# SEA SUMMATION

BY ZARAH ADILAH SAHIB

Fig. 0.01. Authors Own, Strong Tidal Waves , 2019. (Title Page)

Fig. 0.02. Reuters/Andrej Ivanov, Photograph of Climate Change Protest, 2019.

# SEA SUMMATION.

How Waterfront Urbanisation Can Use Hydrological Strategies While Facilitating For Climate Change

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A 120 Point Thesis Submitted To The
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School of Architecture

2019

Fig. 0.03. Authors Own, Strong Tidal Waves , 2019.

To all those the invaluable,

Firstly, I would like to acknowledge my parents, who have supported me not just through University but giving me guidance, support and teachings throughout my childhood, now and in future.  Thank you for putting up with me taking countless all-nighters, picking me up from really late uni nights, and pushing to do the absolute best out of my study and career,

University would not be the same without my friends. Thank you for making my time at university such an enjoyable experience. We have always managed to keep each other going even in the most stressful times,

To my lectures over the past 5 years, who have given me their time, knowledge, expertise, understanding me and pushed me to do my best,

To my work colleagues for the last 4 years who have helped me grow in knowledge, passion and skills deeply in Landscape architecture. It has been an invaluable experience having been around much talented and kind people.

Lastly, thank you to my supervisor Brennan, for pushing me to do my absolute best, being a great work colleague, teacher and supervisor. I am grateful for the advice, constant guidance you have given me and clarity and drive for my passion in landscape architecture.

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Fig. 0.04. Authors Own, Severe storm event brewing in Wellington City, 2019.

**ABSTRACT.**


Urban inclination has unfavourably allowed for urban development throughout New Zealand to be found either along once naturally ecologically established and natural defensive coastal shorelines, waterfronts or along reclaimed shores to be developed on top of. Through reclamation, it has shown fundamentals of how we want to live closer to the water's edge, however in this process the lack of social and ecological space is diminishing and being catalyst residential and high end luxury private space (Dianne Menzez). Urban inclination should propose that urban waterfronts become multifunctional and facilitate towards a great public space. However with a deep attachment for the water's edge, we orientate living ourselves towards the water which also shows an interesting argument between the city and coast relationship that also comes with increasing climate change conditions.

Climate change has been under extensive focus for frequent years, conditions of notably large New Zealand urban sites remain under threat of infringing sea level rise and storm events which are in need for proper systematic infrastructure for this adaption purpose. With significant numbers of infrastructural systems situated in close proximity to waterfront environments, the rising numbers of communities orientated towards this face vulnerability to such global issues. In events of future sea level rise, increasing flooding will definitely impact the prone waterfronts Wellington City is one of New Zealand's most vulnerable sites to sea level rise due to its proximity to coastal edges. Its low lying surface and unsustainable infrastructure and design promotes flooding through deficient water networks.

This thesis identifies the Wellington's post-industrial site; Centerport with proposals for intended residential development. There is however a great level of susceptibility the site does not meet needs for protection from arising climate conditions, and its current poor social relation to the wider waterfront, which this thesis intends to investigate and resolve.

Centerport remains vulnerable to being a crucial domain for connectivity to the harbour edge and coastal hazard impact compared to other waterfronts. Through the means of researching adaptive water technological systems, this thesis hopes it will provide and conceptualise an impact within private and public communities through addressing coastal resilience, waterfront resilience and provide permeable adaptive waterfront design for the arising climate conditions.

RESEARCH QUESTION

## HOW CAN WE INTEGRATE MULTIFUNCTIONAL SPATIAL DESIGN AND COASTAL DEFENCE ALONG VULNERABLE CITY WATERFRONTS?

Fig. 0.05. Authors Own, Tidal Beach Waves, 2019.

# 01

# Introduction.

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Fig. 1.06. Authors Own, Tidal Beach Waves, 2019.

Climate change is progressively becoming a problem, not only, it will exacerbate existing problems. In an urban context this is currently seen through events of heavy rainfall and flooding. Many rainfall events have proven the existing hydrological systems (made to reduce the effects on ground) are obsolete and design implementation is used as a tool to fix this. Current methods of design however are no longer appropriate and sufficient with the impacts of climate change arising and further need for urbanisation growth simultaneously.

There is opportunity for better-integrated and multifunctional responsive design, which adapts to a set of climate conditions. By suggesting resilient design implementation, there is potential for urban contexts adapting to existing and upcoming conditions and give ability for cities to bounce back from storm scenarios. By opening limitations of social and ecological integrated design, a multifunctional design approach is used to address existing site problems and the upcoming storm surge and sea level complexities.

It is important to understand some of the impacts of climate change and association with sea level rise are yet to exist. It is assumed factors such as subsiding sea bed levels may also impact and accelerate the rates of sea level rise and further implication predicted such as storm surge, coastal erosion, saltwater intrusion, however for the purpose of this thesis the aims are to more importantly address the implications of sea level rise/flooding and storm surges within a urban waterfront position.

# Climate Change.

**THE ISSUE.**

Global Warming Is Leading
Towards A Global Sea Level Rise

**THE SOLUTION.**

# GLOBAL HOTSPOTS.

> **20** *of the hottest years on record have happened in the last* **22** *years.*


> *Pre Industrial, the amount of* **Carbon Dioxide** *in the atmosphere was* **280** *parts per* **million**. *It is now* **400** *parts per* **million** .
>
> Zdnet, 2019.

Fig. 1.07. Authors Own, Global Hotspots for upcoming Climate Change, 2019.

Fig. 1.08. Newsie, Large Tidal waves in Lyall Bay show threat of rising seas and storms, 2019.

## CLIMATE CHANGE.

Climate change has been an extensive focus in recent years, and with adequate reason. Anthropogenic changes have exposed the world to inundations of sea level rise and significantly notable amounts of urban flooding. Globally sea levels are 120m higher than what used to be 20,000 years ago, warmer climates are producing oceans anywhere between 6 to 30m higher than what used to be, a further 0.74m sea rise will displace 115 million people before the encroaching seas. New Zealand is one inundated nation whose urban centres will be displaced in the likely event of all ice caps melting. Urbanisation has been classified as "the most critically endangered bioregion on earth" with the arising climate change implications (Richard J. Weller).

The following repercussions of anthropogenic climate changes directly impacting New Zealand will be;

- More frequent extreme weathers such as draught and floods
- Higher temperatures
- Increased rain patterns

These impacts directly affect New Zealand water resources, demanding an increase of water supply during hotter days, longer summers, higher river flows and raised water temperature affecting aquatic fauna and flora. Sea level Rise also has its consequences of coastal flooding, storm surge, saltwater intrusions and increased erosion, requiring immediate coastal protection. Disruptions to daily life may also cause disruptions in transport infrastructure with damaged roads and railway lines.

Draught, degrading water quality and flooding have already been becoming more apparent in recent years within New Zealand. Biodiversity and ecosystems are devitalising, while urban populations are expanding. As a reciprocation of climate change, in prevailing events of major storms and floods, there has been a result of degraded water quality and supply due to the current incapable and brim-full water networks. The expansion of urbanisation has led to this loss of eco systems protecting coastal environments and land. The lack of natural harbour defence is due to our misuse of coastal water, coastal edges and urban treatments for dwelling, systems for healthy eco systems given for human uses are diminishing. The abundance of New Zealand coastlines which once used to be home native ecosystems are now urban development hotspots which lack the technological and natural systems to withstand impacts on active land use.

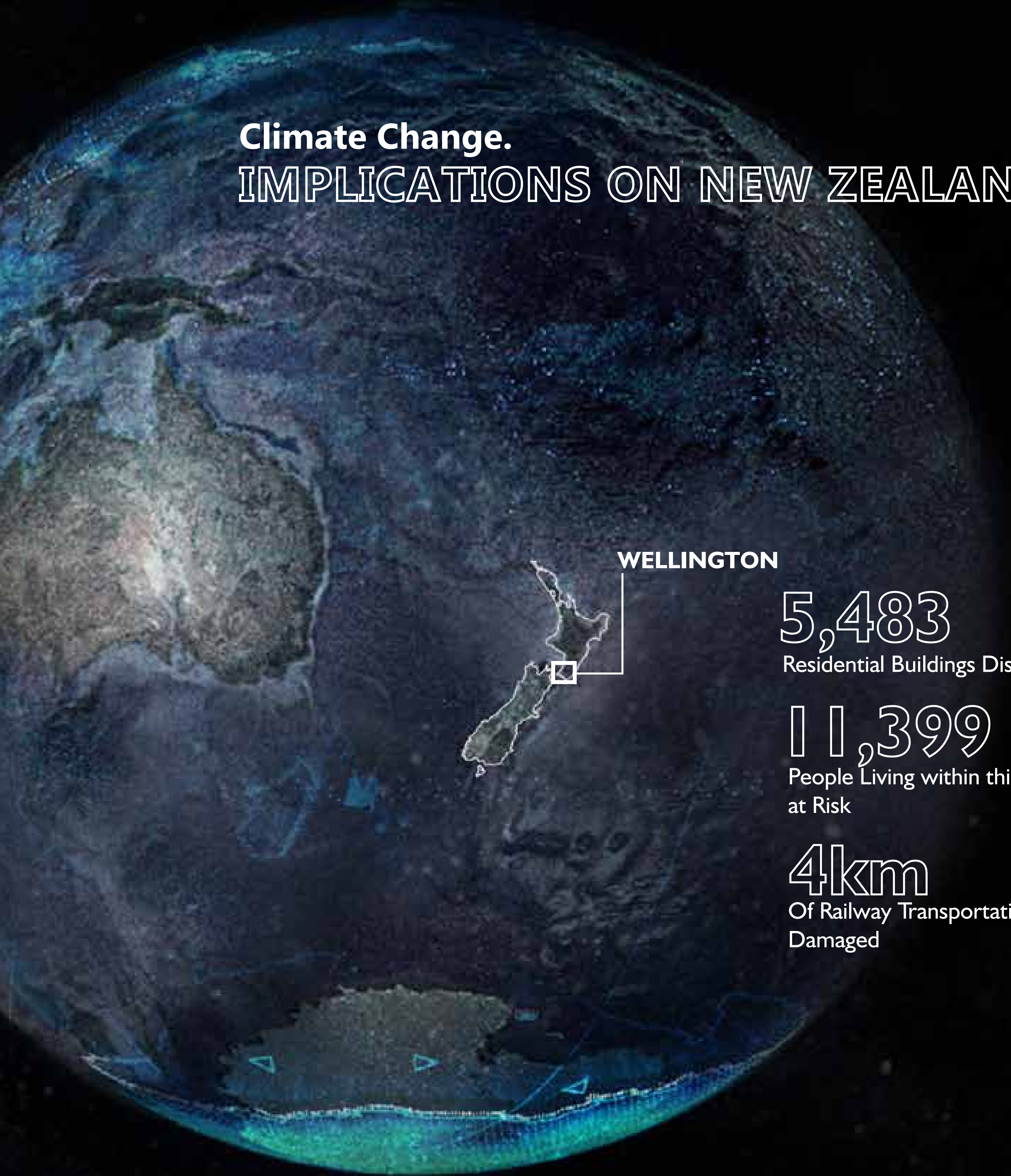
With a worst-case scenario of climatic impact on New Zealand being a 2m rise Sea Level within the century, it is seen necessary to defend strategy against SLR and climatic issues is delivered to ensure to protection and continuity of waterfront occupation within a progressively expanding urban era. This thesis proposes to mitigate issues of SLR and Anthropogenic Climatic Change affects by enabling a multifunctional waterfront design scheme, based on understanding of literatures to form a basis of design driven strategy. This thesis will explore the inundation of climate issues on urban waterfronts. The testing criteria for resilience will explore theoretical realms to provide some attributes for WSUD, Ecological Edges and waterfront multi- functionality.

# NEW ZEALAND DATA. Rising Sea Level Rates.

Ministry of the Environment, 2018


Fig. 1.09. Authors Own, Rising Sea Level Rates per Year, 2019.

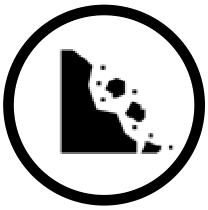
## Climate Change.
# IMPLICATIONS ON NEW ZEALAND.




**5,483**
Residential Buildings Displaced

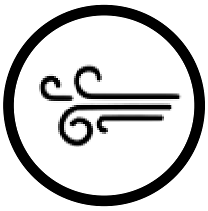
**11,399**
People Living within this Zone are at Risk

**4km**
Of Railway Transportation will be Damaged



**INCREASED EROSION**

-Coastal Flooding
-Saltwater Intrusion
+ Need increased Coastal Protection



**EXTREME WEATHER CONDITIONS**

10% Stronger Wind Conditions

**INCREASED RAINFALL AND DRAUGHTS**

- 20% increase in rainfall
- 2 Degree increase in Max and Min temperatures

**HIGHER TEMPERATURES.**

- Longer Summers with Increased Temperatures
- More Draughts
-Higher demand for water
-Soil moisture and temperatures affected
- Raised water temperatures will aggravated water quality problems
- Snow Decrease

Ministry of the Environment, 2018

Fig. 1.10. Authors Own, New Zealand Illustration, 2019.

Fig. 1.11. Cameron Downer, Storm Surge causing Flooding of Roads, 2015.

## SEA LEVEL RISE.

Countless studies and documentation have postulated the observations of rising sea levels, this being a result of the anthropogenic changes due to the production of atmospheric greenhouse gases. It has been noted since the early 1900's, that an acceleration towards catastrophic global warming has occurred as a result of these industrial and civilisation advancements. Earlier trends recorded New Zealand's rising sea level rates around 1mm per year. This is now much closer to 2.5mm per year. Although the rates of sea level slight verily, this has accelerated the projected min sea level rise to be 0.5m higher by 2050 and max sea level height of 3m by 2150. Further afflicted implications of sea level have be observed by scientists, such as the increased acceleration of subsiding sea bed levels, however for the purpose of this thesis the implications being addressed include;

- Storm surges (with implications of coastal erosion and ecosystem degradation)

-Flooding (Sea Level Rise)

The Paris target is an official global agreement between nations whom signed to reduce greenhouse gas emissions in effort to mitigate implications of extreme climate measure. Currently the global temperature has accelerated over the century to 1.5 degrees Celsius, still accelerating towards 2 degrees Celsius. The target is to reduce this global temperature and keep at 2 degrees Celsius this century (Ministry for the Environment). For this to happen, it has encouraged for designers to provide new possibilities of site adaption and protection through working with nature and its natural sustaining ecological processes. It provides landscape architectural designers with a new opportunity protect the built environment.


2 M
Sea Level Rise Increase in the next Century
(2080 - 2100)
1 M
Sea Level Rise Increase in the next few
decades (2040-2050)


2.8M
Sea Level Rise Increase projected for in the next few decades (2150)
0.16M
Increase in sea level over the past century
2.22MM
Sea Level Rise Increase per year in Wellington


Fig. 1.12. Unknown, Predicted Sea Level Rise Increase in Wellington, 2019. (Page 22-23)

Fig. 1.13. Authors Own, Map of Wellington Harbour Inundation in Surge Event, 2019.

Fig. 1.14. NZ Herald, Rough Seas damaging property in Timaru, 2015.

## STORM SURGE.

Storm surges hold a massive implication on our low lying coastal and urbanised territories. It is predicted the impact of this anthropogenic climate change would rise tidal waves by 3m higher than what is today. These would occur more frequently and although this is just a temporary wave and water table increase, the effects of this would lead to destruction of coastal edges, major flooding, destruction of surviving eco systems and increased coastal erosion. As water levels accelerate, surge levels and frequency will accelerate as well (Ministry for the Environment).

Along with storm surge, erosion has significant damaging effects on infrastructure, ecosystems and development along waterfront and costal edges. Sea level rise 'causes rates of coastal erosion to accelerate' (Mitchell, 2016). The expected increases in sea level rise, along with increases in wave height, intensity and frequency have high potentials of strong surges damaging active waterfront sites.

*Fig.1.15.*

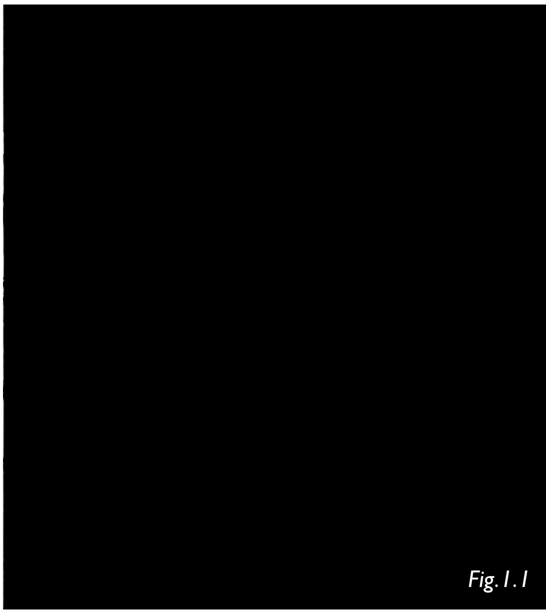


*Fig.1.1*

**02.** *2013. June*
*Island Bay*
**Storm Surge**

# SIGNIFICANT STORM EVENTS IN WELLINGTON.

## The Effect of the upcoming Climate Change in Wellington.

*Fig.1.16.*

**01.** *2015. June*
*Lyall Bay*
**Storm Surge**

Fig. 1.15. Unknown, High Waves causing Flooding in Lyall Bay, 2015.

Fig. 1.16. Scott George, High Waves causing Flooding in Lyall Bay, 2015.

Fig. 1.17. RNZ, Severe storm causes Sea Wall to break, 2013.

Fig. 1.18. RNZ, High Waves Flooding Roads, 2013.

Fig. 1.19. Unknown/Stuff, Heavy Rainfall causes Flooding of Wellington Railway Station, 2019.

*Fig.1.18.*

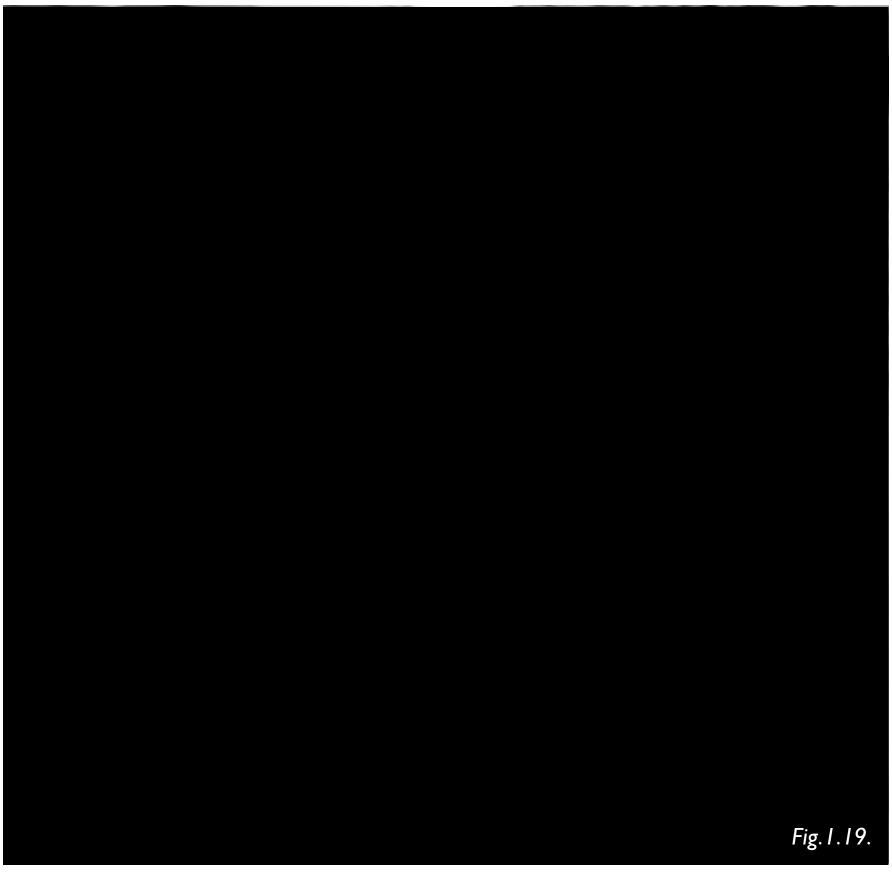


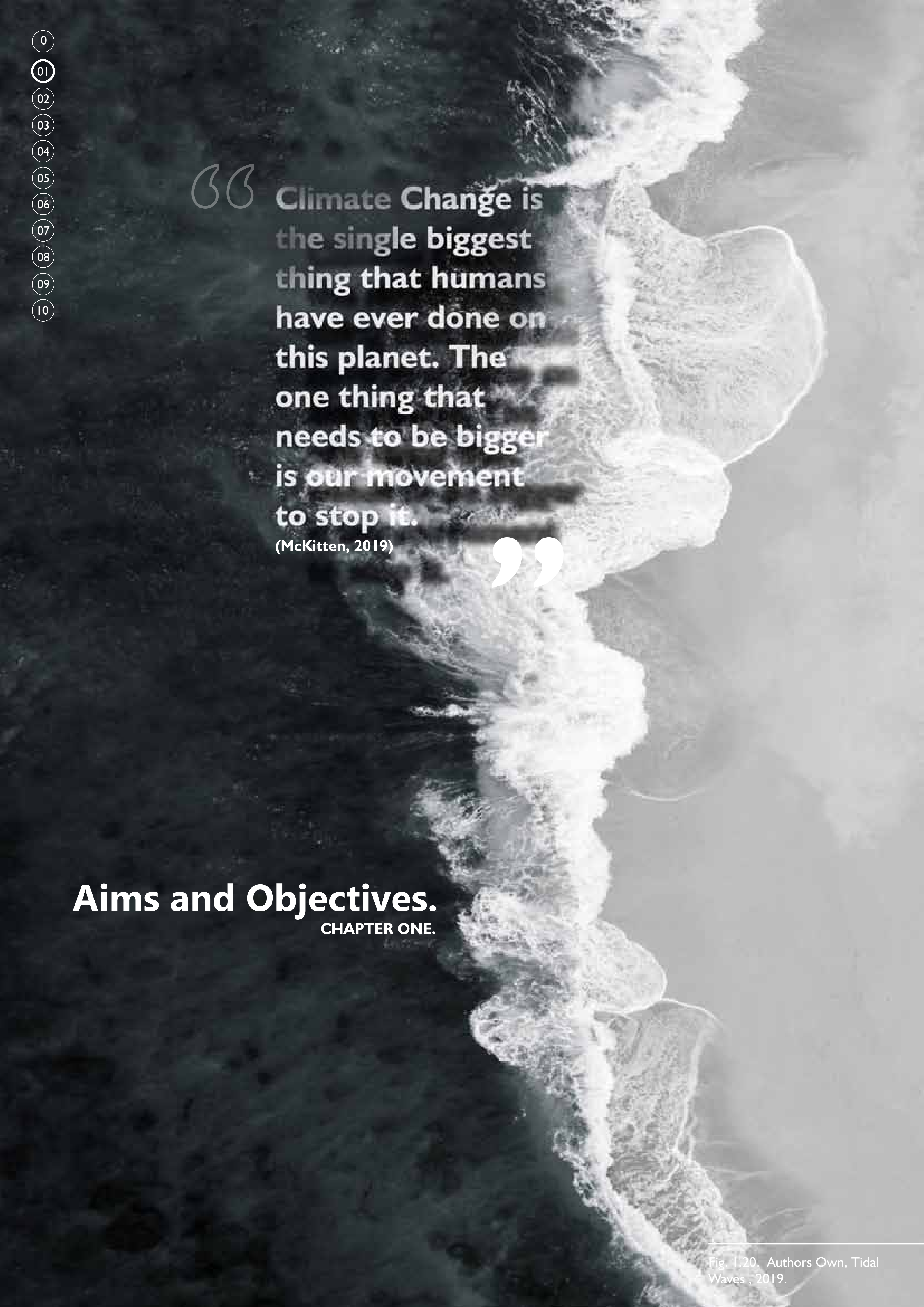
*Fig.1.19.*

**03.**

*2019. March*

*Wellington Railway Station*

**Heavy Flood Event**



> “Climate Change is the single biggest thing that humans have ever done on this planet. The one thing that needs to be bigger is our movement to stop it.”
> (McKitten, 2019)

# Aims and Objectives.

## CHAPTER ONE.

Fig. 1.20. Authors Own, Tidal Waves , 2019.

## AIMS

**01**

To challenge the city to sea tension

**02**

To facilitate and create benefits for the surrounding infrastructure by designing a resilient, self-sufficient city.

**03**

Provide a stronger system that will enhance the costal ecology and provide sustainable living.

## OBJECTIVES

**01**

Understand the potential of the future re housing development and its connection to water sensitive design structure through literature review and case study explorations

**02**

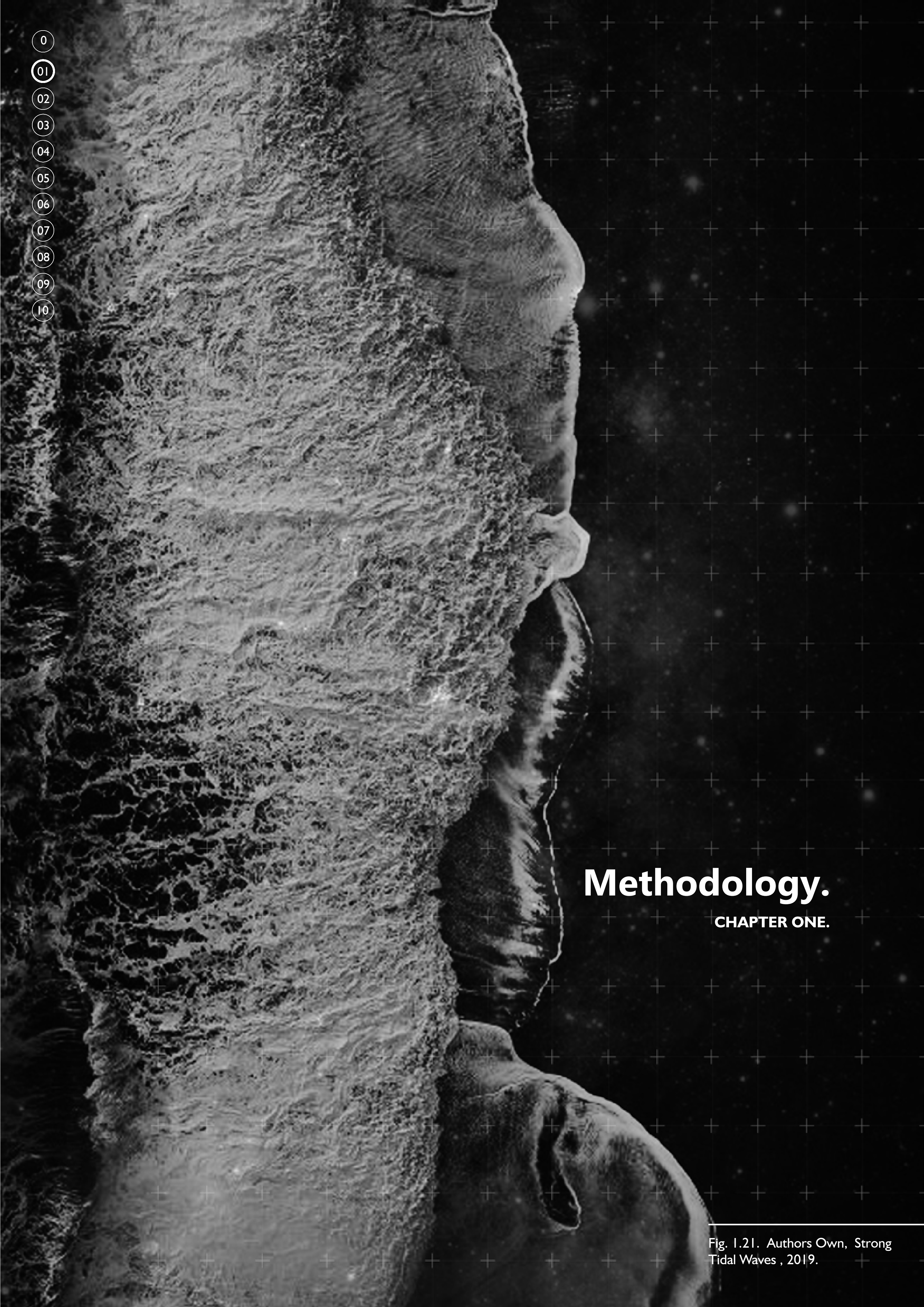
Understand storm events and mitigation methods through programme, function, literature and thorough site analysis

**03**

Understand Water Sensitive technologies as a landscape tool, in order to achieve the above aims by analysis and infrastructure explorations

**04**

Question and understand the programme of waterfronts, social, ecological, economical interrelationship by testing out hybrid iterations of water infrastructure, setting strategy testing these through flooding scenarios and evaluate these approaches



# Methodology.

## CHAPTER ONE.

Fig. 1.21. Authors Own, Strong Tidal Waves , 2019.

The world is dealing with the complex issue of climate change. The effects of anthropogenic climate change have its own emerging problems on New Zealand shores as is its complex site specific and global wide upcoming complexities. Furthermore in New Zealand, a propulsion of expeditious urbanisation is forcing the bounty of the foreshore to give up its natural resistance to such climatic issues and provide residential expansion onto the coastal rims.

Urban design has allowed for propositional dealing of ecological and social Multifuntionality to produce successful and resilient habitude. Due to diverse site concerns, the approach this thesis takes is to provide a resilient multifunctional design led solution. In the past, Wellington has been brought up and built accustom to the current needs, this has been a one-dimensional driver which discouraged harmony with significant ecological systems which defend and protect our land and shores. The design methodology acompasses the ability to re conceptualise and provide sustainable and advanced design solution, in addressing current site needs as well as the upcoming.

This research seeks to address how multifunctional spatial design can mitigate the effects of climate change while dealing with urbanisation.

RESPONSE.

An introductory approach to this thesis looks at is understanding positions from theoretical literature review in relation to waterfronts, urbanisation and coastal defence design resolution, from here a criteria of what to observe on site and what potential design strategies could be implemented will help drive the direction of this design thesis.

The design process then beings with site responsive investigation into the current site conditions. This is a linear process however; the two main speculations this will fall under are social and hydrological, understanding the components on site and the wider context in relation to how these are functioning.

This process includes conducting a range of site visits to understand which spaces are important, contextualise the waterfront, how they are utilised or under utilised, how they function, accessibility and any ecological significance (which acts a natural defence systems currently, what conditions these are in) and how other areas of the waterfront compare and perform. While performing site observation and gathering analysis historic relations and knowledge of relevance would also be looked into as well. Overall site strengths and opportunities will be drawn out. Through this a mix perceptible and non-perceptible data will allow for initial design hunches which intend to amend threats and weakness of site and build upon strengths and opportunities.

PRODUCING.

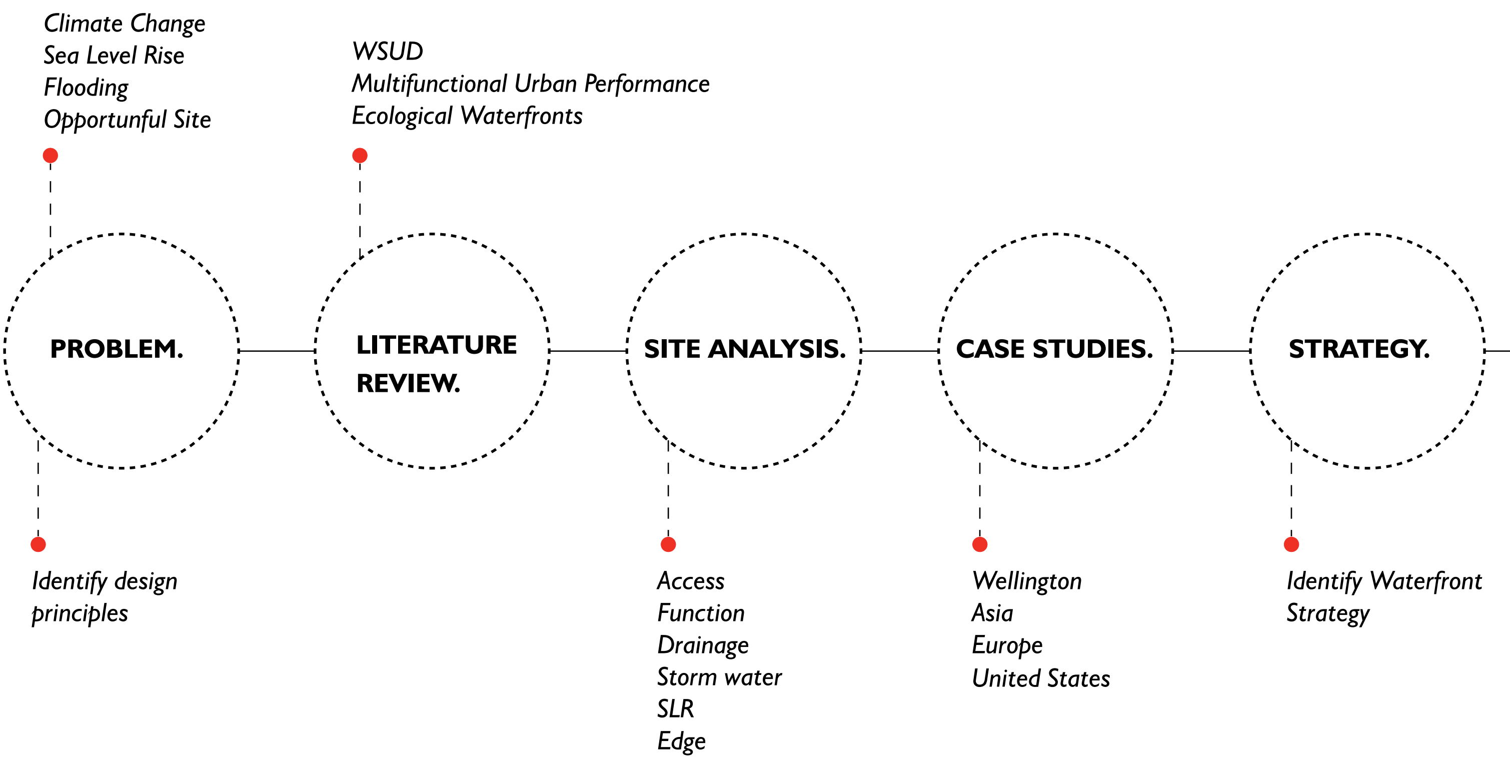
From here the process forms into sub phases of understanding technology which would facilitate for the up coming and site complexities. This would looking at testing social and ecological technology against a criteria and implemented for site design. Understanding of various technologies will help drive and discern multifunctional solutions and strategy to initialize preliminary concepts from. Concepts will explore and uncover knowledge and issues that are currently missing. This will tested though a variety of drawing techniques such as diagrams, mapping, plan, sections and axonometric.

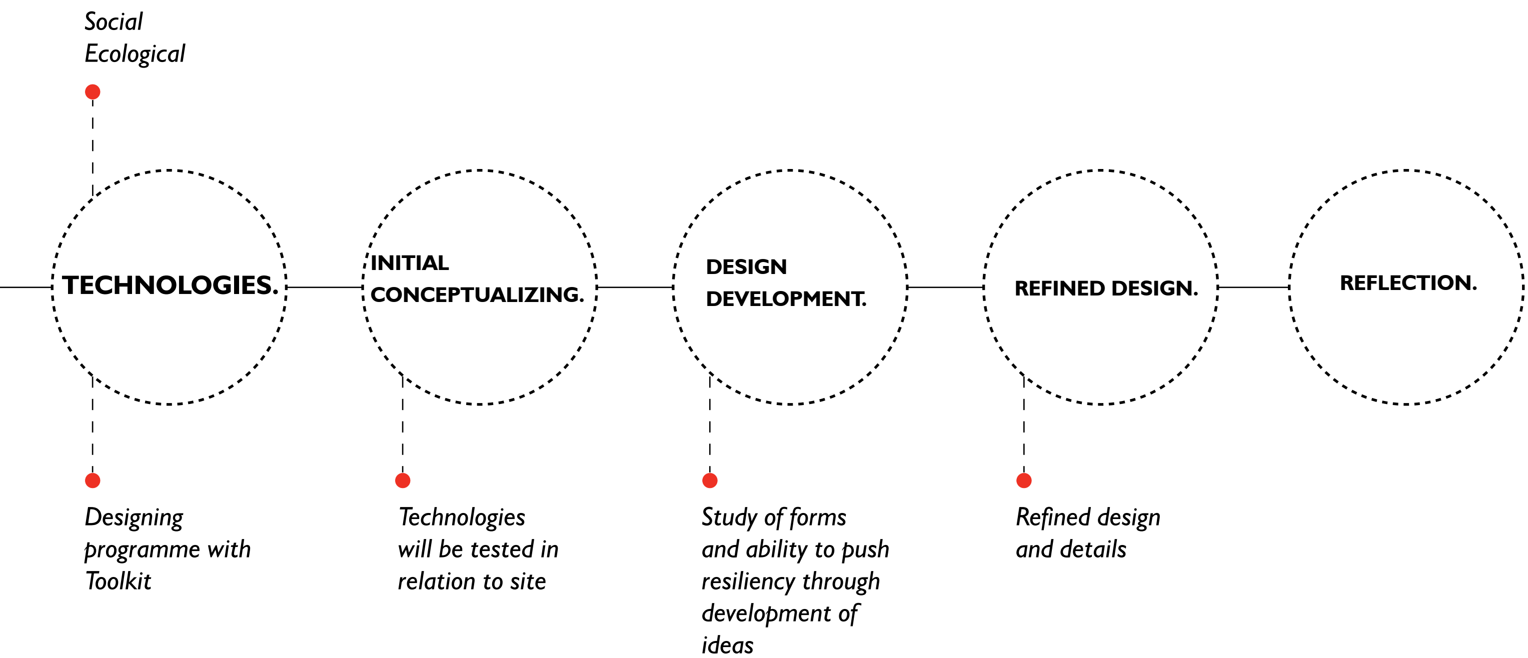
DEVELOPMENT.

After an exploration of possible preliminary conceptual design opportunities, these will be critically assessed against design aims and objectives as criteria from which final design will be selected and developed upon. (Based on its ability to satisfy these objectives).

Design will be refined and developed through further site details, shown through various site scales highlighting and important systems within site. This will be through drawing techniques such as, site zooms, plans, sections, perspectives, axonometric, materials, plant species and palettes.

## METHODOLOGY DIAGRAM.





Social
Ecological
TECHNOLOGIES.
INITIAL
CONCEPTUALIZING.
DESIGN
DEVELOPMENT.
REFINED DESIGN.
REFLECTION.
Designing
programme with
Toolkit
Technologies
will be tested in
relation to site
Study of forms
and ability to push
resiliency through
development of
ideas
Refined design
and details

## DESIGN PROCESS.

### 01.

### Identify Strategies

Understanding how systems can function simultaneously to work within a larger system.

### 02.

### Technologies

Identify possible systems that can be applied to site in order to enable design for the mitigation of climate change inundations.

### 03.

### Exposure of Potential Capacity of Adaptivity

Enabling design systems to be tested onto initial micro site scales.

### 04.

### Implementation and Prioritising

Testing initial conceptual ideas and development of form within site.

05.

### Identify and Refine

A Potential strategy is chosen to develop with, this is included in further conceptual developments.

06.

### Development

Design strategy is further developed, maximising public integration with site and integration of urban context with the waterfront. This is developed further to achieve the most possible resilient solution for public and site, achieving all design criteria.

07.

### Development and Phase

Developed design is tested at a variety of scales throughout site, to understand its functions and usability.

08.

### Critical Reflection

Reflection of Design Outcome.

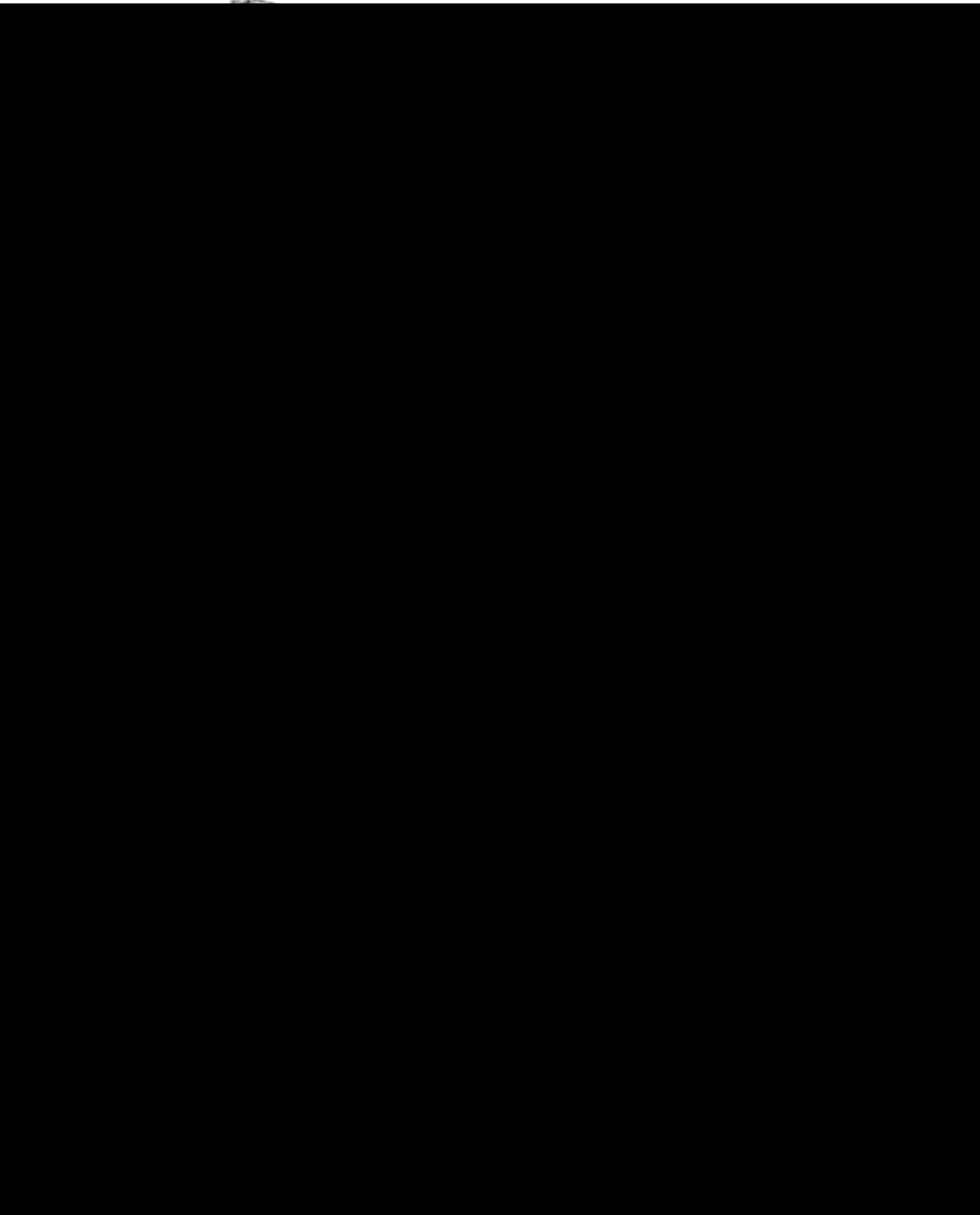


Fig. 1.22. Shannon Stapleton, Students hold signs during a demonstration against climate change in New York , 2019.

