flooding is predictable and, crucially, preventable. I hope to champion landscape architecture as a front-line provider of preventative measures to foreseeable problems ... i.e., fences at the tops of cliffs we face so that we can avoid the need for ambulances at the bottoms.



Of the few cities that are now trying to prepare, like Miami, finding that 11th-hour, affordable, and purely engineered solutions aren't acceptable to the people they intend to protect is common. Is bad publicity the reason my hometown of sea-level Honolulu, HI evidences little interest or effort to look at, much less take action to manage, our own routine flooding and coastal erosion?

With this project, I hope to 'seed' a design that proves and improves upon Honolulu's resilience and leadership amongst American coastal cities.

Waikiki is an apt location to seed and subsequently scale:



Honolulu is vulnerable to the Pacific Ocean. It is without the natural protections of its prior reefs and marshlands following wanton modification by unchecked development and decades of abuse by tourism. Therefore, it can forge a path and expand the knowledge base upon which other American coastal cities can draw. In the next decades, Honolulu will set precedents, one way or the other ... I'd like them to be a good ones.

Existential into Actionable

With a real world problem identified, I needed to know that I could refine my existential questions into <u>one question</u>, which was both answerable & actionable ...

Can humanity live at the water's edge in harmony with nature?

Can compelling tropical tourist attractions and local amenities be made to simultaneously serve as protective infrastructure?

How can landscape architecture refortify Waikiki's vulnerable coastline by refocusing on resilient solutions that continually refuel our tourism-driven economy?

The Cost

Absolute costs are both complex to derive and beyond the scope of this project. However, a meaningful assessment of what is risked by inaction is easily related by simple, key metrics. Below is an infographic that illustrates 3 key metrics. They are: 1) homes damaged/destroyed, 2) people dead/displaced/distressed, and 3) income lost. Because, long before Honolulu is fully submerged by the sea, big storms will lift the ever-rising Pacific directly into Waikiki for a minute, or an hour, or a day. In any case, the losses will be catastrophic. In fact, the losses will be on the scale of 23,300 housing units affected by flooding-related damage or inaccessibility. 46,000 residents & employees + 2.7 million visitor will experience limitation or loss of life, limb, property, income, or liberty. And \$15.2B in revenue per year will be lost. And that's just for the 1 square mile neighborhood of greater Waikiki. Visually it looks like this:



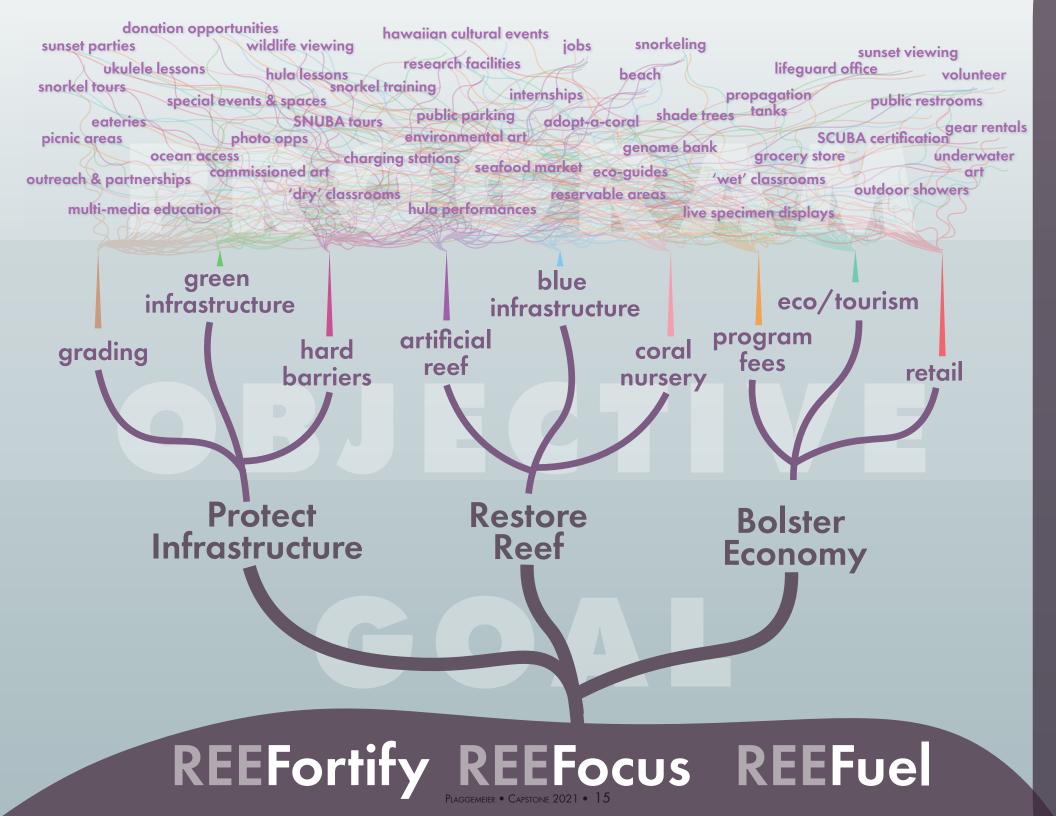
A Clear Path Forward ...

I love the process of working from chaos to clarity. And in this case, solving the problems we face will involve virtually everyone and everything ... such is the nature of global change, I suppose. Therefore, thinking both long- and short-term, I believe that most, if not all, of the issues that will arise in the public demand can be sorted into these 3 wishes on the genie's lamp:

- 1. Protect what we have.
- 2. Make the protections stronger over time.
- 3. Make the protections advantage us, with no overt losses.

Considering these wishes (demands) did make me think, "Wow, I wish we had a genie," they also helped me define a set of achievable goals (the needs), objectives (the available tools), and begin to consider the types of programs that a well-designed solution could offer.

The infographic (page right) lays out my goals, objectives, etc. in a coral growth 'tree.'



Methodology - Biomimicry

For years I've been fascinated by and following the field of study called biomimicry. I believe that the study of biomimicry offers exciting, relevant, and intelligent solutions that have yet to be implemented at a scale sufficient to protect an entire city's primary coastline and economic engine. I'm excited to see what I can find, discover, or invent based on the 'intelligence' demonstrated by living organisms with the benefit of eons of evolution. Basically, I'd like to see how I can apply the study to landscape architecture as these examples from other disciplines have done for their respective fields.



Shark Skin » Speed Suit



Weeds » Velcro[®]



Beaver Pelt » High Performance Wetsuits



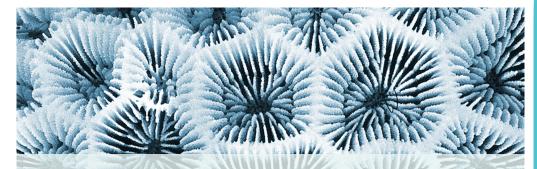
Stenocara Beetle » Water Collecting Fabric

What is biomimicry?

Biomimicry is learning from and emulating natural forms, processes, and ecosystems to create more sustainable design. ~ Janine Benyus

The simplest plants and animals have succeeded for millennia ... utterly without our input. Perhaps the best, most resilient, future-proofed, growth-promoting, and responsive design is found with them. Biomimetic designs have been shown to be smart, naturally harmonious/ nature-embracing, adaptive, and beautiful. Drawing on successful templates in nature this project explores these models at a new scale.





1. Mimic Natural Form





2. Mimic Natural Process



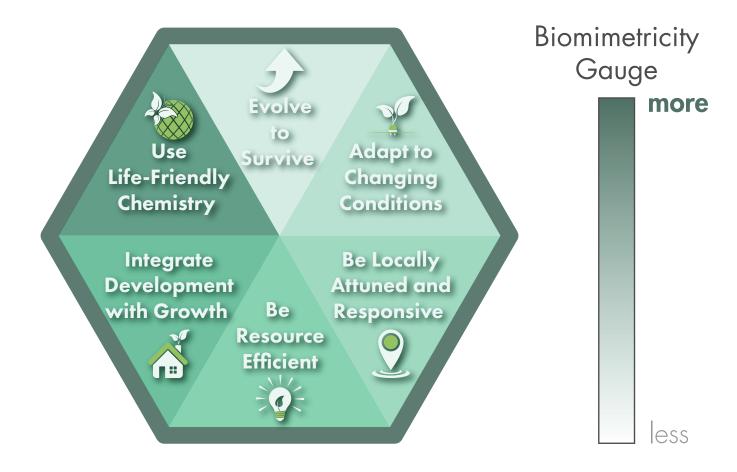
3. Mimic Natural Ecosystem



Methodology - Biomimicry

In her book "Biomimicry: Innovations Inspired by Nature" published in 1997, Janine Benyus coined a new term and codified a new discipline. Biomimicry describes design solutions inspired by processes and structures found in nature. Initially, she provided the 3 levels of biomimicry shown on the preceding page.

On Biomimicry Institute's website, Benyus further details "Life's Principles," which are 6 categories that define measurable actions designers can aspire to. As appropriate to this project, I allowed her rubric to inform my design decisions. I created the "biomimetricity gauge" as a way of revealing how successful I believe I was.



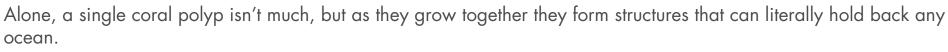
Metaphor – coral reef

There was no search to be done for a design metaphor as the choice was obvious to me from the beginning. In my younger years, I raised corals and know there is a wealth of inspiration in the reef. I also know that the 'stony' or reef-building corals are of the subclass: hexacorallia (pictured right.) They have a generally hexagonal structure, which tiles perfectly and is the strongest polygonal shape in the universe with its three 120° angles.

Colony

Say it with me:

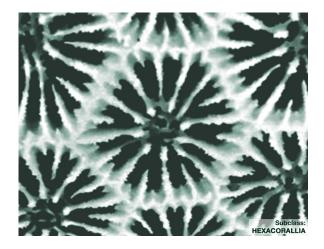
Hexagons are the Bestagons! ~ CGP Grey, YouTuber



Individual(s)







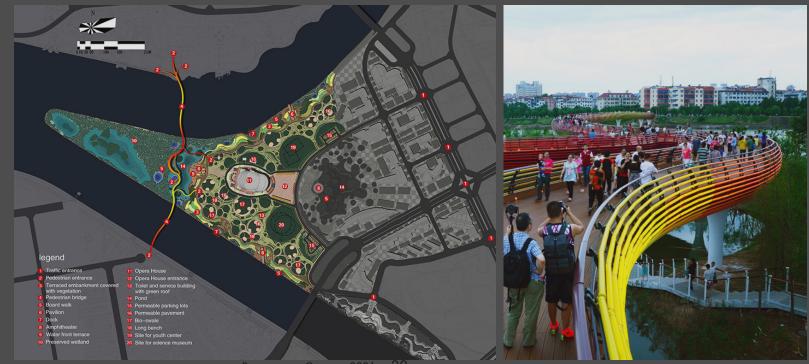


Yanweizhou Park

Typology: Flood Resilience, Bridges and Piers Firm Turenscape Location: Jinhua City, China

Jinhua City, China, like many Chinese cities, put up a flood wall around a riparian zone park to keep it dry during the annual monsoon season. The 'park's' ecology faltered and it became an unused, community-dividing eyesore. By developing an elevated bridge park, taking down the flood wall, and allowing the annual floods to return, the park was restored to its natural riparian beauty. The bridge-park, resembling a dragon, has reportedly deepened residents' and visitors' connection to the national and local culture.