# OPPORTUNITY OF A DESIGNER.

As a Landscape architectural designer, there is a positive opportunity to explore new technologies and systems to work with the new conditions climate has provoked. Through this, this thesis intends to challenge the current degrading landscape systems, test site vulnerabilities of a deprogrammed site and integrate resilient design solution.

In doing this it allows me to challenge the current standardised water infrastructure systems through implementing adaptive water filtration technology and processes, improving the ecological and sustainable performance of the city. The degradation of biodiversity over time may be able to regenerate in new areas not known able to exist. It is important to understand how the natural landscapes are functioning and how they are changing over time to be able design for the potential future. This allows the designed environment to be prepared for what climate puts in front of it. With this in mind, we can use this positive opportunity to explore how to deal with the issues of sea level rise that would also address it through a multifunctional waterfront. It is thought, the more healthy and sustainable approach used to address the issues will directly impact and improve ecological conditions. Future urban development could benefit from this approach in mitigating urban runoff, flood and coastal protection through regeneration of naturally defensive systems.

> **“We have a single MISSION: to PROTECT and hand on the PLANET to the next generation.”**
>
> **(Francis Hollande, 2019)**

# 02

# Literature Review.

CHAPTER TWO.

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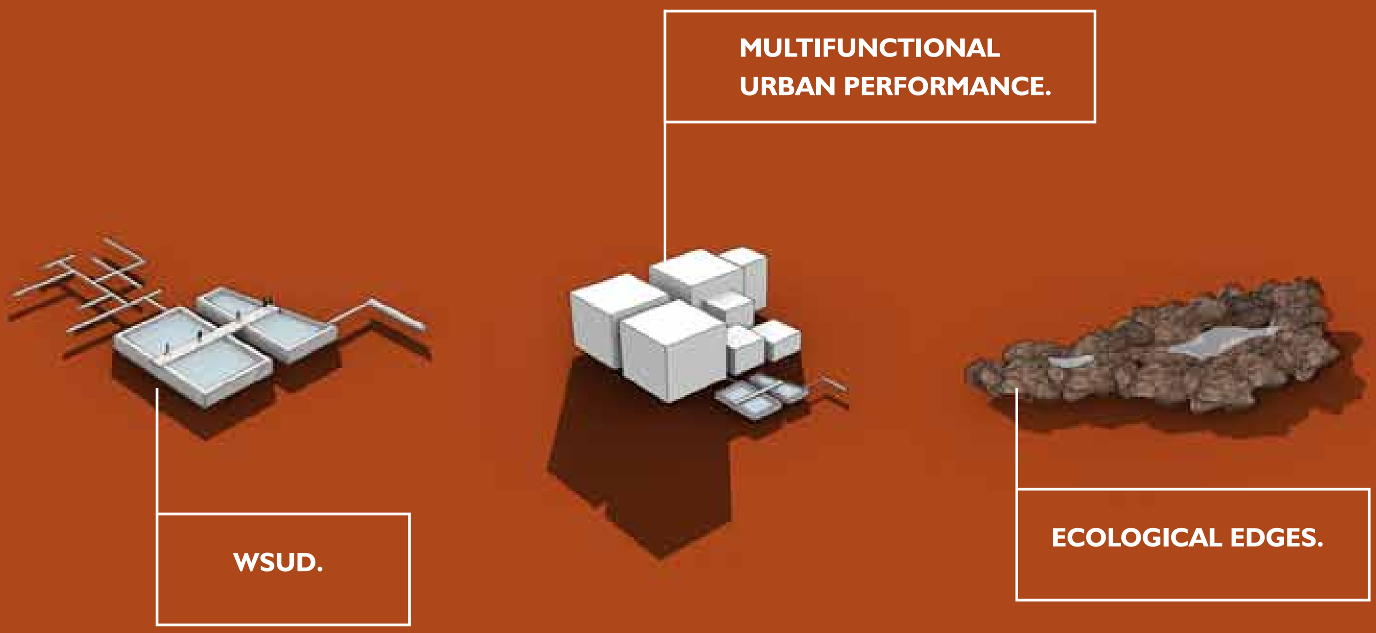


This chapter addresses theories, which form the positioning of this thesis and establish criteria in order to respond to inundation and mitigation strategies of Sea Level Rise, Water Re-use and Multi-functionality. The theories integrate common ideas with three main positions formed below;

- Water Sensitive Urban Design
- Multifunctional Urban Performance
- Ecological Edges

The theories together identify infrastructural landscape technological approaches, which remove site vulnerabilities and impacts of climate change. Through softscape and hardscape strategies, interventions purposefully propose new methods to adapt to these new conditions within a multifunctional waterfront site, while mitigating existing site up arising climate change threats.

For each theory, a case study will be identified. Case studies of similar contextual relevance will be assessed on how they successfully respond to theoretical approaches and if these meet criteria of aims and objectives of thesis design research.

Fig.2.01. Authors Own, Literature Review Illustrations, 2019.

## TERMINOLOGY.

Through literature key terms have been identified which relate to and enable key strategic design opportunities to address the needs of this thesis. The following terms have been acknowledged and expressed through many theorists judgements, however the definition of these in regards to this thesis will be discussed below;

DYNAMIC WATERFRONT / MULTIFUNCTIONAL WATERFRONT:

Practitioner and theorist Dianne Brand's suggests a successful waterfront should be composed of certain elements working together in order to create a successful experience and design. The key elements mentioned are; Industry, Sport, Recreation and Entertainment. The functioning of all these elements together drives a diverse public orientation towards a site. Industry, while providing economic benefit attracts public to a certain destination. Having recreational, sport and entertainment spaces creates for a better successful and enjoyable site. It is seen beneficial and cost effective for multiple functions to take place at once rather than one. Critiques by Brand have been made on exclusive residential development within ports that create a hierarchy of space. There is a need for more and socially diverse users to enjoy a space, not just one (Witherell) .

Along with this, practitioners point out the importance of protecting and enhancing the ecological systems waterfronts hold. Practitioner Kate Orff sees a strong potential in relationships between eco systems and public. "There are positive opportunities for people, industry and eco systems to thrive of each other" (Waterfront Alliance). While protecting the land, public can be provided new ways of interacting with the landscape. Ecological and social waterfronts are strongly encouraged to work in harmony together. Although Brands suggests only industry, sport, recreation and entertainment are important functions of a waterfront, it is shown as a positive opportunity for eco systems on site to simultaneously function.

Grounded on these principles, this thesis proposes to utilise the multiple programmes within the waterfront space to address all elements related to site design being; being Residential, Storm water, Active Waterfront, Recreational and industrial use of space.

RESILIENT DESIGN / ADAPTIVE DESIGN:

Theorists have pushed for more resilient strategies in enabling waterfront design, this term is often referred to as a way design solution can recover more quickly from extreme storm events. Being able to enable a site to adapt to these events and recover quickly. Theorist CS Holling holds up an interesting argument as he depicts the cycle and stability of resilient ecological systems. An example in the context of flora, one view over time can be seen as flora disappears and species become extinct. Another view concentrates not so much on the presence of numbers but the time and constancy of fluctuation of species. Similarly, Holling emphasises fluctuation is part of the system. If not climate change, another event would result in the same thing happening. It gives an opportunity for the environment to remove its excess toxicity and re-establish. Similarly the term provides designers with an opportunity to design sites that can fluctuate, and bounce back from scenarios.

The term resilience signifies an opportunity to design a space which can function as;

a) Multifunctional at the same time

b) Work as a whole integrated system

c) Provide social and ecological interaction with site

d) Adapt to climate conditions and mitigate these problems within an urban environment

Kate Orff further describes resiliency as adaptive site design solution for dealing with climate change, through this she encourages creating "urban habitats, social interaction and encouraging people be to stewards for the natural environment" (Orff).
Through this term 'resiliency,' multiple design solutions and techniques can be recognized. When resilience is mentioned within this thesis, it provides a mix of ideas into a single term.

SELF-SUSTAINING SYSTEMS:

A self-sustaining system is a process where an environment filtrates, decimates and restores itself. This system has strong resilience qualities that work on their own. A precedent of this can be seen within coastal wetlands. These tidal wetlands also known as salt marshes are prone to flooding. When flooding occurs, plants dieback and move further back inland for regrowth. In events of climate change and sea level rise, coastal wetland plants can absorb large amounts of water and regrow. A large amount of space is needed for this however, which is why such areas are left untouched from human habitation. This process complements the ideas resilient design depicts, with the ability to with take storms and restore itself after (Charles Simenstad).

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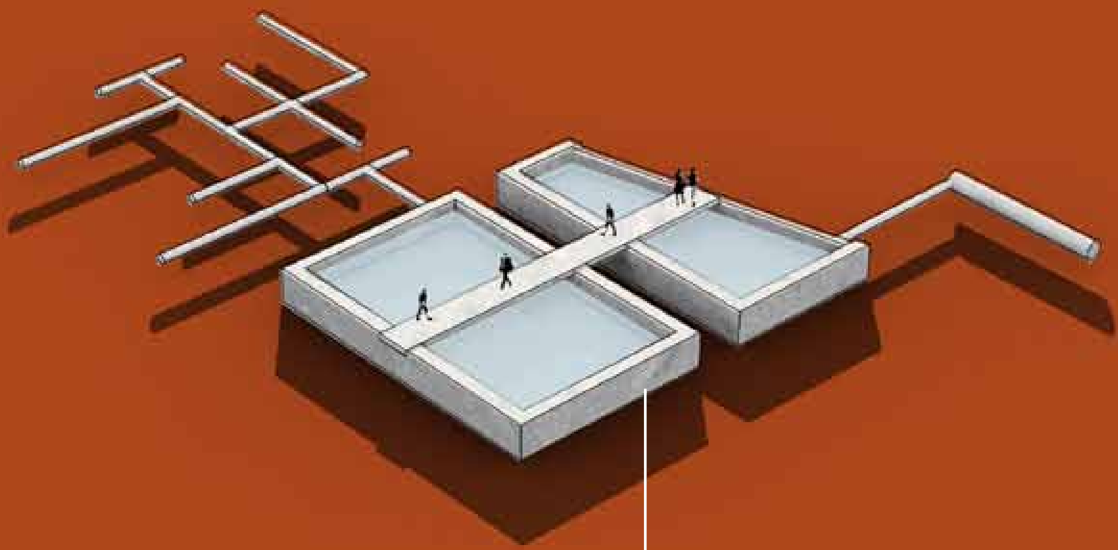


**WSUD.**

This section explores the objectives and implementation techniques of WSUD

Fig. 2.02. Authors Own, WSUD Literature Review Illustrations, 2019.

It is apparent through recent years there has been a degradation in water quality, aquatic life and environmental life. Conventional water network systems, such as storm water and waste water systems, have posed negative effects on the quality of water through non-capable water capacities and over loaded systems leaking into other pipe network such a waste water contamination. The purpose of these networks are to rapidly export water away, within the current and expansive urbanisation it has forced to necessitate standardised networks. Conversely, this has increased more vulnerability to surface flooding, contamination of waterways and loss of connection to native eco systems. One objective of this design research is to provide improved and sustainable living strategy while building capacity for healthier waters and improving the current run off/storm water system.

Water sensitive urban design is an approach which will help combat flooding issues and flooding conditions created though climate change as well as the revival of coastal ecologies in event of Sea Level Rise. There are many benefits to Water Sensitive Urban Design, which reduce pressure of drainage networks, bio climatic technologies allow for mitigation of carbon emissions, pollutants, and improved public amenities. Three key elements which this tool (WSUD) addresses design through are; Water Capture, Storm Water Integration into Social environments and Pollutant Mitigation.

WATER CAPTURE.

Theorist Jodi Clarke associates effective storm water management design with water capturing solutions. Within an urbanised environment where there is a lack of permeability for surface water to drain through, overflows start happening. Reducing the areas of water runoff and capturing helps mitigate this issues of flooding. Clarkes thinking behind this would suggest using small scale interventions throughout the site can help collect and mitigate flood prone areas. Small systems within a large runoff catchment would benefit the whole site, reduce flooding and improving biodiversity of site through cost effective means of smaller interactive interventions.

Clarke further elucidates the effect of the small interventions capturing within the wider storm water catchment, in particular with natural systems of rainfall and surface water runoff. For example capturing runoff water before it enters the storm water networks cleanses pollutants and takes pressure of these networks before it enters the harbour. Harbour water would also be less contaminated, benefitting the surrounding region and natural ecology of the environment additionally (Clarke). By facilitating for water catchment design within different regions, the larger catchment would still obtain benefits of this. Appropriate methods used to design would however need to consider factors such as watershed and water velocities, to obtain suitable results and targets.

Permeable systems be implemented for water capture could be:
- Contaminant removal wetlands
- Retention units
- Bio retention swales
- Porous Paving
- Sub Surface / Surface wetland typologies

## SOCIAL INTEGRATION.

Wellington city council has defined Water Sensitive Urban Design as
"An approach of water resource management in urban environments that addresses both water quantity and water quality issues. This promotes and integrates natural water systems with built form and landscapes for more a resourceful use of water within the public realm" (Wellington City Council).

It is also mentioned to encourage to social ability of this space, encouraging a unique complexity of social and ecological parameters merging in order to create benefit for both the environment and enhancement of public amenity. Theorists such as Clarke agree with this, implying the treatment of water allows for designers to get a better understanding of its connection to the wider context and social relations, treatment at source helps chances of less water contamination and run off complications within urban expanses while enhancing the usability and appearance of a space. It is encouraged to design with publicly visible sites that also educate people on the importance of this ecological design. This design could also include public visibility engagement areas at collection point of water, recreational use at points of filtration and stopping points where process has been complete which help people become more aware of the process and quality eco systems which benefit and mitigate flood problems.

Clarke validates the use of Water Sensitive Urban Design as an useful strategy for improvement in urban environmental conditions. It is notable through international case studies that have used water sensitive urban design as a tool in enabling this goal of reaching clean waterways again through interactive public spaces (Fig.2.03 -2.08.).

## POLLUTANT MITIGATION.

As suggested, the use of Water Sensitive Urban Design allows for mitigation of site flood concerns and provides ecological and social systems for further water protection and reuse. It is important to do more than necessitate standardised networks. Thinking more resiliently and adapting to the impending climate conditions through flood prevention. The implementations of this would suggest greater surface treatment takes place as opposed to underground, allowing for healthier passage ways through existing storm water networks (Clarke). An overlooked problem within current networks is the quality of water being carried out to harbours, this not only affects the quality of biodiversity underwater, it affects the public opportunity to engage with water, being a critical element needed within waterfronts. Surface water runoff can contain many toxic chemicals and pollution which destroy functioning ecological habitats and restrict public from access unhealthy waters. There is opportunity to mitigate pollution through enabling design to treat these unhealthy waterways. Many theorists such as Clarke outline certain measure which need to take place to treat polluted water. This process can be broken up into three categories;

1. Collection and conveyance
2. Retention and Distribution
3. Infiltration and Evapotranspiration

Certain measures are also needed to take place in order for this process of pollutant mitigation to happen being;

-Identify the catchment size, and percentage to treat (2-4%)
-Identify velocity and amount of runoff dealing with
-Average rainfalls within area
-Outlining certain size treatment catchment would be needed to design with

## CASE STUDIES.

The case studies identified below are leading examples of adaptive waterfront design through using water sensitive urban design tools. They highlight important ideas theorists have mentioned and have become opportunities to put theory of water sensitive urban design into practice on site. Case studies identify similar qualities to the chosen thesis site, indicating strong and exemplar opportunities the site can present.

## WAITANGI PARK PRECEDENT.

Waitangi Park, a successful waterfront was design and completed in 2007, reprogramming a space part of Wellington waterfront to becoming a more publicly and bio diverse engaging area. The context of this site once lied under a culverted stream, similarly with Centerport, which was enabled through water sensitive design tools to celebrate its existence through a treatment wetland. Waitangi Park is an example of multifunctional space, recreation, water filtration, and civic function for all ages. Its presence shows ecologically driven design can allow public to engage through site in a variety of ways while enhancing the public usability of site and protect waterways through filtration of storm water directed through the Waitangi stream. The design aims to improve water quality entering the harbour while allowing for water harvesting, and retention though renewable energy use and reducing greenhouse gases (waal). Although the Waitangi Park design doesn't site lie within a post industrial context, the loss of biodiversity once the stream was culverted showed degradation in water quality similarly like Centerport. It has shown potential to regenerate a lost ecology which helped re establish healthy water ways that is crucial in mitigating harmful toxins from the environment which accelerate anthropogenic conditions. By stabilizing and controlling urban heat through bio climate oriented design, effects of climate change can be reduced.

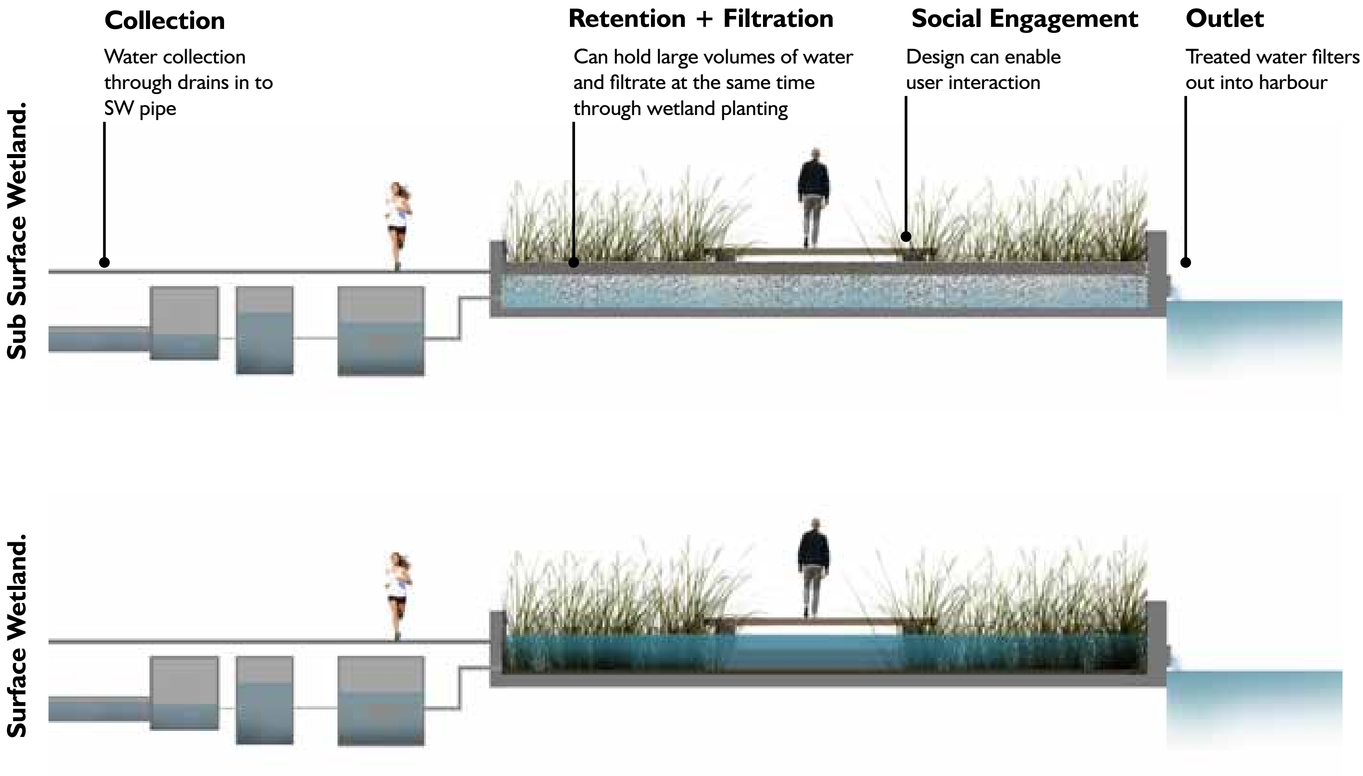




Fig. 2.04.


Fig. 2.05.

Fig. 2.03. Authors Own, Wetland Process Diagram, 2019.

Fig. 2.04. Wraights +Associates, Waitangi Park view over grown vegetation, 2014

Fig. 2.05. Wraights +Associates, Waitangi Park Permeable Waterfront Walkways, 2014

**Social +Ecological functions of a Treatment Wetland.**

Fig. 2.06.

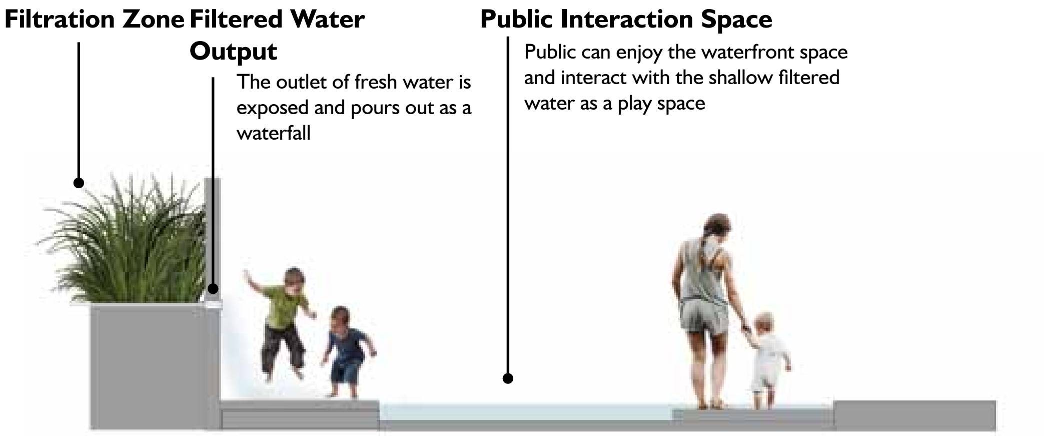



Fig. 2.07.

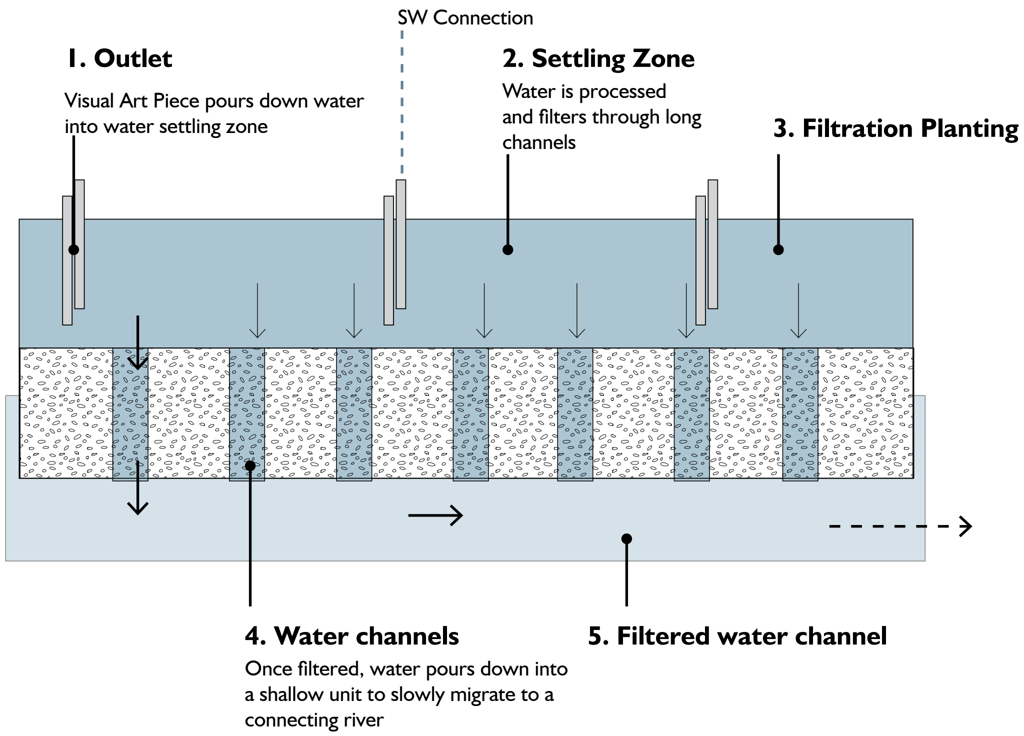
SHERBOURNE COMMON.

Previously being a post industrial site within the waterfront, an opportunity was found to reprogram the once unusable site to a central waterfront attraction. The design effectively ties the urban grid with the waterfront and displays a filtration storm water design through sculptural art elements. The design enables awareness of how water sensitive technology and filtration processes work by exposing elements of the water process. The water settlement pond is showcased through a sculptural art piece pouring water down, which then migrates through small ponds. Not only does this enhance the waterfront precinct, it demonstrates how water would typically down pour and flow through SW pipes, however through WSUD it has been celebrated and exposed to public to witness the process. This design shows the potential of allowing public to engage with a once industrial space, now a central waterfront element that has increased the value of site, development residential blocks and campuses have been developed within its surroundings. Likewise Centerport can become a celebrated waterfront space, encouraging users to come while enhancing the ecology of site simultaneously.

Fig. 2.06. Archdaily, Sherbourne Common/PFS Studio, 2013

Fig. 2.07. Authors Own, Exploration of Interactive Waterfront and Wetland Space, 2019

**Sherbourne Common Treatment System.**




Water sensitive urban design as a tool allows designers to understand how wider scale relationships affect the processes of runoff occurring within site. It provides a platform to encourage working as one whole infrastructural system that can be broken down to smaller site interventions for this. By using some of the techniques mentioned above, there is opportunity for site to function as one large component and create different social experiences and destinations through this. The Wellington site chosen for this thesis currently functions as post industrial ports. Ideas through water sensitive urban design could enable the restoration of lost biodiversity in the area. Imposing water treatment on site would enable the opportunity for aesthetically improved sites as well as public space. Centerport contributes a large amount of toxic chemical waste flushing into the harbour which water sensitive urban design can use as a regenerative tool to redesign within the post industrial site, collect and mitigate run off problems.

Key elements design should consists of based upon these principles are;

-Creating small interventions throughout site to capture runoff water
-Design a publicly visible storm water treatment design to allow users to engage with and enhance space quality
-Storm Water Treatment system determined on size of catchment

Fig. 2.08. Authors Own, Sherbourne Common Wetland Process Diagram, 2019.

## MULTIFUNCTIONAL URBAN PERFORMANCE.

This section looks at the overall approach of visioning urban areas as a completely integrated multifunctional system.

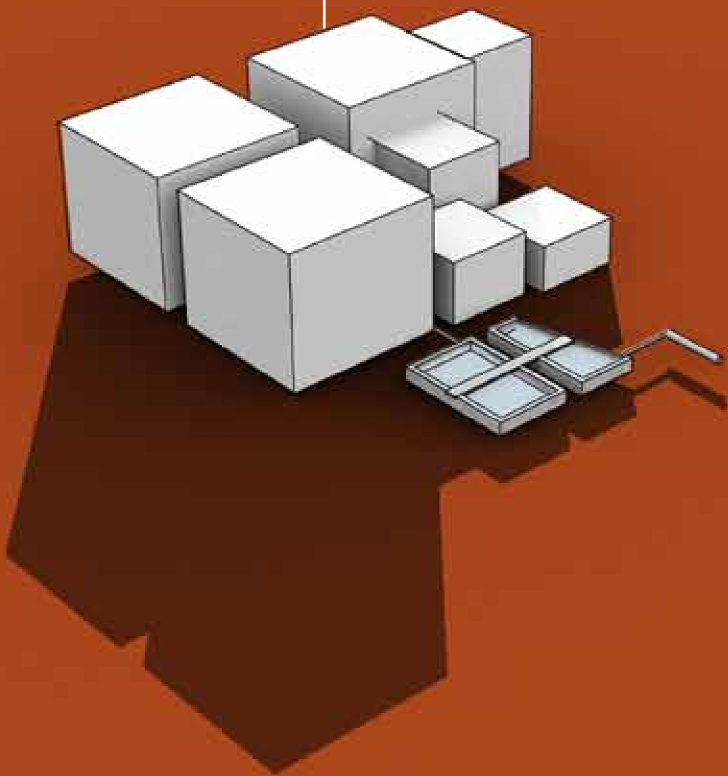


Fig. 2.09. Authors Own, Multifunctional Urban Performance Literature Review Illustrations, 2019.

## MULTIFUNCTIONAL URBAN PERFORMANCE.

Active waterfronts have become a more prominent feature within urban environments, as have more ecologically driven and greener cities within the expanse of urbanisation in effort for greenhouse gas reduction. Globally initiative has been shown that creating more resilient, sustainable and socially interactive landscapes make people aware of the impacts urbanisation has had previously on these natural systems. In order for long term ecological procreation, resilient cities have identified manner of which the protection and quality of life can be adapted with new social and ecological drivers.

Waterfronts being a prominent feature, however also possess the risk with high perceived value within the economic market which draws to further development and use of this space economically, such as industrial or residential. This however segregates the waterfront public use, and creates hierarchy of territory which should not be present within such an opportunistic site. Dianne Brands suggests there is a need to allow multiple users to use space, which can still function economical, but also allow diverse public groups to enjoy waterfronts as well, therefore creating a multifunctional space. By activating a site, it creates for a more successful place.

In order for an active waterfront to be successful, it should be dynamic. The key elements brands suggests these should include are; industry, sport, recreation, entertainment. These key elements combined are what make some of the most successful waterfronts and allow for more public engagement with site. However these alone don't consider the health of waterfronts and coastal defence after decades, soon deteriorating harbours further. The performance of how the waterfronts sustain should be attended to as well.

A term 'Performalism' was addressed by theorist Susannah Hagan. In her writing of Performalism: environmental metrics and Urban Design, she addresses the urban fabric through looking into environmental design performance foremost. Hagans concerns with urban design are the lack of attention towards environmental development and protection. It is argued, "turning a city into an ecosystem is a far more complex and more interesting process than merely activating a space " (Hagan). She expresses the potential for resilient and sustainable landscapes, especially in developing areas of which systems can work socially, economically and ecologically. There is opportunity for natural systems and social engagement to work together. In creating a multifunctional waterfront and programming public facilities, these can all be built upon the core ecological driver. For this thesis site similarly, responding to site ecological needs first can help articulate how the waterfront can function and allow users to orientate themselves towards it.

BOSTON WATERFRONT VISION, BOSTON.

The design and reprogramming of Boston's waterfront shows a similar situation that is applicable to the scope of this thesis. It demonstrates theory such as of 'Performalism' to be developed into design. In alarming events of climate change arising, Boston responded through an effective ecologically driven design proposal, enabling the protection and adaption through storms of coastal foreshores. The design is oriented towards protection of the urban edges which frames the coastal and urban design programme. This concept aims to strengthen the public realm, which is lacking in the area, its connection with neighbourhoods, strengthening access and the cities flood resilience. The open space waterfront is home for harbour ports, ships and docking. Efforts to protect from the rising sea levels are demonstrated through hard and soft adaptive landscape strategies, to mitigate storm surge impacts, flooding and the rising seas. The area prone to storms has allowed for design to respond to this by modifying the landscape to a more ecologically driven natural system, that allows events to impact site and withstand from these through the coastal edge that act as adaptive barriers in event of storm, and still perform as social platforms all other times.

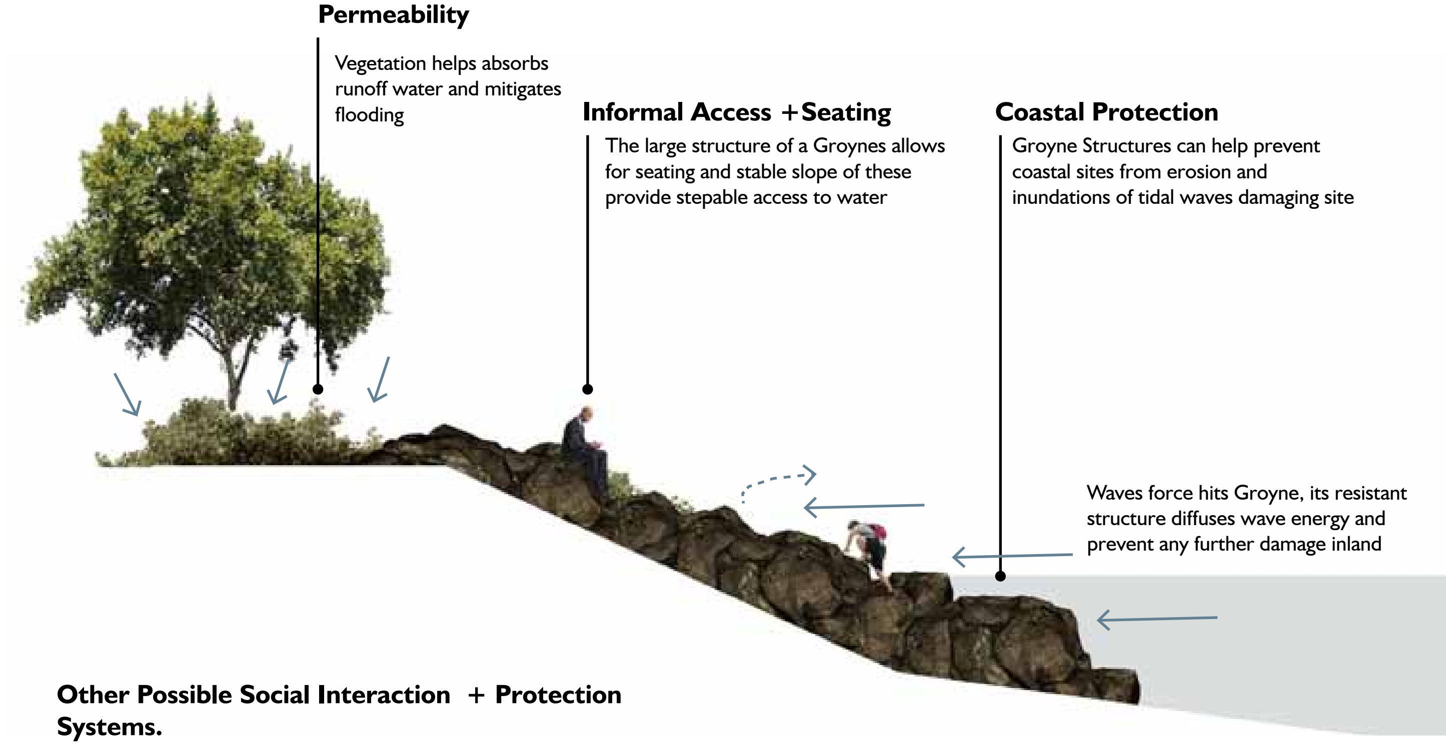
Similarity in problems with Wellington's northern ports is addressed. The design suggests an approach that allows water to come in and drain easily, with increased permeability around waterfront edges in event of storm surge and remain an active social space at all times, being seen as an adaptable landscape. Rather than using a conventional seawall which could adapt to public use, this scheme deals with working with natural elements rather than fighting against them. This project demonstrates is multifunctional design through the merge of ecological, public, urban, civic and development within design.

Fig. 2.10. MVVAINC, Boston Waterfront Visionto promote Public Use of Site and Protection from Storm Surges, 2015.

Fig. 2.11. Authors Own, Illustrations of Groyne Structure and Other Possibilities for Encouraging Public use of Site, 2019. (Opposite Page)

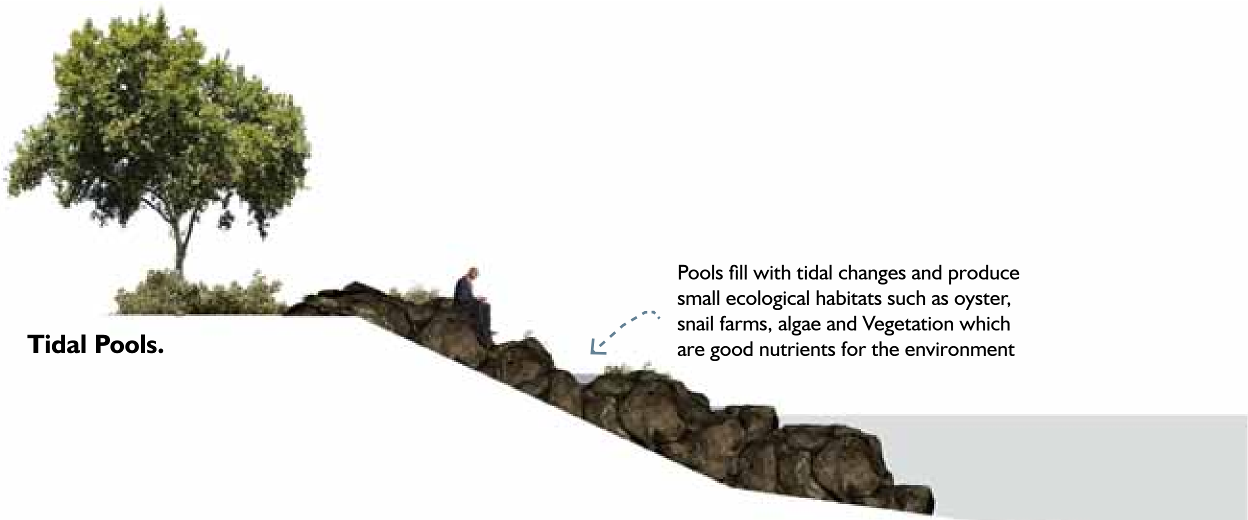
## Benefits of a Coastal Groyne Structure.

Exploration of Boston Waterfronts proposed Flood Mitigation System

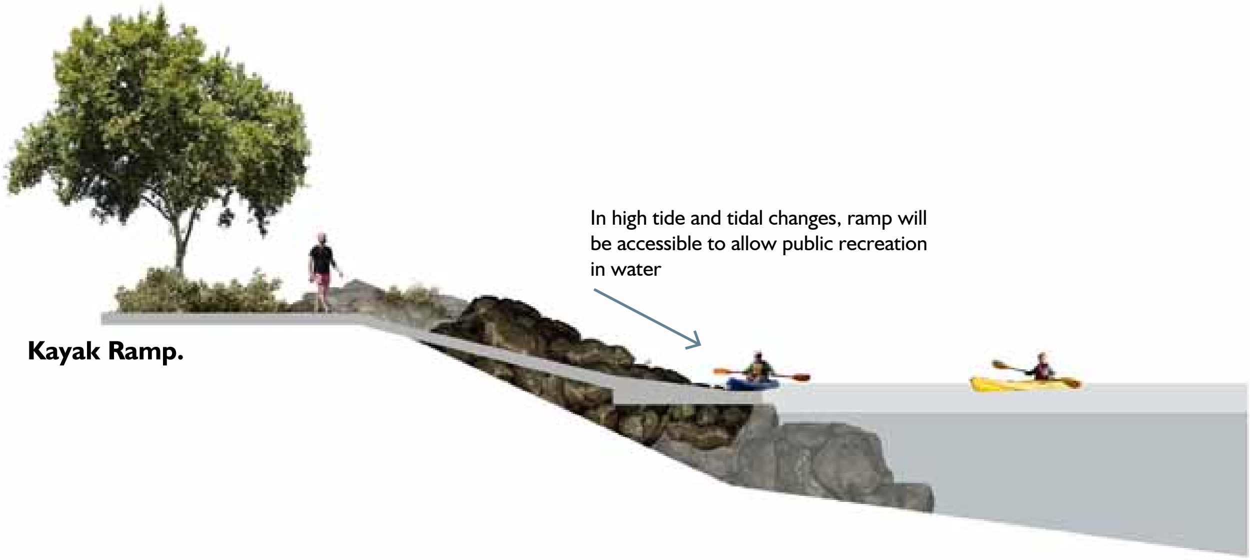



## Other Possible Social Interaction + Protection Systems.

### Tidal Pools.




### Kayak Ramp.



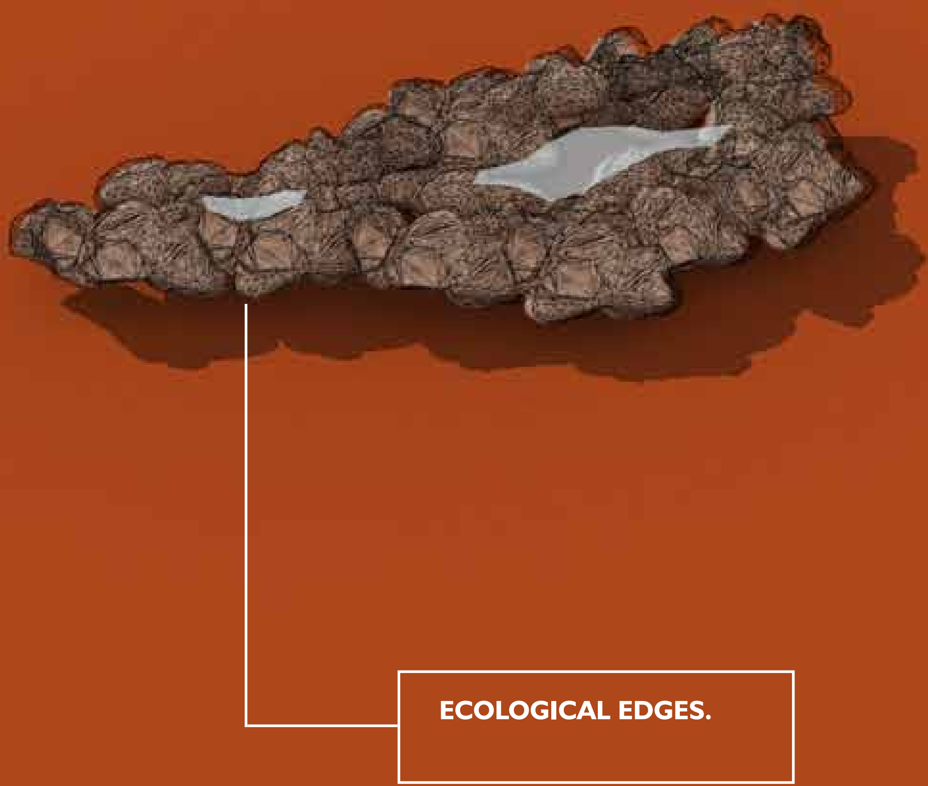


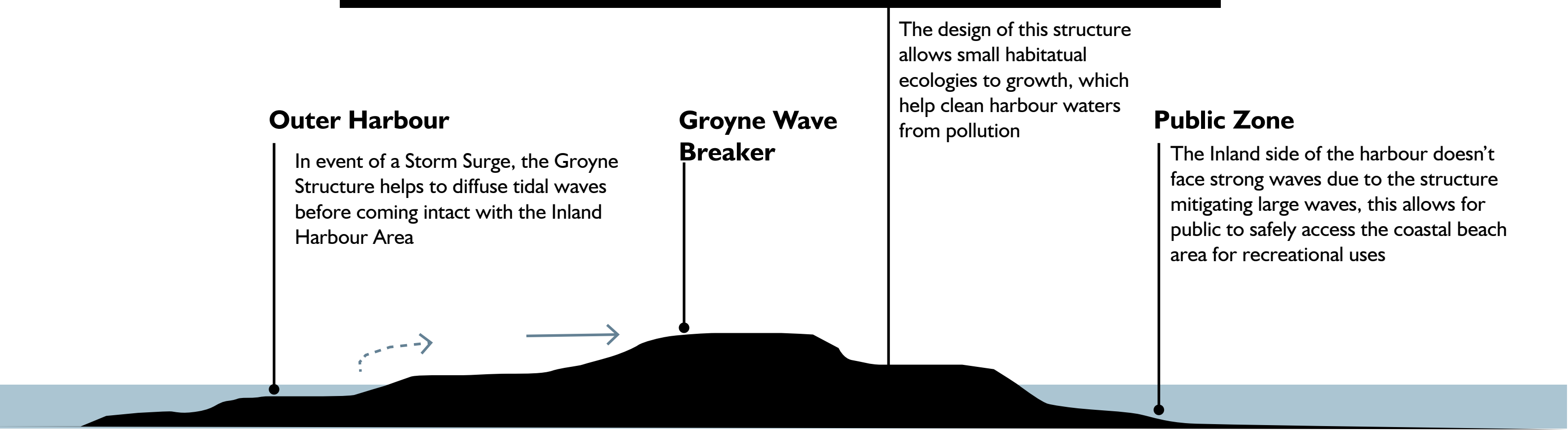

Fig. 2.12. Authors Own, Ecological Edges Literature Review Illustrations, 2019.

## ECOLOGICAL EDGES.

The strength of waterfront success lies in its power of connecting shorelines with city. This also relates to the expansion and encouragement of waterfront life within cities as it plays one of the most crucial roles in connecting humans with water, physically or visually. With the expanse of urbanisation the demand for this has increased, as well as the bond this shares with development on these prominent sites. (Anna Breen)

The threshold of waterfronts, between water and land has its own complexities and it isn't quite clear where this line ends, this is rather a moving transitions from land to water. It also however makes for interesting conflict with the propositions of waterfront development as well as there is a need for upcoming protection from existing and approaching conditions of rising seas. There needs to be adaption and need for change from upcoming rising seas and storms. Humans have been building structurally engineered barriers for this to fight back the sea, however this is not the only solution. Practitioner Kate Orff challenges that there is a need to work with nature, not against it (Architectural Digest). Orff suggests enabling bio climate design regenerates a rich diversity of marine life while providing natural defence systems which absorb large amounts of water that flush out again. Systems such as tidal water ecosystems help reduce urban heat and pollution through marine ecologies filtering harbour waters out. The process of taking in toxins, puts out nutrients into harbours, with healthy water climate impacts can be reduced. Through tidal movements, this process of flushing and cleaning protects urban edges from events of flooding and allows for healthier systems to produce. Further benefits of this include mitigation of waves and coastal flooding while cleaning of polluted waters, even erosion control. Projects Orff has proposed such as Living Break Waters is a prime example of this, which will be discussed later on. By allowing the edges to interact with people and ocean habitats and work in multifunctional ways, this provides resilient design solution, of adapting to site needs and creating positive opportunities to give back to people and site. Orff highlights this importance of healthy ecosystems as role in social waterfront design.

Fig. 2.13.




LIVING BREAKWATERS.

Southern Shore of Staten Island is vulnerable towards inundations during storm surges, which has resulted in significant amounts of coastal flooding and coastal erosion. The resilient strategy proposed aims to deal with the mitigation of tidal wave action and speed down risk of erosion through implanting living breakwaters. Scape studio uses theoretical grounds such as living ecosystems to propose implemented oyster-tecture, use of oyster reefs as breakwater to prevent sedimentation, prevent tidal exposure and generate cleaner water. Orff explains the concept of a single bivalve(shell) being able to filter up to 50 gallons of water a day. While preparing for arising storm events the concept of regenerative ecological landscapes can became social amenities for public and a natural defence system against storms.

Waterfronts, in particular abandoned post-industrial sites offer great catalysts for regeneration. As Wellington waterfront is reclaimed, it is a non-permeable site, prone to flooding that lacks any ecological significance. Northern Wellington Waterfront has an opportunity to perpetuate resilience through design to deliver for climate needs while becoming a generative, active landmark. Literature has suggested there are fundamentals for narrating and regenerating waterfront success, but by also allowing natural living ecosystems to produce, this can speed up and mitigate large flood/storm event scenarios.

Coinciding ideas of Bioclimatic, living waters and healthy ecosystems emphasise positive social and ecological parameters of waterfronts. This leads to general ideas within thesis the regeneration of ecological landscapes would start to be noticed will directly affect and improve ecological conditions. In order for such design objectives to be achieved it is also important to see the implications of wider context and connection . Working as a large infrastructural system driver that adapts to Wellingtons site flooding conditions, a new opportunity for development to work coherently will be investigated through this thesis.

Fig. 2.13. Scape, Ecological Structure of Oyster Tecture, 2017.

Fig. 2.14. Authors Own, Breakwater Illustration, 2019.

**FINDINGS.**

The three theoretical subjects studied have provided design solutions to understand and enable site design with, which include;

-Test social and ecological design integrated design tools (tools would include;

Desalination, Subsurface wetlands, Surface Wetlands, Bio Swales, Retention Ponds, Permeable Paving, Raised Marine Beach, Tidal Pools, Ecological Seawalls, Oyster/Groyne/Living Edges, Green Roofs, Staged Storm water Wetland, Daylighted Wharf)

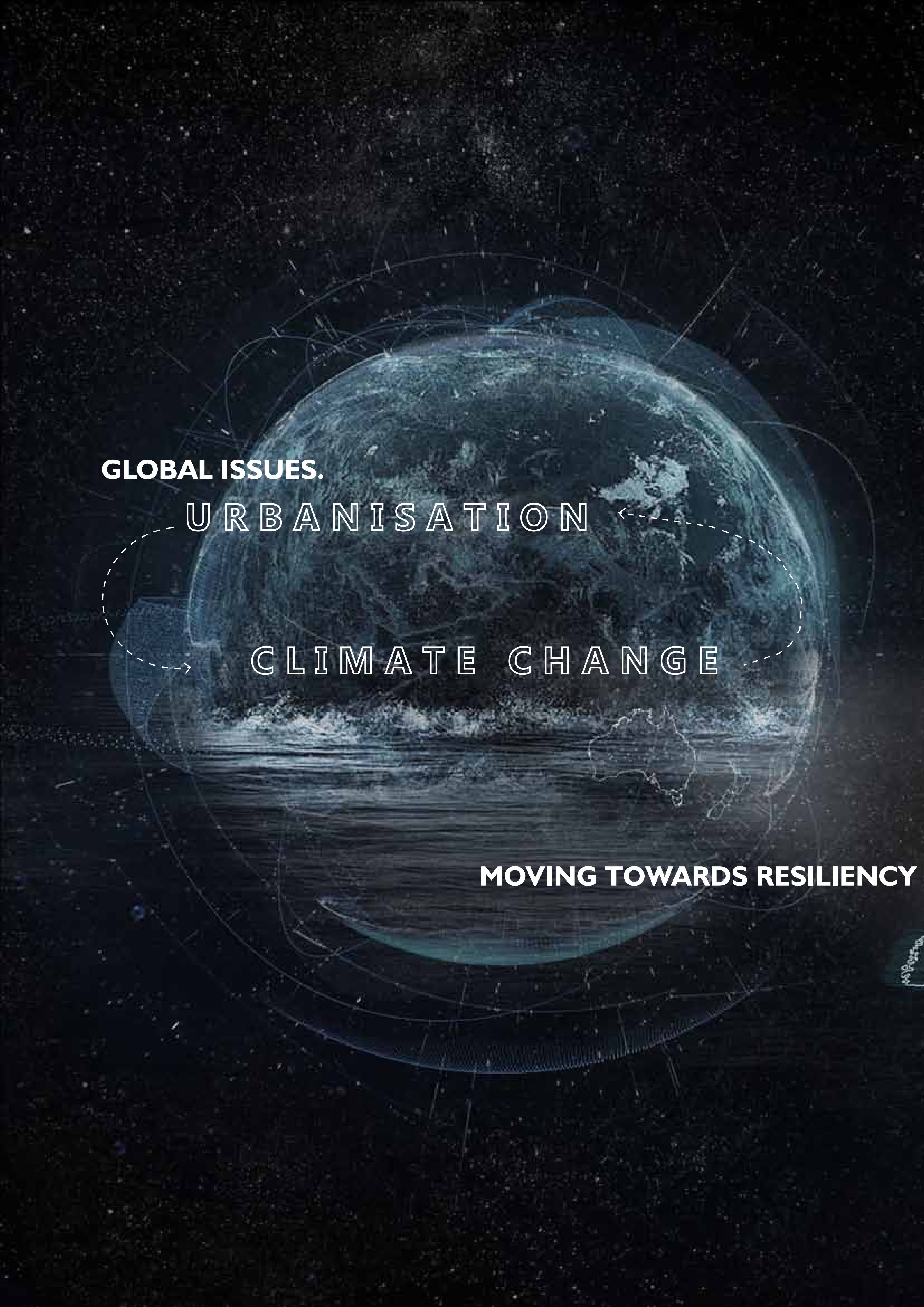
-A design strategy integrating functions of a dynamic waterfront, being ecological, recreational, industrial, entertainment and residential within a waterfront

-Activate harbour edge through public access, while adaptable protection of site from flooding events

-Water Sensitive Urban design that, captures runoff water, filtrates, and provides social interaction through small scale design interventions along site

-Allow natural ecological systems to function, which may celebrate sites coastal past

-Functional site design which can adapt to weather scenarios to be used in or after flood events


GLOBAL ISSUES.
URBANISATION
CLIMATE CHANGE
MOVING TOWARDS RESILIENCY

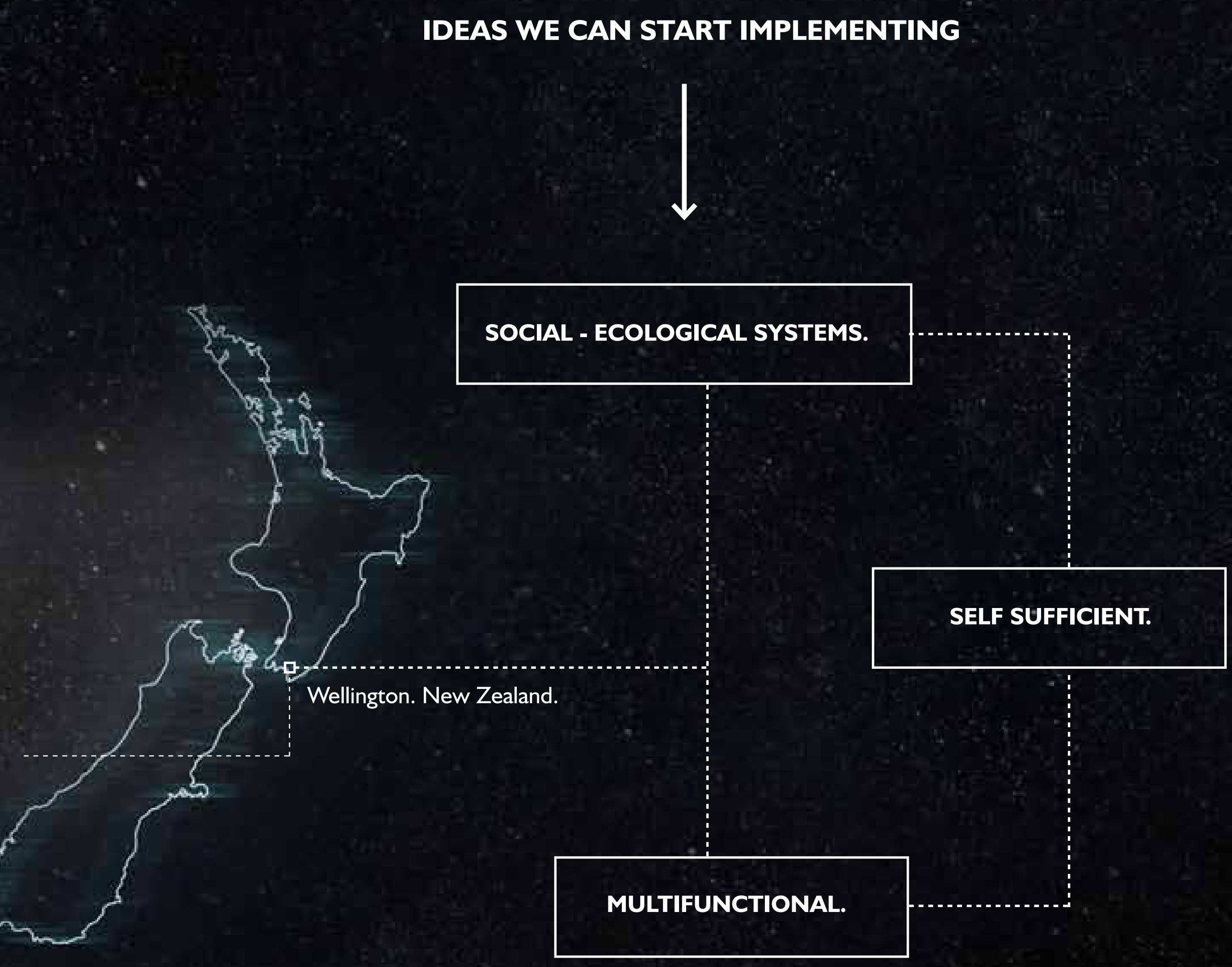



Fig. 2.15. Authors Own, Global Movement Towards Resiliency Diagram, 2019.

# 03

# Site Analysis.

**CHAPTER THREE.**

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| Urbanisation | 116 |
| Overall Findings | 120 |
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Fig. 3.01. Authors Own, Tidal Beach Waves, 2019.

## SITE ANALYSIS INTRODUCTION.

This chapter identifies the chosen thesis site in relation to its three distinct scales, wider Wellington region, immediate waterfront edges and the ports. Wider Wellington and site specific qualities identify Wellingtons industrial ports as an opportune location and environment to test this thesis's research question concerning the future of Wellington in the event of arising climate change implications such as storm surge and sea level rise.

A prime focus within the scope of this thesis is the successful integration of public and residential areas to co-exist within an increasingly expanding urban centre and prime waterfront location. Centerport is a notable site exemplar of waterfront conditions which can require and withstand tests of the upcoming challenges of which future design can be align upon. Key conditions explored will be site history, topography and ecologies, key underground infrastructures, transportation and social networks as well as coastal and environmental hazards. A pragmatic assessment of opportunities and constraints in relation to site will be accompanied with a concluding reflective analysis to identify strong areas of concern, further enabling design solutions.

# Site. Centreport.

Through history many ports and much reclamation have shaped what cities are today, Wellington is just the same. The history buried through reclamation and construction upon thriving tribal cultivated coastlines have become of a centre of industrial sites built upon timber ports. Wellington has been through this immoderate change within the last century. The site this thesis focuses on, Centerport has also become an imperative asset through the century. The vast scale of this site takes up a wide portion of Wellington's waterfront and harbour views. This immense section of land is detached from public and serves as an industrial business sector for Wellington. Majority if the area is dedicated to storage warehouses, administration buildings, cool store warehouses, maintenance buildings, shipping and cargo containers. Centerport has high economic capability and serves as a good service trade point nationally and internationally, contributing $2.5 billion to GDP1.

Few figures that indicate the success and economic reliance on Centerport are stated below,

- Supports 21,000 jobs in new Zealand
- Facilitates $20 billion in freight services
- Enables exports and imports of $3.3 billion within international markets
- In 2018 Centerport has had an underlying profit up by 37% to $11.8 million
- Boosted economy by $59m with 238,000 cruise passengers

With the huge economic reliance and success of Centerport, the use of reclaimed ports has meant a restriction in public access to ports and waterfront edges where people can go down to the water. Centerport and the surrounding ports have two main edge conditions being timber wharf and riprap groyne. Although much of Wellington harbour edge has riprap which allows people to go down to the water, this is a hazard on site as land reclamation rises 2m above water, with a sudden vertical fall of 10m on the eastern and southern side. On the western side there is almost a 15m vertical drop, with a tidal average change of 1.7m. With a huge contributing factor to Wellington and New Zealand's economy, a part of Centerport's working industry will be left to function in consideration for this thesis (Centreport).

A statement from brand suggests the need of crucial elements to become successful dynamic waterfronts. These four elements are industry, sports, recreation and entertainment. In correlation to reports suggesting future plans of site and needs of Wellington, a few more functions which should be examined are sustainability, tourism and residential development.

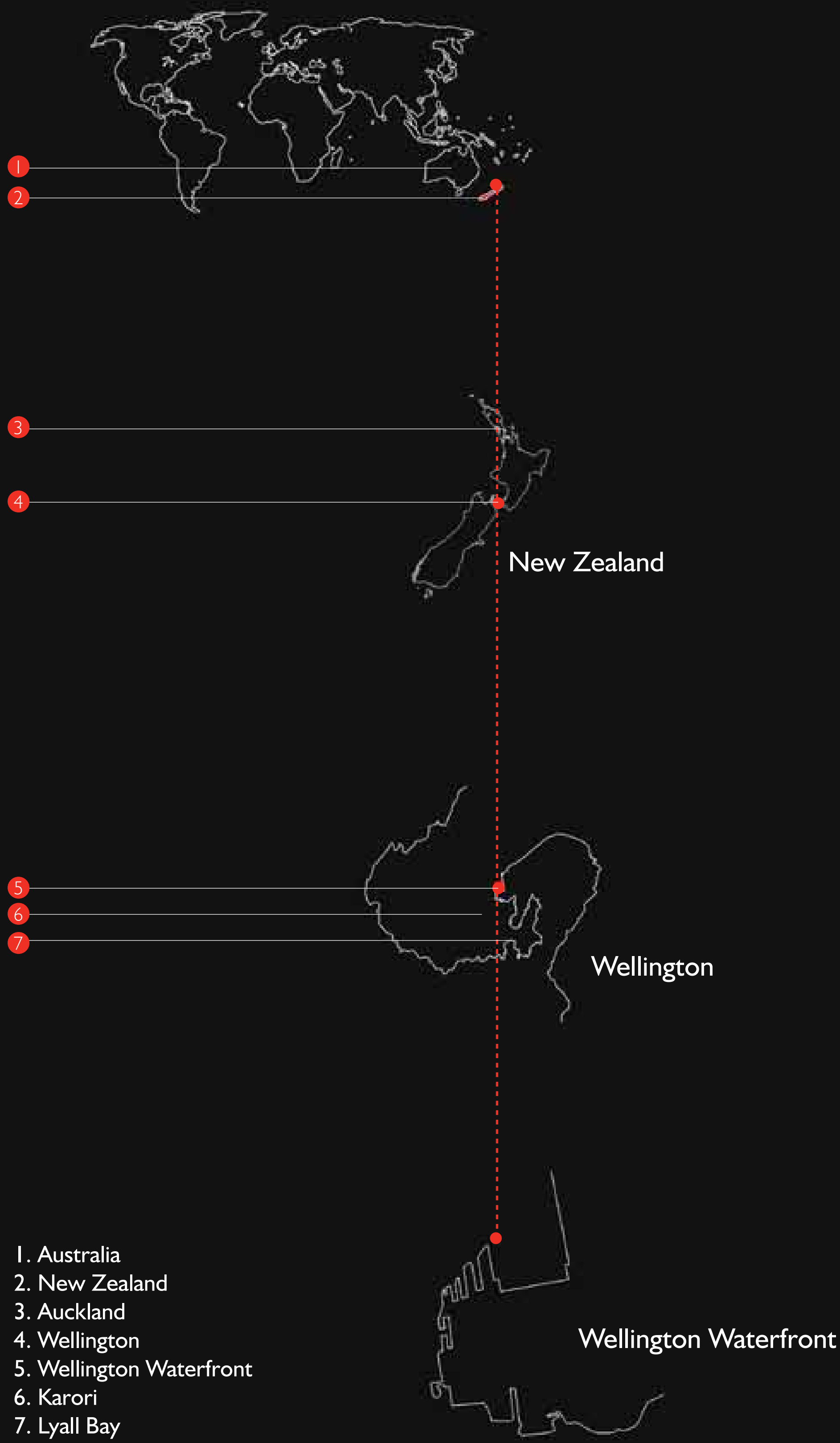


Fig. 3.02. Authors Own, Context and Site Location Map, 2019.


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Historic/Present Wharfs of Wellington

*1. Pipitea Wharf (Present; reclaimed Centerport)*
*2. Kings Wharf*
*3. Glasgow Wharf*
*4. Railway Wharf*
*5. Ferry Wharf*
*6. Queens Wharf*
*7. Clyde Quay*

# CONTEXT.

*Wellington Harbour*

Wellington is one of the most vulnerable cities in New Zealand. Post Industrial areas in particular have higher vulnerability to this issue with no ecological protection to mitigate these factors. By using landscape techniques to develop a strategy for post industrial areas, this can help mitigate issues of climate change while enhancing the ecological and social conditions of site.


Fig. 3.03. Authors Own, Wellington Harbour Location Map, 2019.


Fig. 3.04. Authors Own, Wellington Aerial, 2019.

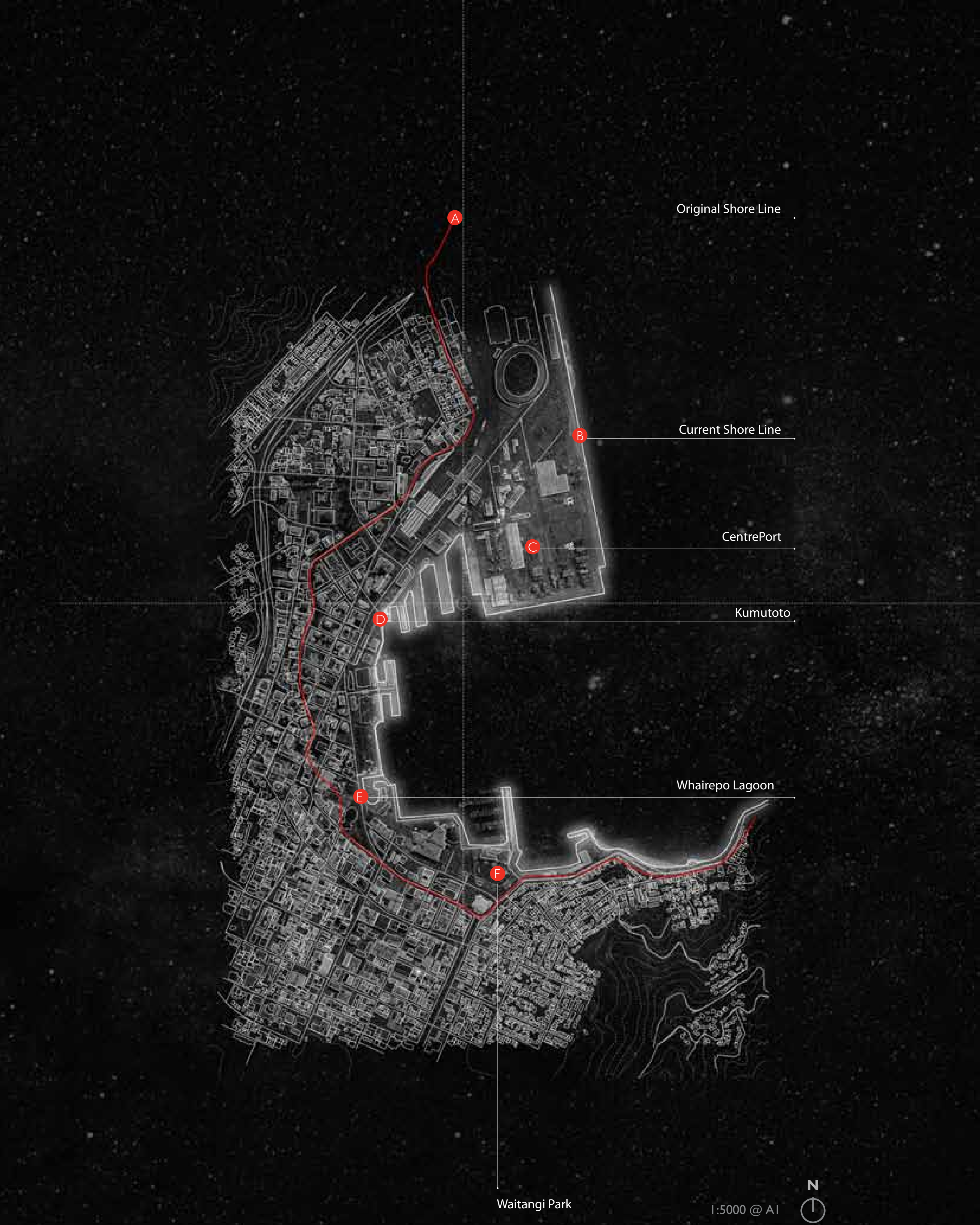


Fig. 3.05. Authors Own, Significant Landscape Landmarks in Wellington, 2019.

Fig. 3.06. Authors Own, Wellington Precincts, 2019. (Opposite Page)


**THE PRECINCTS.**

Differentiation of Waterfront spaces.

Wellington has a unique waterfront where the entire waterfront harbour has several different precincts with their own identity, history and culture.

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Fig. 3.07. Authors Own, Centreport Programmes, 2019.

Fig. 3.08. Authors Own, Wellington Aerial Over Clouds, 2019. (Opposite Page)

## SITE PROGRAMMES.

1. Westpac Stadium
2. Centreport Offices
3. Warehouse
4. Container terminal
5. NZ Customs Service
6. Container Storage
7. Greater Regional Wellington Council
8. Warehouse
9. Straight Shipping
10. BNZ
11. Cargo Containers
12. Coldstore Warehouse
13. Wellington Railway Station

## A HISTORY OF THE SITE.

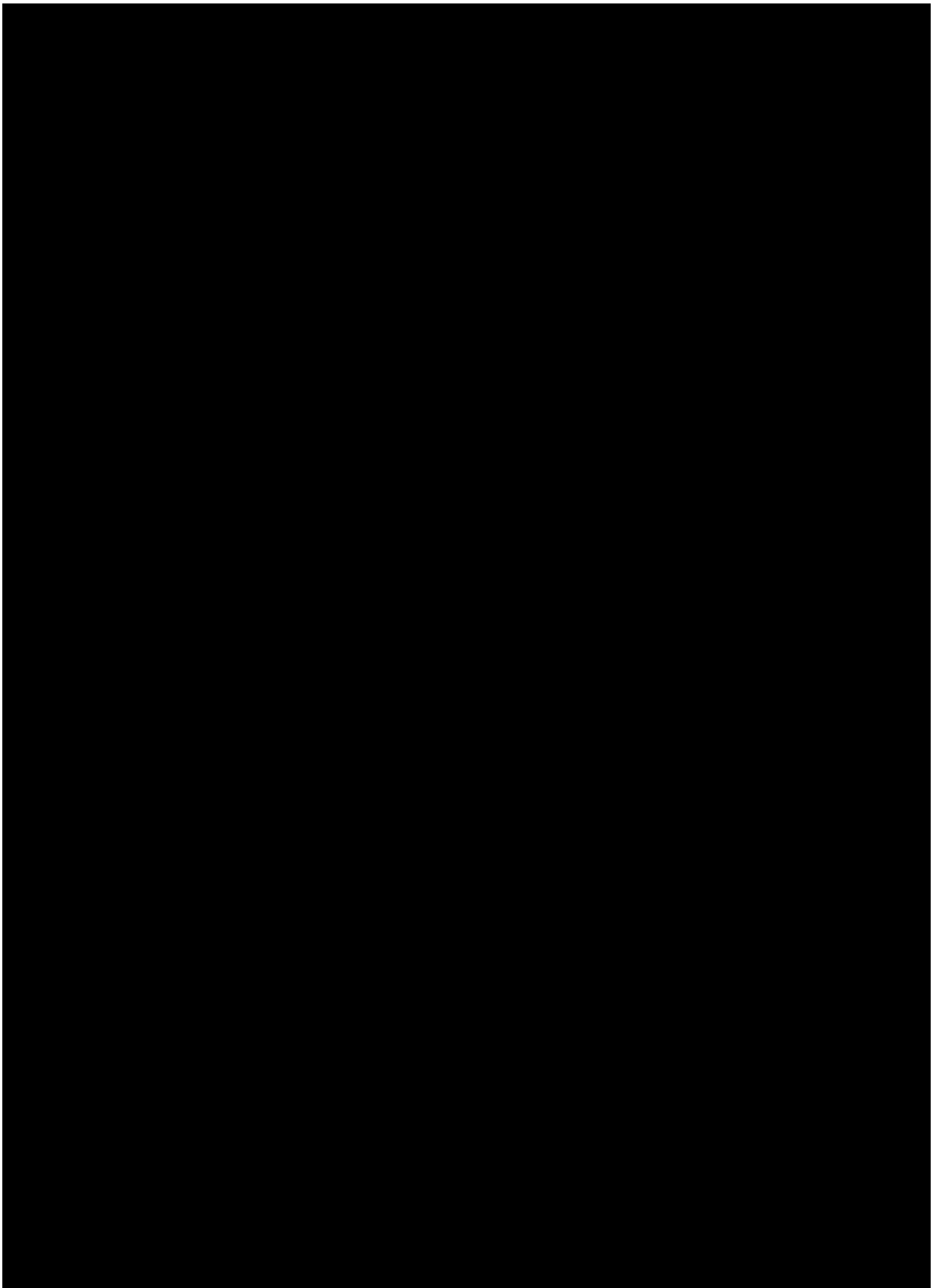
1800's
PIPITEA PA

Fig. 3.09. Sketch of the Pipitea stream, prior to European Settlement and culverting.

Prior to Wellington's reclamation, several streams ran down the vegetated hill tops, down to the Wellingtons coastal harbours. Most of which streams have been culverted into SW pipes now used to remain territories of early Ngati Awa pa settlements. Pipitea pa, closely linked with the site of Centerport, had its stream running down Karori hills, entering the mouth of Wellington harbour where Westpac Stadium lies today. Rich and fertile waters allowed for an abundance of cultivation and food collection. The importance of Pipitea stream was evidently important to the local pa, however due to settlement and great portions of land being sold through this time, this soon diminished and streams were piped underground, many tribes lost land and migrated further south. A detraction of flora and fauna, as well as natural environmental processes such as flood defence sustained, the consequences of this are evident today with impermeable surfaces, lack of natural catchments, lack of flood mitigation, loss a vegetation and polluted waterways (Wellington City Council).

Fig. 3.09. WCL, Sketch of the Pipitea stream, prior to European Settlement and culverting, 1845.

Fig. 3.10. WCL, Illustration of Pipitea Pa Settlement prior to European Settlement, 1845. (Opposite Page)



1800's
PIPITEA PA

Fig. 3.10. Illustration of Pipitea Pa Settlement prior to European Settlement.

The natural structure of Pipitea Stream not only allowed for Pa to harvest, it protected land from flooding with its permeable structure of vegetation and flood banks. Marsh land had also formed over time where water would sit still under vegetation. Key qualities of these plants allowed plants to filter water and remove any negative toxins and pollution occurring which create a healthy eco system.

Fig. 3.11. WCL, Sketch of the Pipitea stream after European Settlement, 1871.

## TIME LINE OF WELLINGTON SETTLEMENT.

The European settlement of Wellington shows the thinking behind what created Wellington today, water systems were developed after widespread problems occurred, this was sufficient enough for settlement then, however with increased rainfall, increased population and increased impermeability of site the old systems are out of date.

### Pre European Settlement

Te Upoko-O-Te-Ika: Whatonga, a chief of Kurahaupo waka was the first person to settle on the lands at the tip or the north island. This area was known as the head of the fish (Te Upoko-O-Te Ika)

### 1800-1830's - Migration South

Hilltop pa were established over the centuries strategically on sheltered sites around Wellington harbour. These people are known to be associated with Ngati Ira, where they established their own coastal territories. They were pushed further down as tribes from the Taranaki region moved south. Many Ngati Ira had started to leave by the 1830's.

### 1839 - Sale of Land

London based New Zealand Company ship purchased land in agreement with Maori chiefs. One tenth of land was allocated to signatory chiefs and their families, the rest was sold to British settlers. by the 1830's.

### 1840 - European Settlement Begins

British settlers came ashore to Petone, The town relocated further south west, and was soon named Wellington. Town acres were drawn up and allocated settlers. Former Maori were also evicted from this land, dwellings, churches and pubs were constructed.

### 1855 - Earthquake

23 January 1855 Wellington was hit by a strong 8.2 earthquake centred 25km away. Widespread damaged was done and the landscape had been significantly altered, many areas risen by 1.5meters.

### 1879 - Water Supply

After inspection of many contaminated human and animal faeces infested water, the Karori reservoir was opened and provided to provide safe and clean drinking water

### 1890-1904 - Sewage system construction

As a significant and rapidly increasing amount of diseases spread linked to poor sewage soaked backyards, a sewage system was installed to mitigate this

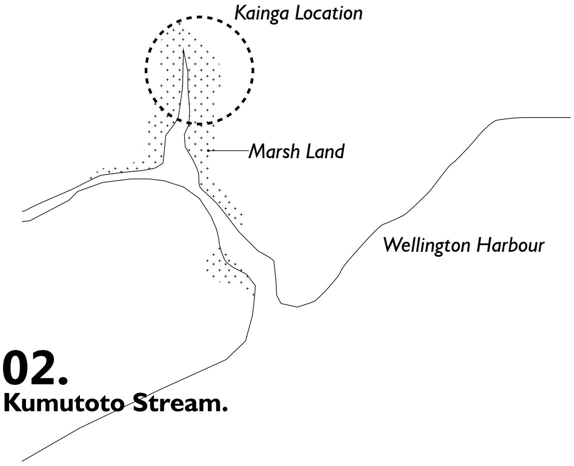
### 1967-1972 - Urban Motorway Construction

### 2000 - Westpac Stadium Opening

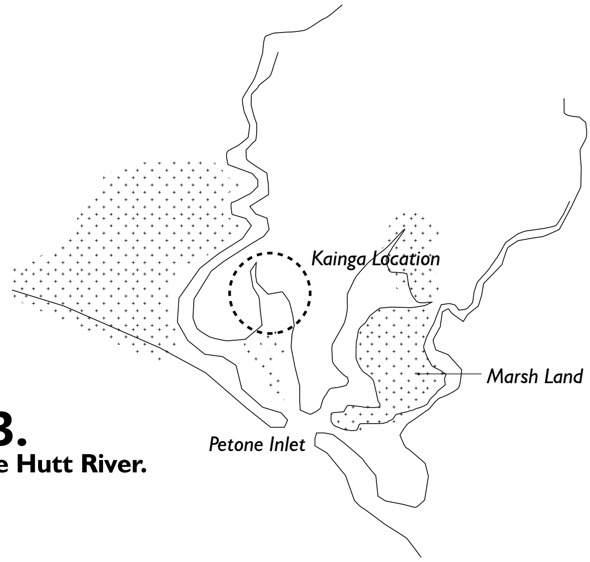
A $125 million sports arena was opened on a disused railway land north of the city.

(WCC, 2019)

**A COMPARATIVE STUDY OF WELLINGTON'S CULVERTED STREAMS.**




**02.**
**Kumutoto Stream.**



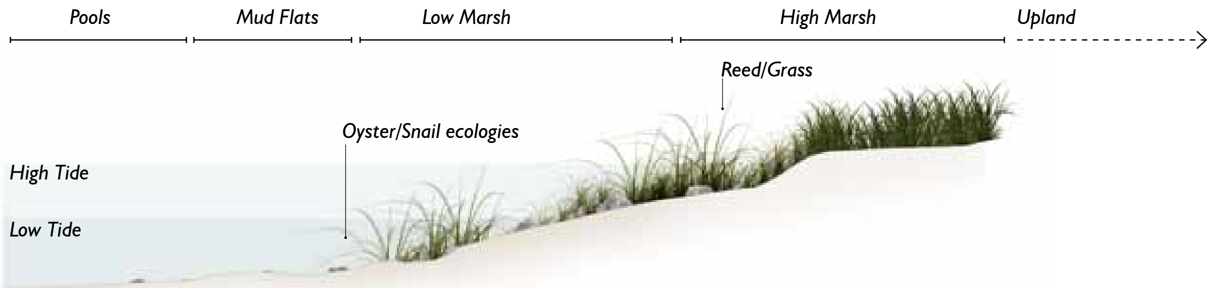

**03.**
**The Hutt River.**

**Significance Of Historic Marshes within Wellington Streams.**

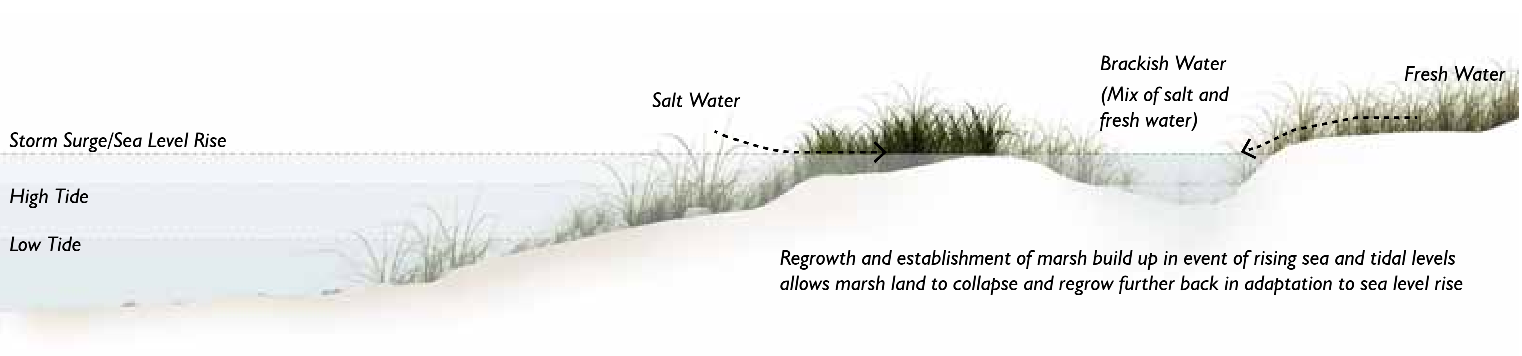
The formation of Wellington stream marshes are studied as they provide resilient qualities which this thesis's site currently lacks. Marshes provide many benefits for the environment, that can also be adapted to climate change conditions and carry qualities of Salt water and fresh water intrusion that would occur on site if these were to be re-introduced.