- Flood permissive design
- Create connections between communities



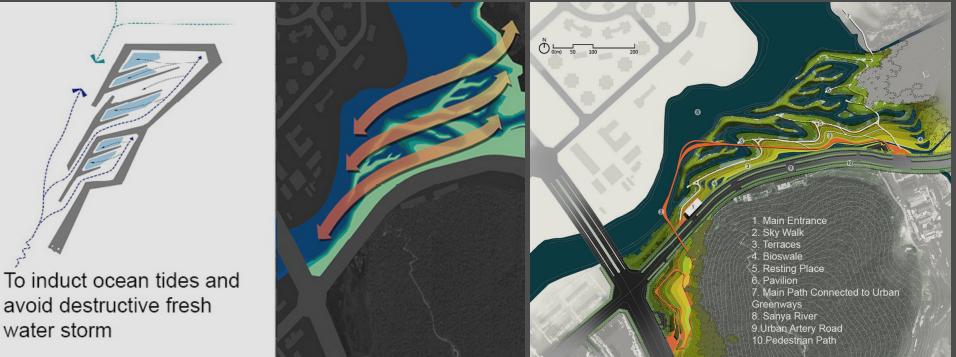
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Deep Form of Designed Nature

Typology: Ecological Restoration, Flood Resilience Firm: Turenscape Location: Sanya City, China

A 25-acre, ecologically critical site at the convergence of the Sanya River and Pacific Ocean floods daily due to tidal surge ... worse during times of heavy rain. Terraforming inter-locking "fingers" of mangrove increased the river's edge effect and diverted ocean tides into the flood-friendly park, away from the river. A network of pedestrian walkways that flow along the finger's banks, dotted with shady pavilions inspire visitors to enjoy the natural beauty without overheating.

- Use nature as a mitigation against flooding events and sea-level rise
- Work with nature, not against it
- Provide opportunities for people to interact intimately with nature



St. Pete's Pier

Typology: Bridges and Piers Firm: Rogers and Associates Location: St. Petersburg, Florida

St.Pete's pier has had multiple identities. It began as a pier for a railroad serving the fishing boats unloading product and equipment. Later it was developed into a recreational pier with a restaurant. The aging structure became an afterthought on the cities shoreline. Inspired by the pier's past and community input, the new pier, completed in 2021, has been rebuilt to include an ecology education center and is again a vital part of the community's new 'Pier District.'

- An historic but 'dead' location is an opportunity to revitalize a community and refocus it on ecosystem preservation
- Promote human connection with nature



Barangaroo Reserve

Typology: Waterfront Redevelopment Firm: PWP Landscape Architecture Location: Sydney, Australia

Barangaroo Reserve reversed 'Millers Point' concrete container port and restored the natural park-like headland. Visitors are guided by historical maps and paintings the a park of over 75,000 plantings native to the Sydney region and a new foreshore of 10,000 sandstone blocks excavated directly from the site. Both its name, Barangaroo, and the restored natural beauty honor relationship between the archipelago islands and Sydney's and the importance of the city's indigenous people.

- SLR mitigation can be both functional, beautiful, and a usable amenity
- Use available, local materials



GENERAL SITE SPECS

In the hope that this project will serve as a 'seed' (proof of concept) that can scale to protect Waikiki's entire coastline, I propose to develop Waikiki's 'back 40' (technically, its back 6). It is furthest away from today's primary tourist activity on Waikiki's renowned beaches, largely overlooked, equally vulnerable, and contains only ruins & obsolete structures. Observations of current users show that it serves primarily as a tiny parking lot & an impromptu crosswalk for local residents who wish to access the ocean. As a starting point for construction it is least likely to interrupt Waikiki's status quo. Its current features include:

- ~6 acres of flat, oceanfront land & ~3 acres of coastal ocean floor
- Waterfront location in Honolulu, HI, in the tourist district of Waikiki
- Consists of 4 tax map keys (TMK)
- Contains:
 - Waikiki WWI Memorial Natatorium
 - The Waikiki Aquarium
 - The Waikiki Marine Conservation Zone
- Site is bound to the:
 - WEST by the Pacific Ocean
 - EAST by Kalakaua Ave
 - NORTH by Kapiolani Beach Park
 - SOUTH by the 'gold coast,' a residential zone made up of midrise and boutique condo towers

WAIKIKI

OAHU

HONOLULU

- A Residential Zone
 B Park Space
 C Roll Call of Honor

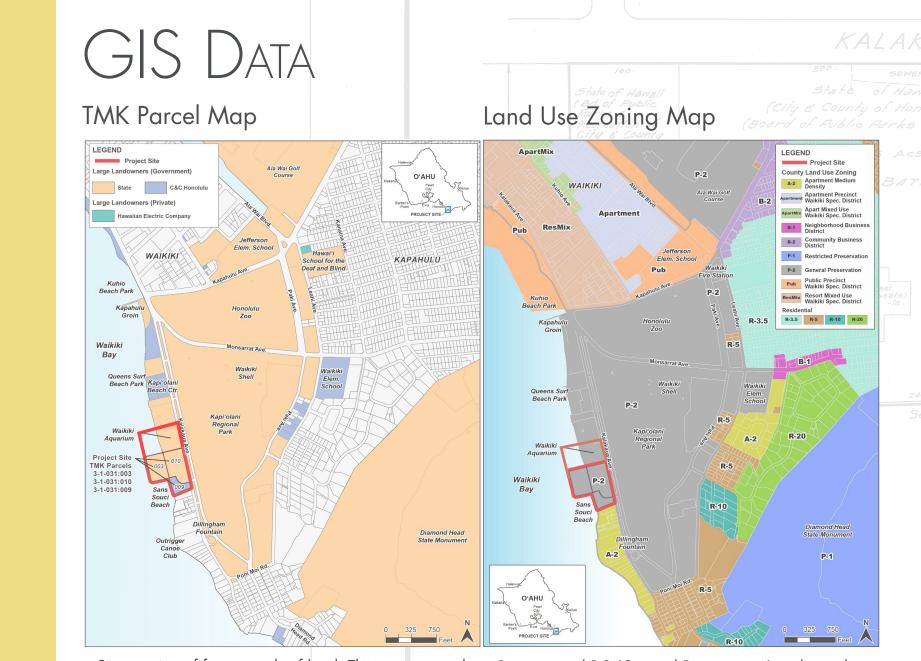
- Volleyball Court D
- E Parking
- F WWI Memorial Natatorium
- **G** Exhibition Space
- H Waikiki Aquarium
- Waikiki Marine Conservation Zone

F

- 🤳 Kapiolani Park
- K Kapiolani Beach Park
- L Kaimana (San Souci) Beach

150'

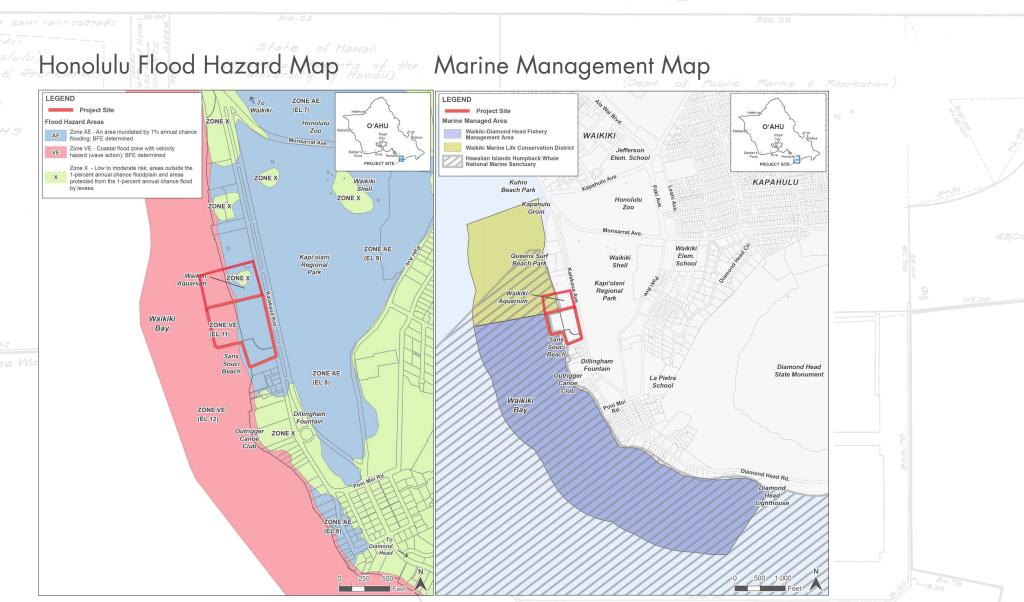
K)



Site consists of four parcels of land. Three are owned by the State of Hawaii. One is owned by the City and County of Honolulu. The Waikiki War Memorial Complex and Waikiki Aquarium predate modern zoning regulations and their uses do not conform to the existing regulations. Site is zoned P-2 (General Preservation) and is within the Diamond Head Special District. The goal of the preservation district is to reserve and manage significant open space, recreational lands, and lands of scenic and other natural resource value.

AUA

AVENUE



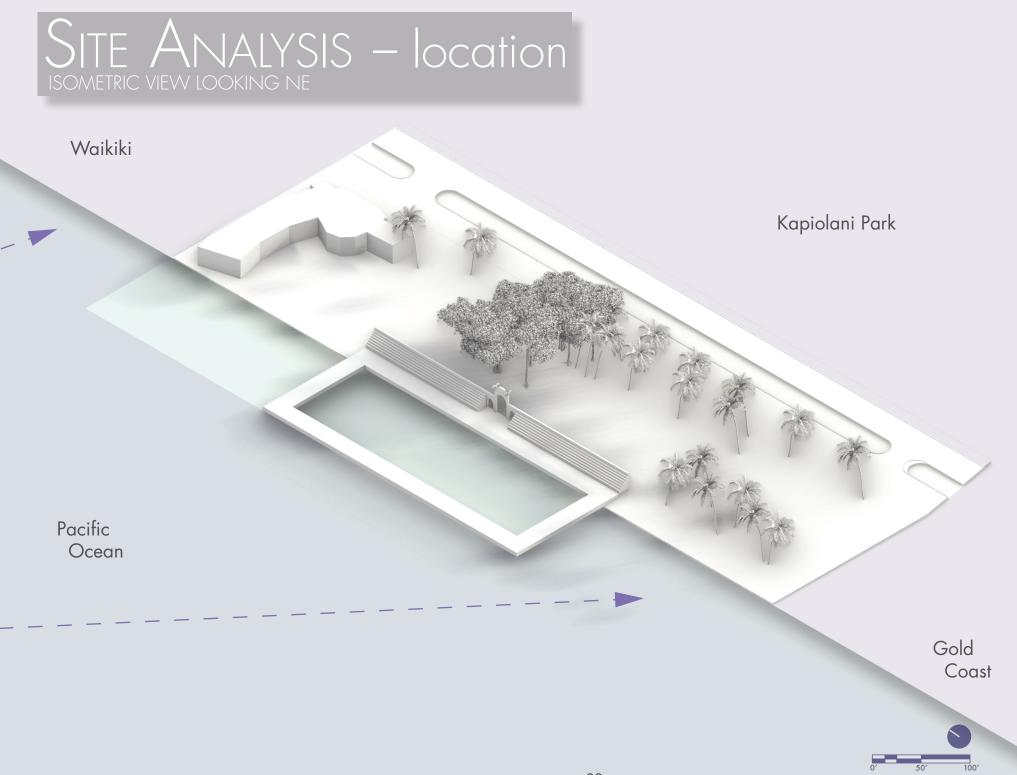
The Waikiki coastal zone has been assigned a moderate to high overall hazard assessment score by USGS. A low coastal slope makes it especially vulnerable to damage from large storms and seasonal high wave flooding. The site contains two managed marine areas: the Waikiki Marine Life Conservation Area & the Waikiki-Diamond Head Fishery Management Area.