**Benefits of Coastal Marshland**

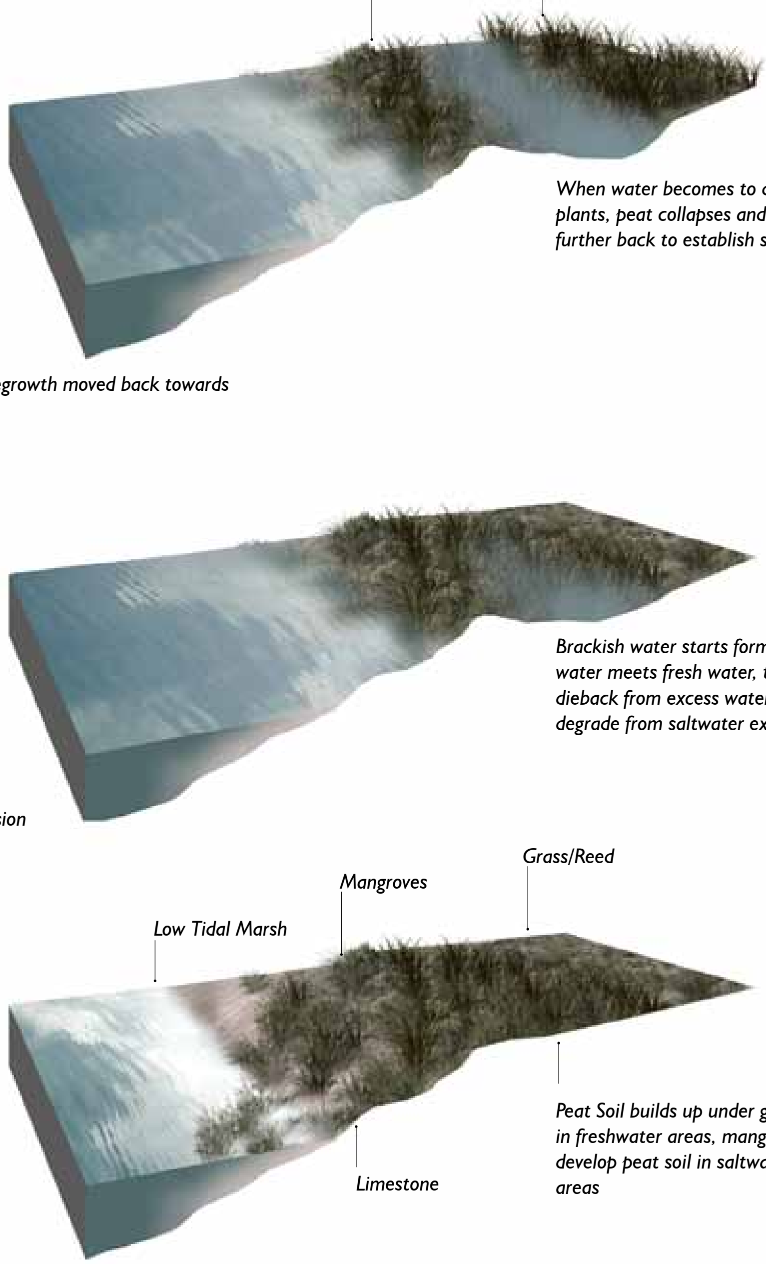
- Natural barriers for coastal defence
- Attractive landscape - high amenity values
- Growth as adaption to sea level rise
- Limitation of erosion
- Sediment management
- Substrate
- Wave reduction
- Low hydrodynamics
- Inundation zones, preforms with tidal behaviour




*Typical Marsh Section - an indication of what historic marsh territory would look like and function before settlement began*




*Regrowth and establishment of marsh build up in event of rising sea and tidal levels allows marsh land to collapse and regrow further back in adaptation to sea level rise*

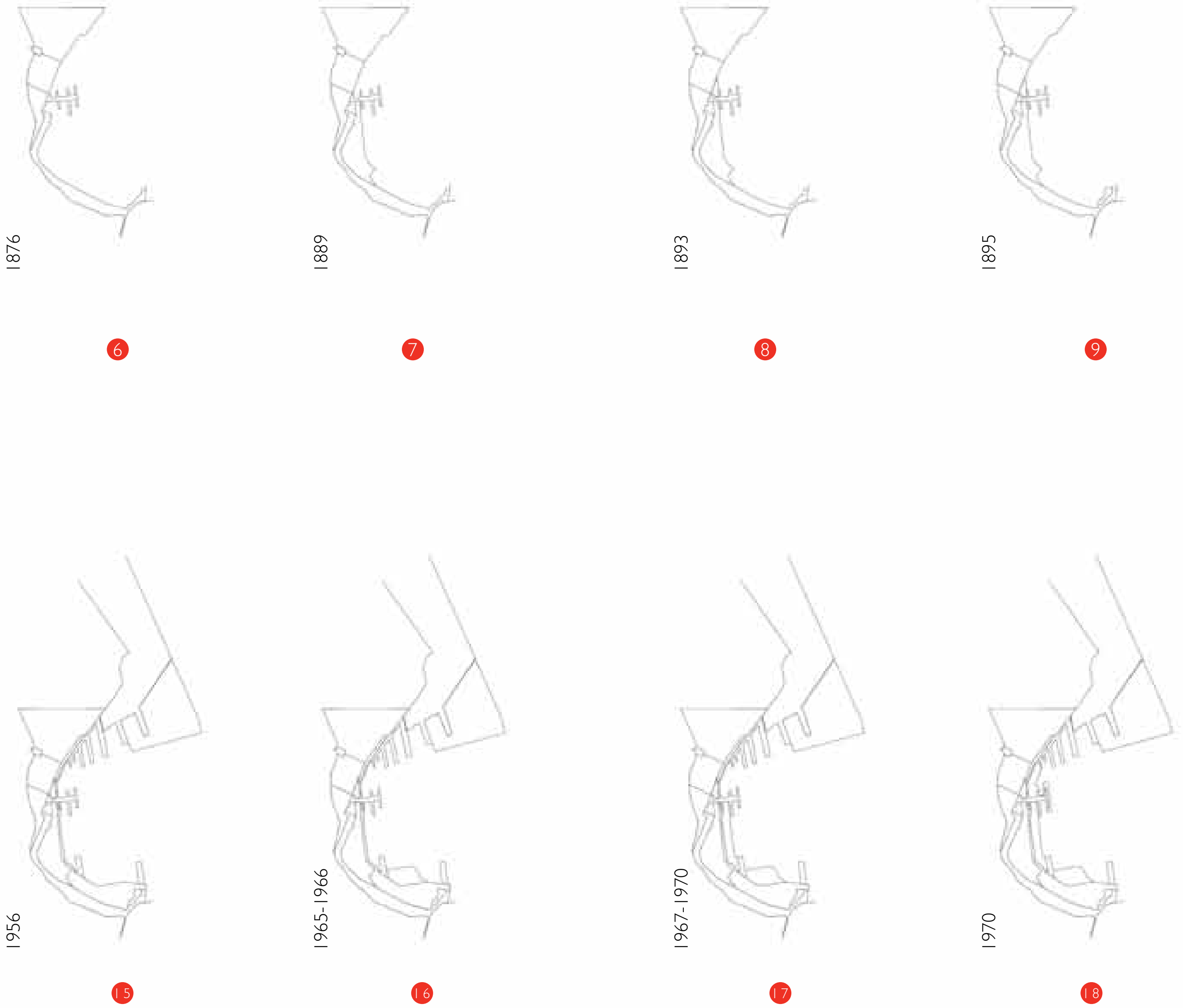



**Process of Marsh Formation.**

Fig. 3.12. Authors Own, Illustration of Marsh Formation in Wellington, 2019. (Opposite Page)

Fig. 3.13. Authors Own, Illustration on Marsh Growth Process, 2019.


1
Original Shoreline
2
First Seawall
3
1857 -1863
4
1865
5
1866-1867
10
1899
11
1901-1904
12
1905
13
1907
14
1930




**GROWTH OF WELLINGTON WATERFRONT THROUGH RECLAMATION.**

Fig. 3.14. Authors Own, Wellington Reclamation Timeline, 2019.


Fig. 3.15. Authors Own, Wellington Reclamation Extents, 2019.

## STRUCTURES OF RECLAMATION.

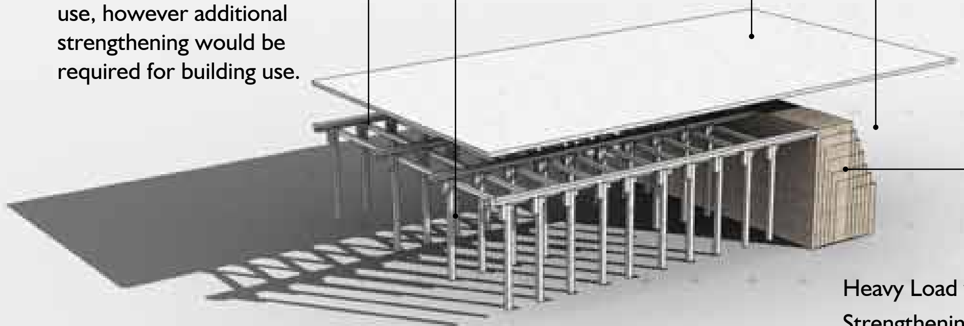
Reclaimed sites provide opportunity for correction as they have more vulnerability to erosion and lack ecological system due to impermeable surfaces and fill.

Majority of Ports remain on piles, dimensions of these piles varies between 480-660mm, with 1-2m spreads depending on gravitational loads of buildings. There are two main timber wharf structures within Centreport, the remaining site is Fill. ( See Fig.3.16.)

## RECLAMATION AND PILE STRUCTURES.

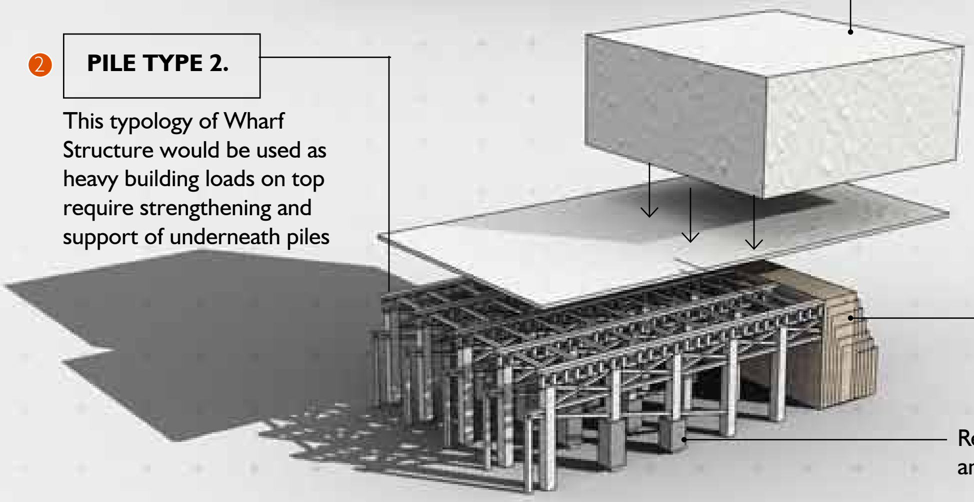
1 **PILE TYPE 1.**

Wharf Structure allows for Vehicle and Pedestrian use, however additional strengthening would be required for building use.




2 **PILE TYPE 2.**

This typology of Wharf Structure would be used as heavy building loads on top require strengthening and support of underneath piles




**FILL TYPE.**

A standard reclamation fill like this would be developed over time. As the coastal edge keeps getting pushed out, further seawalls are constructed for this which can be seen underneath.

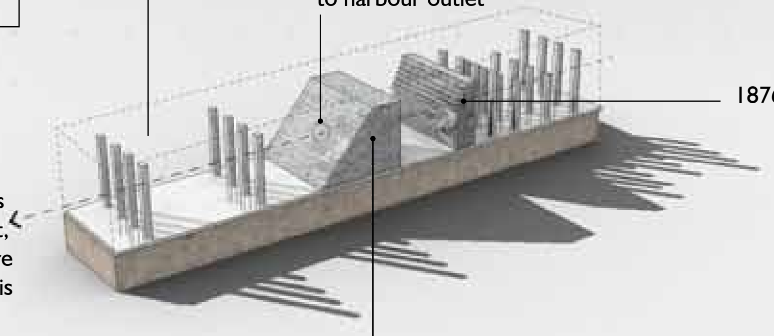



Fig. 3.16. Authors Own, Illustration of Wharf Pile Structures, 2019.

## Transition Of Reclamation Fill, Creating An Impermeable Site.

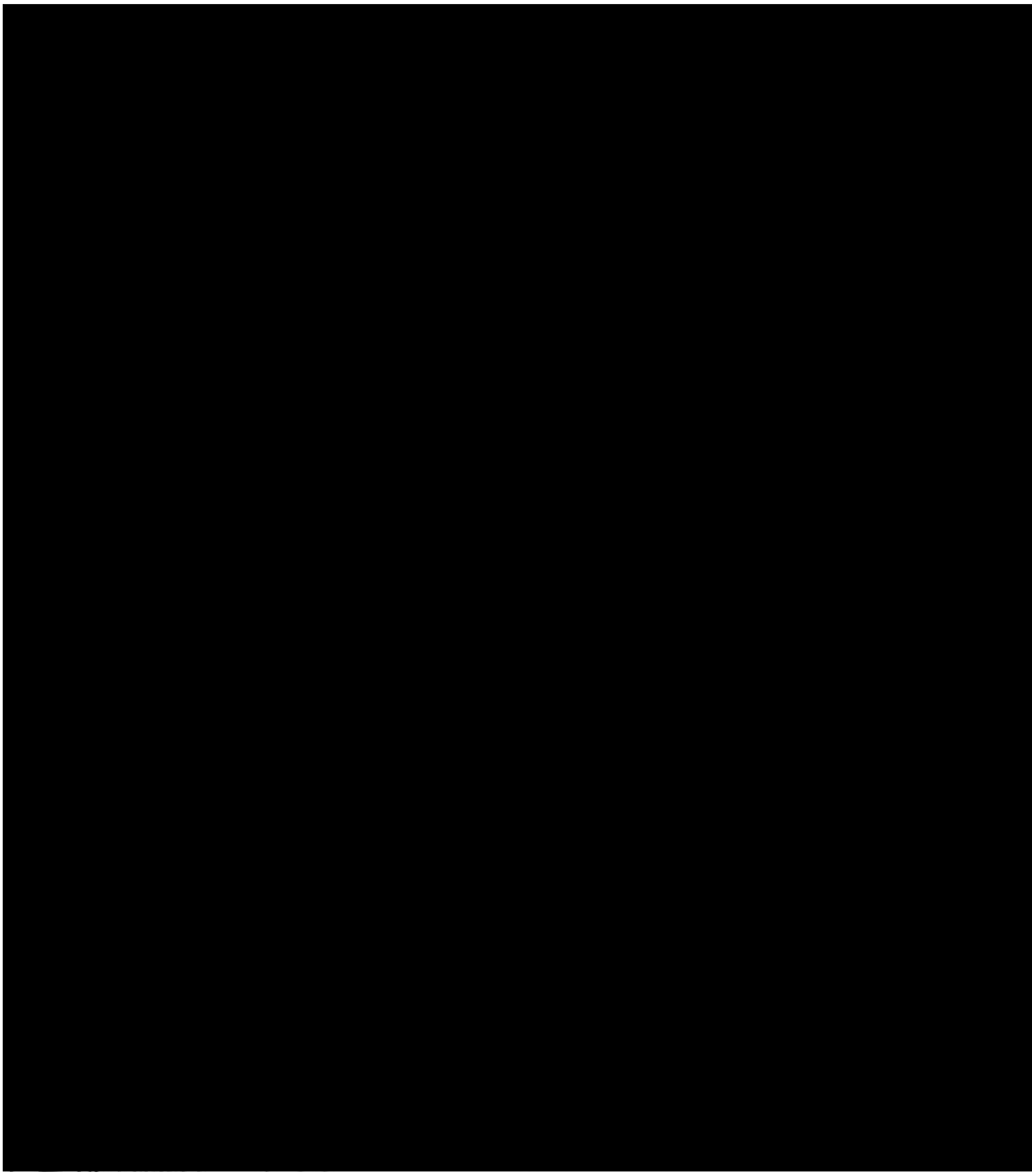
1925

1938

1969

1979

Fig. 3.17. LINZ, Wellington Reclamation Over The 20th Century, 2019.



**Culverted Streams for Urban Reclamation Fill.**

The numerous amount of streams culverted portrays the mass declination in habitat, ecology and environmental significance and protection of site from climate change events. These areas are dominantly impermeable sites which now have high vulnerability to flooding.

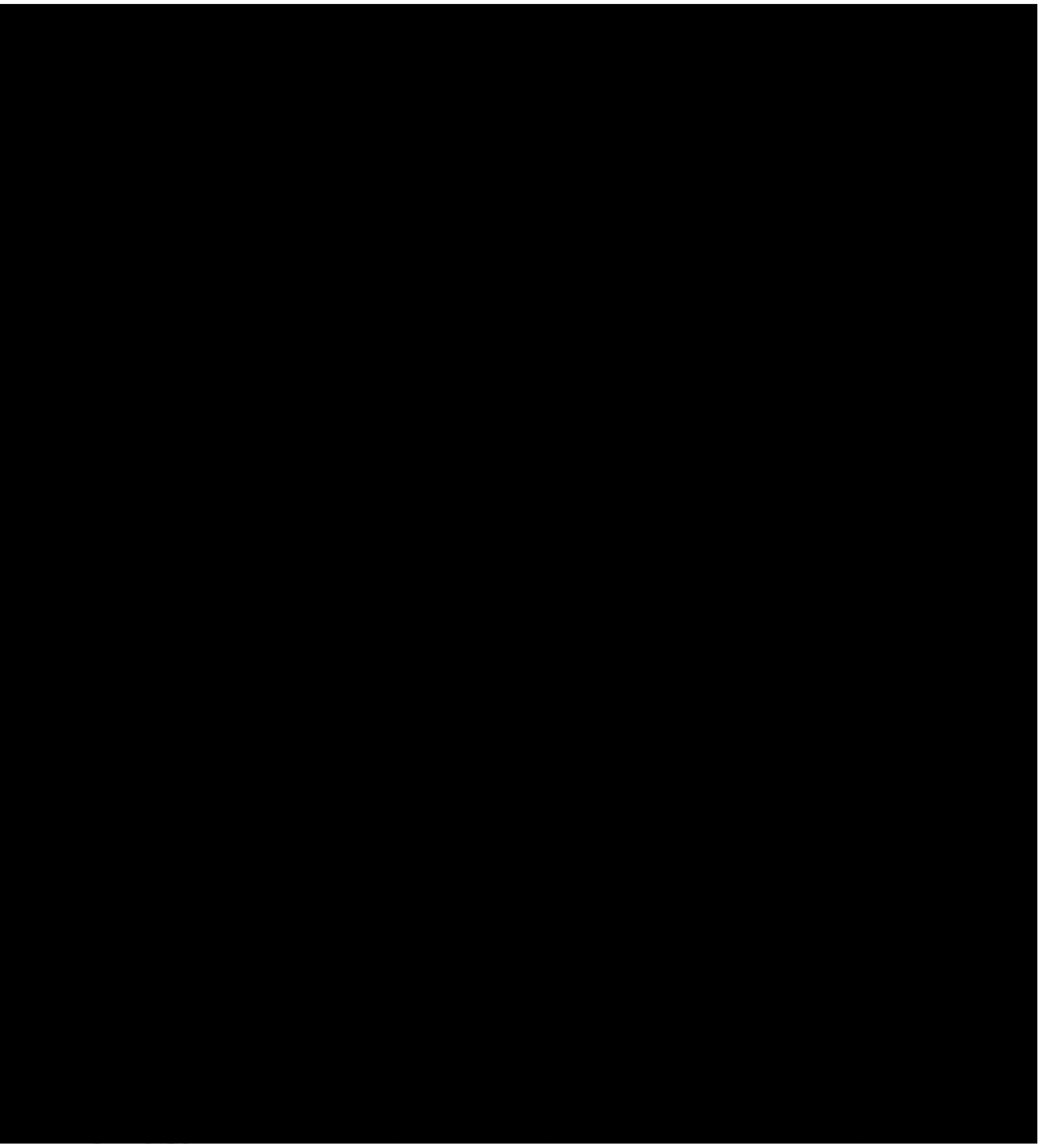


Fig. 3.18. WCL, Wellington Reclamation Over The 20th Century, 2019.


## PERMEABILITY OF THE WATERFRONT.

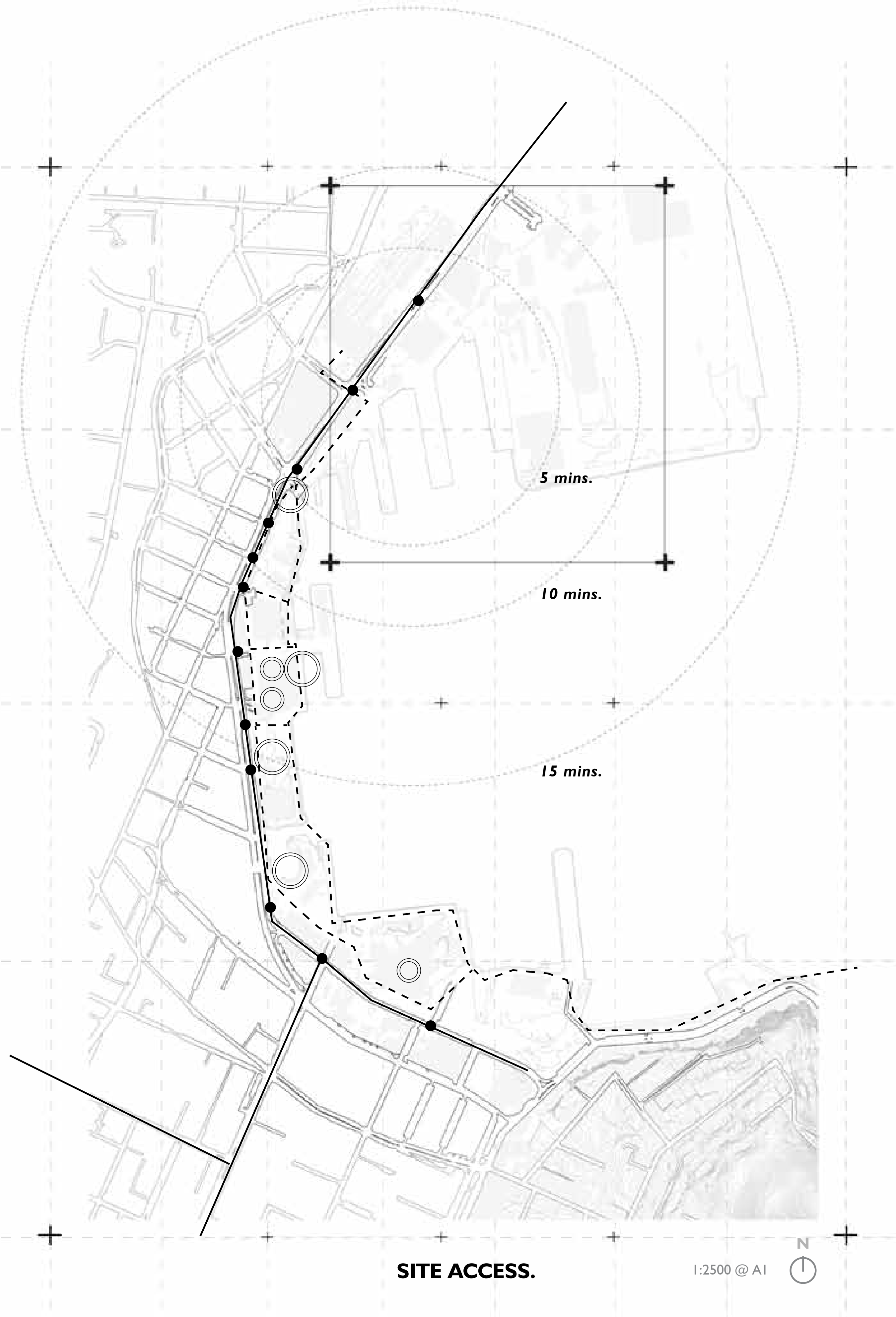
In event of Storm surge or major the flooding, the Waterfront is the first zone likely to be inundated. Majority of the area is prone to flooding due to its impermeability and surface treatment. Only few areas within the waterfront are likely to absorb any water run off which is inadequate to the frequency and capacity of flood events.

Fig. 3.19. Authors Own, Impermeability of Wellington Waterfront, 2019.

## EXISTING INFRASTRUCTURES.

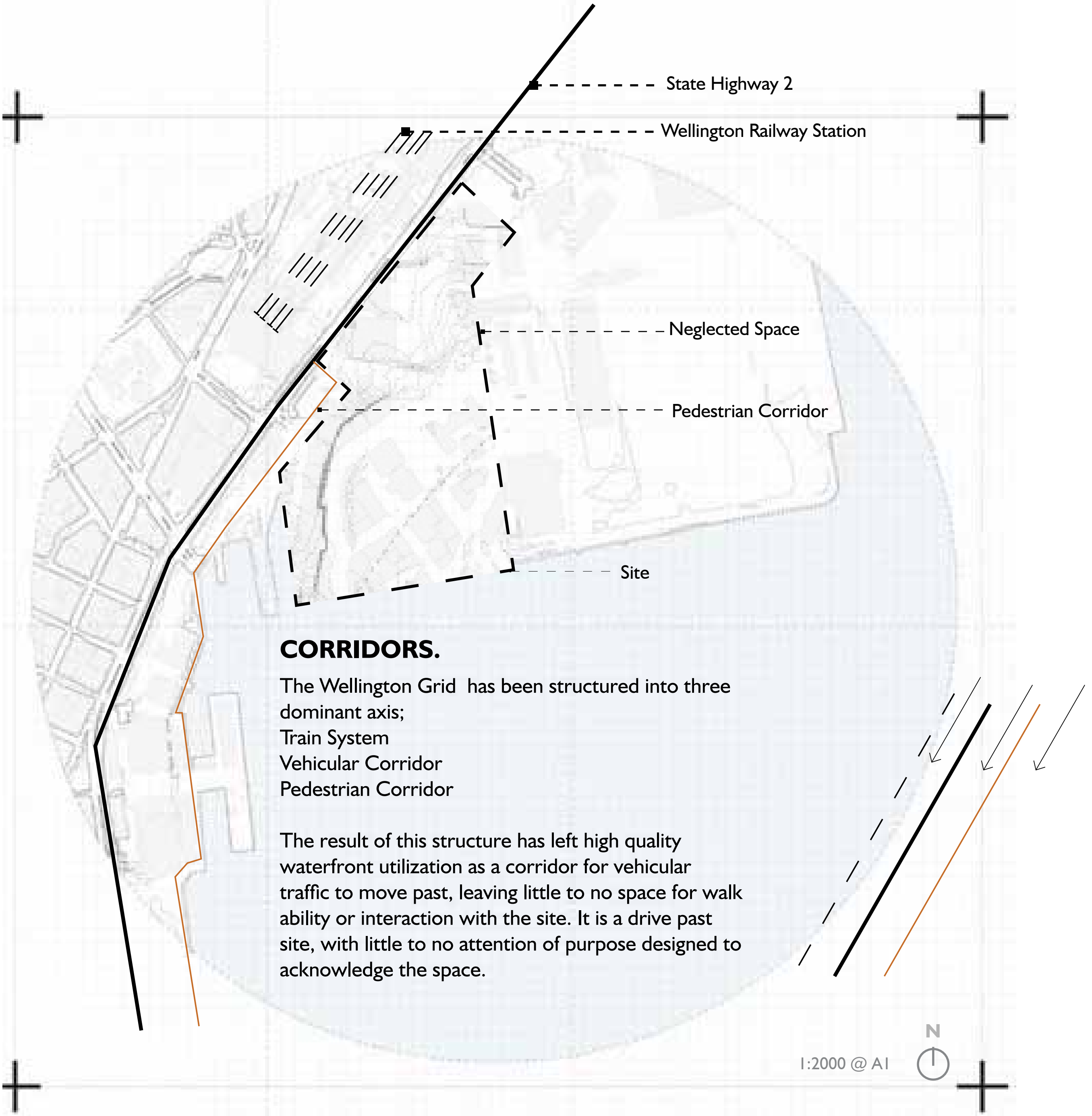
- Seawall (refer to edge conditions for wall types)
- Road
- Wetland
- Stormwater Network
- Waste Water Network
- Drinking Water Network


Fig. 3.20. Authors Own, Current Waterfront Infrastructure, 2019.




**SITE ACCESS.**

1:2500 @ A1




## CORRIDORS.

The Wellington Grid has been structured into three dominant axis;
Train System
Vehicular Corridor
Pedestrian Corridor

The result of this structure has left high quality waterfront utilization as a corridor for vehicular traffic to move past, leaving little to no space for walk ability or interaction with the site. It is a drive past site, with little to no attention of purpose designed to acknowledge the space.

## SITE ACCESS LEGEND.

Dominant City Corridors

Dominant Pedestrian Corridors

Access ways to Waterfront

Key Functions/Waterfront Destinations

- Kumutoto Wharf
- Fergs Kayaking
- Frankits Park
- Whairepo Lagoon

- TSB Bank Arena
- Wellington Indoor Sports Facility
- Fergs Rockclimbing

Fig. 3.21. Authors Own, Current Access to Waterfront, 2019.

Fig. 3.22. Authors Own, Current Road Orientation, 2019. (Opposite Page)

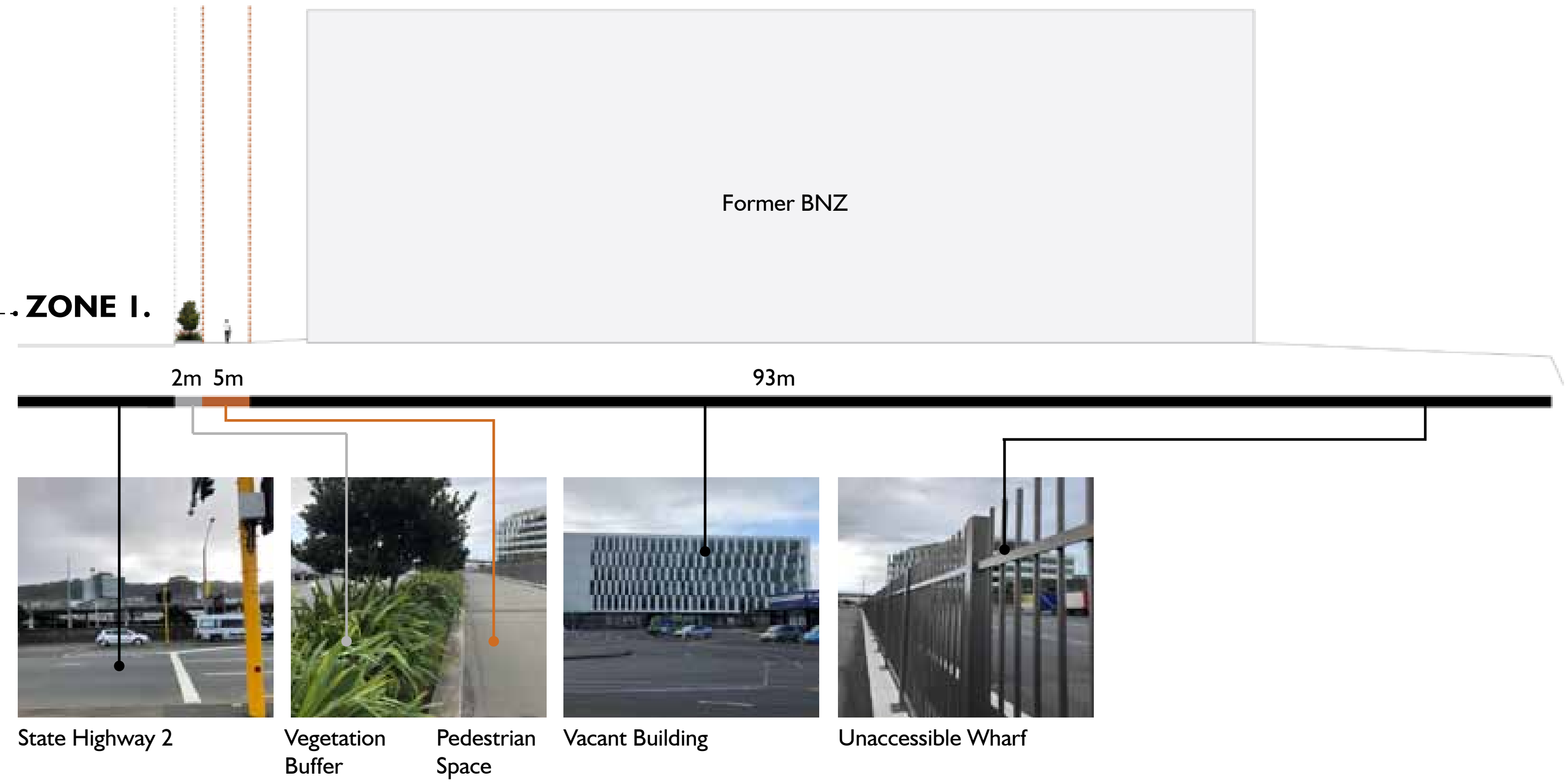

## LACK OF TERRITORY.

Of the studied area, majority of the site is dedicated towards parking or vehicle use. This not only limits the pedestrian use of site, it is a hazard for pedestrians as well. A footpath is the primary zone for pedestrians and public use. Majority of the site and access to the harbours edge is fenced of for safety from industrial port use. For the integration of public use of site, a pedestrian dominant zone would need to be considered in order to allow people to safely access and use site.

Fig. 3.23. Authors Own, Lack of Waterfront Territory, 2019.

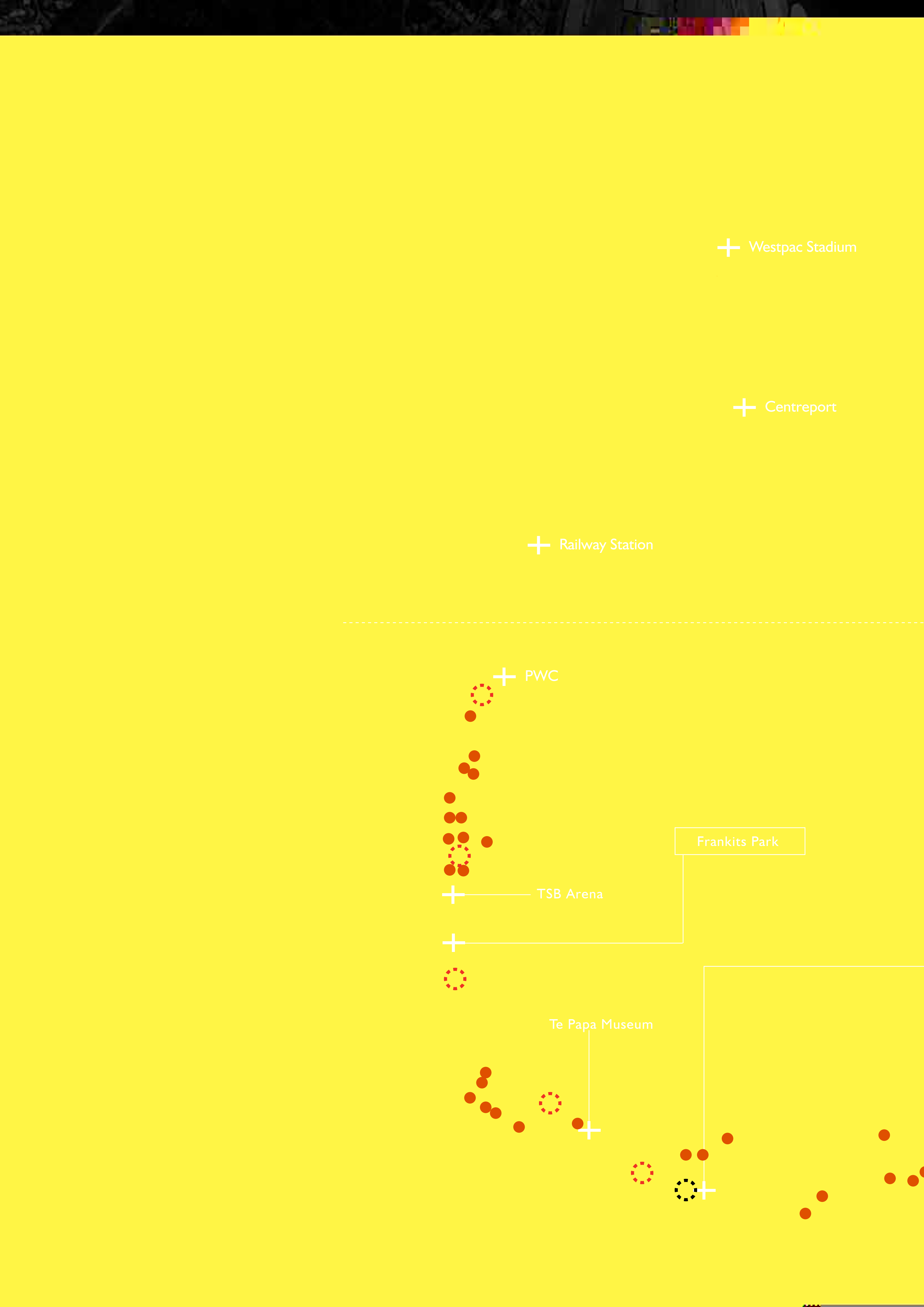
Fig. 3.24. Authors Own, Lack of Waterfront Territory Sectional Study, 2019. (Opposite Page)

## ZONE 1.



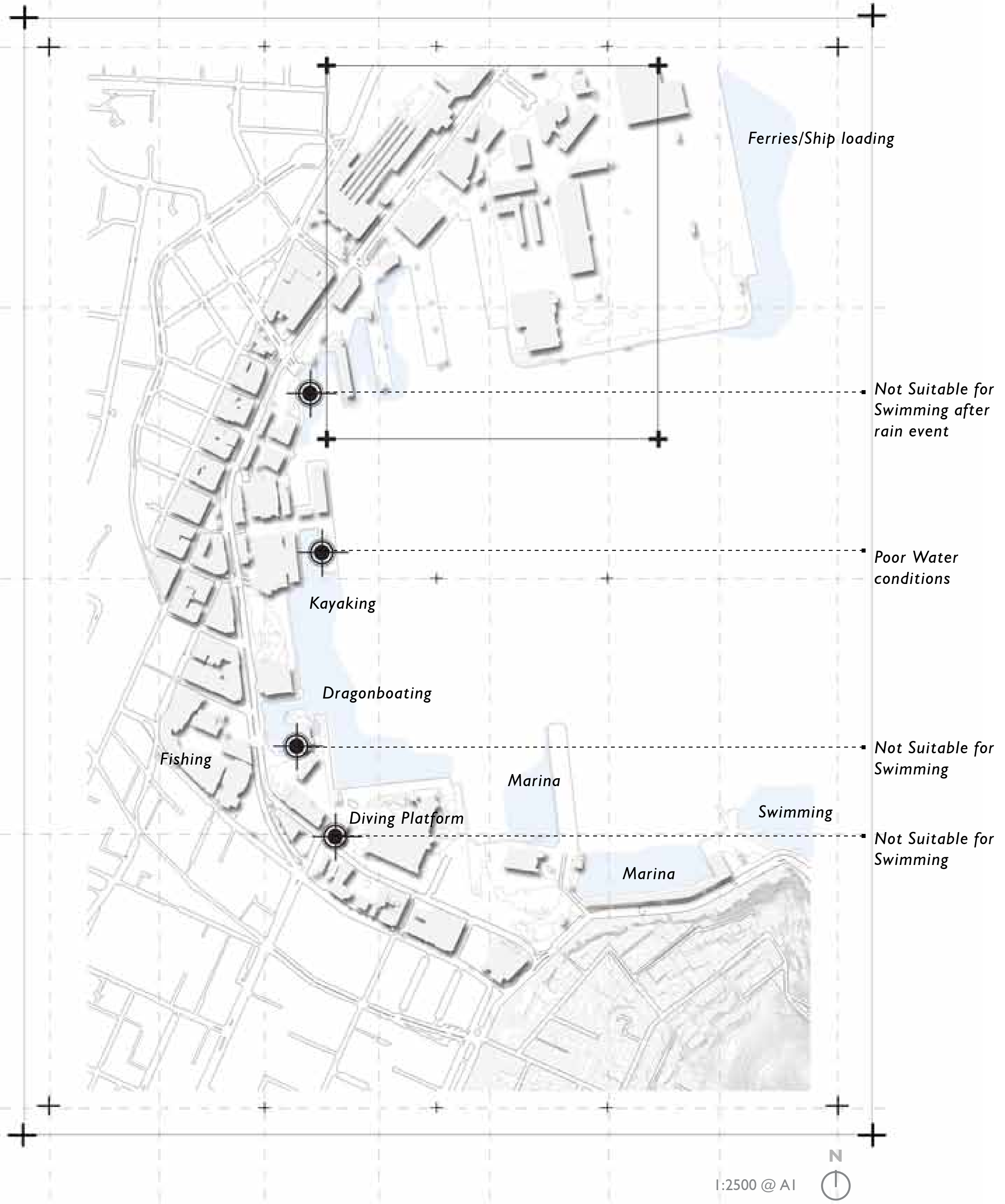

The vegetation use on site is very limited and purely for acting as a buffer between buildings and road. This does not help with excessive water run off or engaging people with the space.

## ZONE 2.



Westpac Stadium
Centreport
Railway Station
PWC
Frankits Park
TSB Arena
Te Papa Museum


Fig. 3.25. Authors Own, Study of Waterfront Programme, 2019.


Ferries/Ship loading
Not Suitable for Swimming after rain event
Poor Water conditions
Kayaking
Dragonboating
Not Suitable for Swimming
Fishing
Marina
Swimming
Diving Platform
Not Suitable for Swimming
Marina
N
1:2500 @ A1

## MARINA ACTIVITIES.

It is evident within Wellington Waterfront, the majority of public activities is skewed towards the lower ends of Wellingtons Harbour. These programs are dominantly destinations (Food or Events) that draw people to a site. It is assumed if these facilities weren't there, the waterfront would simply be a thoroughfare zone to reach a certain destination within the urban region. There is a lack of recreational functions within the waterfront due to contamination of water. Interestingly, the only public recreation available are water related. These show an interesting structure of the waterfront in which people like to utilise and enjoy the harbour waters. The lack of public destination in the upper half of the waterfront also results in the lack of public engagement and use of site. With this it evident, in order to engage people with a site, a public function needs to be developed to draw people into the space. It is also evident, the success of waterfronts is in its ability to draw people to the water's edge and water recreation which this thesis aims to implement.

Fig. 3.26. Authors Own, Study of Waterfront Marine Activities, 2019. (Opposite Page)

# ACTIVE PUBLIC ZONES.

Very Active        Least Active

Very Active, used daily, morning, lunch, afternoons till night, some areas vary on season eg, people more likely to use the sit outside and relax during summer.

Active, public use this space at only limited times of the day such as lunch and afternoons

Least Active, areas used mainly as thoroughfare, very minimal or no people use space for public use. (Typically areas of residential and commercial activity)


Fig. 3.27. Authors Own, Active Zones of Wellington Waterfront, 2019.

Fig. 3.28. Authors Own, Walkthrough Waterfront Active Zones, 2019. (Opposite Page)

1 Cafes and bars surround the area and create a great destination point for people to migrate to. Because of the active building uses around the area, this area becomes a resting point. Steps entering the water are also designed for people to sit on within this zone.

2 This space is used frequently, more often by children. The lack of dining areas detracts people from staying for too long and becomes a thoroughfare zone. This space can also be used as an event space.

3 Heavily occupied space from restaurants, recreation and a thoroughfare zone.

4 Usually an event space, the large open area accommodates for resting, eating and drinking, recreational activities.

5 Used largely at lunch times, with harbour views, seating and Restaurants

6 The lack of public orientated facilities detracts public from occupying space. Occasional cyclist or runner passes through.


Fig. 3.29. Authors Own, Study of Waterfront Edges Conditions, 2019.

Fig. 3.30. Authors Own, Access types of Water Interaction, 2019. (Opposite Page)

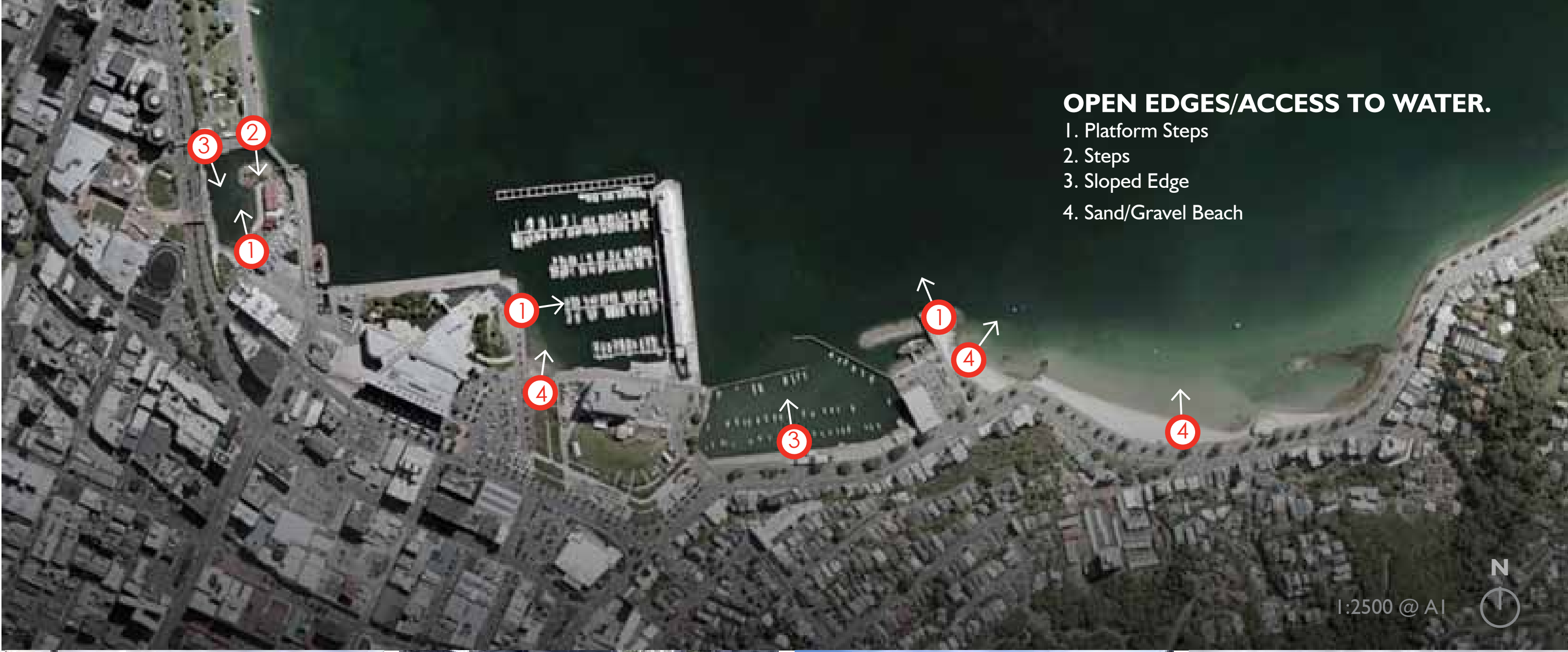



Fig. 67. Te Papa Steps to Harbour

Fig. 68. Platform Steps in Wairepo Lagoon

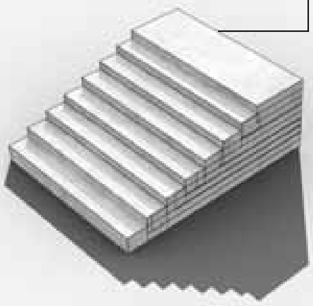
Fig. 69. Boat Ramp at Oriental Bay

Fig. 70. Oriental Bay Beach

1

STEPS

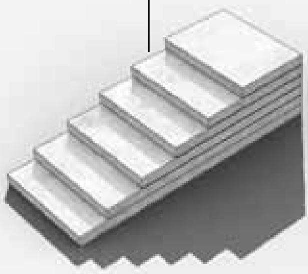
Steps allows for people to sit close to the waters edge and invites people to enter the harbour



The design of wide platforms allows for people to seat, lie down and rest while absorbing harbour views

2

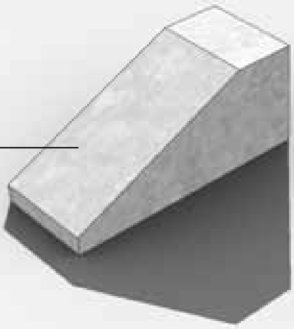
PLATFORM STEPS



3

SLOPE

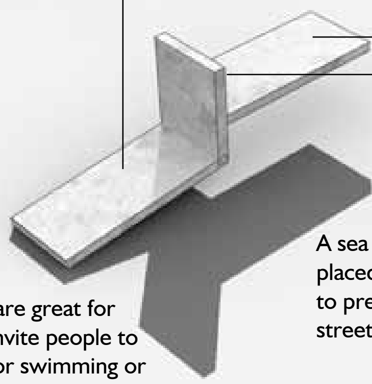
Sloped edges restrict public from going into water, this is more for boats, kayaks and recreational purposes



4

SAND/GRAVEL BEACH

Footpath



Soft Beaches are great for relaxing and invite people to enter water for swimming or other water recreation

A sea wall is usually placed further back to prevent flooding of streets

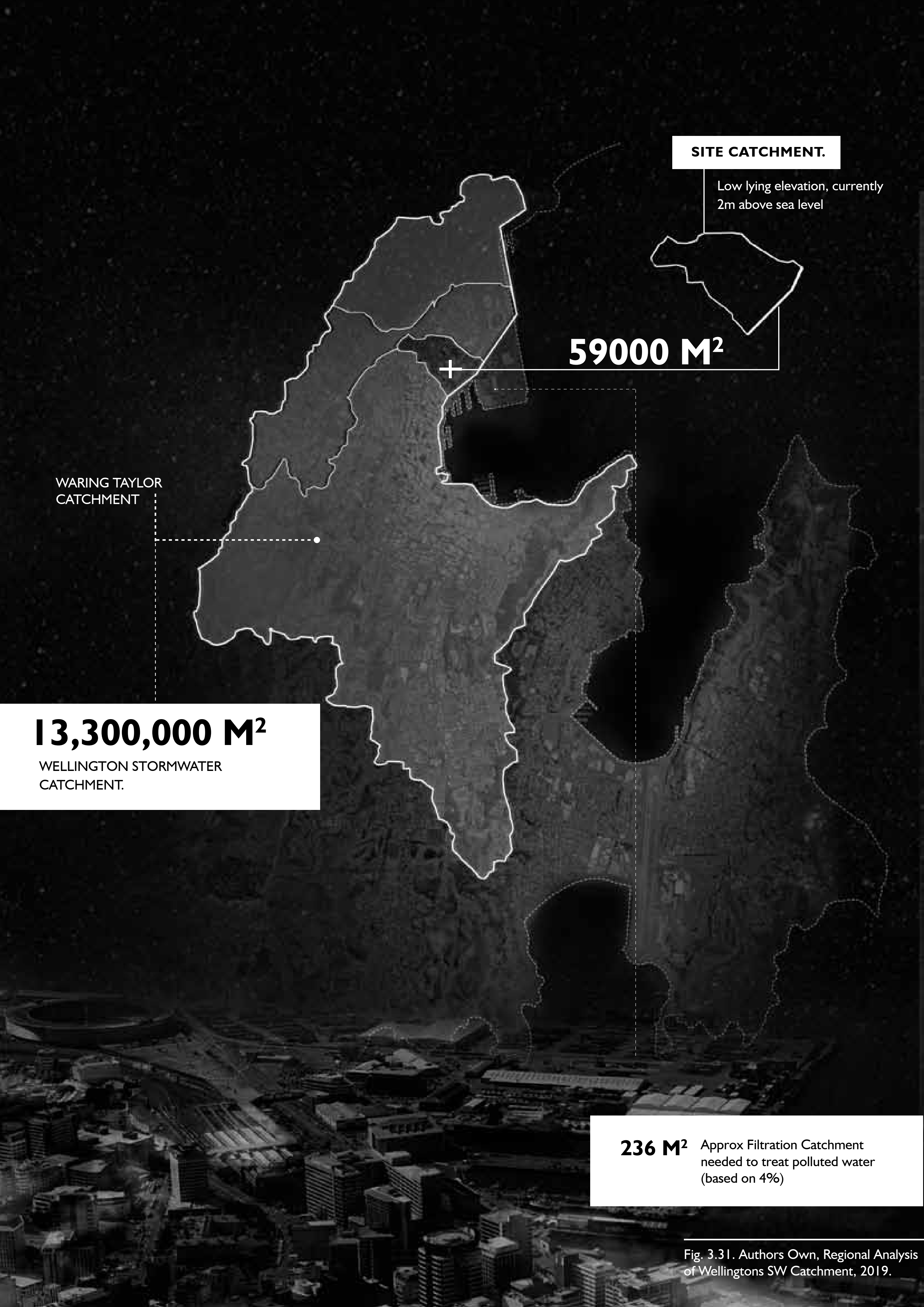



Fig. 3.31. Authors Own, Regional Analysis of Wellingtons SW Catchment, 2019.

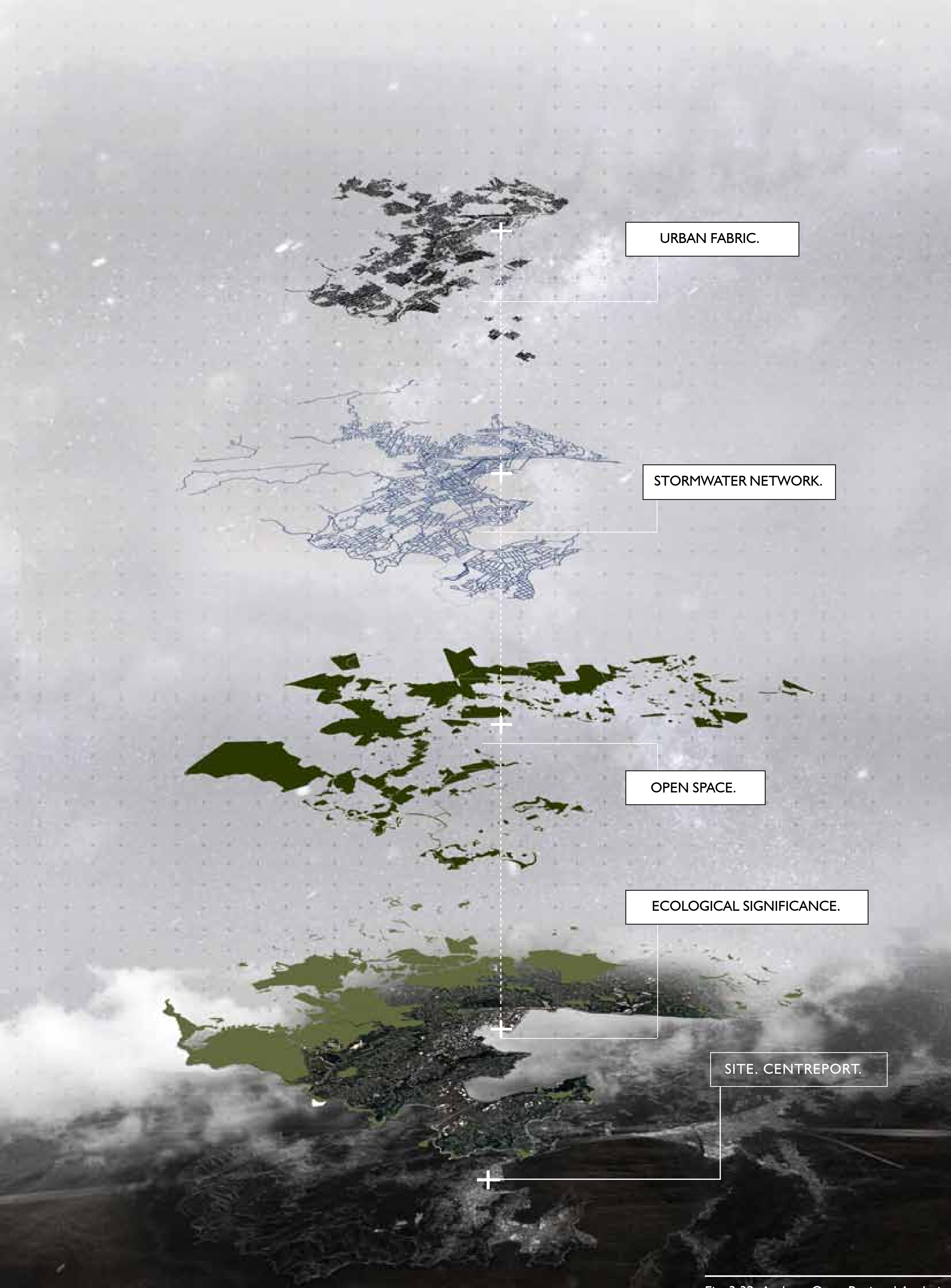
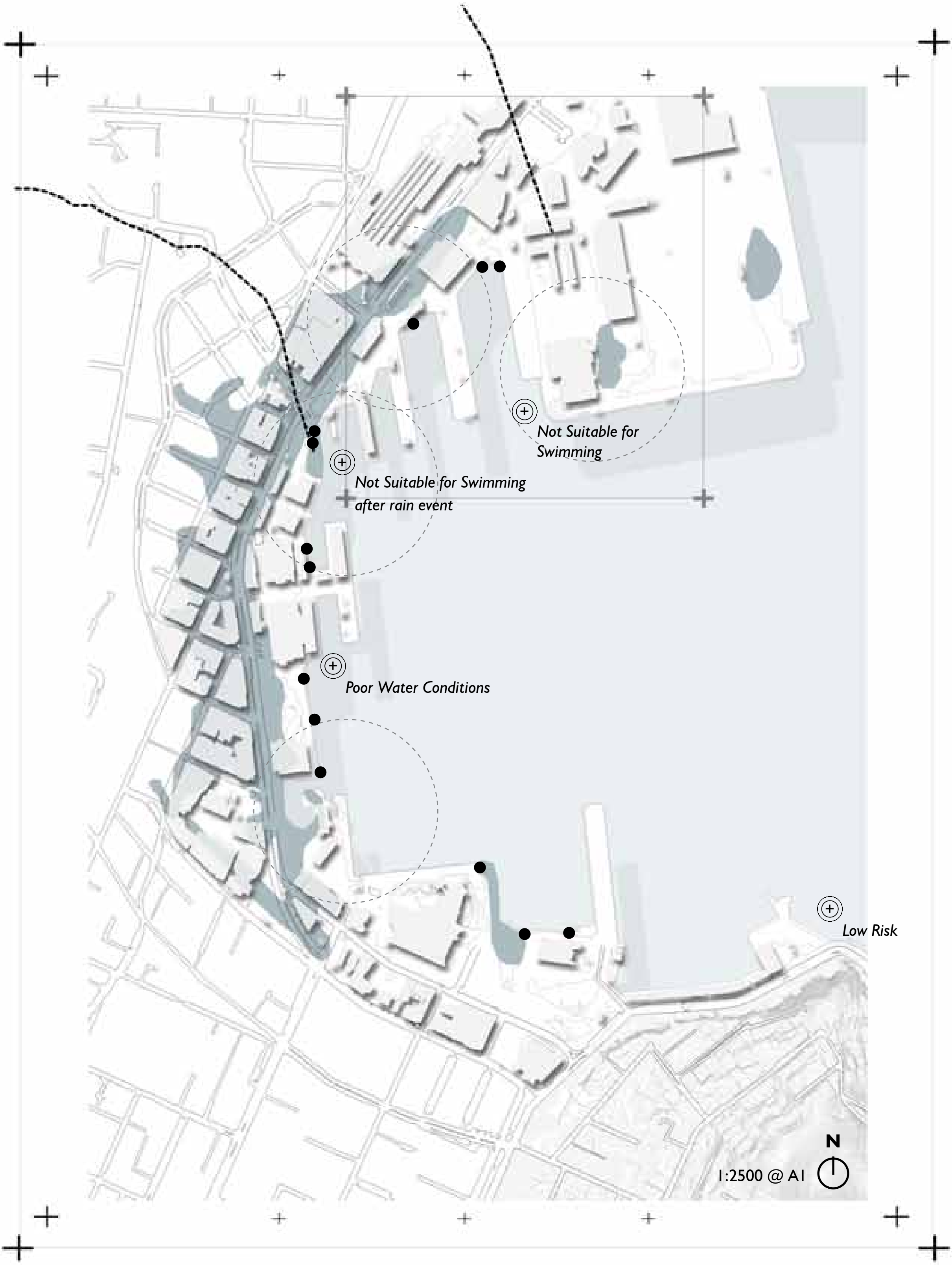



Fig. 3.32. Authors Own, Regional Analysis of Wellingtons Urban Fabric, 2019.




## HARBOUR RUNOFF.

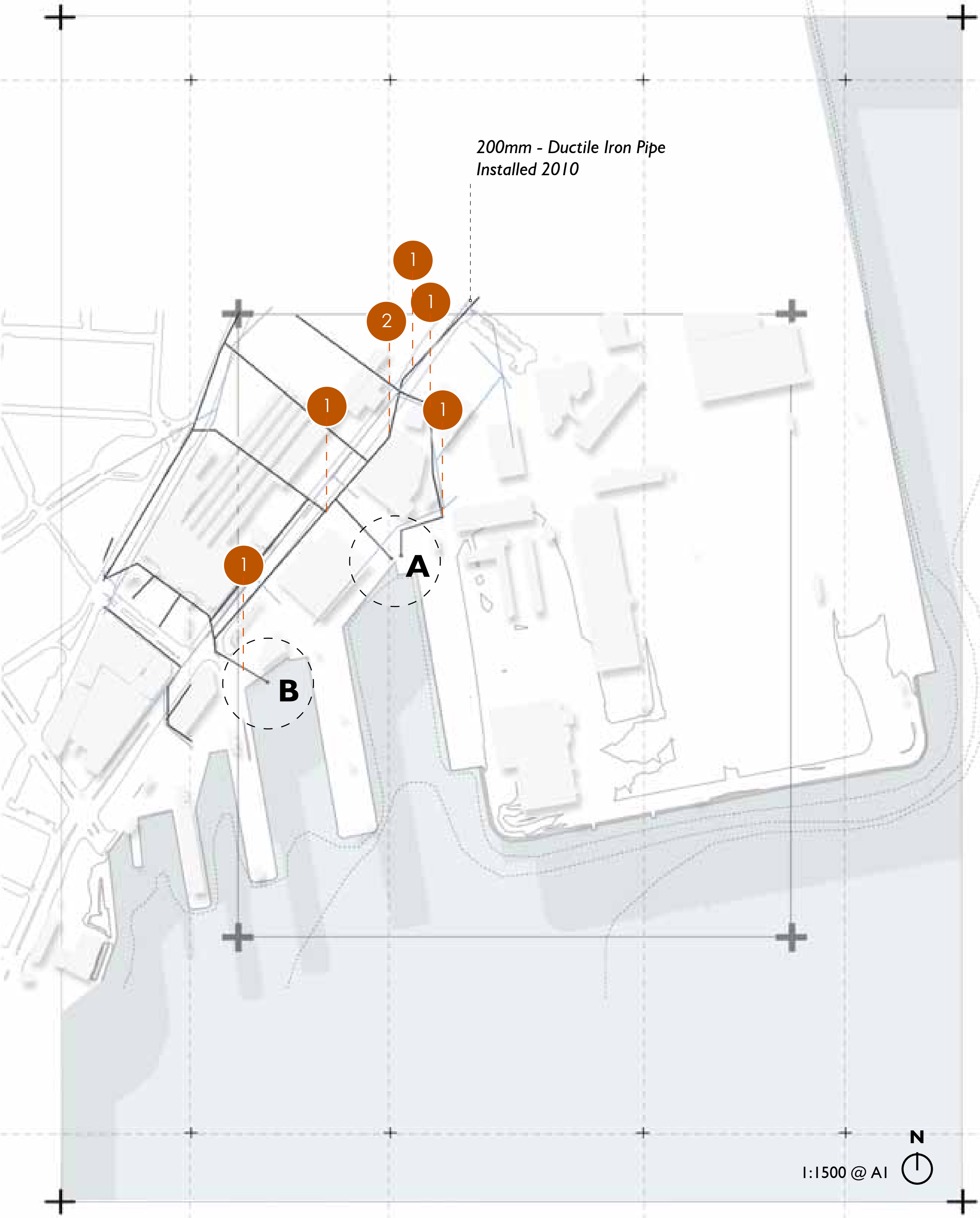
.......... Culverted Streams
- Pipitea Stream
- Kumutoto Stream

Flood Prone Zones

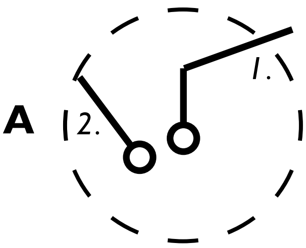
Stormwater Outlets

Areas of Immediate vulnerability and overflow of stormwater/ water systems

Fig. 3.33. Authors Own, Study of Wellington Waterfront Flood Zones, 2019.

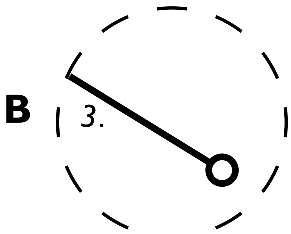



Stormwater Outlets on Site




1. 1050mm - Concrete Pipe
Installed 2010

2. 300mm - Reinforced Concrete Pipe



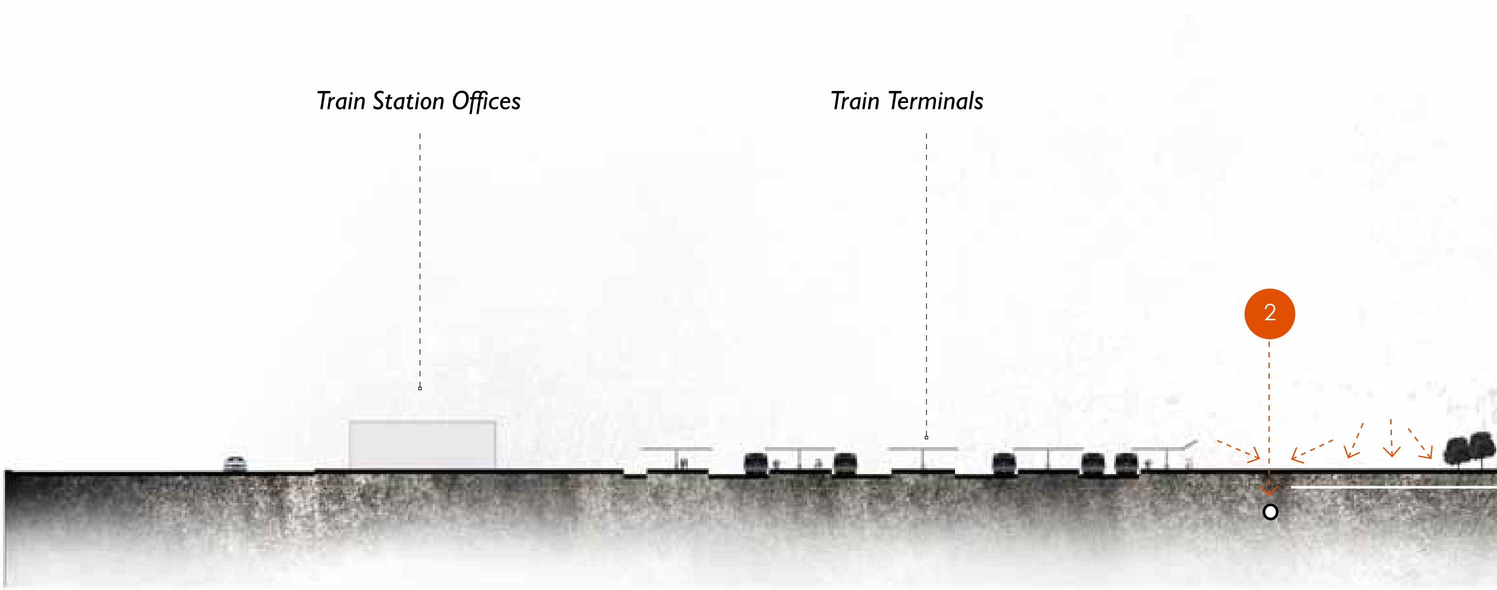

3. 1200mm - Concrete Pipe
Installed 1930

**STORM WATER SYSTEMS.**
Pollutant sources

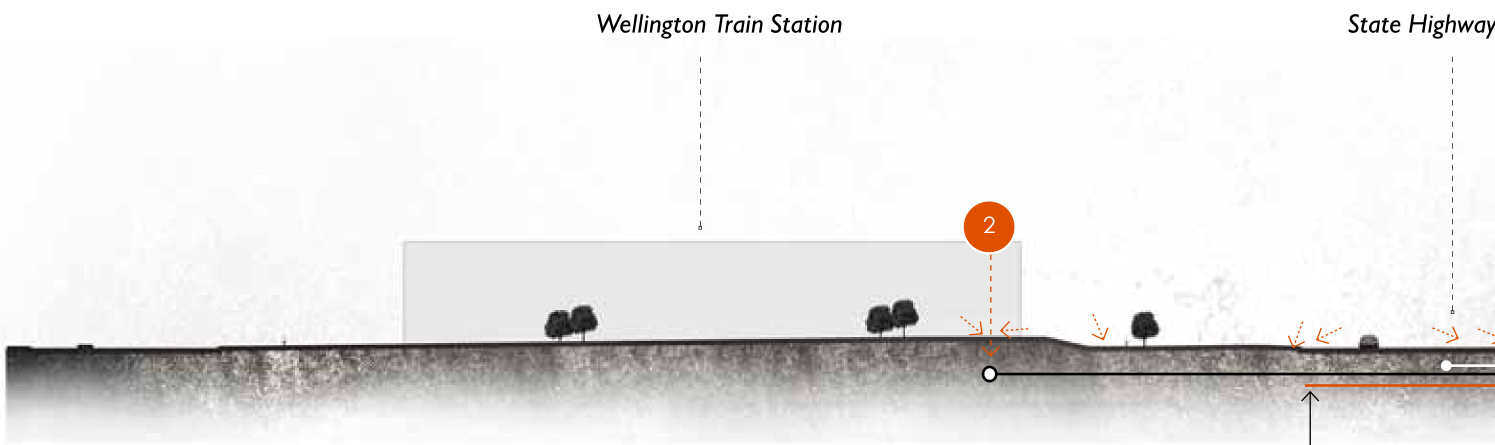
1 Industrial Pollutants
Garbage Debris, heavy metals, dirt, oil, grease, antifreeze, toxic chemicals, nitrogen, phosphorus, animal fesse

2 Roadway Pollutants
Heavy Metals, oil, grease, zinc, other toxic chemicals

Fig. 3.34. Authors Own, Study of Wellington Waterfront Pollutant Sources, 2019.

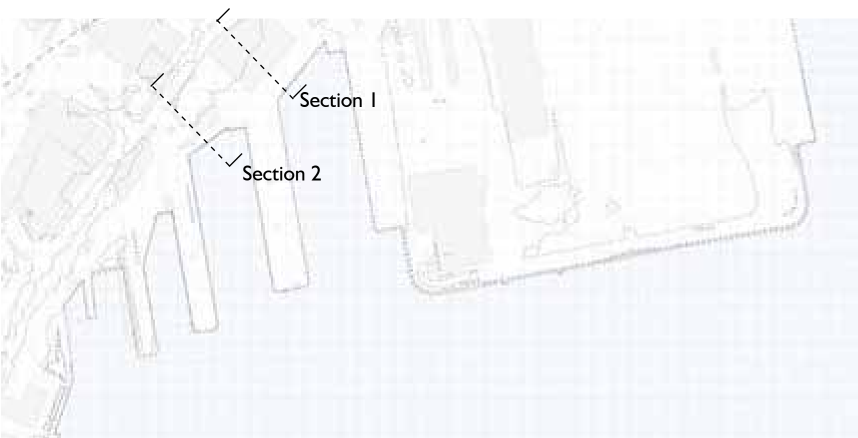



**Section 1.** 1:500 @ A1




**Section 2.** 1:500 @ A1

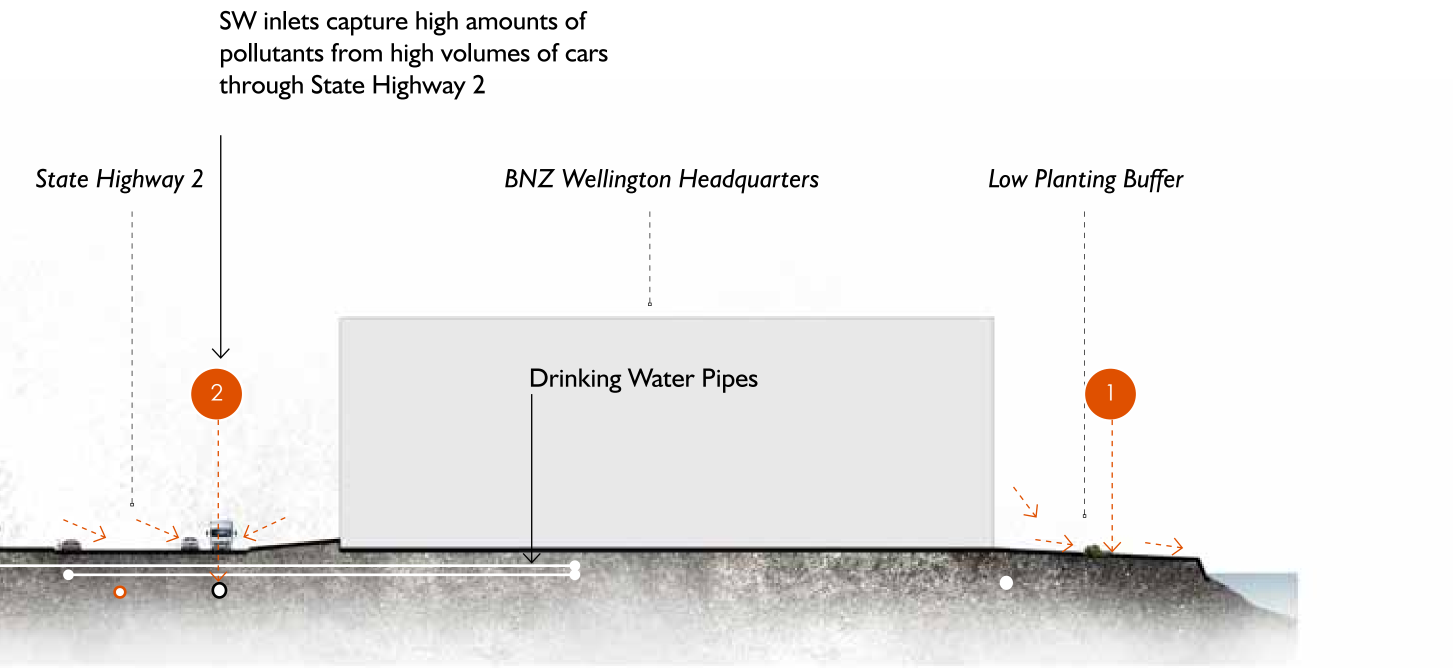
Wastewater pipes being situated close to SW pipes leads to contamination and overflow of wastewater in SW catchments. ( See Fig.3.38.)

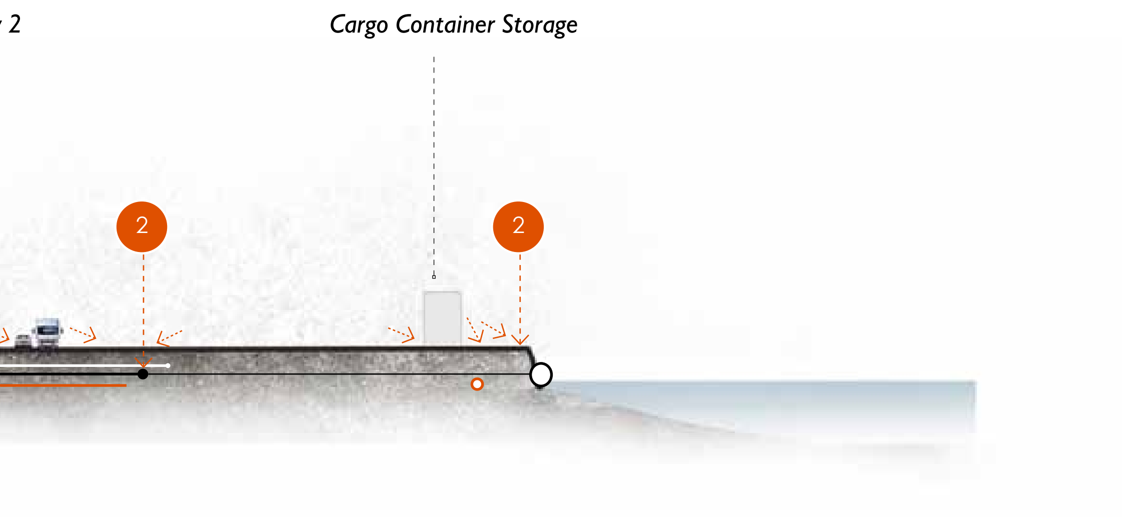



**Location Plan.**

**Network Legend.**

- SW Inlet
- SW Connection
- SW Outlet
- WW Pipe
- WW Pipe
- SW Pipe




Situated next to this thesis's site is State Highway 2 which is a dominant vehicle passage that connects Northern Wellington to the city. A high level of traffic flows through this area, that carries large amounts of car chemicals and fuel onto roads. In events of rainfall, these toxins are flushed into SW drains that lead out to discharge in the harbour. Because of this the harbour is becoming more polluted and harbour habitats are diminishing.

Similarly with the industrial use of site, large amounts of chemicals are washed into the ocean. These create the two main pollutant sources entering the harbour, industrial and roadway pollutants. Identified above is where SW inlets carry and discharge. As identified above, the main sources of pollutant captures can be seen, for this purpose in order to filtrate and reduce polluted water entering the harbour it is seen best to capture and treat pollutants at source. This will be enable in design to capture and filter runoff from source of SH2.

Fig. 3.35. Authors Own, Sectional Diagrams of Runoff Pollutants entering Harbour, 2019.

“Wellington's dirty water revealed”

Wellington sewage could enter the harbour for days - stay out and limit water use

Amber-Leigh Woolf · 19:20, Dec 20 2019

“Wellington's urban streams are failing to meet clean water targets”

Katie Chapman · 19:14, Aug 25 2015

"Slips and flooding around Wellington as wild weather hits New Zealand"

Tom Hunt · 09:49, Dec 18 2019

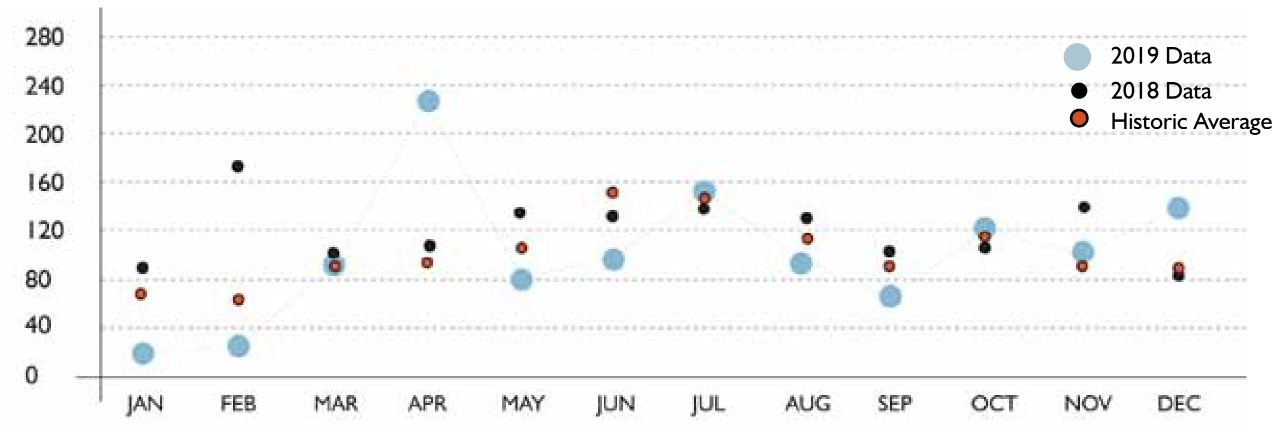



Diagram of Wellington's Annual Rainfall shows dramatic change in frequency and intensity of rain of climate conditions change.

Days of Rain per Year: 104.5mm
Annual Precipitation: 1254mm (Metservice, 2020)

Fig. 3.36. Authors Own, Compilation of Stuff NZ News Articles, 2019. (Pages 110-111)

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# 550KM

**Of Piped Waterways in Wellington.**

# 61%

Of monitored waterways are
**"poor"** or **"very poor"**
(Ministry for the Environment, 2013)

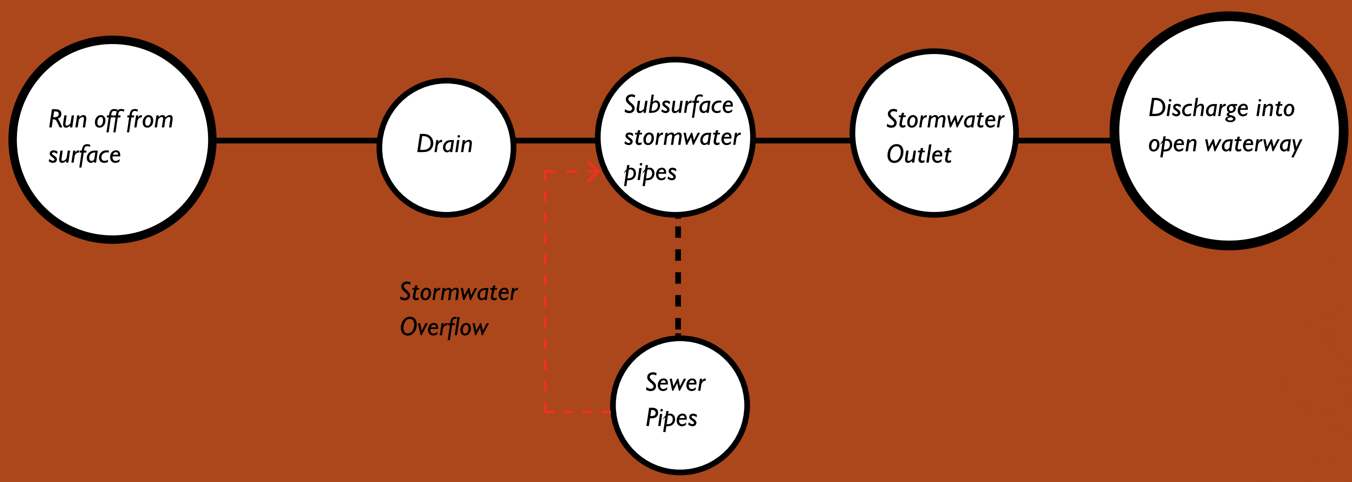
> "Wellington Report 2019: Capital's climate change reality – Slips, storms and flooding are on their way"

**95%** Of urban streams are piped

Only 24% of Wellingtons Water in Excellent Condition $\frac{24}{100}$

Fig. 3.37. Authors Own, Compilation of Polluted Waterways Stats, 2019.

## WASTEWATER CONTAMINATION.




STORM WATER NETWORK.

Wellington water quality has been a discussion since early European settlement, starting 1839. After notice of several wide spread diseases contracted from poor water infrastructural systems, it was reasoned unsafe to consume town water due to contamination and overflow of sewage, drinking and storm water systems. Wellington's streams revealed high levels of pollution. At this point, in 1866 several streams began to culvert into poorly constructed brick channels. A sewage system was constructed, followed by a storm water system. It wasn't long till streams were topographically transformed into engineered SW catchments, the Waring Taylor catchment. At present, Storm water and waste water systems are in poor conditions due to age and poor construction in early settlement days. The networks were built with the purpose of holding water quantity, not providing water quality. With increasingly frequent and higher volumes of water flow, as well as arising risks of climate conditions, higher volumes of water run through these systems, which exceed their current capacity, resulting in overflow flooding.

Traditional storm water systems collect rain and runoff water on site, which gets discharged into the harbour. Apart from sumps, which hold little amounts of litter and sediment, there is no treatment of storm water before it gets discharged. Within the Waring Taylor catchment runs high traffic flows through the terrace, urban motorway and state highway two (Fig.3.35.). These areas contain high levels of runoff toxic car and industrial chemicals being discharges into the harbour. 90% of the Waring Taylor catchment has been classified in poor conditions, requiring health renewal systems. Many regions of Wellington harbour are classified poor condition to swim in.

There is a disparity in ecological health of waterways when relating urban and rural stream health. This strongly relies on conditioning of the catchment. Waterways predominantly surrounded by flora with limited human influence tend to have stronger ecosystems to function, cycle nutrients, sediment and pollution, often having these rural waterways classified as "excellent" condition. Wellington regional council more frequently classify urban waterways as , fair or poor, due to the lack of treatment, bio climate and polluted discharge entering harbours, resulting in poor harbour conditions. In relation to the arising climatic conditions, there is potential for these once rural waterways to reduce urban heat created through burning toxins flowing into our resourceful ecosystems and waterways. This can help mitigate pollution, through environmental nutrients cleaning waterways and stabilise the global temperature and further rising seas.

Fig. 3.38. Authors Own, Waste water contamination in SW network diagram, 2019.