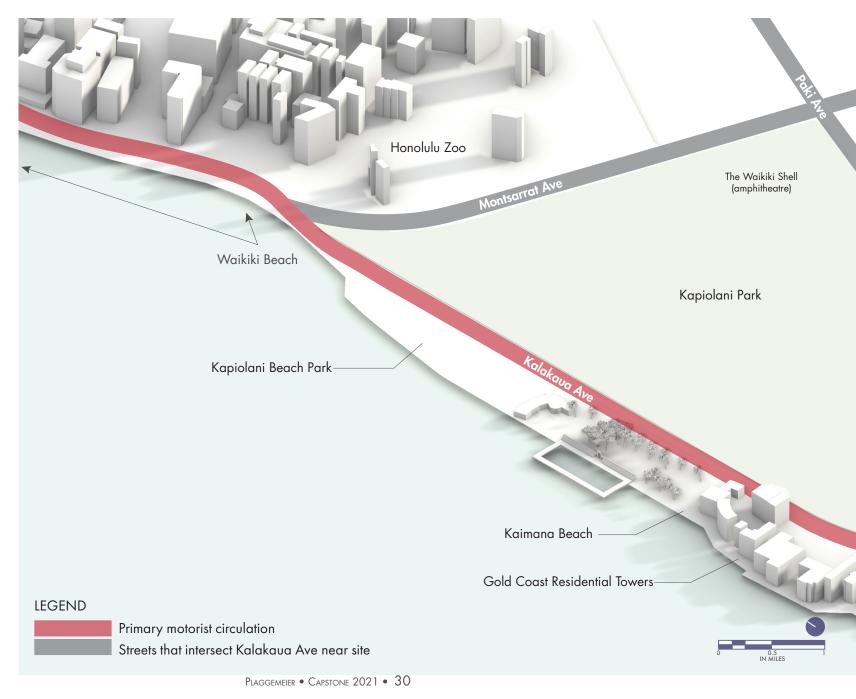
- ADDITION TO MEMORIAL PARK- PART A POR. EXEC. ORD. 3943

ADDITION TO MEMORIAL -PARK - PART B FOR EXEC. ORD. 3943

Background: City and County of Honolulu Plat Map

Waikiki	
	Kapiolani Park
Pacific Ocean	Gold
REGIONAL ANALYSIS -	- location
	0 0.5 1 IN MILES





SITE ANALYSIS - circulation

LEGEND

Lo Walkiki via seawall promenade

.......

- Secondary pedestrian circulation
 - Primary pedestrian circulation (sidewalk along Kalakaua Ave)
- •••••••• Pedestrian desire paths

Crosswalks

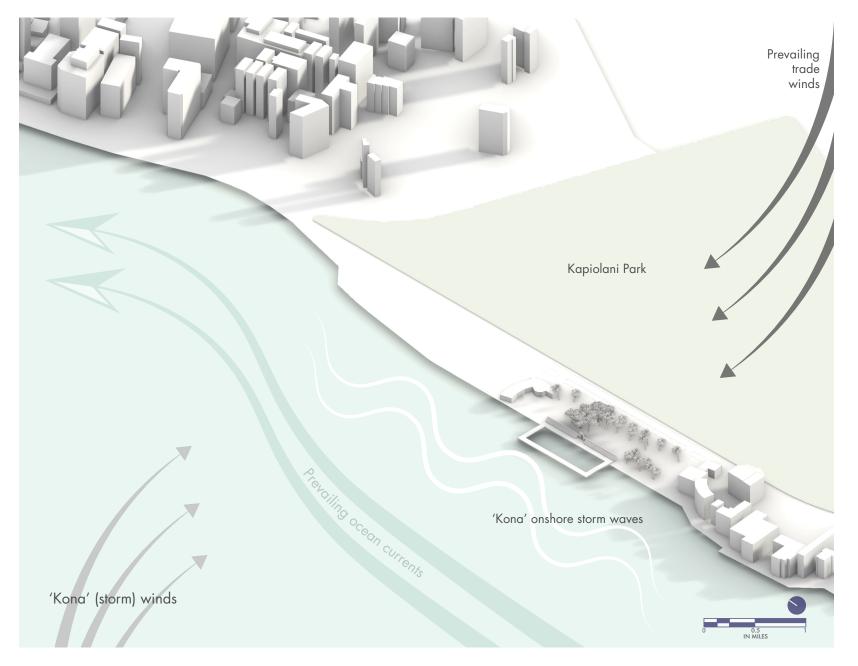
Single lane automobile circulation with parallel parking

Angle-in parking/parking lot

Ocean ingresses/egresses

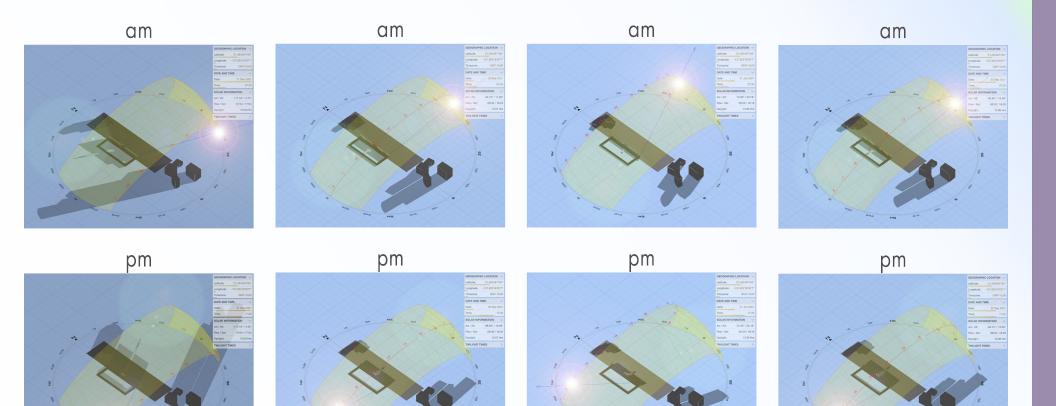
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SITE ANALYSIS – wind & waves





Winter Spring Summer Autumn



SITE ANALYSIS - connectivity

<u>KEY</u>

'Da Bus' Route

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- School/University
- 🕭 Biki
- Point of Interest
- 🗎 Lodging
- Surf/Swim/Snorkel
- H Hospital
- Solice/Fire
- Project Site
- 1-mile radii

SITE ANALYSIS – significant tree inventory



Banyan Ficus benghalensis

Not saltwater tolerant. Banyans on site are estimated to be over a century old.



Hau Tree Hibiscus tiliaceus (not pictured)

Tolerant of short-term inundation with saltwater. Culturally significant to Native Hawaiian medicine and sailing.



Coconut Palm Cocos nucifera

Tolerant of short-term inundation with saltwater. Historically & culturally significant as food of the monarchy.

The Waikiki Aquarium

The Waikiki Aquarium, originally built in 1901, is the 2nd aquarium built in the U.S. and it is really showing its age. The facility is small, sorely outdated, and patronage has dropped sharply decade after decade.

Worse yet, its grounds experience regular inundation by the ocean. The aquarium is built 12 feet from the current sea wall ... a wall that is overtopped by Honolulu's high-high tide (aka "king tide") at least twice yearly. The extent of flooding and resultant damage varies with the height of the king tide and the weather conditions (i.e., wind) at the time.



The Waikiki Aquarium sits a mere 12' from the ocean, and, at sea level.



Limited tourist and resident activity has resulted in limited investment in maintenance of the grounds and frontage.

3. The Waikiki Aquarium, built c. 1955

 \bigcirc

SITE PHOTO KEY MAP

The Waikiki Natatorium War Memorial

In 1927, the Waikiki Natatorium War Memorial opened. The structure is in the beaux-arts style ans was meant to be serve as a living memorial to Hawaiian residents who fought and died in WW1. Unfortunately, the quality of the construction materials used and the uninformed design of the pool have plagued the building since it opened. It closed after 2 years due to structural concerns and poor water quality. It was intermittently open between the years of 1929 and 1965. Hopes to restore it prevailed from 1965 until it was declared permanently closed in 1979. Today it stands crumbling slowing into the Pacific, a blight, not a tribute, to the people to whom it is dedicated. It is circumferentially fenced off with warning signs. Discussions continue about reviving the natatorium, however, those discussions never include planning for climate change and sea level rise. In 2018, an environmental impact study (EIS) was performed and found that anaerobic sedimentation has generated 5-7' of toxic sludge in the pool.



Limited tourist and resident activity has resulted in limited investment in maintenance of the grounds and frontage.





Previously a hau tree arbor, the trees long ago succumbed to intermittent saltwater flooding.

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32323

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Pool deck has deteriorated and is collapsing into the ocean.



A lovely tribute that was never well-adopted by residents or tourist.

5. The beaux-art facade of Waikiki's crumbling war memorial.

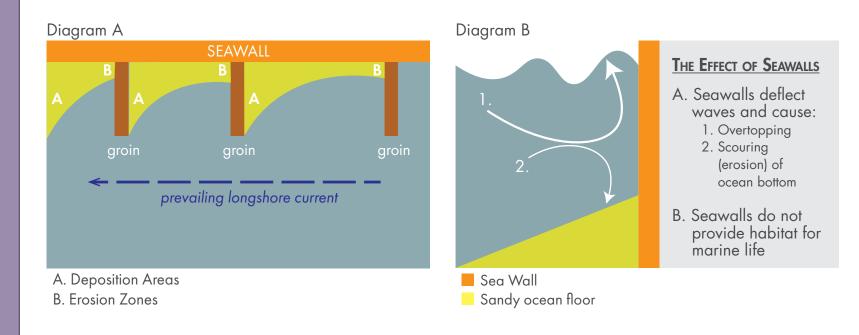
Seavvalls & Groins

History of Waikiki's Shoreline

Waikiki's shoreline, originally marshland, has been heavily modified with landfill onshore and dredging offshore. Waikiki Beach is man-made and maintained for tourism by building seawalls and groins. These structures have succeeded in maintaining the 'tropical getaway' found in brochures since the 40's but they've also had unexpected environmental consequences.