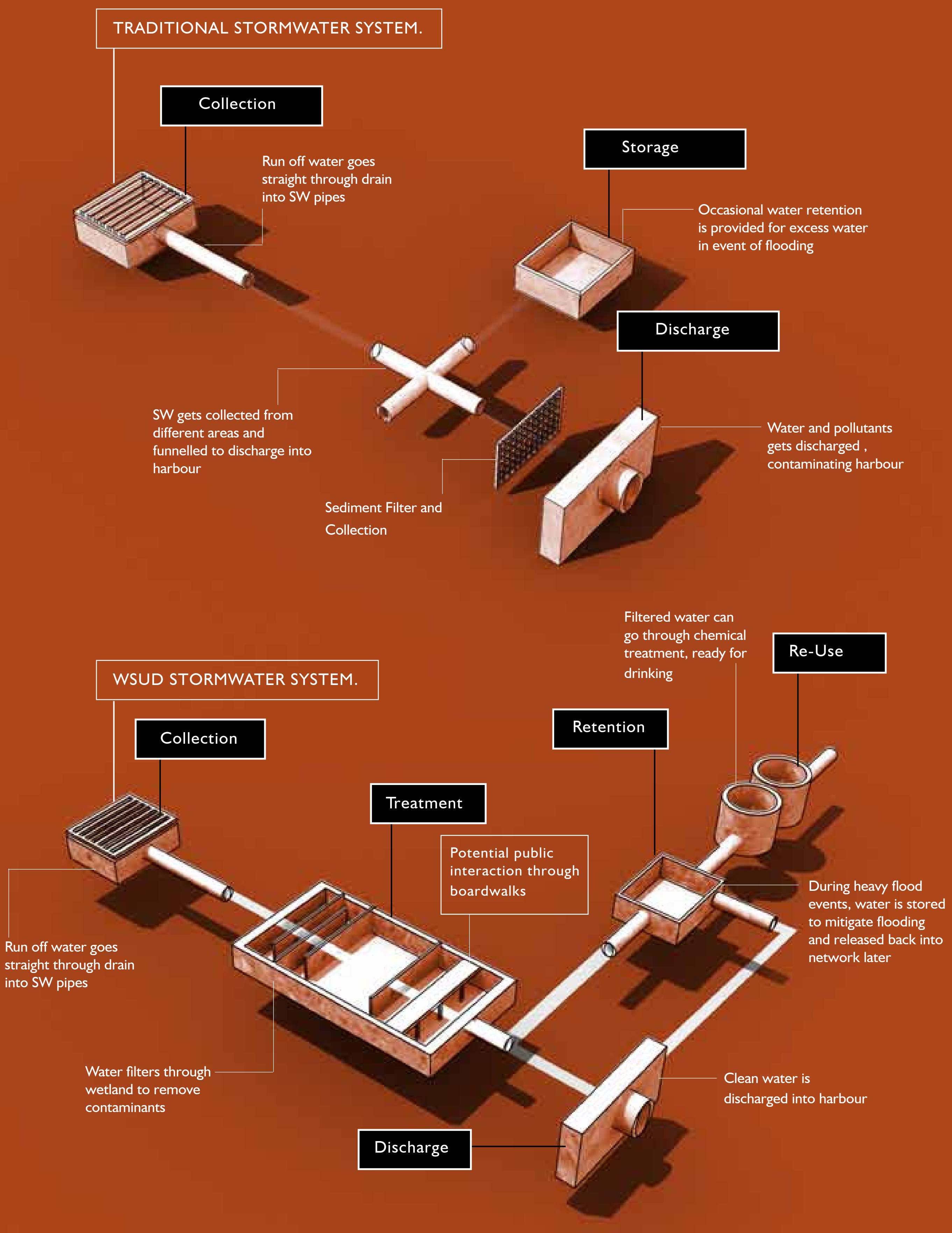



Fig. 3.39. Authors Own, Illustration of Standard and Proposed WSUD SW network, 2019.

Fig. 3.40. WCC, Development Proposed next to Westpac Stadium to accommodate for increased population, 2017.


Fig. 3.41. Authors Own, Plan of Proposed Development, 2019.

**PROPOSED DEVELOPMENT.** Key ideas the development wants to consider are:

**Ecological**
- Increased buffer vegetation
- Green roofs

**Residential**
- 6⁺ New residential/ mixed use apartment blocks

**Public/Leisure**
- New 12,000 seat indoor sports arena
- Multiple use ferry terminals in Centreport
- Increased waterfront public space

**Issues**
- Geotechnical issue of reclamations
- Liquefaction
-Risk of lateral spreading
- Land remediation would be required
- Seawall improvements
- Protection of Reclamation and from Lateral Spreading

URBANISATION.

The urban environment is becoming the most prevailed locality for life. Majority of the world's population is living in within city regions. It is undisputable there is an increase in population and increasing urban development to accommodate for this massive shift to living within urban zones. By 2050, 70% of the world is predicted to be living within urban areas. Within New Zealand, this has been an 86% increase of population within urban areas over the last few decades. Many reports have proposed the demand for residential develop along waterfronts and city centres. The practicality of city dwelling has its convenience and benefit's, however it is also a leading contribute to the closure of waterfront zones, often seen as private, high end areas as Menzie suggests (Menzie). This thesis's current unused Wellington port site is in appeal for residential development, though the effect of this may remain as an unusable public site. It is intended through design to create a waterfront as a place of multifunctional programme, enabling residential and public use to work in harmony with the urban environment (While).

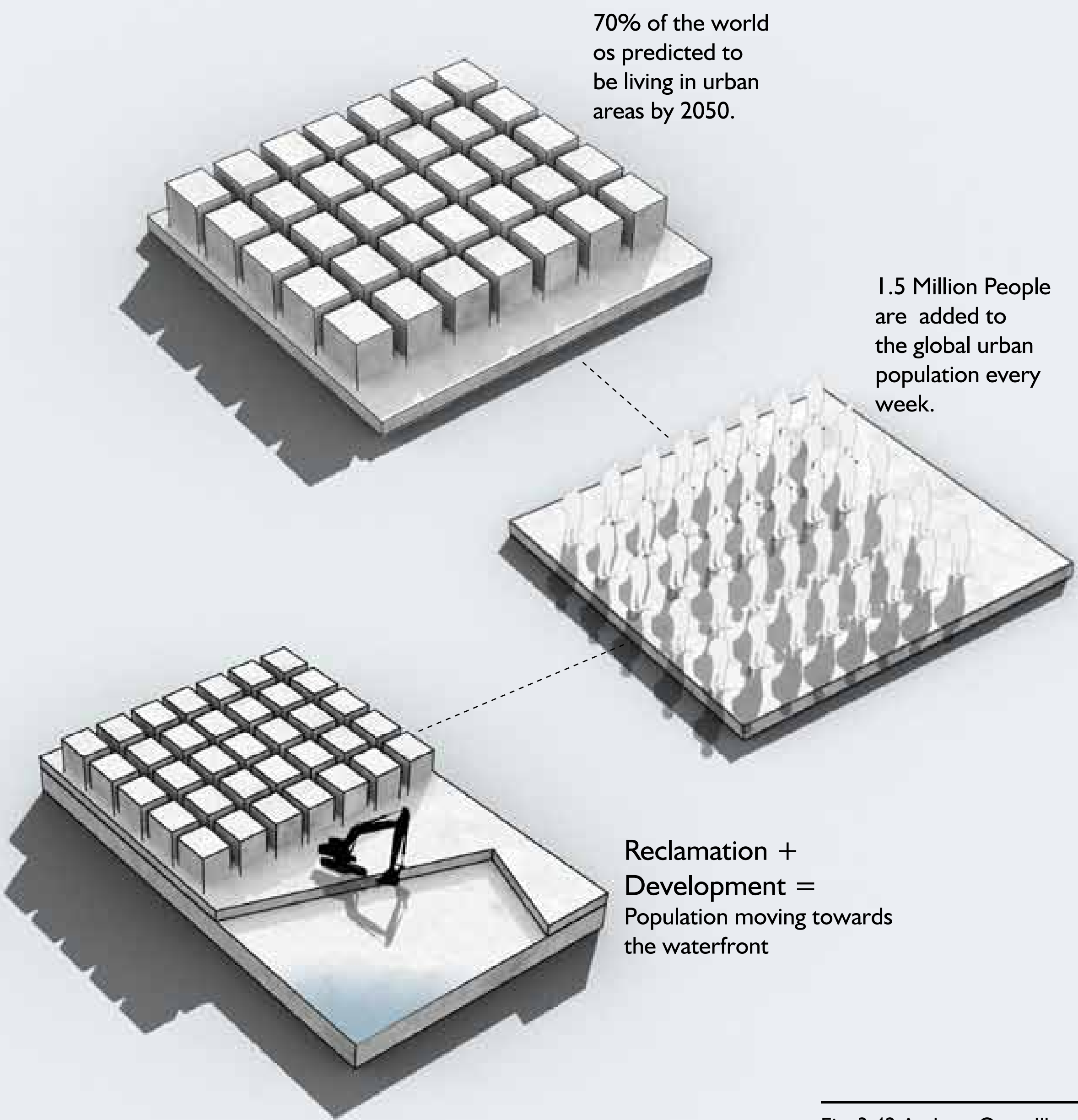
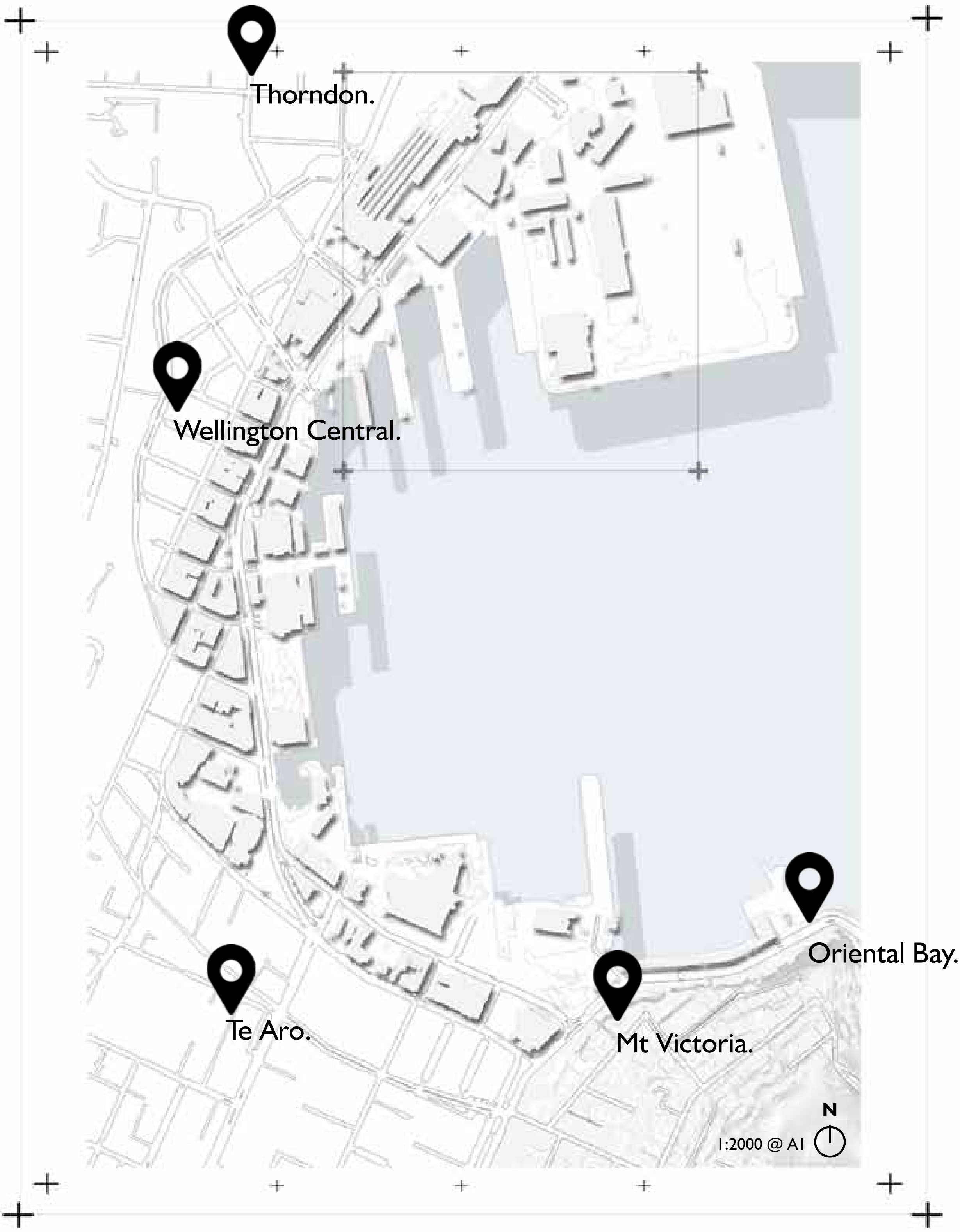



Fig. 3.42 Authors Own, Illustration of increased population, reclamation and development, 2019.




**Population Growth.**
Statistics identify areas prone to development first with increased population settling within these areas (Stats, 2018).

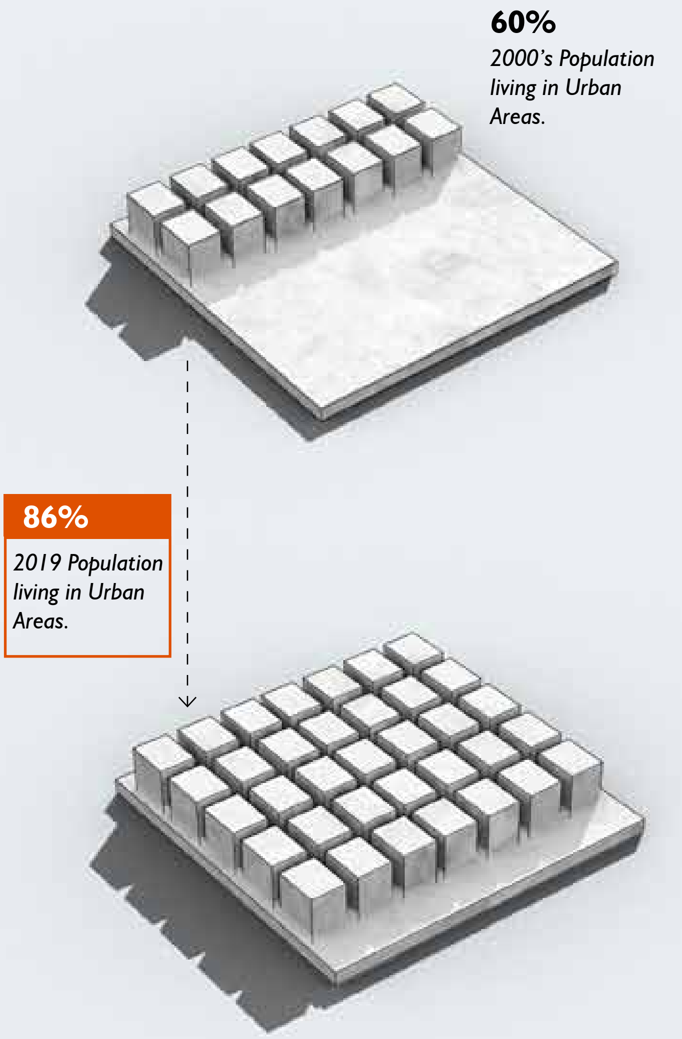
**Wellington Central**
2019: 4,022
2043: 8,037
^ 99%

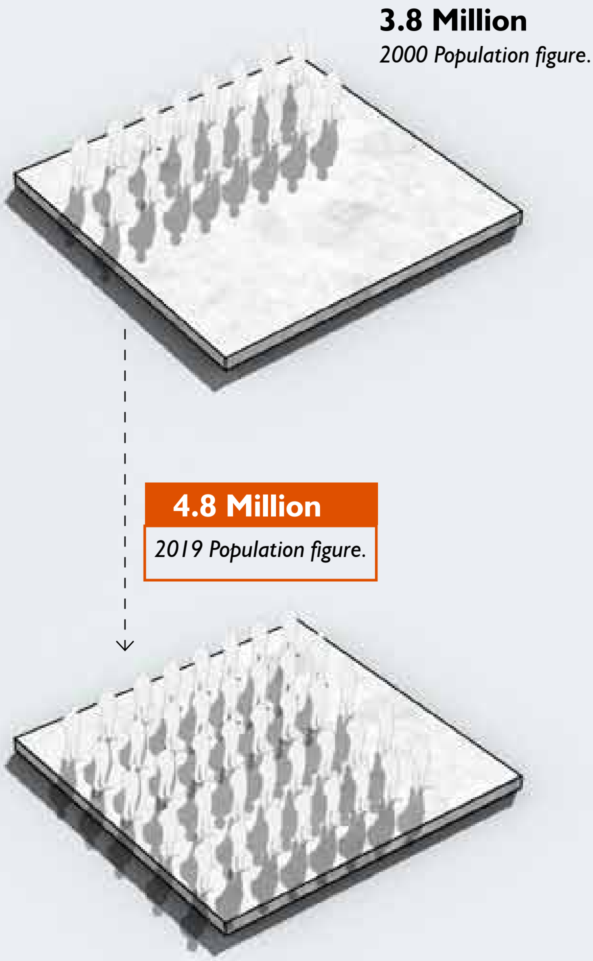
**Thorndon**
2019: 4,804
2043: 5,967
^ 24%

**Te Aro**
2019: 13,085
2043: 19,416
^ 49%

**Mt Victoria**
2019: 5,865
2043: 6,207
^ 9%

**Oriental Bay**
2019: 3,433
2043: 3,818
^ 9%



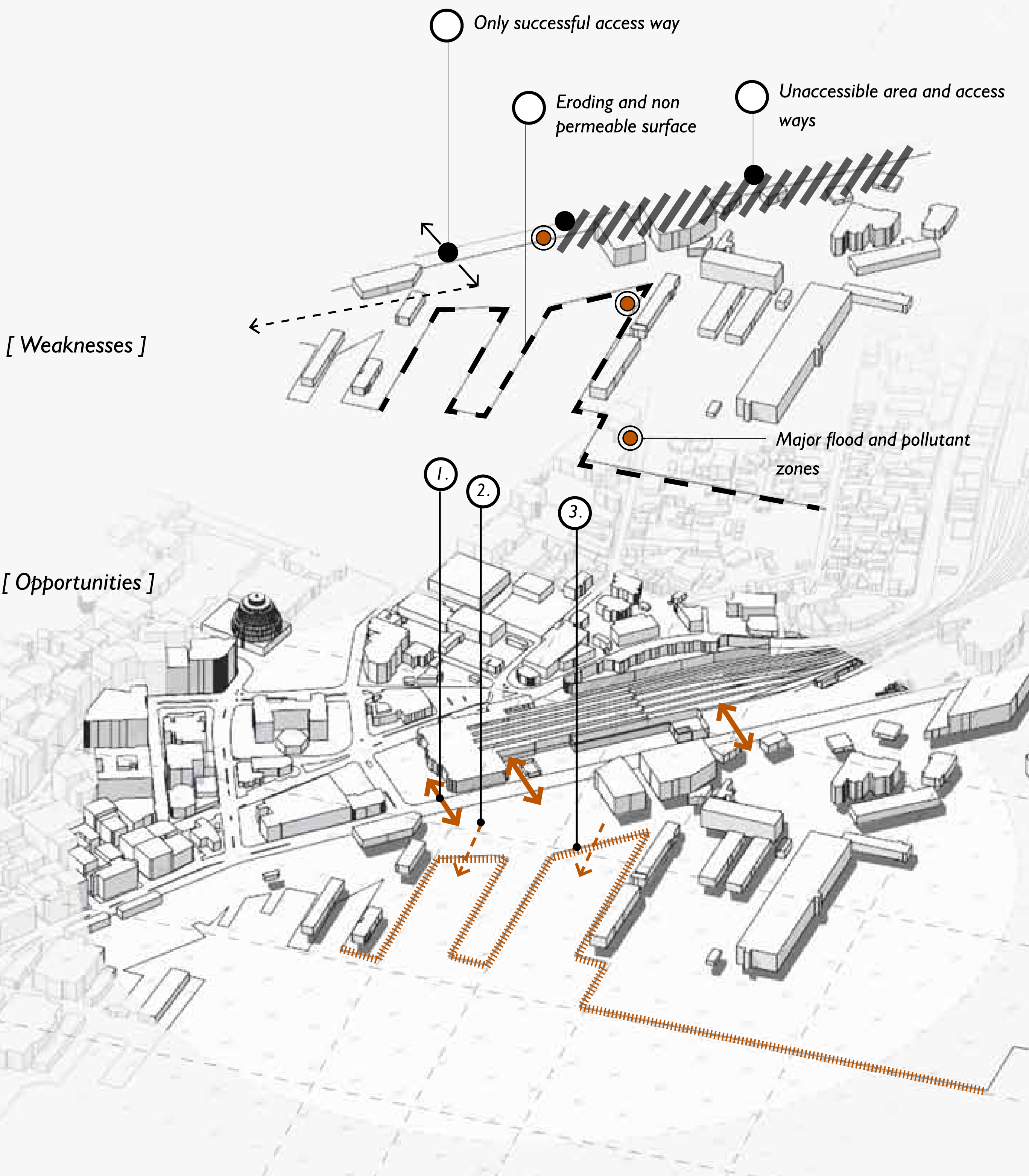

**Urban Expansion in New Zealand.**

Increasing population within the city is causing for increased development around central Wellington and in particular around waterfronts (Stats, 2018)

Fig. 3.43. Authors Own, Study of Wellington Population Growth, 2019. (Opposite Page)

Fig. 3.44. Authors Own, Illustration of increased population and development, 2019.

# FINDINGS.




**Site Issues.**
Degrading Edge
No Connection
Lack Of Permeability And Public Use On Site
Flooding
Polluted Waters

**Global Issues.**
Storm Surge
Increased Rainfall
Increased Urban Residential

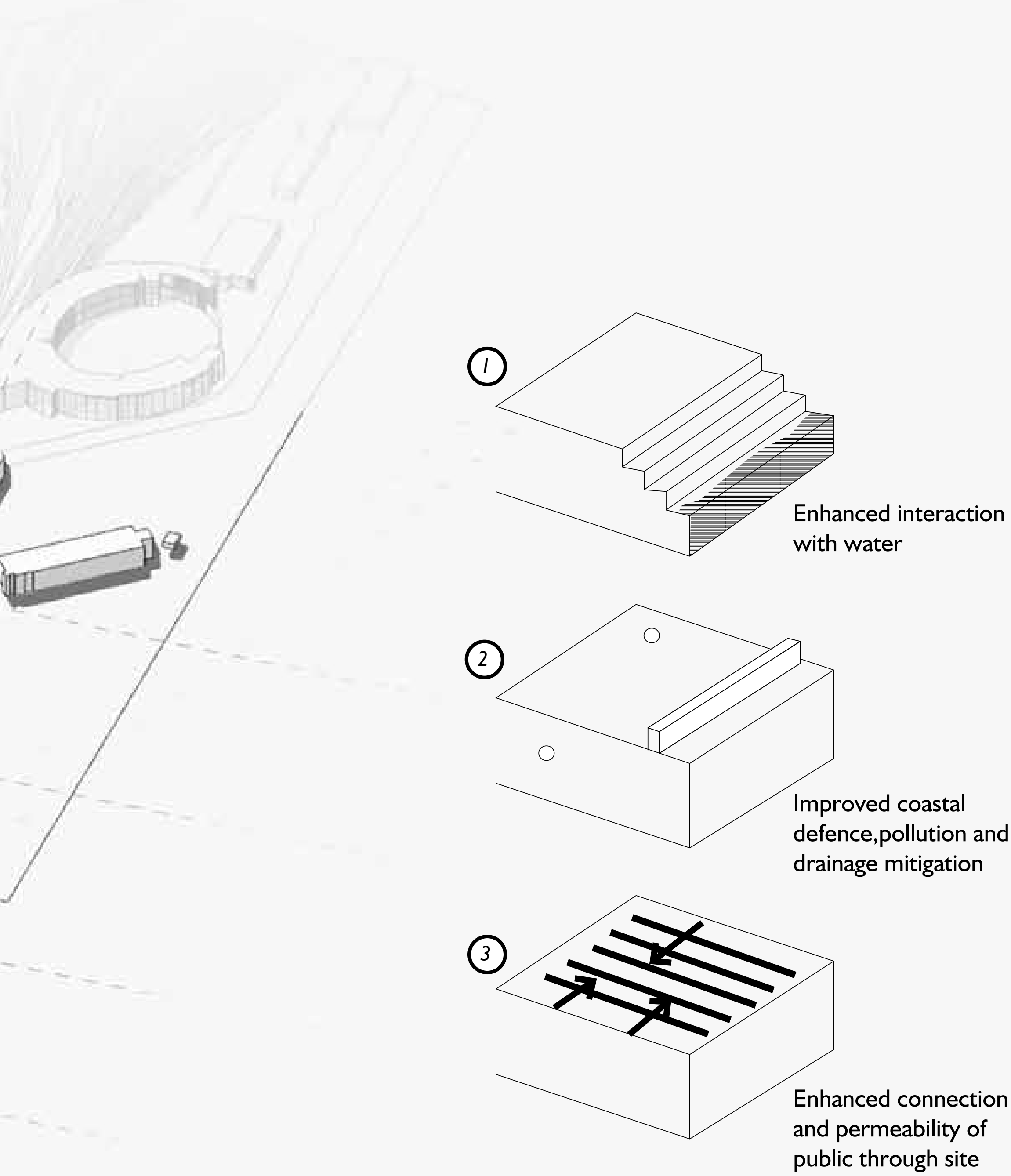



Fig. 3.45. Authors Own, Illustration of Design Opportunities and Weaknesses, 2019.

# Findings.

SITE ANALYSIS.

This chapter has highlighted some of the following site specific weaknesses and opportunities which should be addressed:

- Enhancing and creating safe access to the waterfront. Creating a more permeable and accessible site for public from train station and other areas of waterfront. Creating a stronger link with site by creating destination points public can enjoy.

- Enhancing the natural eco system by providing room for new tidal ecologies, species such as oyster, snail, and native fish species to habitat site.

- Enhanced social interaction, in particular celebrating the location of being a waterfront and providing access to water, as well as social destinations through site in a sustainable manner.

- Enhancing the existing Storm water system, creating room for more permeable space and runoff orientated catchments through site to mitigate major flood event while celebrating the engineered technology of how storm water infrastructure works.

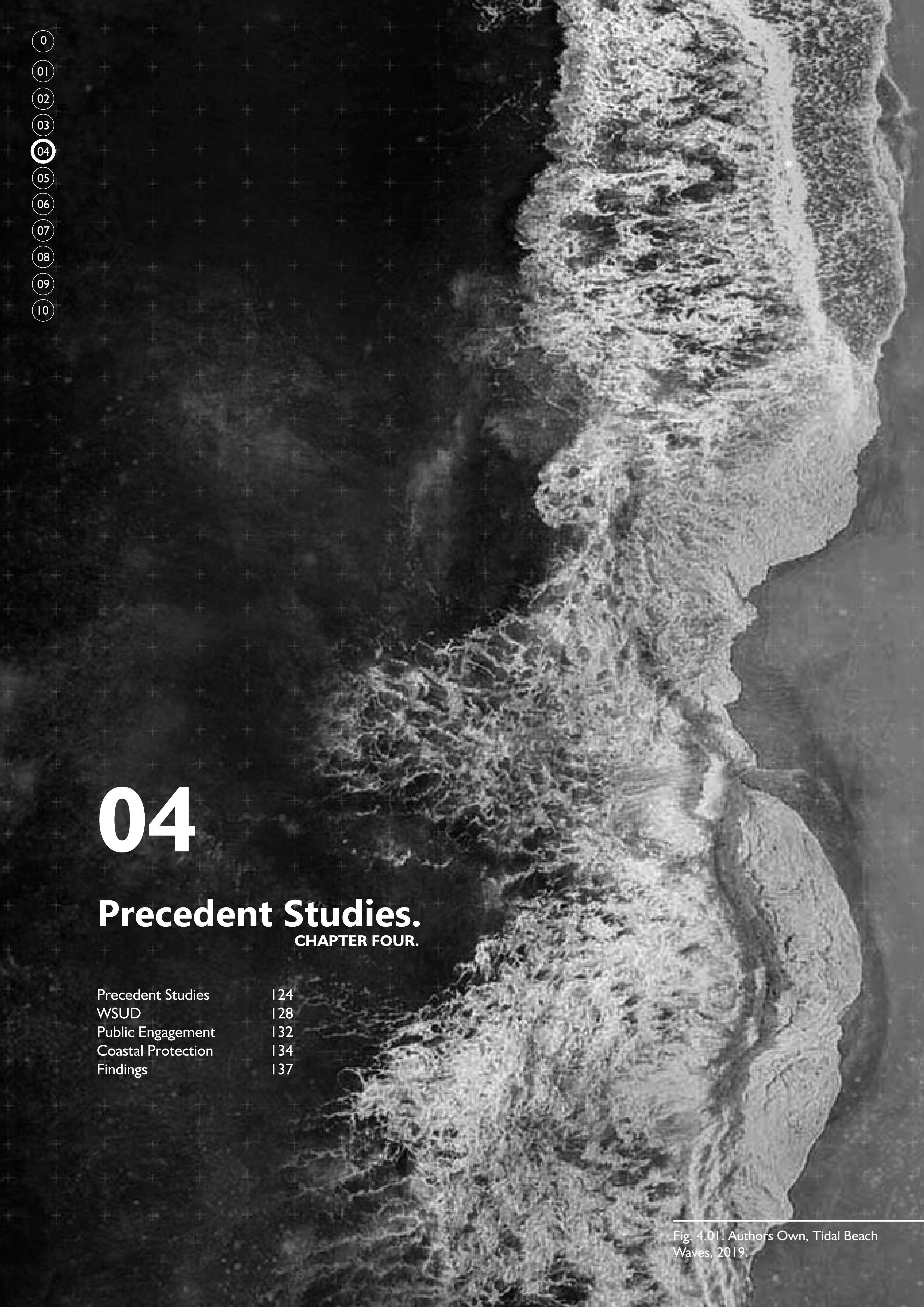
- Celebrating the piped Pipitea stream through creating a day lighted catchment which can filtrate, treat and provide space of public and non-public access. Integration of this should be through the urban environment and proving some heritage of the culverted stream.

- Improved coastal defence from erosion, surge flooding and sea level rise while being able to cleanse the polluted harbour.

- Drainage mitigation and ensure safe public access and protective health of waterways.

Some potential approaches and solutions to these problems will be investigated further through precedent studies.

Fig. 3.46. Authors Own, Tidal Waves, 2019. (Opposite Page)



# 04

## Precedent Studies.
**CHAPTER FOUR.**

| | |
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| Public Engagement | 132 |
| Coastal Protection | 134 |
| Findings | 137 |

Fig. 4.01. Authors Own, Tidal Beach Waves, 2019.

Within disparate urban contexts, waterfronts have been programmed to facilitate public actives and engage public interaction with the harbour and water itself. Industrial ports have been excluded from this realm due to requirements of safety, security, economic reliance and constantly changing landscapes, presenting limitations to the work environment. Wellington waterfront wraps the inner harbour with a variety of waterfront precincts suited towards human recreational waterfront use, being leisure, recreation, food, boat, kayaking and swimming facilities. The industrial ports of the northern waterfront region cover a huge expanse of this harbour with restricted site use. There is an incipient need of urban centres to be integrated with industrial ports as well as for public and town requirements. The lack of ecological process on site contributes to a large measure of harbour pollution contributing to the effects of arising climate changes. Within no natural filtration and biodiversity to help encourage healthy waterways, pollution will lead to warmer and toxics oceans which used to produce healthy sea life, now increasing sea level rise. It is therefore a challenge to protect working port sites and integrate public and ecological design simultaneously along this Wellington waterfront. Case studies have been explicitly researched in relation to the Wellington precondition and proposed design intents.

These look at the following case studies of national and international relevance in relation to:

-Industrial/post-industrial sites
-Port Design
-Urban Waterfronts
-Storm Water Management
-Eco System Restoration
-Flood Mitigation
-Coastal Habitats
-Stream Restoration


## PRECEDENT STUDIES: LOCATION OF RELEVANT PROJECTS.

WSUD.
Public Engagement.
Coastal Protection.

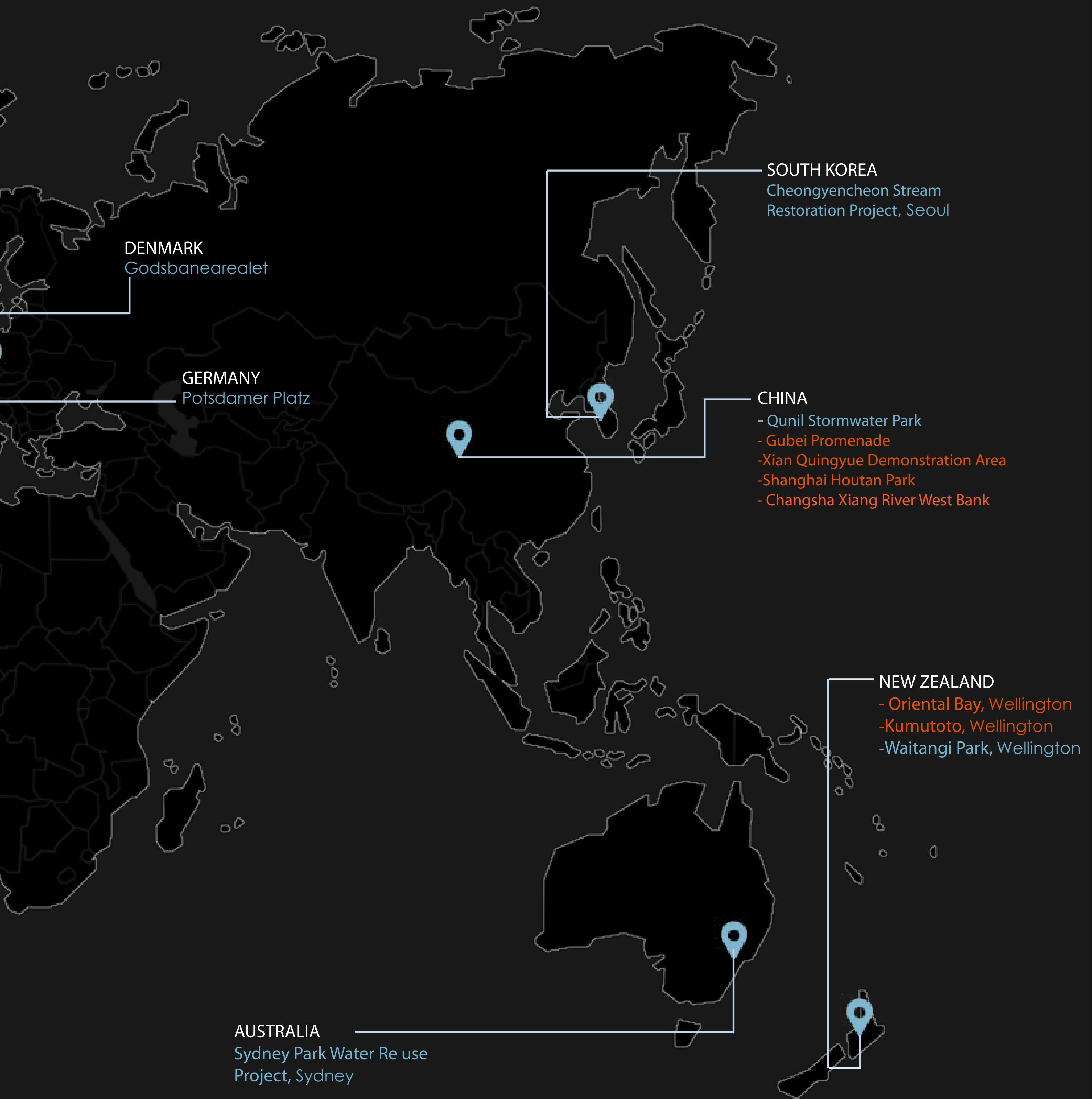



Fig. 4.02. Authors Own, Precedent Locations, 2019.

Fig. 4.03.

Fig. 4.04.

Fig. 4.05.

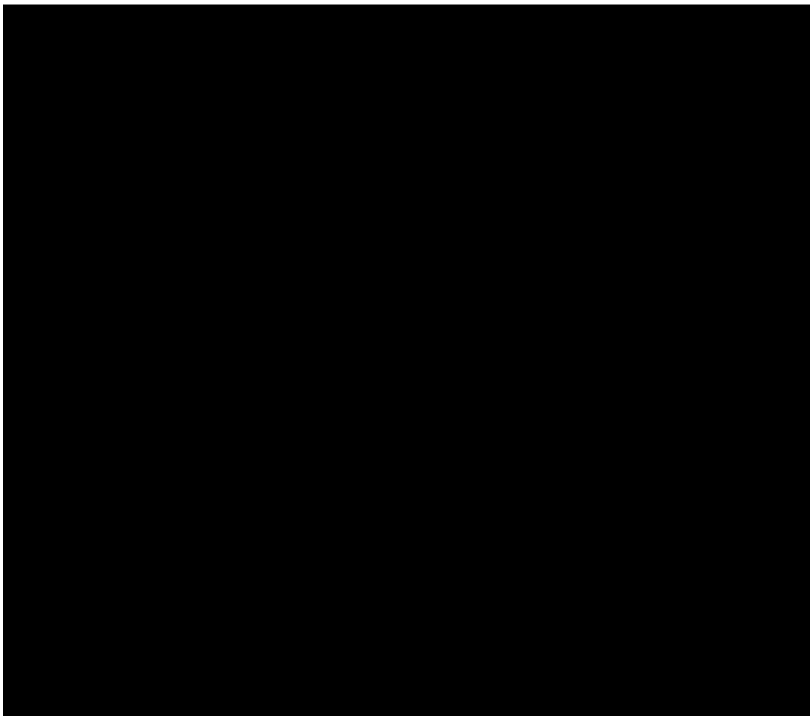


Fig. 4.06.

**01.** Sw 12Th Avenue Green Street, Oregon
Urban Rain Design – Kevin Perry

- Catchment for runoff water through impervious surfaces within streets, sidewalks
- 8,000 sq. feet of storm water surface captured through storm water planters built on 12inch curbs
- Enhances streetscape and permeability, safety and ecology and quality of waterways
- Works with environmental factors
- Show relation to urban context
- A micro ecological environment

**02.** Brisbane City Hall Rain Garden, California
Urban Rain Design – Kevin Perry

- Demonstrates sustainable storm water management
- Parking lot space turned into a rain garden catchment in urban area
- High aesthetic design, enhancing surrounding
- Links spaces together
- Provides habitat for native birds
- Micro ecological environment

**03.** Smith Memorial Student Union Plaza, Oregon
Urban Rain Design – Kevin Perry

- Public plaza and thoroughfare design
- Sustainable green infrastructure design for storm water runoff mitigation
- Provides comfort and enhancing surrounding
- Merge of ecology and technology
- Links different programmed spaces together
- Micro Ecological design

**04.** Sydney Park Water Re use Project
Turf Design Studio, Turpin + Crawford

- Enhanced ecological preservation and filtration design
- Increased habitat, filtrations, biodiversity and recreation
- Successful merge of ecology and technology for Storm water Re Use
- Educational moments through exposing of treatment systems turned into statement design piece art piece
- Sustainable residential development design
- River, swale, wetlands, Re Usable Water

Fig. 4.07.

Fig. 4.08.

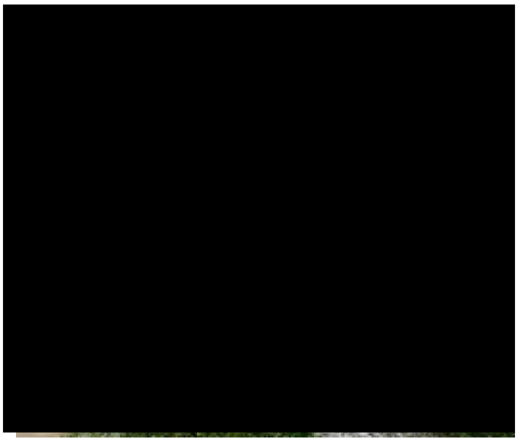


Fig. 4.09.

Fig. 4.10.

05. Gubei Promenade
SWA Group

- Design for bioclimatic and urban heat reduction
- Wellbeing space for public to use as thoroughfare and resting place
- Storm water runoff filtration and collection
- Connects spaces within urban environment
- Increased wildlife habitat
- Reflection and celebration of site history through recycled traditional materials

06. Rail Road Park
Tom Leader Studio

- Habitat and natural ecology restoration
- Recreational space for all ages
- Celebrates site railway corridor history
- Provides flood mitigation through basin design
- Large Park design allows for event and civic functions to utilise space
- Gathering location

07. Cheongyencheon Stream Restoration Project
SeoAhn Total Landscape

- Former Roadway restored to natural river way
- Provides flood protection
- Reduces urban heat, bio climate design
- Increased biodiversity, native fauna and flora specie regeneration
- Reduction of air and water pollution
- Celebrates history of pipe stream and promotes public park/leisure space

08. Waitangi Park
Wraight Athfeild Landscape + Architecture

- Waterfront wetland design
- Celebrates presence of Piped Waitangi Stream
- Recreational, Leisure, multi-use site
- Sustainable Water Sensitive Urban Design
- Water Retention and treatment
- Native vegetation regeneration, Biodiversity, cultivation
- Renewable energy source

[redacted]

Fig. 4.11.

[redacted]

Fig. 4.12.

[redacted]

Fig. 4.13.

[redacted]

Fig. 4.14.

09. Qunil Stormwater Park
Turenscape

- Increased biodiversity
- Flood absorbent and retention park design
- Multi use park space
- Educational landscape
- Bioclimatic control design
- Celebrates ecology, past and present of site

10. Sherbourne Common, Cananda
PFS Studio

- Post Industrial, pre unused site design
- Storm water filtration
- Celebration of Storm water filtration process through engineered artwork elements
- Public oriented design
- Ties urban waterfront with campus together
- Interactive and multiuse space design

11. Emory University Water Re Use Project, United States

- Sustainable water re use design
- Campus and educational design
- Waste water recycling into reusable drinking water
- Technology oriented design
- Sustainable development design

12. Potsdamer Platz, Berlin, Germany
Atelier Dreiseitl

- Enhances aesthetics of site
- Bio climate design, humidifies air
- Civic plaza rainwater catchment of buildings and ground, sustainable design
- Temporary retention of rainwater in cisterns
- Increased biodiversity in urban environment
- Merge of ecology, storm water capture technology and social destination and thoroughfare

Fig. 4.15.

13. Waller Creek
Michael Van Valkenburgh

- Urban River restoration
- Increased biodiversity
- Connection to city
- Promotes public interaction with water
- Celebrates river presence
- Flood mitigation design

Fig. 4.16.

14. Godsbanearealet
Polyform Architects

- Sustainable city
- Celebrates former site 'freight train terminal'
- Green infrastructure
- Embraces former site and links to urban context
- Surface water management
- Green roofs

Fig. 4.17.

Fig. 4.18.

Fig. 4.19.

Fig. 4.20.

15. Oriental Bay
Isthmus

- Tidal Ecology Regeneration
- Coastal beach platform
- Tidal Concrete Slabs
- Platform Seating + Boardwalk
- New ecological home to seaweed, fish, algae and people
- Iconic Waterfront Attraction + access to water

16. Shanghai Houtan Park
Turenscape

- Green infrastructure
- Multi use park design
- Increased biodiversity
- New sustainable green technology design to promote biodiversity
- Post industrial design
- Multi programme space, food production, floodwater treatment, habitat creation, educational

17. Xian Quingyue Demonstration Area
Waterlily Design Studio

- Active social destination space
- Water feature and celebration of site design
- Mixed space recreation, leisure and resting space
- Narrative design
- Celebrates historic tales and imprints
- Ties built and natural landscape together

18. Changsha Xiang River West Bank
GVL

- Waterfront riverfront design
- Design focus on interaction between people and water
- Tourism, public oriented
- Multi use space, leisure, seating, recreation, cycleway
- Visually effective space to draw people in
- Celebrates local culture and industrial site elements

Fig. 4.21.

Fig. 4.22.

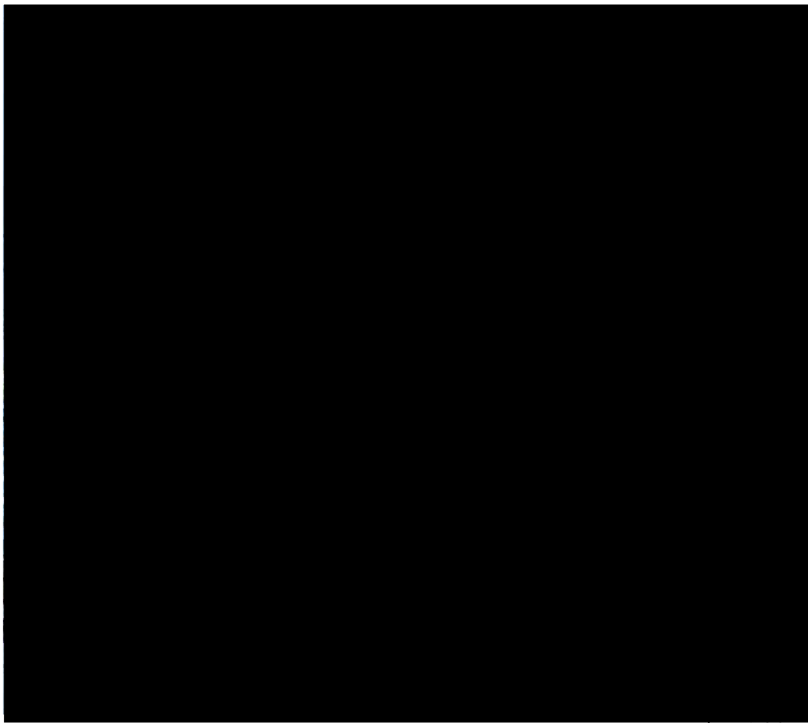


Fig. 4.23.

19. Hudson park and Boulevard
Michael Van Valkenburgh

- Waterfront/Urban Design
- Public Space Design
- Green Infrastructure design
- Thoroughfare Zone
- Leisure/Resting Programme
- Water Runoff Absorbent space

20. Kumutoto Wellington
Isthmus

- Urban Waterfront Design
- Celebrates opening of culverted Kumutoto Stream
- Level steps design allows for seating and leisure
- Folded Timber deck structure provides site attraction
- Flexible public space
- Ties waterfront with rest of Wellington harbour

21. Strijp S
Carve Landscape Architecture

- Post-industrial site
- Public space design
- Embraces original site character
- Temporary design space
- Large concrete elements remind of sites industrial past
- Enhances site area

Fig. 4.24.

Fig. 4.25.

Fig. 4.26.

Fig. 4.27.

22. Oyster Tecture
Scape Architects

- Merge of ecology and technology
- Coastal Defence
- Storm buffer
- Re-establishing tidal ecologies
- Living Ecologies
- Harbour Filtration

23. Boston Waterfront Vision
Michael Van Valkenburgh

- Waterfront design
- Sea Level Rise Design
- Public and water interaction oriented
- Flood absorbent design
- Multiuse spatial design
- Soft edge coastal restoration design

24. Resilient Boston Harbour Vision
Scape Architects

- Resilient waterfront design
- Flood mitigation
- Water runoff design
- Multi use Public and transport spaces
- Storm buffer design
- Adaptive port design into ecological urban landscape

25. Lower Don Lands Master plan
Michael Van Valkenburgh

- Natural Reclamation Design
- Waterway opening and increased ecology design
- Restoration of river ecology
- Increased biodiversity
- Master plan scale, residential, commercial and public site design
- Merge of Urban and Natural Ecology


Fig. 4.28.


Fig. 4.29.


Fig. 4.30.


Fig. 4.31.

26. Buffalo Outer Harbour Master Plan
Scape Architects

- Resilient coastal design
- Improved biodiversity
- Flood Mitigation
- Climate change adaption
- Living ecological breakwaters
- Merge of engineering +ecology

27. Deconstructed Salt Marsh
Scape Architects

- Educational design
- Biodiversity restoration
- Multi use public space
- Celebrates context and history of site
- Designed for tidal changes
- Saltwater and Fresh water design

28. Big U
Bjarke Ingels

- Waterfront design
- Flood mitigation
- Ecological, water absorbent park
- Multi use space
- Sea level rise protection
- Coastal Protection and Public engagement

29. Brooklyn Bridge Park
Michael Van Valkenburgh

- Waterfront Park design
- Multiuse Space
- Coastal erosion protection
- Public and water interaction
- Embraces old site qualities
- Port and reclamation design

Fig. 4.32.

30. China Basin Park
Scape Architects

- Ecological Waterfront
- Tidal shelve design
- Increased biodiversity and harbour health
- Public interaction with water
- Diverse urban landscape, multi-use park
- Cultural and recreational design

FINDINGS.

Case studies have identified the difficulty and success of working with timber ports and reclaimed industrial sites. Although it is seen through many international cases waterfronts often become places unified with the surrounding context, it is defied to allow Wellington waterfront be conceptualized as a resilient and dynamic waterfront that works coherently with the surrounding context. Furthermore many case studies do strongly provide solution for reprogrammed public spaces, they do not however provide this solution for working port integrate with public programme, rather recomposed sites as a whole. Caste studies concisely stated have stood out successful in certain design aspects rather than whole design solutions. Some of which will be discoursed in depth further.

Key conceptual and imperative intentions that will be used further to provide design solution include:

-Sites which embrace and celebrate past programmes and historical relevance

-Biodiversity and habitat restoration is strongly encouraged while bio climate design solutions allow reducing urban heat affects and providing aesthetically pleasing and strong public attractors

-Waterfront design heavily encourages the interaction of public and water design

-Waterfront and coastal design encourages the protection of natural systems and erosion control through naturally engineered landscape technology over imposing engineered concrete structure.

-Living edges, tidal ecologies and coastal ecologies are reintroduced into urban contexts as a means as natural filtration processes and reduction of urban heat.

# 05

# Design Strategy.

**CHAPTER FIVE.**

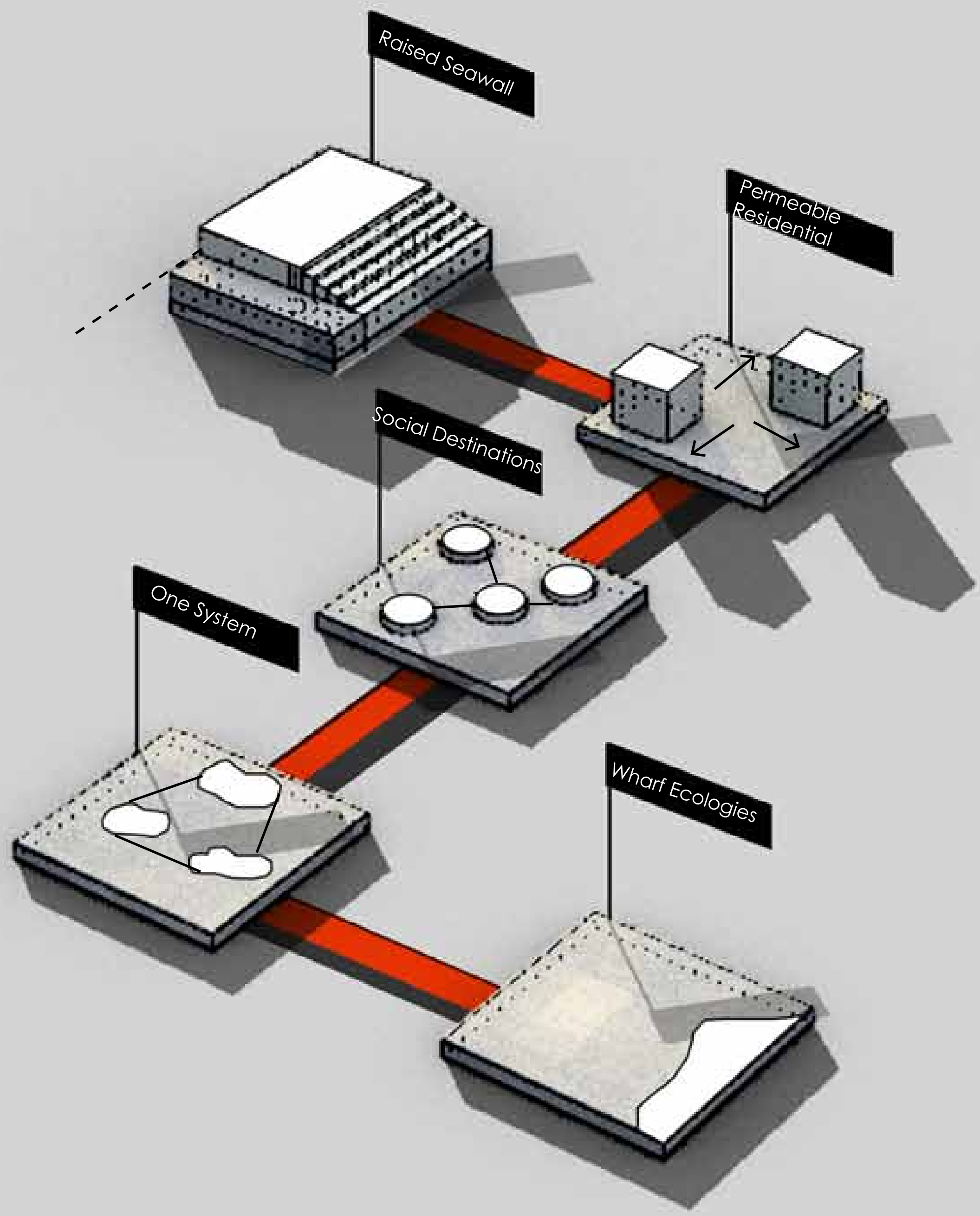
Design Strategy 139
Design Framework 141
Programme Strategy 142

Fig. 5.01. Authors Own, Tidal Beach Waves, 2019.

## DESIGN STRATEGY.

Through previous chapters design opportunities were established in relation to site conditions and addressing the implications climate change poses. A design framework was created in consideration to recognise, celebrate and adapt to the unique qualities of Wellington's waterfront while providing a design approach for mitigation of the effects of climate change within Wellington harbour.

Five key framework ideas were developed and impose new beneficial solutions focussing on resilient design for site to function as; a dynamic waterfront, protect and adapt to qualities of site in events of everyday life, flooding and extreme weather conditions, allowing social, economic, ecological and industrial elements to work conjointly.


Raised Seawall
Permeable Residential
Social Destinations
One System
Wharf Ecologies

## DESIGN FRAMEWORK.

This design framework outlines the core principles that will be implemented into design in accordance to this thesis's research question as solution to mitigate the effects of climate change in the context of Wellington's waterfront. Through this chapter a variety of technologies will be tested as tools to achieving these 5 core principles to design. This will be done through respecting the site conditions and context, and enhancing site qualities in order to test the effectiveness of what a resilient Wellington waterfront could look like.

### PRINCIPLES

#### BREATHABLE WHARF ECOLOGIES

This design principles aims to target and restore the natural processes a healthy waterfront would obtain, by restoring ecological native vegetation and fauna this will act as a natural system to filtrate and clean water while developing and strengthen the natural ecological cycle of a coastal waterfront and provide fresh and safe waters for public to access and preserve.

#### SOCIAL DESTINATION POINTS

Turning an unusable industrial  waterfront into a public driven waterfront with the aim of creating social spaces to attract public and enjoy the waterfront harbour, this will be a variety of destination types for a variety of recreational, leisure, civic and seating uses while ensuring runoff and flood mitigation catchments.

#### ONE LARGE INFRASTRUCTURAL SYSTEM

The aim of the principles allows different social and ecological drivers of the waterfront to work in harmony as one whole system that can assist with storm water filtration, mitigation and flood management problems.

#### PERMEABLE RESIDENTIAL SPACES

In an era of increased urbanisation and demand for developing residential spaces, the waterfront is a key catalyst for development. Within an urban waterfront the aim to provide residential and mixed economic space allows for a dynamic sustainable waterfront for visitors and residents to enjoy off while ensuring public and private safety of people.

#### RAISED SEAWALL

The arising climate conditions have severe implications on coastal urbanised sites full of assets and already sustained lifestyles. By protecting this, a design principle aims to raise zones of the waterfront to mitigate effects of surge and sea level rise in a manner public can utilise space and drainage is allowed for.

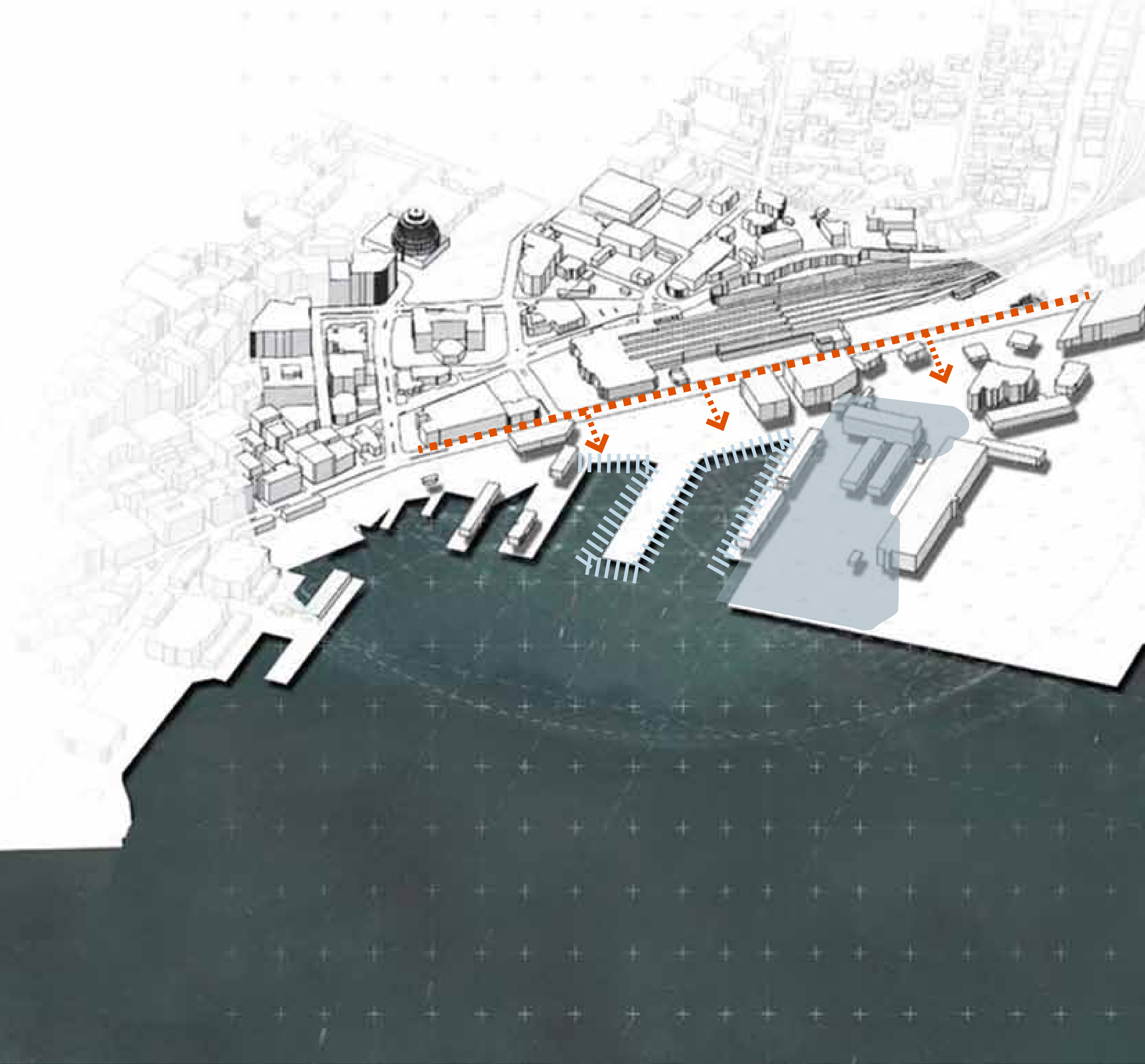
Fig. 5.02. Authors Own, Design Principles Illustration, 2019.

1. INCREASED ACCESS

2. SOCIAL DESTINATION POINTS AROUND HARBOURS EDGE

3. DECLAIMED AND FLOOD PROTECTION SYSTEM

4. "DESTINATION POINTS" TO BRING PEOPLE INTO SPACE



PROGRAMMATIC STRATEGY.

Although the site has been drastically transformed from historical programme, there is a positive opportunity to celebrate lost programs and expand current functions of public Wellington waterfront into resilient new ideas on site. In order to celebrate site as a functioning dynamic and resilient waterfront, key areas of publicly driven program will allow users celebrate the site of a waterfront, being able to access harbour water, invite recreational use of site such as fishing, kayaking, swimming, provide for leisure parks and vegetated boardwalk walkways through functioning wetlands. For this reason, certain sites, scales and technologies will be examined to enable new ideas and a new approach to look at waterfronts.

Fig. 5.03. Authors Own, Design Program Illustration, 2019.

# DESIGN PROCESS.

1

### HYBRID TOOLS.

Starting to generate initial ideas based on theoretical/ precedent/analysis study, looking at resilient infrastructure and how public can be integrated into this.

2

### MICRO CONTEXT.

Exploration of Hybrid tools within initial site context.

3

### MACRO CONTEXT + EDGE CONDITIONS.

A wider site scale is used to explore technologies that can be implemented, and how edge conditions previously identified through site analysis of soft and hard edge benefit design.

# 4

## DESIGN EXPLORATION.

A lack of Function, programme, site and historic relevance was found through previous stages of designing, within this stage the idea of working with both Soft and Hard edges is seen most beneficial and design is developed through 3 distinct concepts for further development.

# 5

## REFINED DESIGN.

The third design exploration was seen most successful in achieving all the design principles that were outlined, this was developed further to get to the final refined design.

# 06

# Technologies.

**CHAPTER SIX.**

Technologies for Design 146
Soft and Hard tools 148
Hybrid Tools 152
Initial Testing on site 154

Fig. 6.01. Authors Own, Tidal Beach Waves, 2019.

WHAT IS A TECHNOLOGY?

The term technology relates to functioning landscape components that have an engineered purpose. This may be for protection, ease, connection or usability. It is a way designers can engage with site looking at different forms and materiality to provide design solution for a problem. Within thesis, this provides opportunity to design edge conditions for the protection of site. In order to obtain this there are few strategies to follow which allow protection of coastal harbours and land while encouraging public interaction. Using terms "Soft Edge" and "Hard Edge" determines the engineered conception which could be applicable on a waterfront site. Although there are definite benefits to both solutions, it will be discoursed which solution would provide better benefit to Wellington waterfront in regards to factors of erosion, sea level rise, storm surge, ecological habitats and public space.

WHY INTEGRATE TECHNOLOGY?

Because of the exploitation and damage mankind has done to the environment, environmental designers are heavily relying on technology to re-introduced resilient and protective systems to fix the harm that has been done. Many systems have been identified through literature and precedent studies which are beneficial to environment and arising climate conditions.

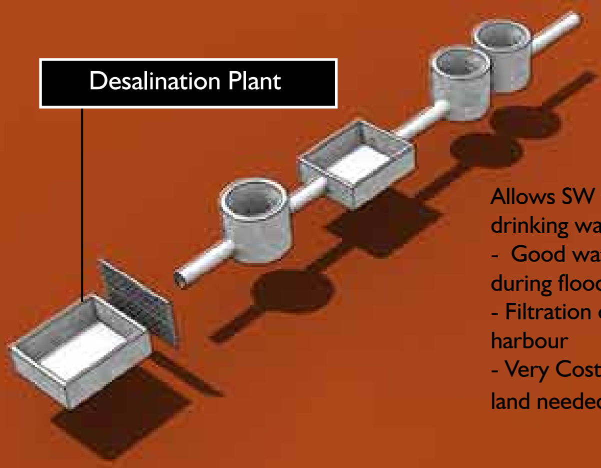
Of the studied technologies, it has been deliberated over which would be of more benefit to the environment and arising climate conditions. There are two key structural approaches these compose of; Hard and Soft Infrastructure. While understanding the benefits of these systems ,it is important to note systems are also are dependant of their site conditions, historic and present, ecological and natural processes they will have to work with.

Hard infrastructure was a primary traditional approach put in place by civil and ecological engineers. This approach required less maintenance, however if damaged, it was very costly and hard to repair. It was seemed beneficial to protect inland and low lying areas by absorbing wave energy, preventing immediate erosion and flooding. These used to have a negative effect on the environment with its static composition that stopped natural processes from occurring.

Over time new notion has been developed into how these man-made structures would pose less of a harmful effect on the environment and new technologies have emerged to include ecological adaption. Some of these have been identified (see Fig.6.02-6.03.) which could be beneficial to integrate into site design.

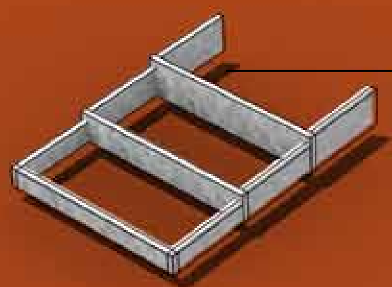
Soft Infrastructure is a method which works with nature rather than trying to stop its natural process. It has less of a negative effect on the environment as it uses ecological practices which increases the environments natural systems. It is less expensive but also more restrictive by its site dependence. Some benefits include, shoreline stabilisation, reduced erosion, increased habitats, increased coastal protection, increased amenity and recreational opportunity, flood mitigation and wave reduction.

### Desalination Plant



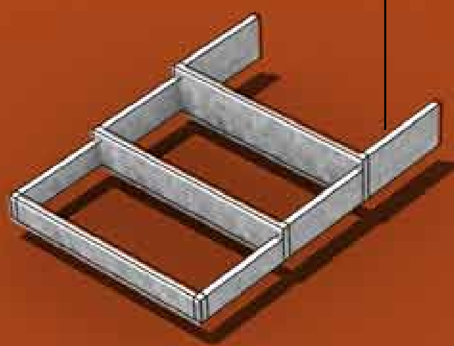
Allows SW to be filtered into drinking water
- Good water retention during floods
- Filtration of water for harbour
- Very Costly, large area of land needed

### Tidal Pools



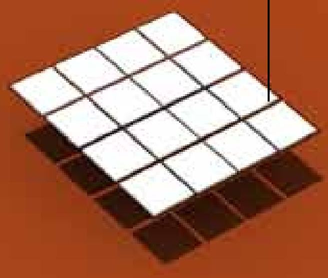
- Reduces wave energy
- Encourages growth of tidal habitats
- Potential recreational use of tidal pools

### Terraced Wetland



- Constructed wetland allows runoff water to filter before entering harbour
- Healthier water promotes better environmental conditions

### Permeable Paving



Run off water absorbs in between pavers to reduce over flow and flooding

BENEFITS OF HARD EDGE INFRASTRUCTURE

-Expensive To Repair
-Very Static
-Slows Down Erosion Process
-Easy For Transporting Large Volumes To Another Place
-Composition Can Allow For Tidal Ecologies Such As Oyster And Snails To Grow
-Static Objects Can Allow For Protection And Public To Utilise Space

## HARD INFRASTRUCTURE. Technologies.

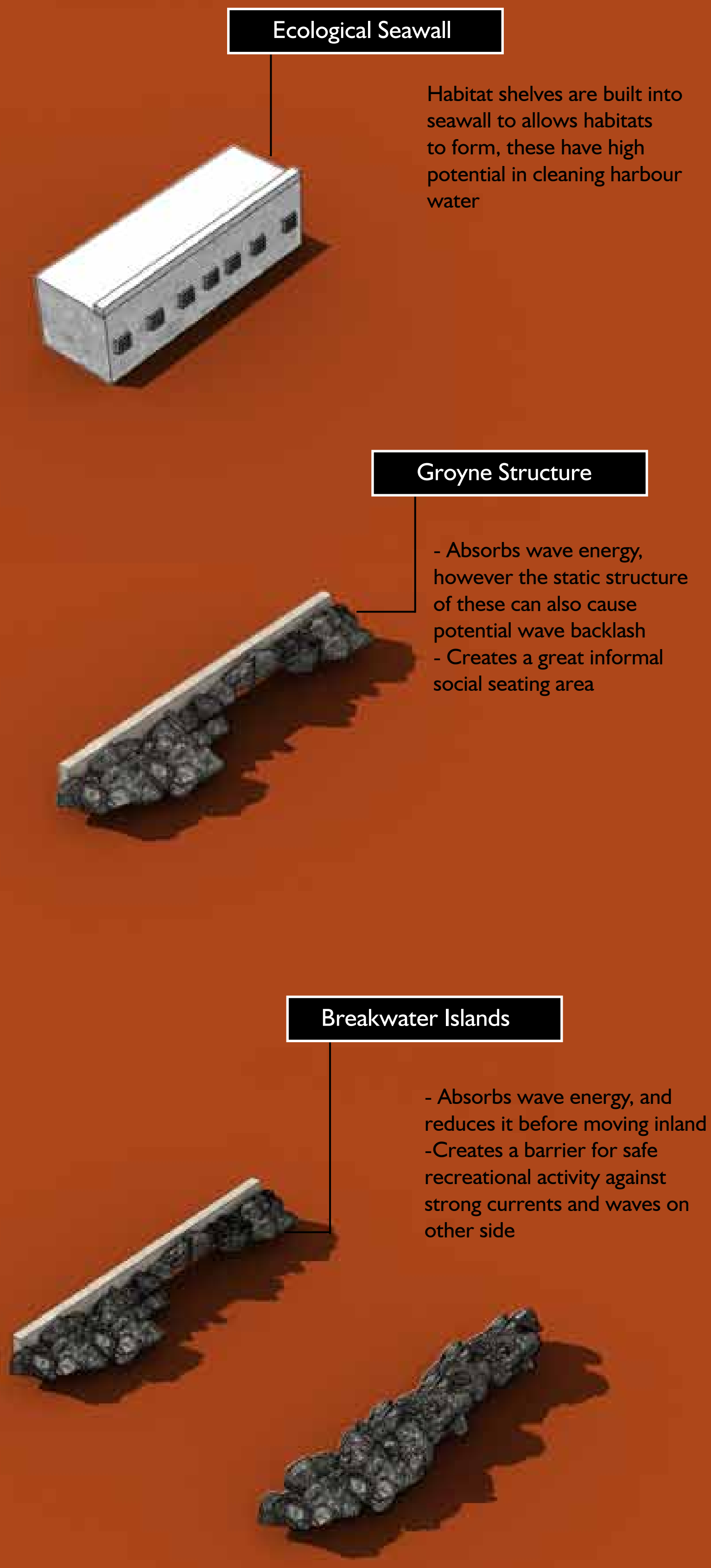
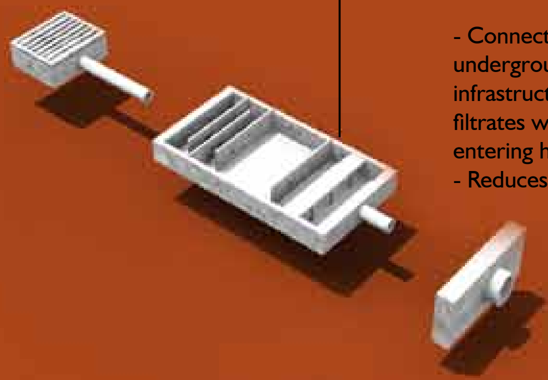



Fig. 6.02. Authors Own, Potential Hard Edge Technologies, 2019. (Pages 148-149)

### Bio Swale

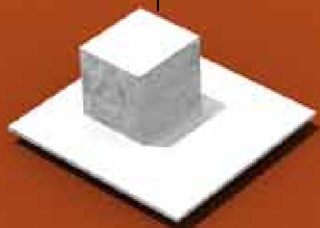
- Captures Run off water and filters it
- Reduces flood potential
- Increases habitats

### Sub-Surface Wetland



- Connects with the underground SW infrastructure and filtrates water before entering harbour
- Reduces flooding

### Green Roofs

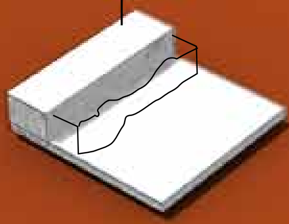


- Reduces Surface Runoff Water
- Treats SW and potential Re Use for Residential purposes
- Aesthetically enhances area

BENEFITS OF SOFT EDGE INFRASTRUCTURE

-Absorbs Wave Energy
-Easily Drains And Filtrates Water
-Can Retain Large Amounts Of Water
-Often A Self-Sustaining System/Functions On Its Own
-Encourages Habitat Life
-Vegetation Can Stabilise Edges And Prevent Erosion
-Large Open Spaces Allow For Public Use Of Space

### Afforestation of Coastal Dunes



- Stabilises Coastal edges
- Reduces Erosion
- Absorbs wave energy
-Reduces flooding

## SOFT INFRASTRUCTURE.
## Technologies.

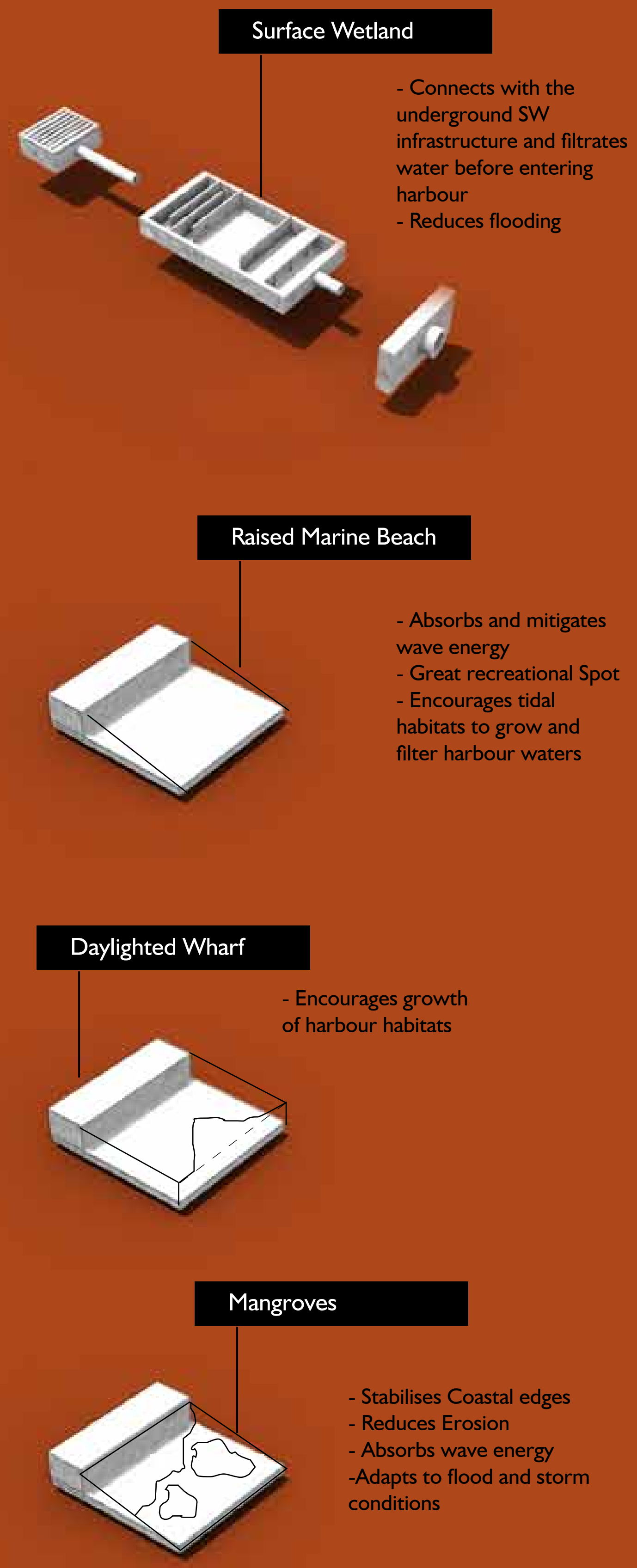



Fig. 6.03. Authors Own, Potential Soft Edge Technologies, 2019.(Pages 150-151)

# HYBRID TOOLS.

## PROGRAM - MULTIFUNCTIONAL SPACE

*Conceptual synergies between Social and Ecological Infrastructure parameters*

[ Goals ]

**01.** *Maximise Active Public surfaces*

**02.** *Overlapping Multiple programs*

X - Categories not applicable

HYBRID TECHNOLOGIES

To begin enabling new ideas for waterfront program and water sensitive design implementation, hybrid technologies were created to test and understand the design complexity that can be created when social user parameters and ecological functioning systems merge.

The aims of these hybrid tools are to firstly conceptualise programmable ideas of maximising active public use and secondly overlapping multiple programmes together to achieve a dynamic waterfront. Few of these hybrid design tools are then tested on various areas of site and scale to conceptualise solutions to developing design with.

ECOLOGICAL INFRASTRUCTURE

*ECOLOGY / RESILIENCE* — *POPULATION / RESIDENTIAL*

*Open Space* — *Park*

*Desalination*

*Subsurface Wetland*

*Surface Wetland*

*Bio Swale*

*Retention Pond*

*Permeable Paving*

*Raised Marine Beach*

*Soft Edge/Tidal Pools*

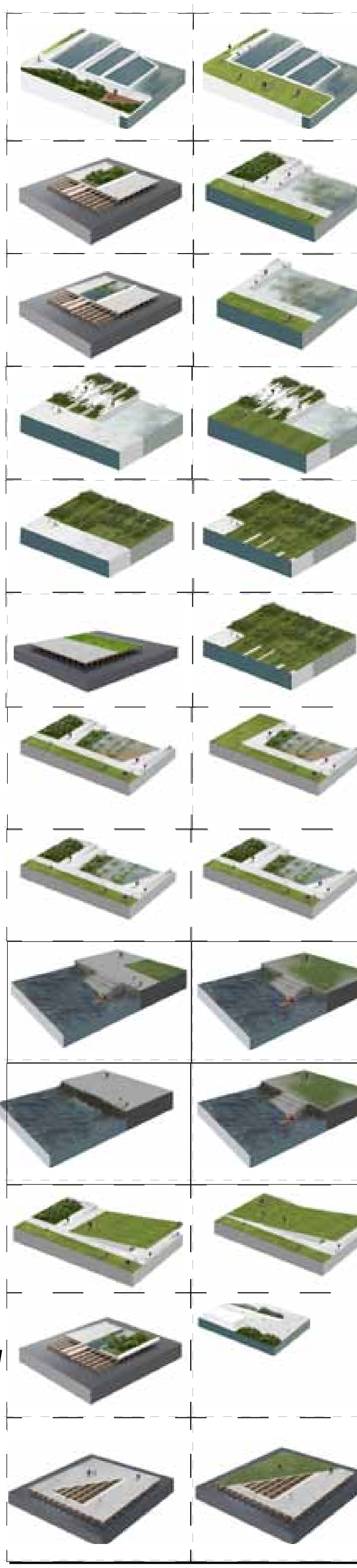
*Ecology Seawall*

*Oyster/Groynes/Living Edges*

*Green Roofs*

*Staged Storm Water Wetland*

*Light entering Piled wharf*



## SOCIAL OPPORTUNITIES

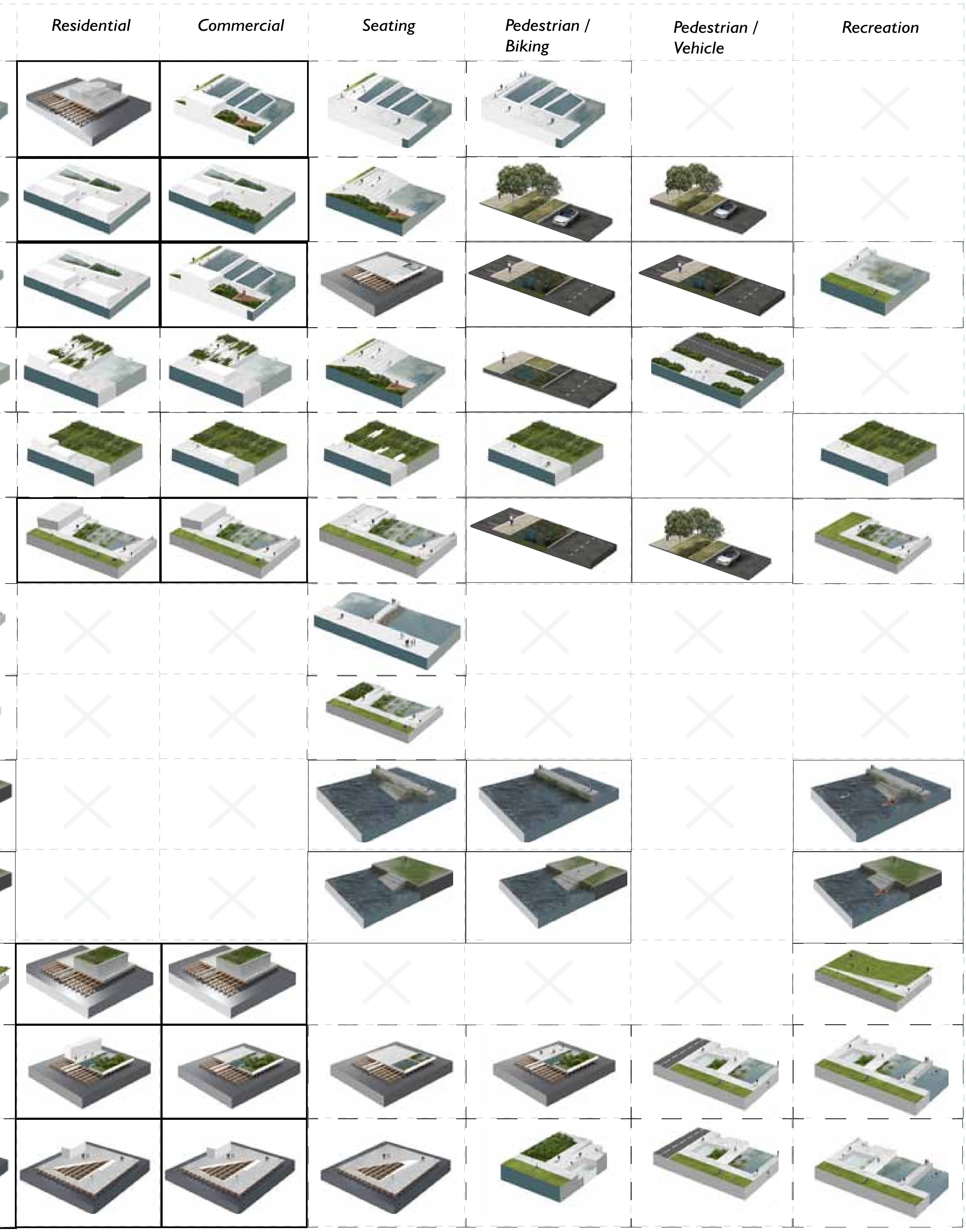
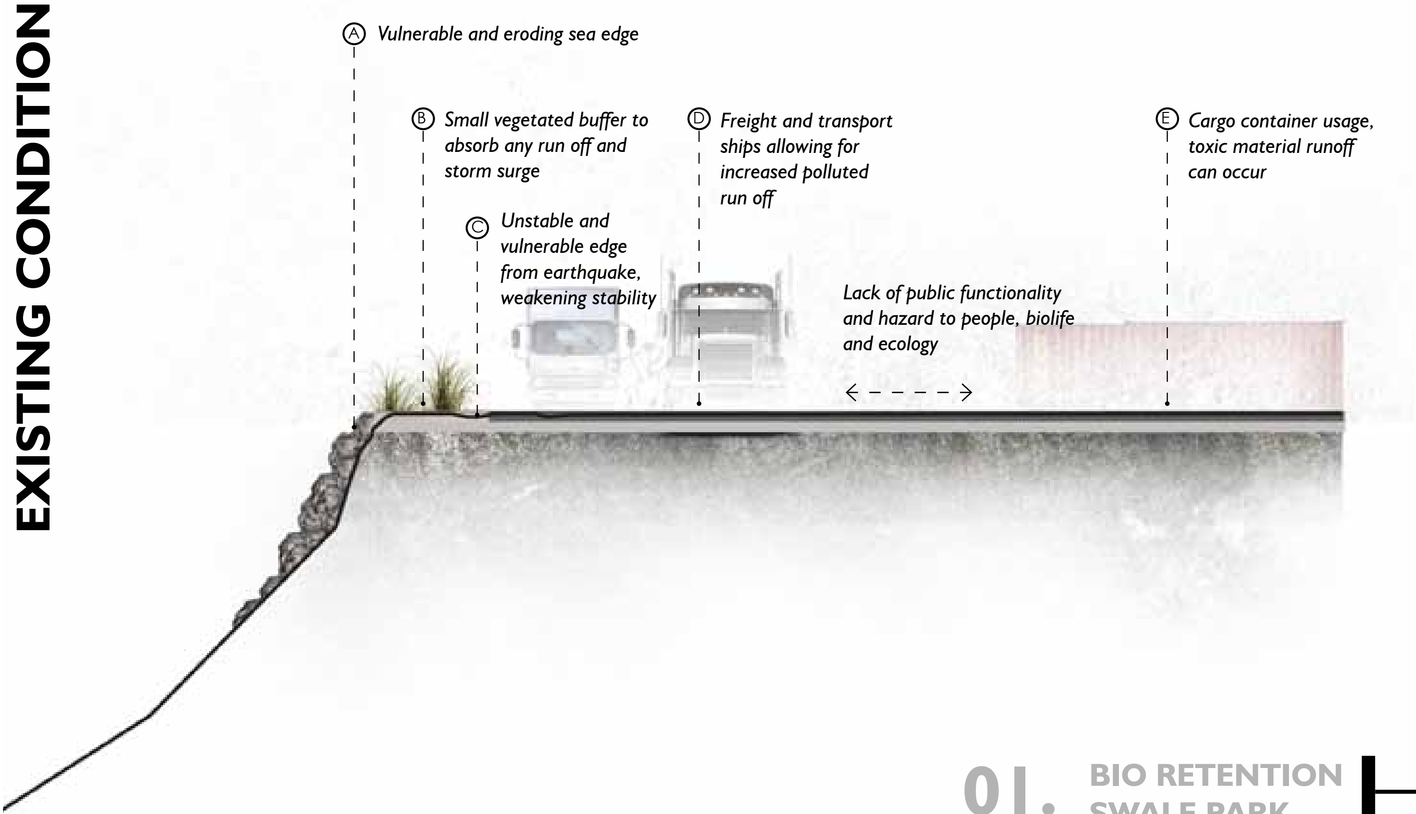



Fig. 6.04. Authors Own, Hybrid Technologies, 2019.