The purpose of seawalls and groins is to interrupt the natural redistribution of sand. (See diagram A, below.) Secondarily, they cause unwanted erosion ... the price to pay. (See diagram B, below.) The proposed project site has experienced both, significantly.

The natatorium pool walls together act as a groin, disrupting the natural northwesterly, longshore transport of sand. The result is accretion on the pool's south side and erosion on its north.



Sand accumulates strongly on the pool's south wall and is stripped from its north.

and a

TI

SEA LEVEL RISE (SLR)

- SECTION RIGHT SIDE - SEA - WALL-- ON - LINE - A - A -

We can't see it. Some people say they don't believe in it. But, it's here and what we don't pay for now will cost us immeasurably more later. Setting denialism aside, we can best prepare by understanding current models on SLR and following the advice of qualified researchers, like those at the National Oceanographic and Atmospheric Administration (NOAA). In 2017, NOAA recommendations are that, "... any waterfront development intended to last 50 or longer should prepare for at least 6' of SLR over the same period of time."

Below is a map of this projects proposed site showing NOAA's model of what only 1.1' of SLR will look like. The natatorium and aquarium are nearly invisible below the 'water.'



A Closer Look

Since releasing their recommendations to the state, NOAA has acknowledged that their predictions were intentionally conservative (to ease the truth for policy makers and not appear alarmist). However, current SLR measurements are outpacing earlier predictions in a significant way. NOAA's predictions, while conservative, for a non-catastrophic, worst case scenario (i.e. if we continue to fill the atmosphere with greenhouse gases at the rate we are today) put maximum SLR in Waikiki at 11'6" by 2100.

Moreover, since the 2021 IPCC report predictions are worse than NOAA'S 2017 modeling, in the diagram below (and the level to which this project provides redundancies in protection), considers a typical high surf level in Waikiki *plus* 11'6" of SLR for a total of 13'6" and is called W.H.I.P. C.R.E.A.M! (What Happens If People <u>C</u>an't <u>Reverse</u>? <u>Absolute Madness</u>!)

SECTION OF NATATORIUM

30

W.H.I.P. C.R.E.A.MI

6' Sea Level Rise Current sea level Original floor of natatorium

4'-5' of sediment

DETAIL TRANSVERSE-SECTION-GRAND STAND SEA WALL DUTTRESS

SEA LEVEL RISE (SLR)



Sep 2021 - low tide

Sep 2021 - high tide

Rendering: 6' SLR

Rendering: 11'6" SLR

"When I was a child, I spoke as a child, I understood as a child, I thought as a child: but when I became a man, I put away childish things."

1 Corinthians 13



6′ by 2070

Visualizing SLR

11′6″ by 2100



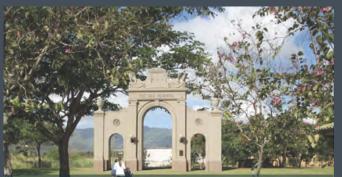
A Hard Truth

Sentimentality is a human condition and one I very much appreciate in my own life at times. While researching this project, especially while researching the history of the natatorium and Waikiki's ongoing SLR, I learned that I am not alone in my love of sentimentality.

Every year or so, there is a push by Hawaii to demolish the natatorium and restore a beach. And every time, a well-meaning citizen's group appears in court to stop the action.

It's past time to end the discussion of restoring or 'saving' the natatorium. Full stop.

Before the ocean takes the whole of it, I propose that, if possible, we salvage the memorial arch and move it to Kapiolani Park across the street where it will be protected and can stand, once again, a proud and historic tribute. Additionally, the on-site 'living memorial' dedication will be transferred to a *truly* living memorial, as is detailed later in this proposal.



How the memorial arch might look in its safe, new park setting.

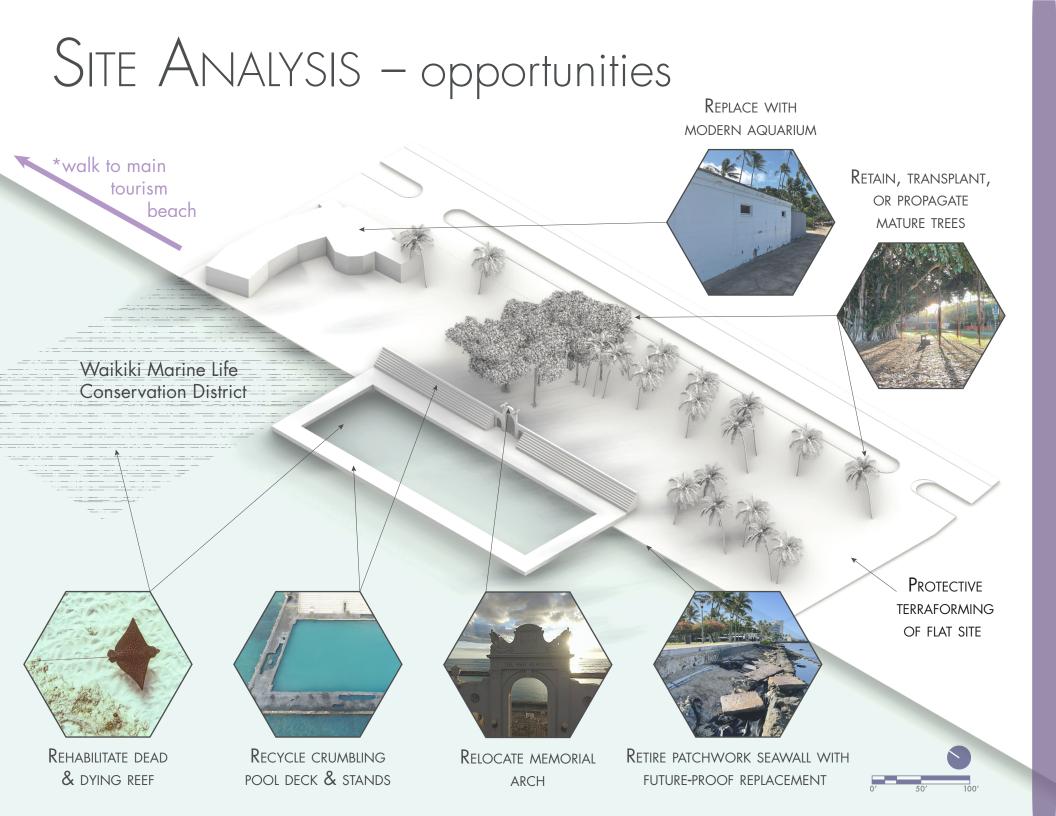
SITE ANALYSIS - constraints

- Kalakaua Ave is an essential artery & has no alternate route; must be protected
- Lifeguard office will need a new home

Waikiki Marine Life Conservation District

- Strict laws protect marine zone from harm & development
- Natatorium registered as:
 1. National monument
 2. Historic building
- is revetment for Kaimana Beach; must remain; rebuild

• Groin (south pool wall)



STAKEHOLDERS (USERS)

The stakeholders, i.e., end users, who will benefit from this seed project will change over time as the seed takes hold, grows to encompass the entirety of Waikiki, and evolves to address the expressed needs of its users. However, the benefits of a successful seed project will begin to impact, to varying degrees, all stakeholders in positive ways immediately. With the notable exception of the first on the list, the following user groups are identified in no order of preference, priority, or benefit.

"Keiki First"

Regarding the schooling of children, American philosopher, John Dewy correctly surmised that, "Education is not preparation for life; education is life itself." This sentiment was furthered by South African President, Nelson Mandela, who identified education as, "... the most powerful weapon which you can use to change the world." On all levels, the success of this project will be measured by its prioritizing of immersive education with an emphasis on accessibility by children of all ages.

SCIENTISTS/RESEARCHERS/STUDENTS & EDUCATORS

Partnership, education, and employment opportunities benefit the students and faculty of the Dept. of Oceanography in the School of Ocean and Earth Science and Technology at the University of Hawaii at Manoa (ranked 16th globally in 2020). Resident and guest scientists & researchers from NOAA and other related marine science fields will have another facility to conduct their work.

LOCAL & HYPER-LOCAL RESIDENTS

As of 2021, there are 963,973 military and civilian residents on Oahu, 40% of which live in Honolulu. Many more commute for work and play. The loss of Waikiki Beach alone is estimated to result in a \$2B annual drop in visitor spending. Waikiki generates about 6.5% of the State's GDP and 7.9% of the State's tax revenue.

THE WORKFORCE

Despite being only 1% of Hawaii's land area, Waikiki employs ~28K people daily, at least 1/3 of whom commute to work from outside the neighborhood.

MILITARY & VETERANS

Hawaii has the largest number of veterans and active military members per capita of any state in the union. They care that the Waikiki Natatorium War Memorial stands tribute to their fallen comrades as an eyesore, a barricaded public safety risk, and a forgotten ruin crumbling into the sea. This project will, to the extent possible, relocate it inside the protected area of Kapiolani Park where it will be safe from the destructive forces of the sea that have plagued it since its dedication.

NATIVE HAWAIIANS

Hawaii's cultural identity is intertwined with the ocean and it plays an integral role in everyday life. This project celebrates and creates opportunities for new spiritual and physical connections.

PARK & FACILITY EMPLOYEES

The City Department of Parks and Recreation is currently responsible for park operations. This work load will be redistributed between the new facilities management and the City Department of Parks and Recreation. The expected increase in visitors will require additional staff and a volunteer community.

BUSINESS OWNERS

From small shops that peddle tchotchkes to tourists to mega-hotels, business owners have invested on Waikiki's frontage road, Kalakaua Ave. A \$100M face lift to the street that extends along the northern Waikiki waterfront prompted businesses to invest an additional whopping \$535M and private sector investments of \$3.4B to update and upgrade the infrastructure as of 2011. Those owners will appreciate the protection of their investments.

PROPERTY OWNERS

Blocks off Kalakaua Ave stand a massive, cramped collection of 1960s/70s-built residential buildings. Combined, they represent the second most densely populated area in Honolulu, with 25,261 people per square mile. The streets on which they stand are vulnerable to any ocean inundation that breaches Kalakaua Ave. Flood damage would bankrupt the majority of owners in these high cost, low quality buildings.

Color blocking space uses

Open Plaza Space

Park Space

- At least one acre
- Safe & ADA compliant pedestrian access into and out of park, including: walkways, seating, shaded areas
- Large & small gathering spaces/picnic areas
- ADA compliant restrooms
- Trees and planted areas

Retail

Terraced Seawall & Promenade with Ocean Access Points - Access points will meet ADA requirements; no slope over 1:20

Reef Rehabilitation

Waikiki Coral Restoration & Genome Bank Eco-Aquarium

 Indoor facility and outdoor exhibits totaling 129,000 sq ft. and including:
 A coral genome bank | a coral nursery | a research facility | an immersive eco-aquarium | educational kiosks | performance space | seating areas | pathways | ADA-compliant public facilities

Dry Classroom

Wet Classroom

Outer Seawall & Groins

- A new seawall that is roughly 300' wide & tall enough to meet NOAA's 6-ft SLR recommendation

- Two groins each being roughly 100' long & tall enough to meet NOAA's 6-ft SLR recommendation

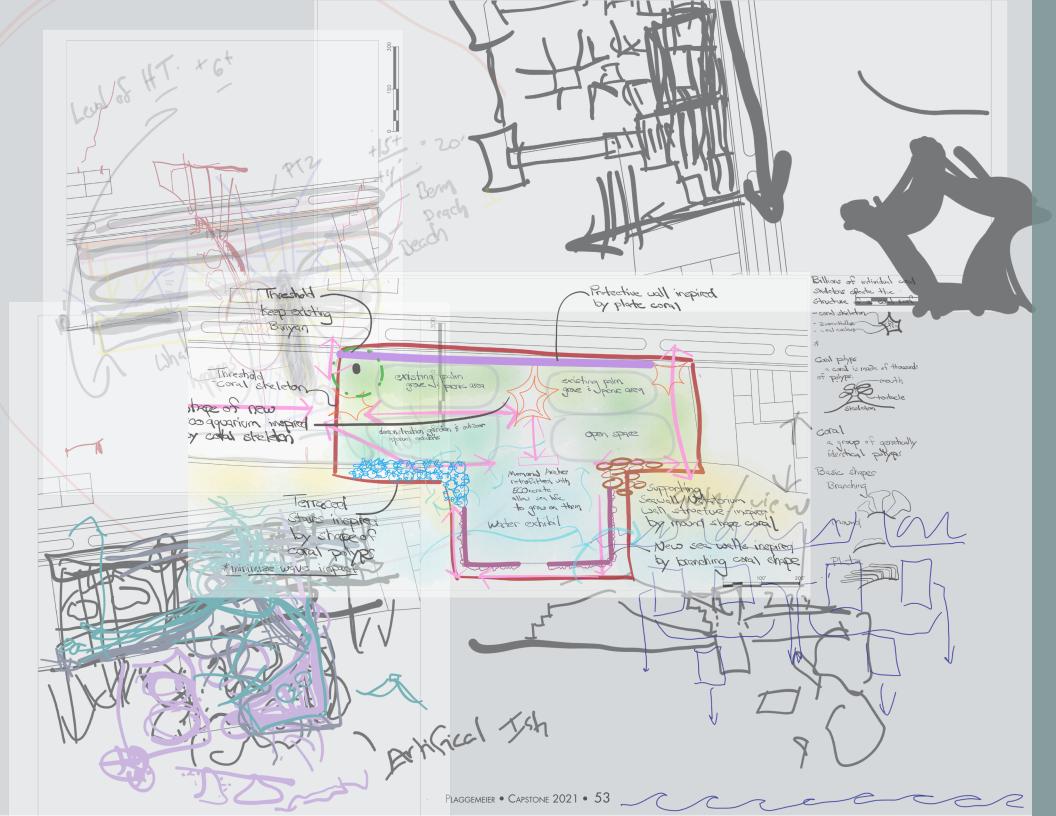
Visualizing Solutions

At some (perhaps arbitrary) point in my ongoing research, I feel well-enough-armed with relevant information to begin imagining possible solutions to known problems and answers to outstanding questions. Knowing that I cannot but be informed by the knowledge I've amassed about a project, I do my best to clear my mind of implicit constraints in order to see how big, innovative, and surprising the possible solutions I dream up are. I do a lot of erratic sketching, scribbling, and daydreaming at this stage. Most of what I generate 'on paper' is both fun and incredibly productive for me but u-u-ugly to look at. (See next page.)

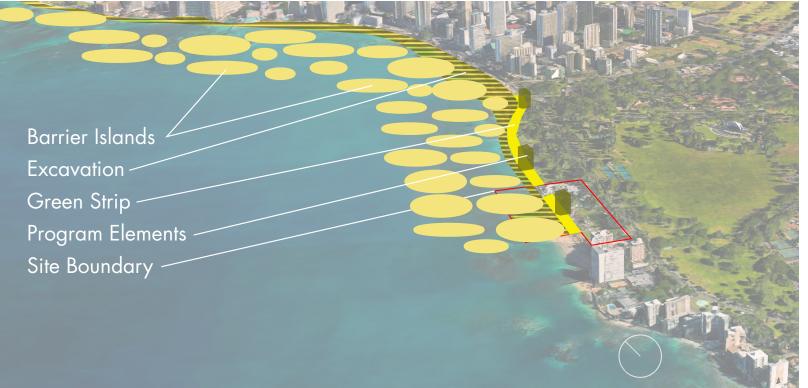
When a feeling of fatigue and epiphany descend upon me, I have typically generated several ideas that won't leave my mind and demand of me that I take a deeper dive. In this case, I felt I'd hit on three concepts viable for further investigation.

- A naturalized shoreline
- A combination seawall/berm with max height at the water's edge and backed by programming/park space in the inland side
- A combination seawall»berm»hidden seawall with max height further from the water's edge and programming/park space on both sides

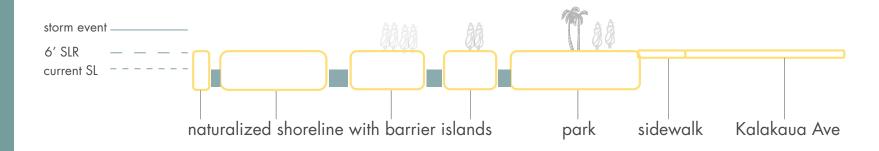
NOTE: It is in these deeper dives that I am able to stress test my ideas. For this project, and given the real world need for this design to be scalable across all of Waikiki, the follow concept development pages extend each design a full mile north beyond the proposed site boundary, which is outlined in red.

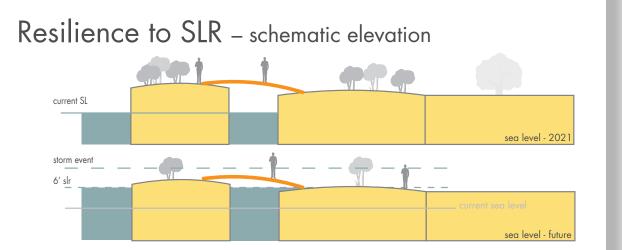


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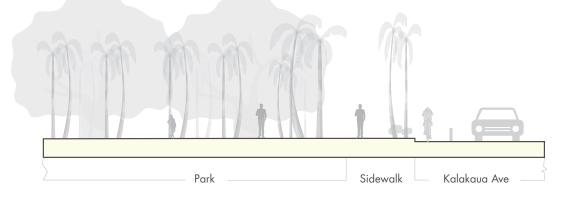


Shore/island – schematic elevation

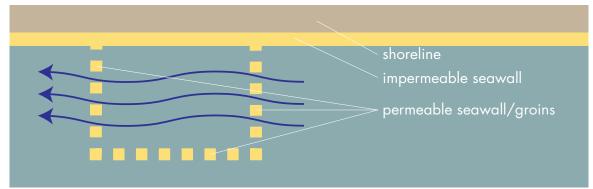




Retained street scape - schematic elevation



Permeable pool wall - schematic plan view





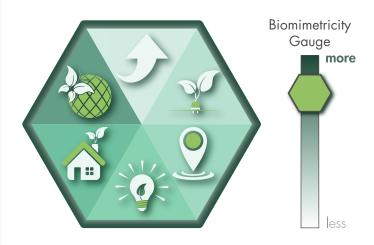
Strengths

- Disperses onshore wave energy
- Ecology restoring
- Unique user experience
- Scalable
- Provides engineered, protected coral growth matrix instead of sandy bottom

Weaknesses

- De minimis protection from SLR
- Insufficient protection of city
 infrastructure
- Requires destruction of existing reef to build with artificial reef/islands
- Little space remains for program elements

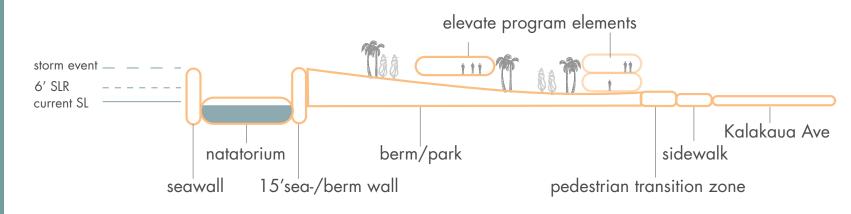
Conclusion: STOP



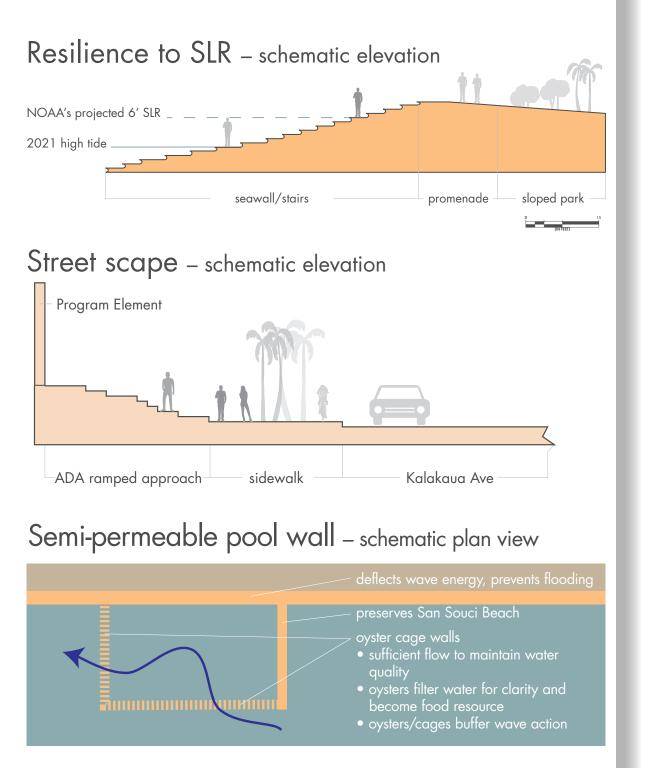
CONCEPT #2 – seawall»berm»park

15' Stepped Seawall Berm/Park Program Elements Sidewalk & Transition Zone to Street 15' Oyster Cage Permeable Seawall 15' Impermeable Seawall & Groin Site Boundary

Seawall to Street – schematic elevation



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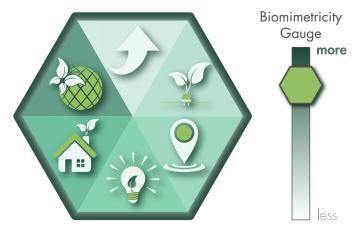
Strengths

- Disperses onshore wave energy
- Protective against SLR
- Retains large open park space and increases ocean access
- Scalable
- Establishes comprehensive reef research, rehabilitation, & restoration infrastructure

Weaknesses

- Alters experience for drivers
- Scaling would replace Waikiki's beaches with stairs
- Unclear if introduction of oysters is advisable

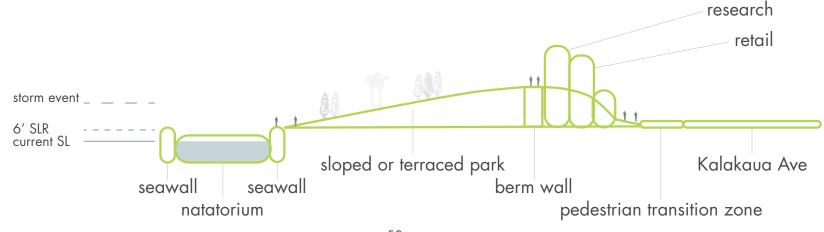
Conclusion: STOP



CONCEPT #3 – seawall»berm»seawall

Berm+Wall+Park Stepped Seawall Program Elements Plaza, Sidewalk & Bike Path Open to Ocean Impermeable Seawalls & Groin Site Boundary

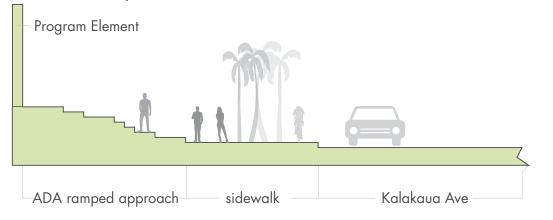
Seawall to Street – schematic elevation



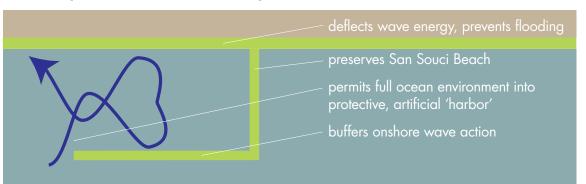
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Street scape - schematic elevation



Solid pool wall with open side – schematic plan view



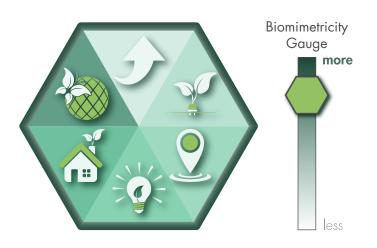
Strengths

- Disperses onshore wave energy
- Protective against SLR
- Increases open park & beach space, increases ocean access
- Scalable
- Establishes comprehensive reef research, rehabilitation, & restoration infrastructure
- Prepared to receive ocean by degrees

Weaknesses

- Alters experience for drivers
- Scaling elevates view plane for businesses & users

Conclusion: PROCEED



PROPOSA PROJECT

A BLANK SLATE PRIMARY GOAL: TBD | PRIMARY OBJECTIVE: TBD | METAPHOR: N/A

The existing structures having been decommissioned and/or moved we can begin to construct the project.

BIOMIMICRY CHECK

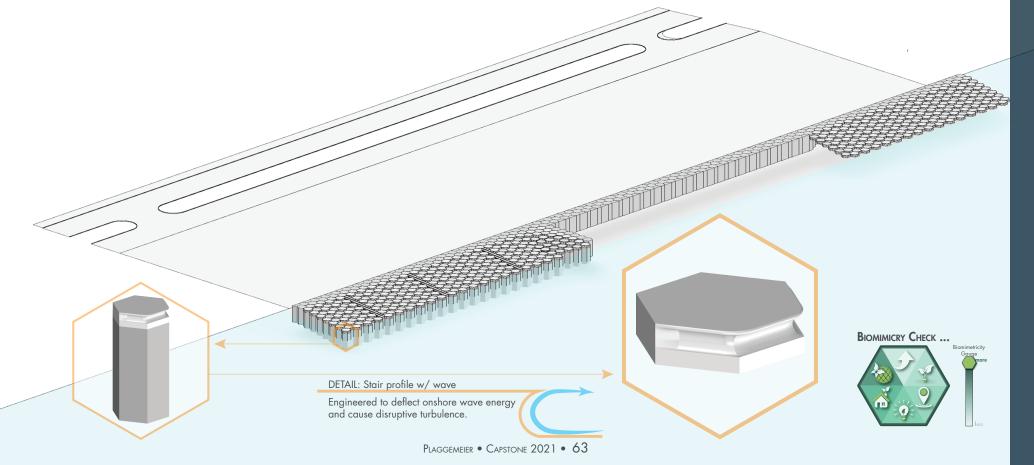


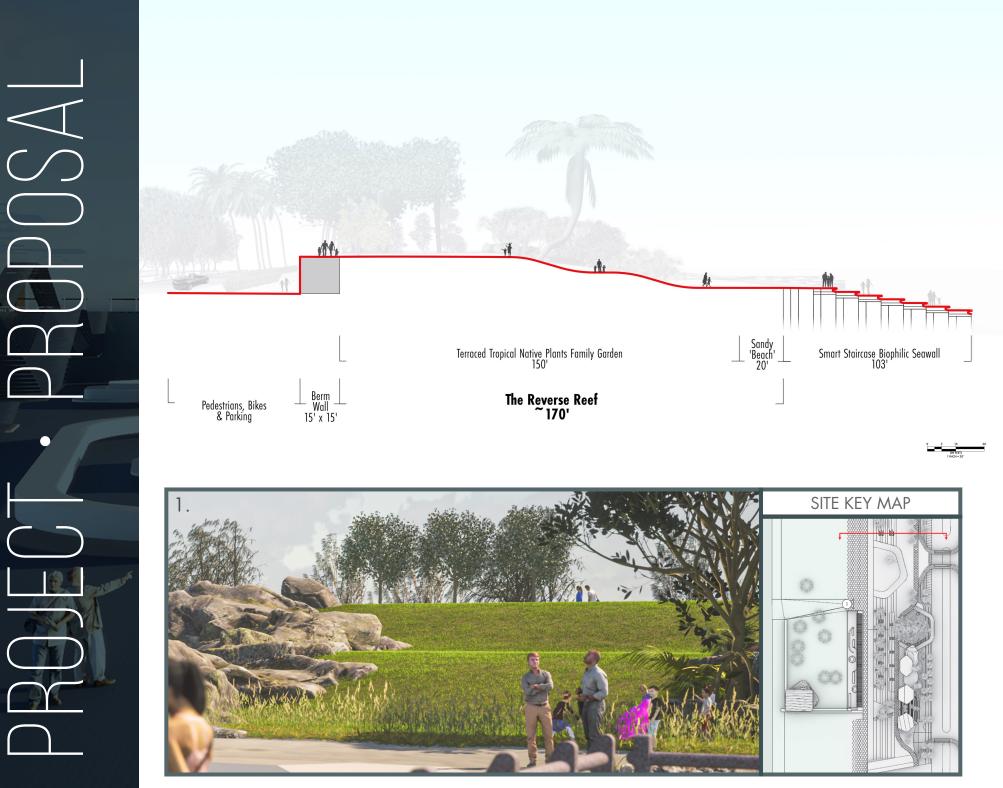
THE Q*BART STAIRS

PRIMARY GOAL: PROTECT INFRASTRUCTURE | PRIMARY OBJECTIVE: HARD BARRIERS | METAPHOR: HEXACORALLIA

Hexacorallia's hexagonal internal skeleton inspired the shape of this combination stair/seawall ... the first line of defense. This defensive structure meets NOAA's recommendations for 50-year protection against SLR. However, unlike a typical seawall, this structure provides safe and easy ingress/egress to the ocean along its full length. Each step has been engineered to break up onshore wave energy, provide a secure base for future corals and habitat for reef dwellers. It is intended to become part of the underwater landscape as SLR progresses in the next century.

- 'Smart' seawall that breaks up and redirects onshore wave energy
- 2-piece modular pillars for easy replacement of exposed topper
- Made of biophilic concrete (i.e., EcoCrete[™] or BioBlocks[™])
- Function as stairs AND seats as most 'steps' have 18' rises, with interspersed 'typical' staircases/handrails





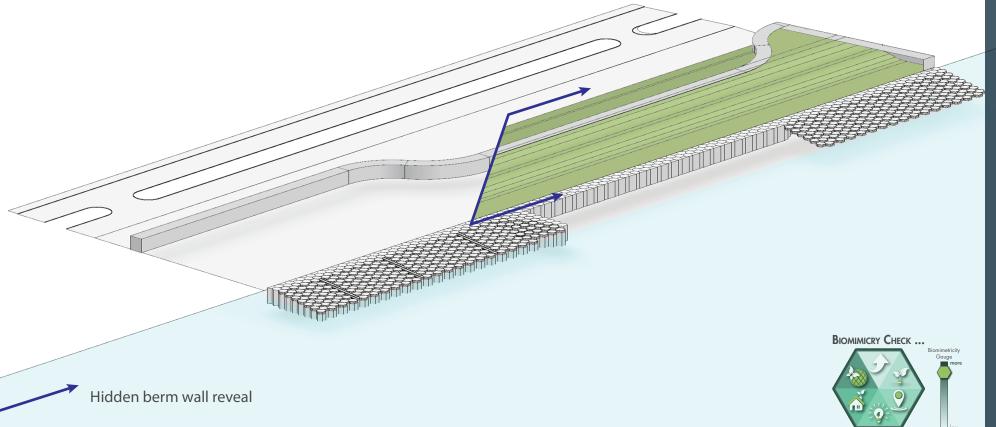
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A Reverse Reef

PRIMARY GOAL: PROTECT INFRASTRUCTURE | PRIMARY OBJECTIVE: GRADING | METAPHOR: FULL REEF ECOSYSTEM

This berm with hidden wall (see diagram below) divides the site into two sections. The seaward side, or 'reclamation' side, built to accept flooding and SLR. In inland side, or protection side, is safely behind a 15' partially buried seawall, called the 'berm wall,' and extends several feet above NOAA'S highest predicted SLR of 11'6." All elements that are or will be found on the reclamation side are designed to become foundation for reef building when they are permanently under water one day.

- 15'-tall, terraced 'run up' fronted with artificial "beach"
- "Beach" will be displaced up berm with future SLR
- Peek height exceeds the W.H.I.P. C.R.E.A.M! SLR line (see pg 41) by several feet and runs the full width of the site



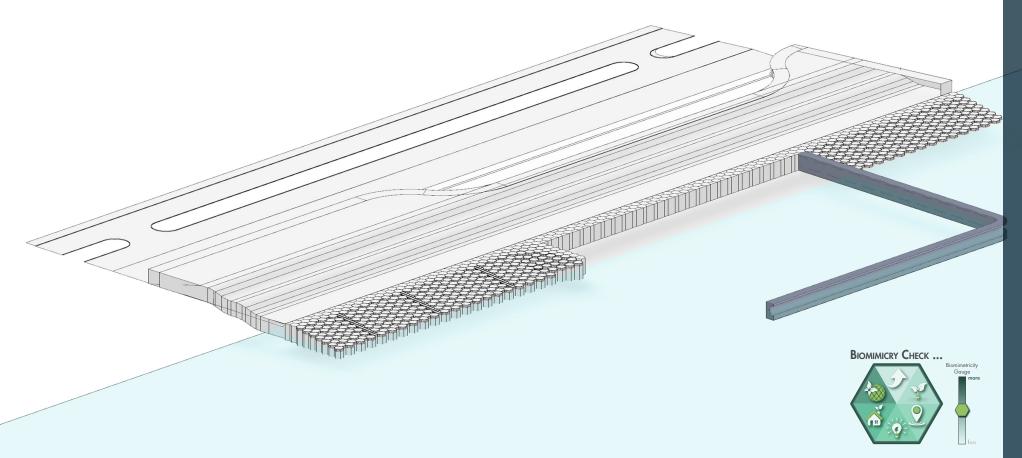
PROPOSAI • PROJEC-

SEAVVALL & GROIN

PRIMARY GOAL: REHABILITATE REEF | PRIMARY OBJECTIVE: BLUE INFRASTRUCTURE | METAPHOR: TABLETOP CORALS

The seawall and groin are protective elements. The seawall buffers onshore wave energy and together with the groin, deflect the longshore current energy without preventing water circulation. The groin serves as a replacement revetment for Kaimana Beach.

- Structure made of biophilic reinforced concrete
- Height is up to NOAA's 50-year, 6' SLR line
- Open to the ocean at one end to prevent stagnation & toxic anaerobic sedimentation



CORALS

Pictured below is a sampling of the corals that will do well at reef building and are diverse enough to create an ecosystem fit for Hawaii's tropical waters. Propagation efforts will focus on these native Hawaiian, tropical reef corals.

- 1. Low Acropora Acropora hemprichi
- 2. Carnation Coral Dendromephthya sp.
- **3.** Sunny Actinia Actinia fragacea
- **4.** Yellow Scroll Coral Turbinaria reniformis
- **5.** Brain Coral Diploria labyrinthiformis

- **6.** Groved Mosaic Coral Favia favus
- 7. Honeycomb Coral Goniastrea edwardsi
- 8. Pulsing Xenia Xenia umbellata
- **9.** Birds Nest Coral Seriatopora hystrix



WAIKIKI ECOQUARIUM | CORAL GENOME BANK | REVERSE OCEANARIUM PRIMARY GOAL: REEF RESTORATION & BOLSTER ECONOMY | PRIMARY OBJECTIVE: CORAL NURSERY & ECOTOURISM | METAPHOR: OPEN OCEAN

Old Waikiki Aquarium is replaced with two 16,000 ft², state-of-the-art, ecotourism/research/education/marine life facility, plus, two public event spaces. A 15,000 ft² reverse oceanarium that has the largest window-on-the-ocean in the world – and – a 7,500 sf, floating 'wet' classroom that will safely rise up its support posts, topped with wind turbines, to 50' above 2021 median sea level. All elements are resilient to or intended to be reclaimed by SLR.

- 1. Floating "wet" classroom with holding/display tanks
 - Pivoting roof, shingled in Tesla® PV shingles, tracks the sun and powers the entire site with clean solar & wind energy
- 2. Submerged coral propagation sculptures and racks for are made of biophilic concrete
- 3. Reverse oceanarium with ADA 'Rainbow Ramps' entries
 - Walls are embedded biophilic concrete seawall with temporary, non-toxic, marine life friendly facade
 - Seating is biophilic concrete with biodegradable smooth coat and embedded with colored aggregate

BIOMIMICRY CHECK

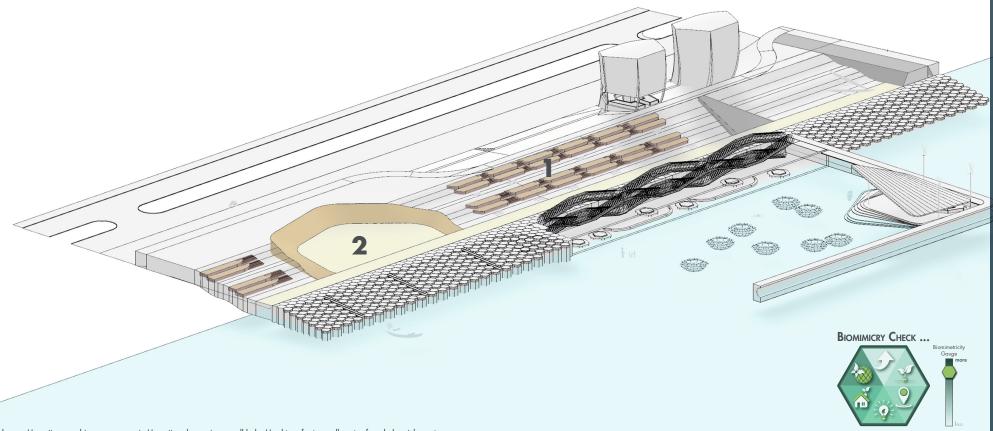




HAWAIIAN PICNIC * PUKAS & LONE NUT COVE

PRIMARY GOAL: PROTECT INFRASTRUCTURE | PRIMARY OBJECTIVE: GRADING & HARD BARRIERS | METAPHOR: ZOOXANTHELLAE

- 1. Hawaiian Picnic 'Puka' Gardens
 - Provide lush, semi-private, reservable, green "groves"
 - Picnic benches are made of colored biophilic concrete
 - Protective redundancy: terraced planting beds are fronted with rockeries that will break up future onshore wave energy
- 2. Lone Nut Cove
 - Public 'beach' and outdoor event space for hula and other performances
 - Protection redundancy: irregular rock structure will break up future onshore wave energy



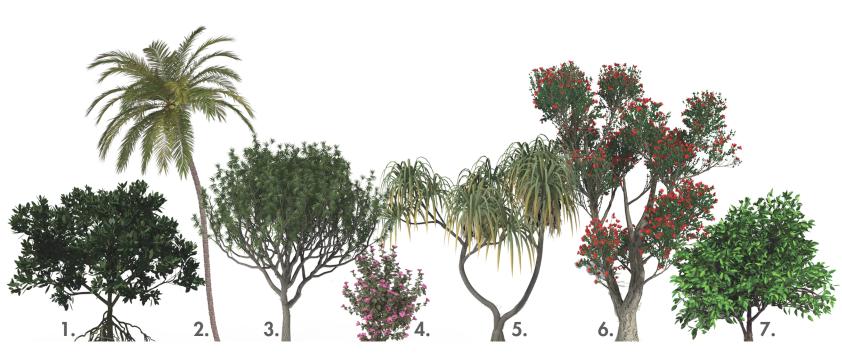
* Puka = a Hawaiian word in common use in Hawaii and meaning: small hole. Used to refer to small parts of a whole, niches, etc.

Trees & Shrubs

Pictured below is a sampling of the trees and shrubs proposed for planting this project. Some are culturally & historically significant to Hawaiian culture. Each is uniquely fit here ... some as beautiful additions to the protection side of the park; others are saltwater tolerant and known for their extensive root systems that stabilize soil.

- 1. Asiatic Mangrove Rhizophora mucronata
- **2.** Coconut Palm Cocos nucifera
- **3. Koa** Acacia koa
- **4.** Hibiscus Hibiscus

- **5.** Screw Pine Pandanus tectorius
- **6.** Ohia Lehua Metrosideros polymorpha
- **7.** Noni Morinda citrifolia

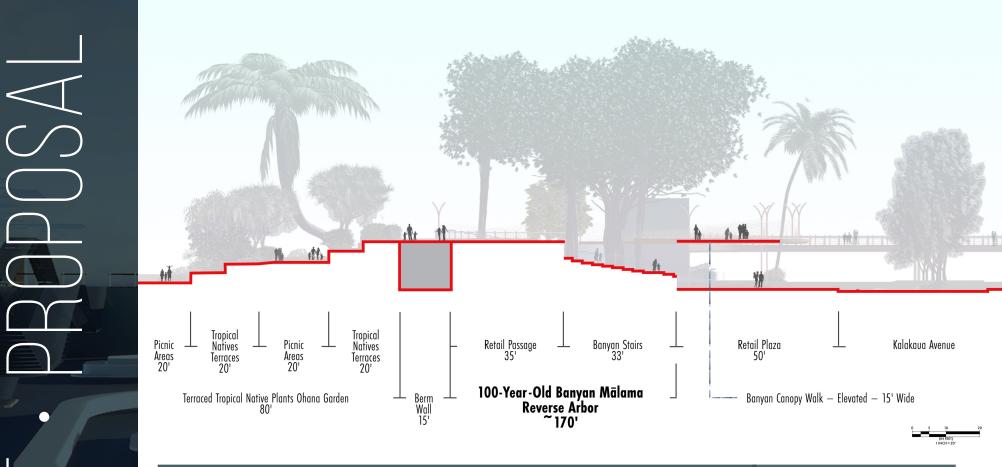


KEEPING IT TOGETHER PRIMARY GOAL: PROTECT INFRASTRUCTURE | PRIMARY OBJECTIVE: GREEN INFRASTRUCTURE | METAPHOR: REEF DIVERSITY

Beyond basic lawns, the 'reclamation' side of the berm will look at feel like a lush, tropical garden/park/coastline. Plantings from beachy ground cover to flowering shrubs and sturdy trees (detailed on pg _) were chosen from native and exotic tropical plants known to:

- Tolerate intermittent inundation with saltwater
- Stabilize hillsides
- Provide shade
- Tolerate periods of drought







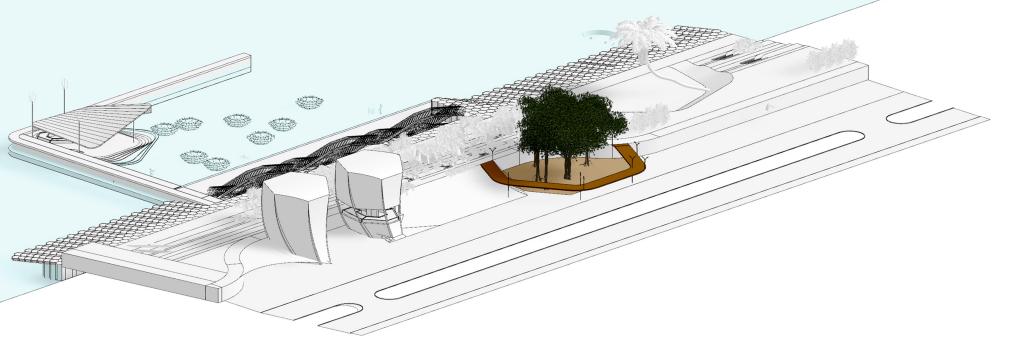
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Reverse Arbor Walk

PRIMARY GOAL: BOLSTER TOURISM | PRIMARY OBJECTIVE: ECO-TOURISM | METAPHOR: HEXACORALLIA

Banyan trees are part of the Waikiki experience and identity. They provide habitat for birds and shade for humans. Not tolerant of transplanting and slow growing, one of the two trees is far enough from the ocean to be saved and in the process, demonstrate the flexibility of the hidden berm wall for future scaling across the front of Waikiki hotels. While banyans essentially build their own arbor, this design provides a 'reverse' arbor that elevates visitors near the tree's canopy provides an uplifting and unique experience.

- The berm wall and canopy walk provide protection for the 100-yr-old banyan
- The banyan's canopy and air roots are prized for the 'magical garden' experience they create
- Conservation: saving a 100-yr-old tree that grows too near the rising ocean in 2021





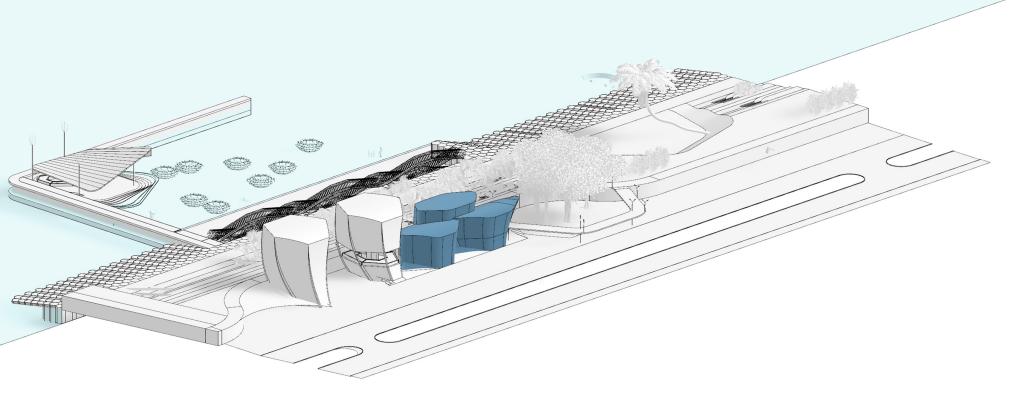




Museum of the Pacific & Retail

PRIMARY GOAL: BOLSTER TOURISM | PRIMARY OBJECTIVE: RETAIL | METAPHOR: N/A

In 1877, Waikiki's tropical waterfront land was dedicated by King David Kalakaua, to "all" seeking refreshment. While the coastline has been heavily modified since that time, it can still serve as a place of refreshment, for both body and mind. Therefore, the 'retail' buildings will contain local eateries, shops, and a new cultural nexus: the Museum of the Pacific.



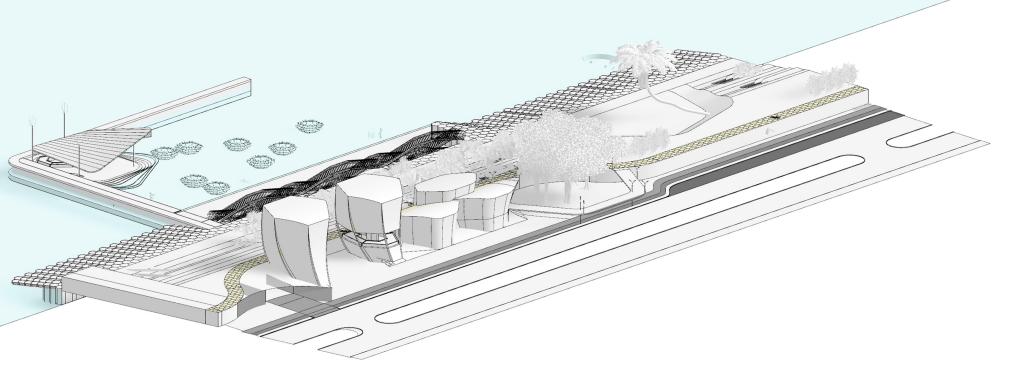






TO & FRO PRIMARY GOAL: BOLSTER ECONOMY | PRIMARY OBJECTIVE: PROGRAM FEES/ECO-TOURISM/RETAIL | METAPHOR: HEXACORALLIA

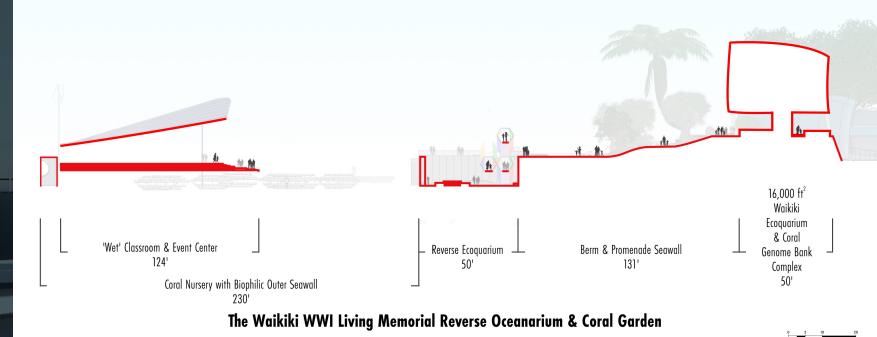
In addition to the promenade that forms the top of the Q*bart stairs/seawall, the top of the hidden berm wall is as entry for pedestrians that runs the full length of the site and can be scaled for the full mile through Waikiki Beach. The sidewalk on the beach side of Kalakaua Ave will be expanded into a modern plaza with planters, seats, and information boards. A dedicated bike lane will be added to the sidewalk. Angle-in parking will replace on-site parking. A bus stop, surfboard storage, a Biki[®] bike-rental station, and dedicated tour bus lane will open up more avenues for arrival and departure. Deliveries will occur via a tunnel hidden below the inland side of the berm. The entry is visible to the left of the new ecoquarium below.







The Waikiki WWI Living Memorial Reverse Oceanarium & Coral Garden

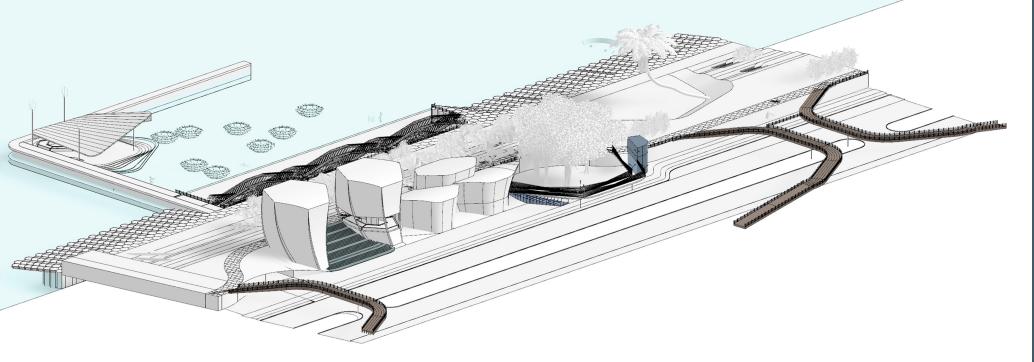




UP & OVER

PRIMARY GOAL: BOLSTER ECONOMY | PRIMARY OBJECTIVE: PROGRAM FEES/ECO-TOURISM/RETAIL | METAPHOR: HEXACORALLIA

Numerous ways of crossing the new 15' berm will be created. Street-level crosswalks will be replaced with safer, overstreet pedestrian footbridges. An elevator large enough for emergency services will lift people to the top of the berm. Two new staircases will be added. One rises from the sidewalk near the base of the banyan inside the Reverse Arbor. The other, called the Volcano Staircase, rises from street level between the two building of the Waikiki Ecoquarium. The experience of scaling it is inspired by the lava flows that created the Hawaiian islands. As visitors rise between the water-like blue glass buildings, their path narrows until they reach the top, surrounded by the fiery red blossoms of the mythical ohia lehua trees, and burst forth into the bright, wide vista of the open air over the tropical blue ocean. They then descend down a lava flow ramp to, across, and even below the ocean's surface where corals thrive.



BIOMIMICRY CHECK





THE WHOLE * PLATE LUNCH

PRIMARY GOAL: BOLSTER ECONOMY | PRIMARY OBJECTIVE: PROGRAM FEES/ECO-TOURISM/RETAIL | METAPHOR: VOLCANIC ROCK

In addition to the many, mature coconut palms that will be conserved from the original site and transplanted to the new pedestrian plaza that fronts Kalakaua Ave, visitors will take in the favorite trees of Hawaii – hau, koa, ironwood, cycad, banyan, and native hibiscus. Come take a free ukulele or palm weaving lesson every Tuesday evening at 7pm.



BIOMIMICRY CHECK ...





Illustrative Site Plan

Biophilic seawall/stairs

Performance beach cove

100-year-old banyan _____

Artificial reef -

Reverse oceanarium

'Wet' classroom

LEGEND

- a Retail with ADA access
- b Reserved picnic gardens
- c Sculpture preview display park
- d Top-of-berm walkway
- e Terraced berm
- $\mathsf{f}-\mathsf{Sand}$
- g Outrigger boathouse/berm wall extension
- h Sidewalk
- i Pedestrian bridges
- j Waikiki Ecoquarium

е

b

g

SIGNAGE – wayfinding & information



ONTHISCOASTIN







Hawaii's then territorial legislature purchases this 6.4-acre waterfront land for a WWI "Memorial Park."

Hawaii didn't acquire statehood until 1959.



1965

Following decades of maintenance neglect & little public interest, the WWI Memorial Natatorium closed, citing poor water quality & an unsafe structure. In the decades that followed, intermittent public interest groups attempted to revitalize the pool but no progress was made as it began crumbling into the ocean.



With the dedication of an international group of scientists, UH Manoa faculty & students, the Waikiki Ecoquarium & Pacific Coral Genome Project, & countless ecotourists, like you, *da reef alive again!* In 2021, 99% of the shallow water corals were dead, but today, they thrive and the native fish have returned, too.



King David Kalakaua designates this tropical waterfront to "all" seeking refreshment.

1927

The newly-dedicated WWI Memorial Natatorium opens to the public. Native son of Hawaii, & five time Olympian, Duke Kahanamoku swims the inaugural first lap.

2021

Competitive open-water swimmer and landscape architecture student, Thomas Plaggemeier, found himself concerned that, in the face of global warming and sea level rise (SLR), the natatorium was certainly doomed to be the first decommissioned war memorial in U.S. history.

As a capstone to his education, he redesigned this site and the Waikiki Marine Life Conservation District adjacent to the pool. His design is resilient to SLR, as well as being Honolulu's first true ecotourism destination. The coral nursery, that sits in the footprint of the old natatorium, was rededicated as a WWI Living Memorial.







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Get in on the action and make a difference that you can see. To volunteer, donate, or create a lifelong memory via ecotourism, contact us at LetMeHelp@TheEcoquarium.com or visit our website. www.TheEcoquarium.com

PLAGGEMEIER • CAPSTONE 2021 • 87

A FINAL THOUGHT ...

Sea Level Rise (SLR) due to climate change affects everything and everyone on the planet. The problems predicted to result from SLR, such as residential displacement, economic loss, damage to essential infrastructure and, most tragically, the potential for loss of life are all catastrophic.

Leaders and citizens of coastal cities, which are home to the majority of the world's population, have difficult decisions to make when it comes to protecting themselves and the systems that keep local and global economies running.

This project recognizes that there is not a one-size-fits-all solution to protecting our coastal cities from SLR and that, to find viable solutions, we can look extensively through as many lenses as we must in order to identify what we consider important enough to protect and what we think is essential to our future.

What is certain for my island home is that there is little time to develop and implement solutions that will offer a substantial level of protection. As I discovered during this project, the extent and varieties of protective infrastructure that can be designed to protect Waikiki from SLR can also play a vital role in invigorating the existing local economy, generate new economic opportunities, and play a role in rehabilitating the reef ecosystem.

This project also demonstrates that applying biomimicry as a design methodology provides a successful strategy in developing a scalable solution that is ecologically appropriate.

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