## EXISTING CONDITIONS.

### [ Groyne Edge ]

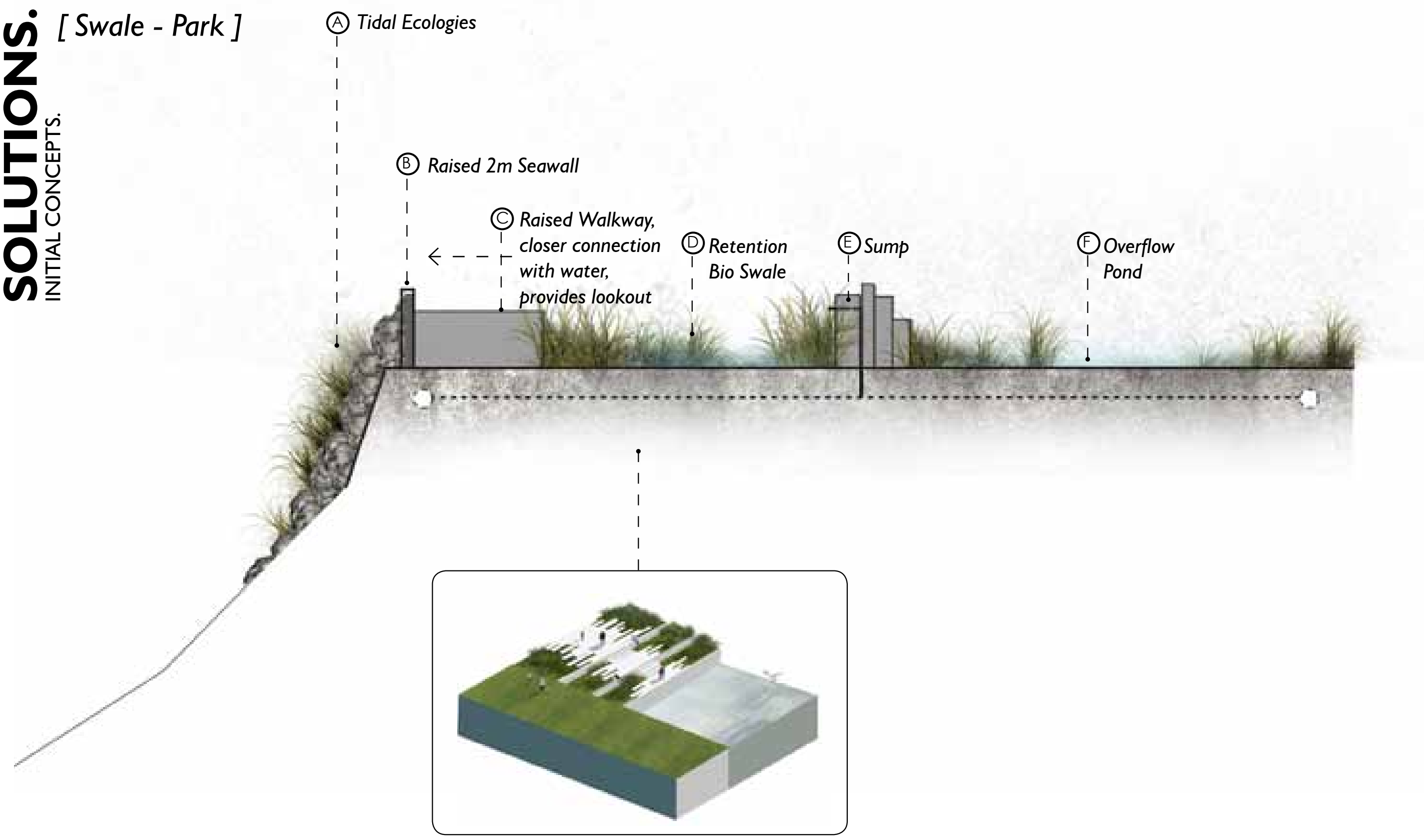


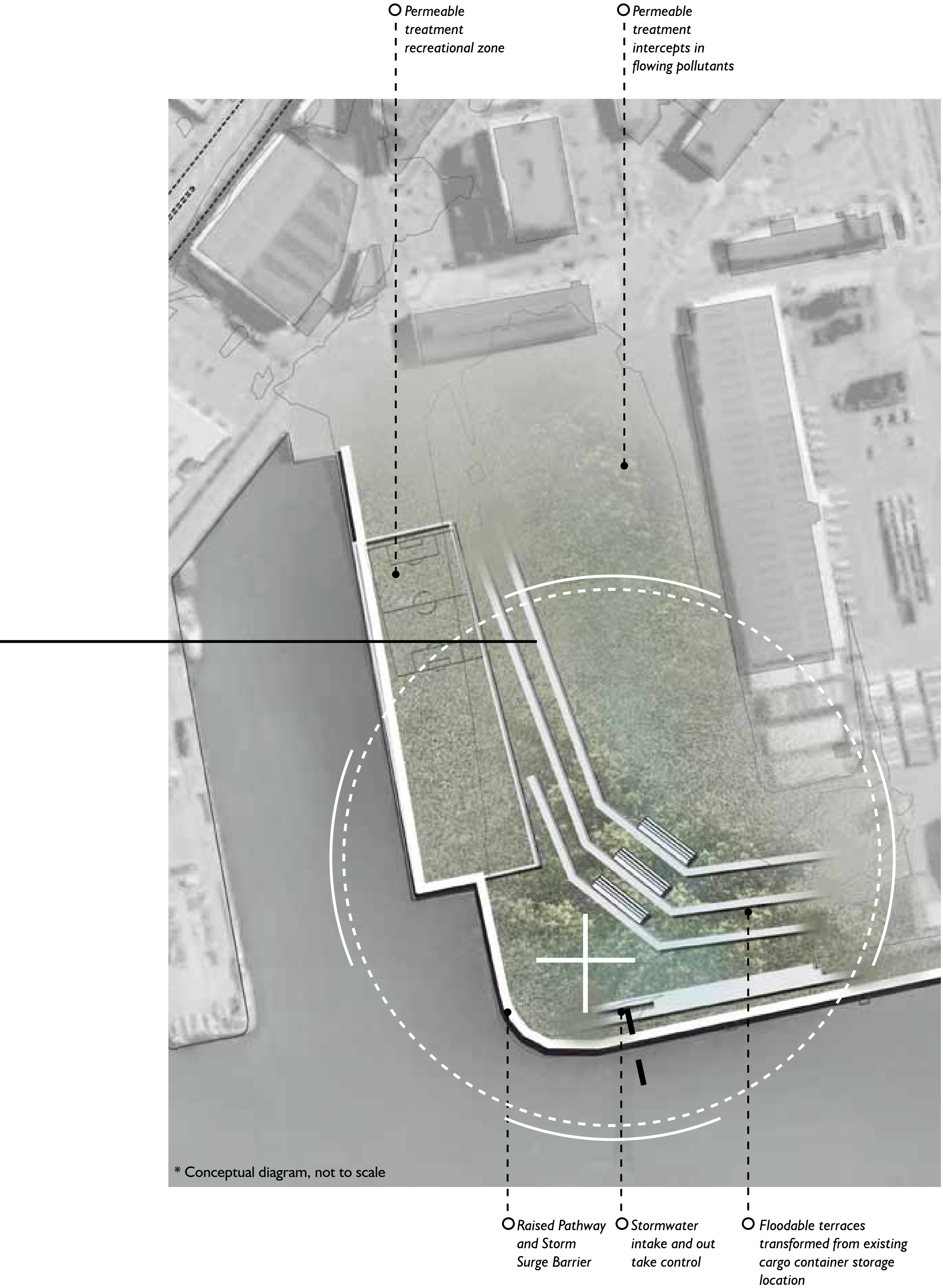

# 01. BIO RETENTION SWALE PARK

## SOLUTIONS.

INITIAL CONCEPTS.

### [ Swale - Park ]



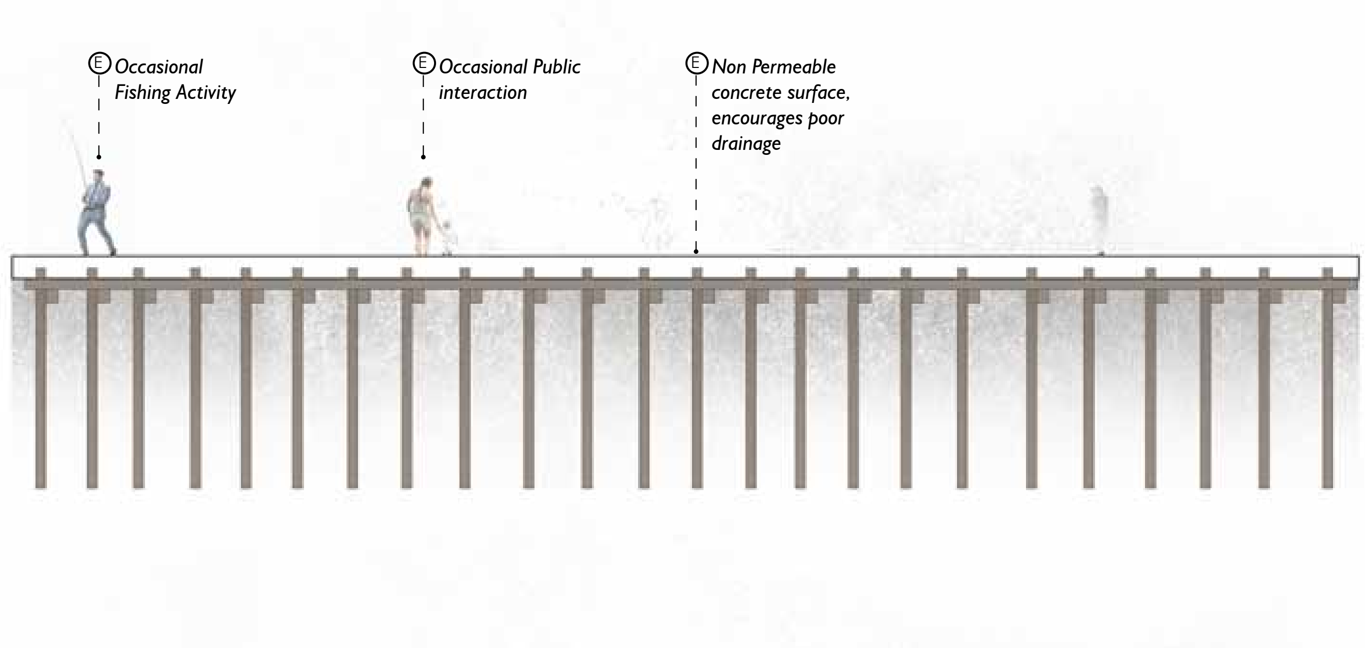



* Conceptual diagrams, not to scale

Fig. 6.05-6.07. Authors Own, Initial Testing of Technology of Site, 2019.

# EXISTING CONDITIONS.

*[ Wharf Piles ]*

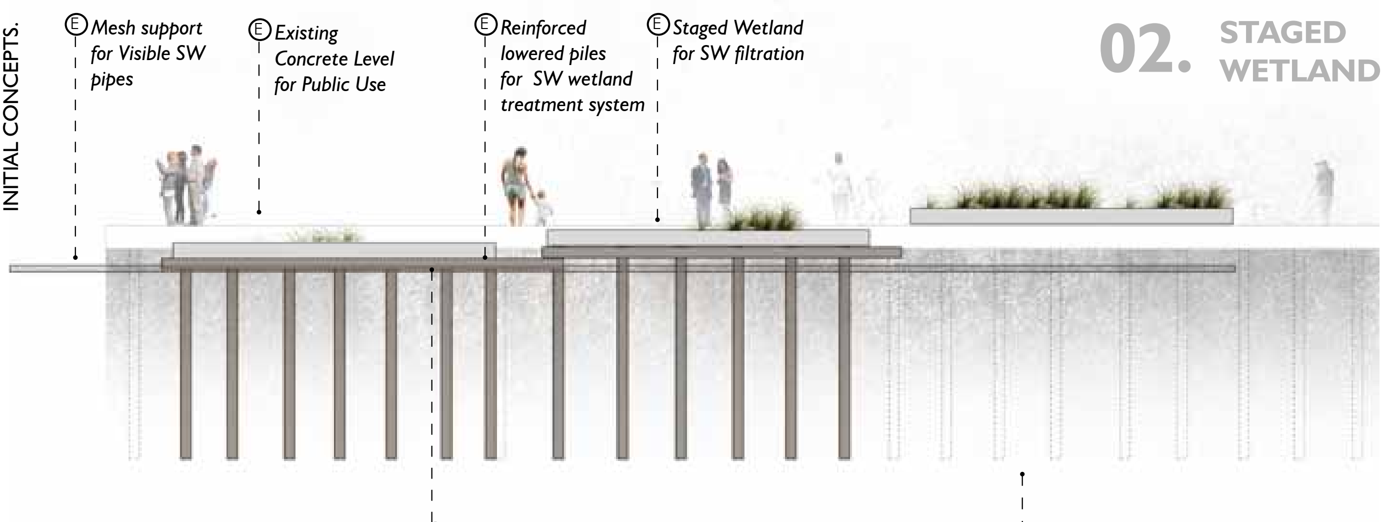


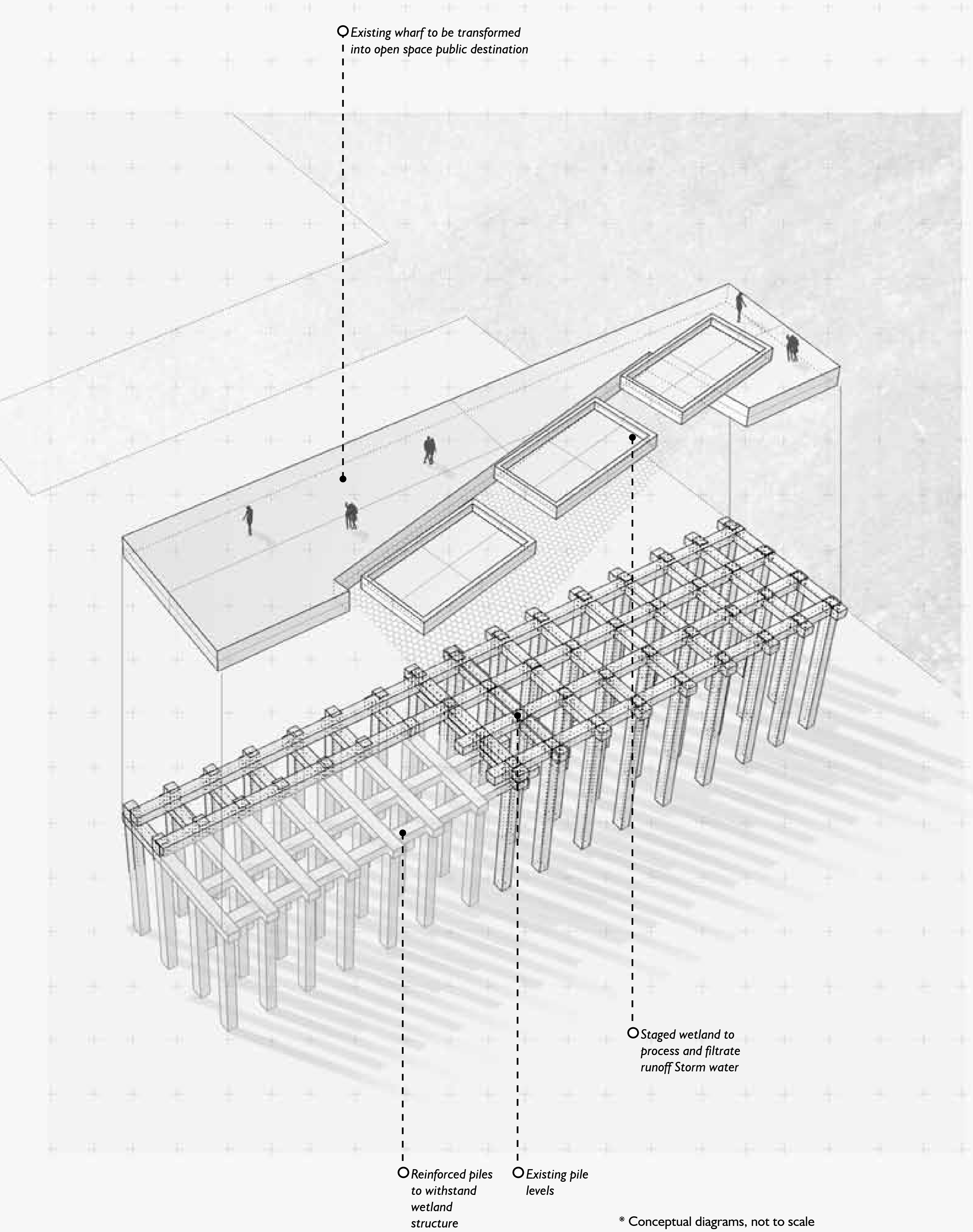

# SOLUTIONS.

INITIAL CONCEPTS.

*[ Staged Wetland - Open Space ]*

## 02. STAGED WETLAND



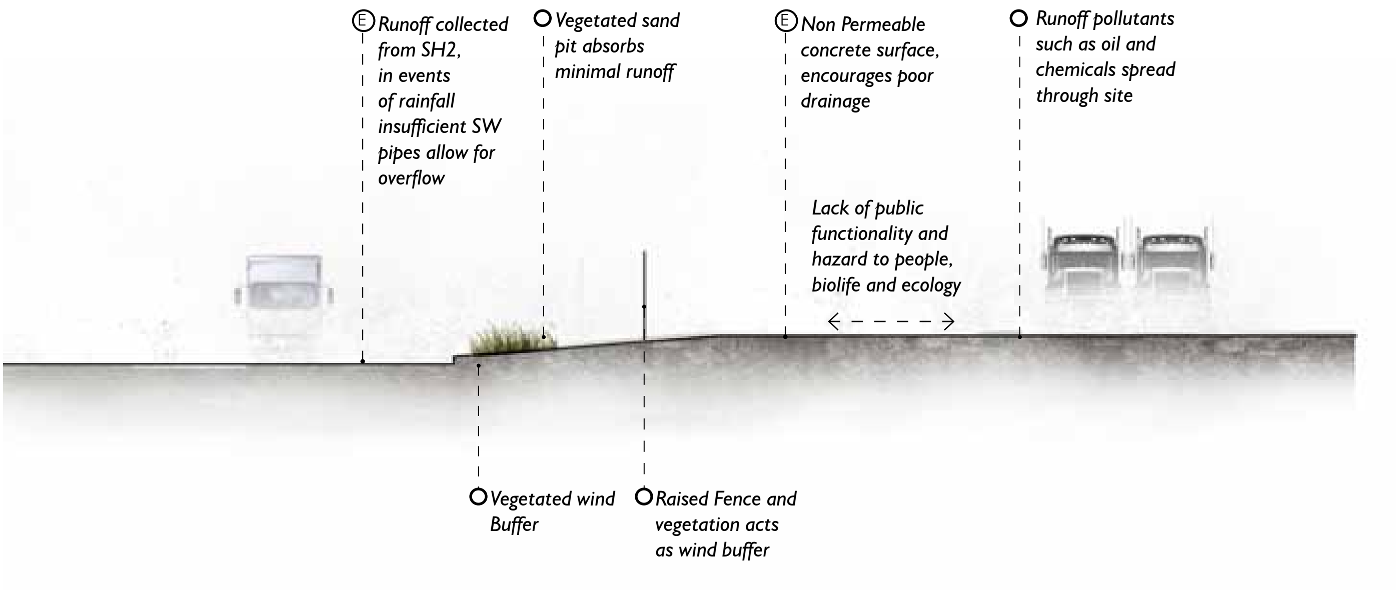




* Conceptual diagrams, not to scale

Fig. 6.08 - 6.10. Authors Own, Initial Testing of Technology of Site, 2019.

# EXISTING CONDITIONS.

*[ Road side ]*

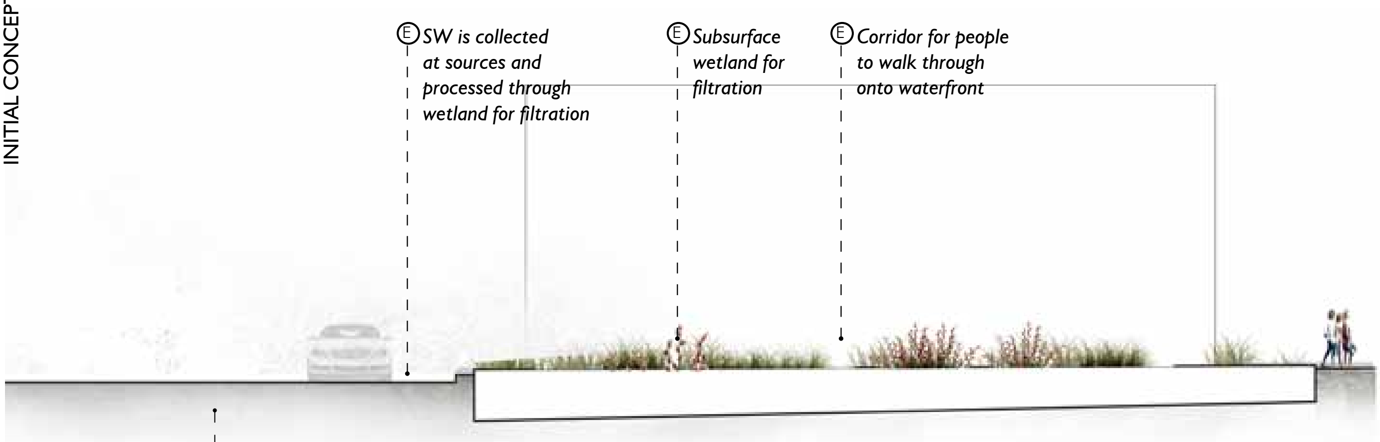


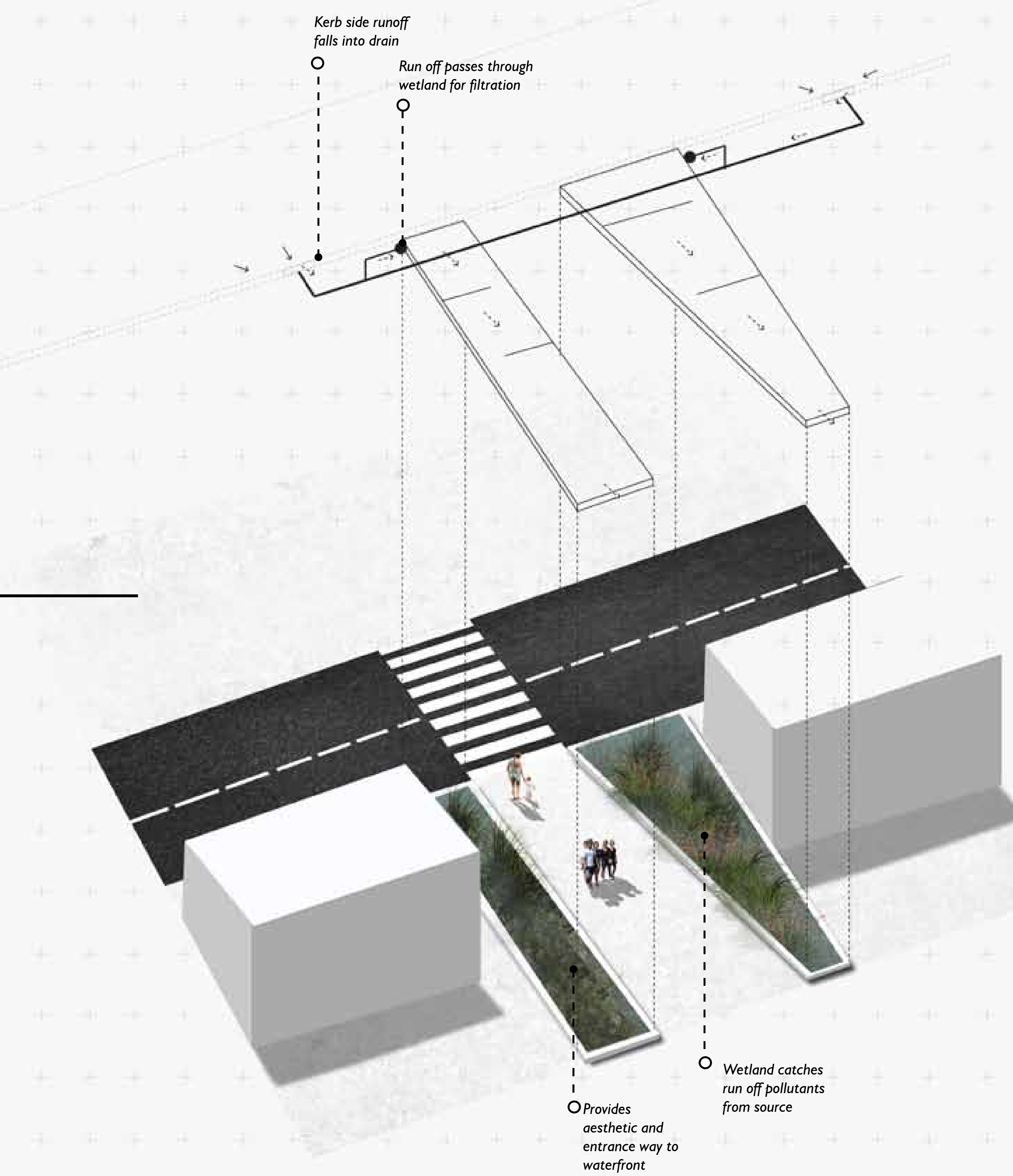



# SOLUTIONS.

INITIAL CONCEPTS.

*[ Sub Surface Wetland - Road ]*



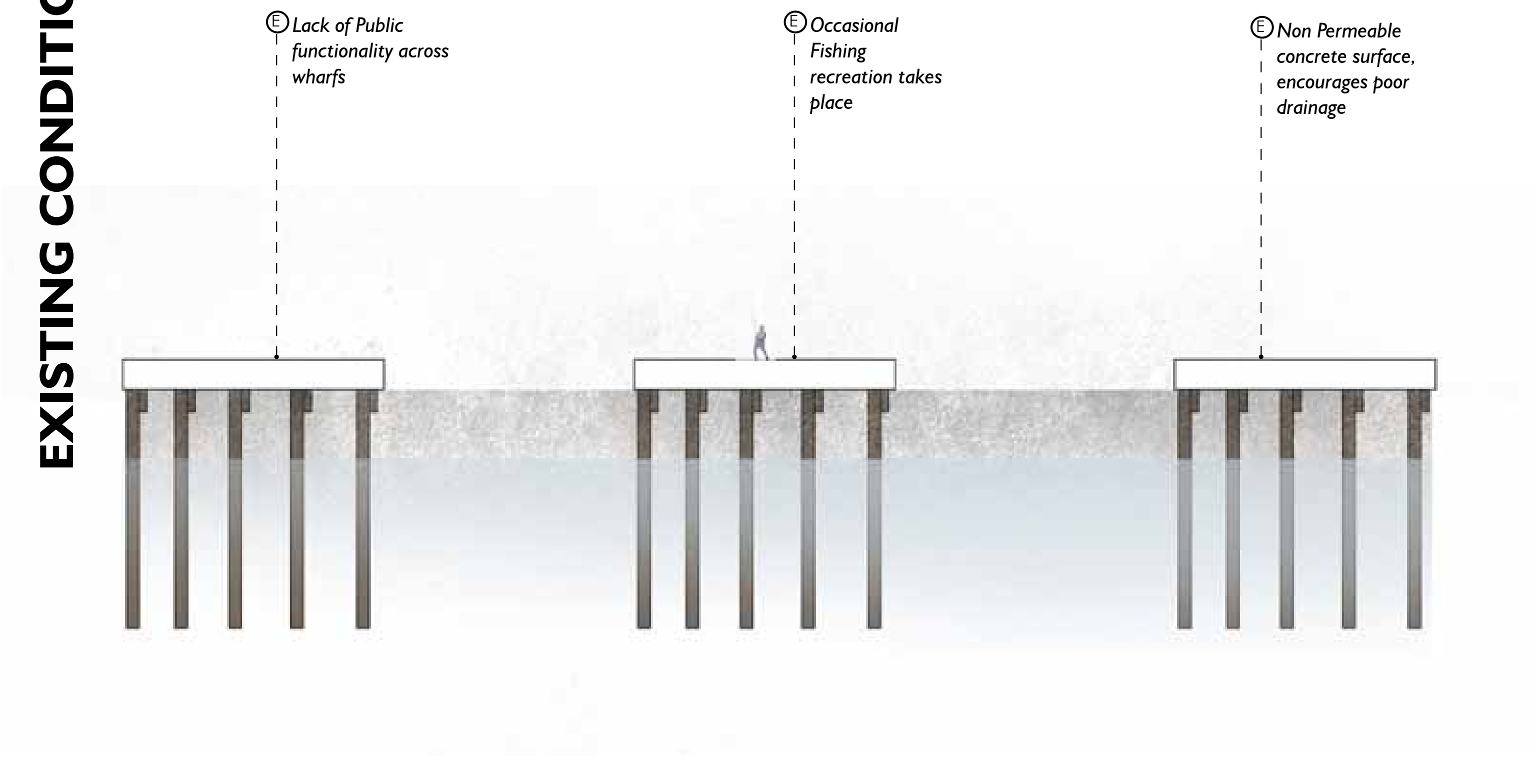




* Conceptual diagrams, not to scale

Fig. 6.11 - 6.13. Authors Own, Initial Testing of Technology of Site, 2019.

# EXISTING CONDITIONS.

[ Wharf Piles ]

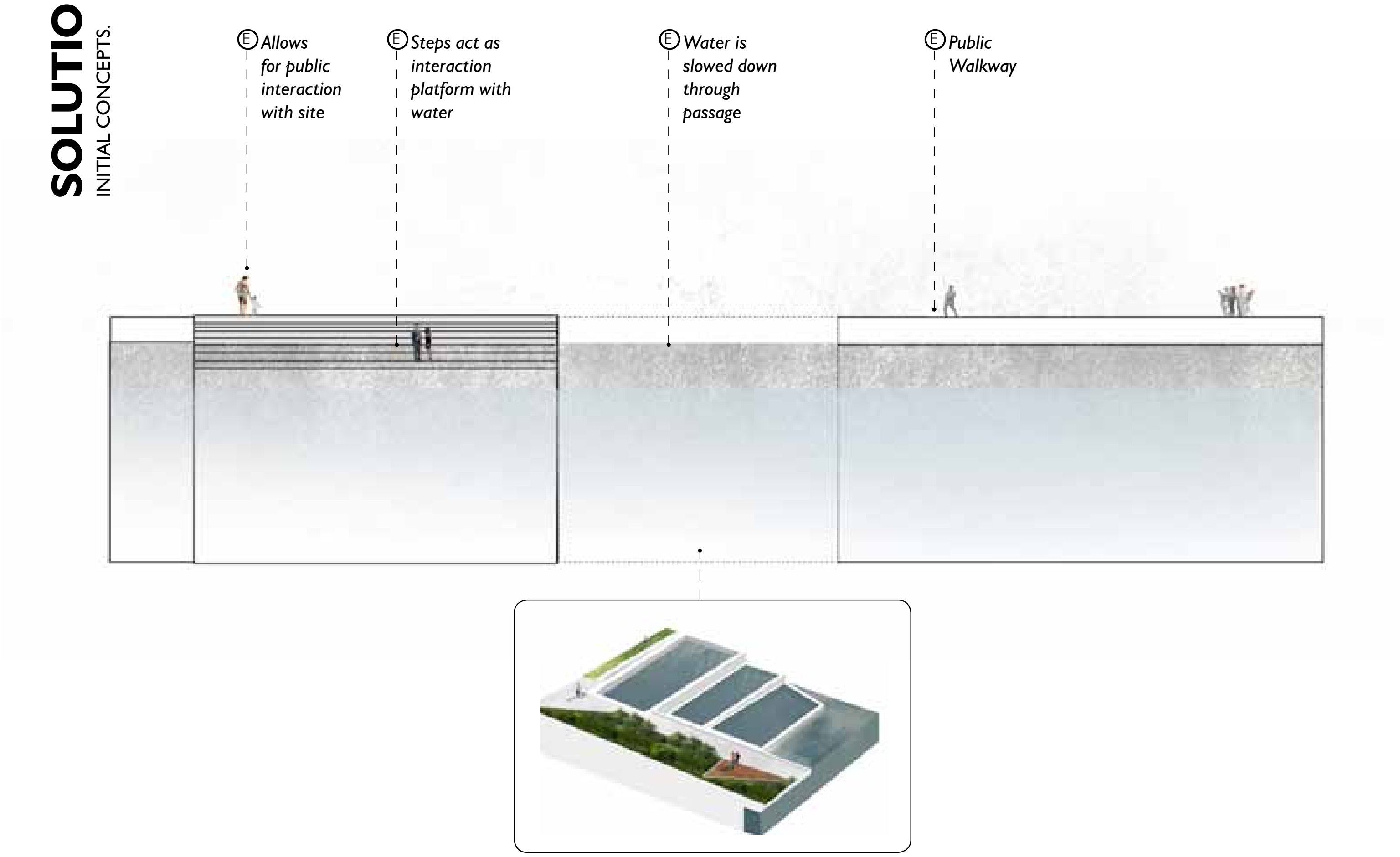


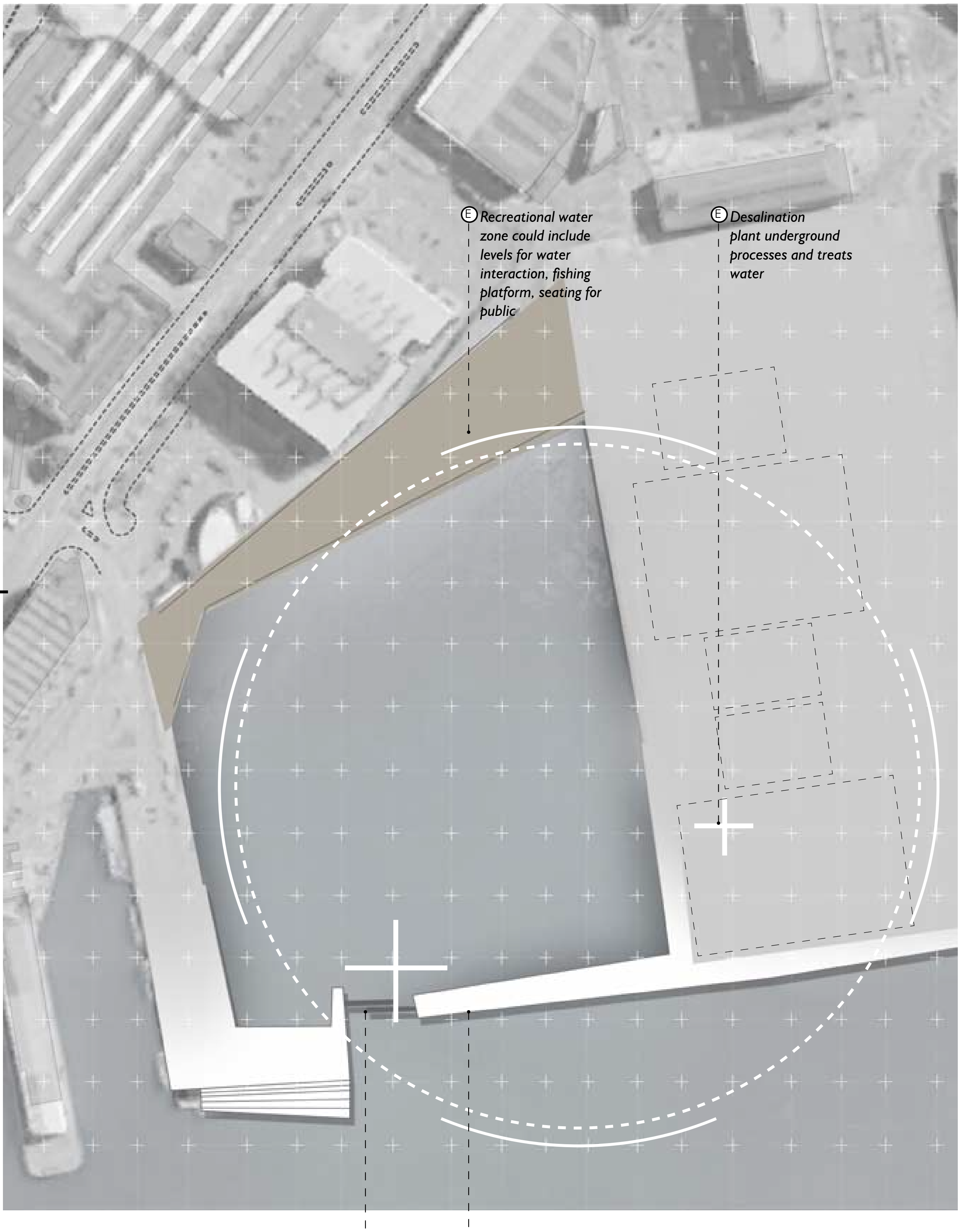



# SOLUTIONS.

INITIAL CONCEPTS.

[ Desalination - Open Space ]



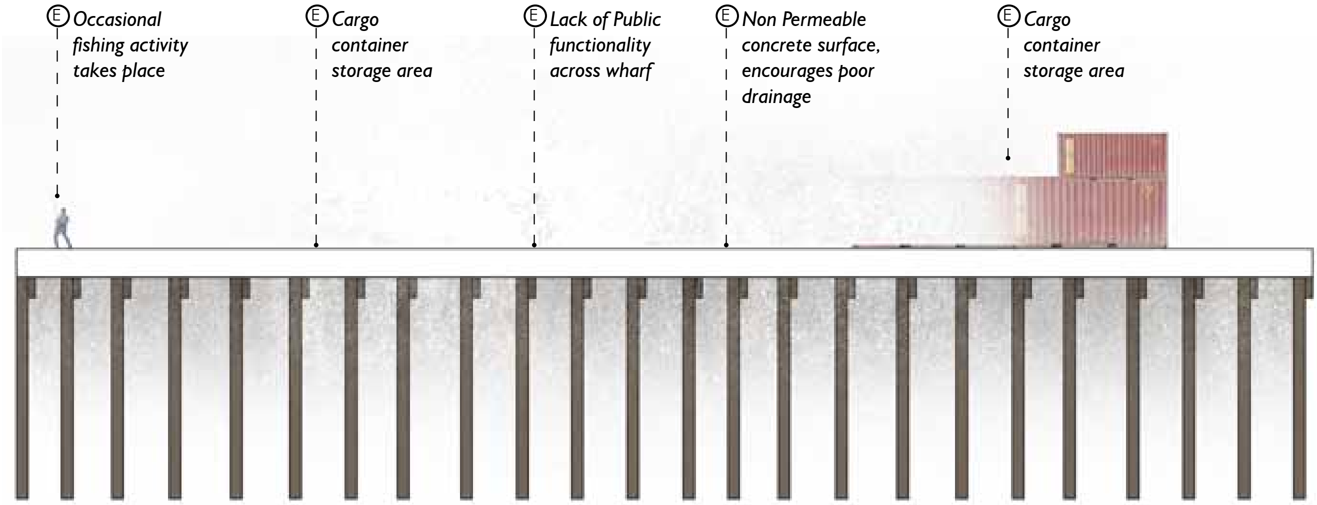



* Conceptual diagrams, not to scale

Fig. 6.14 - 6.16. Authors Own, Initial Testing of Technology of Site, 2019.

## EXISTING CONDITIONS.

*[ Wharf Piles ]*

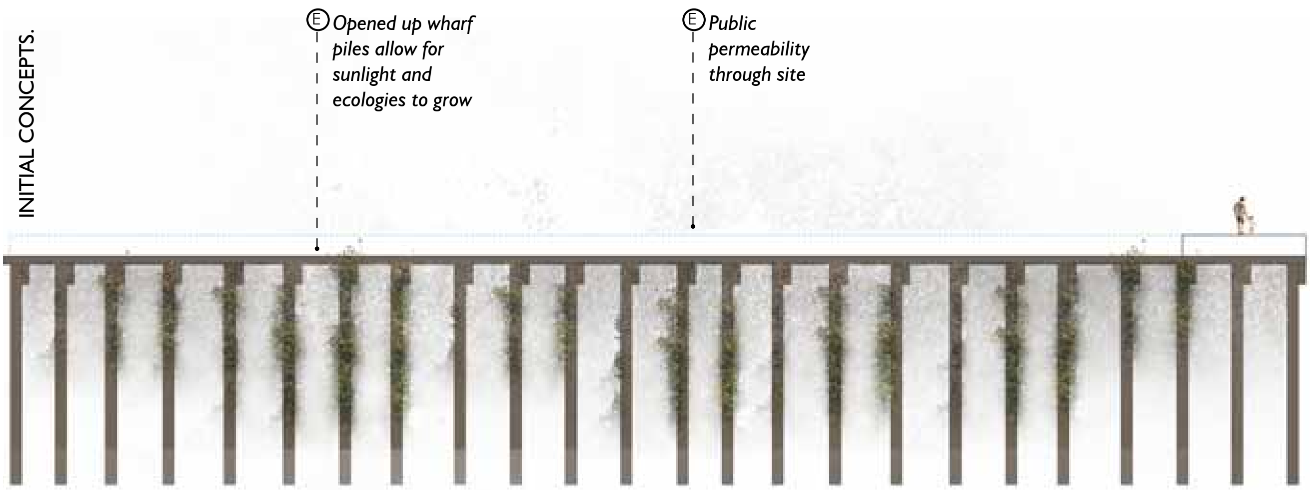


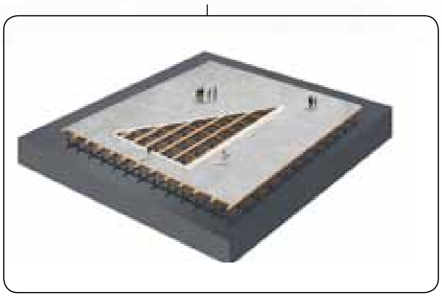

## 05. DAY LIGHTING PILES

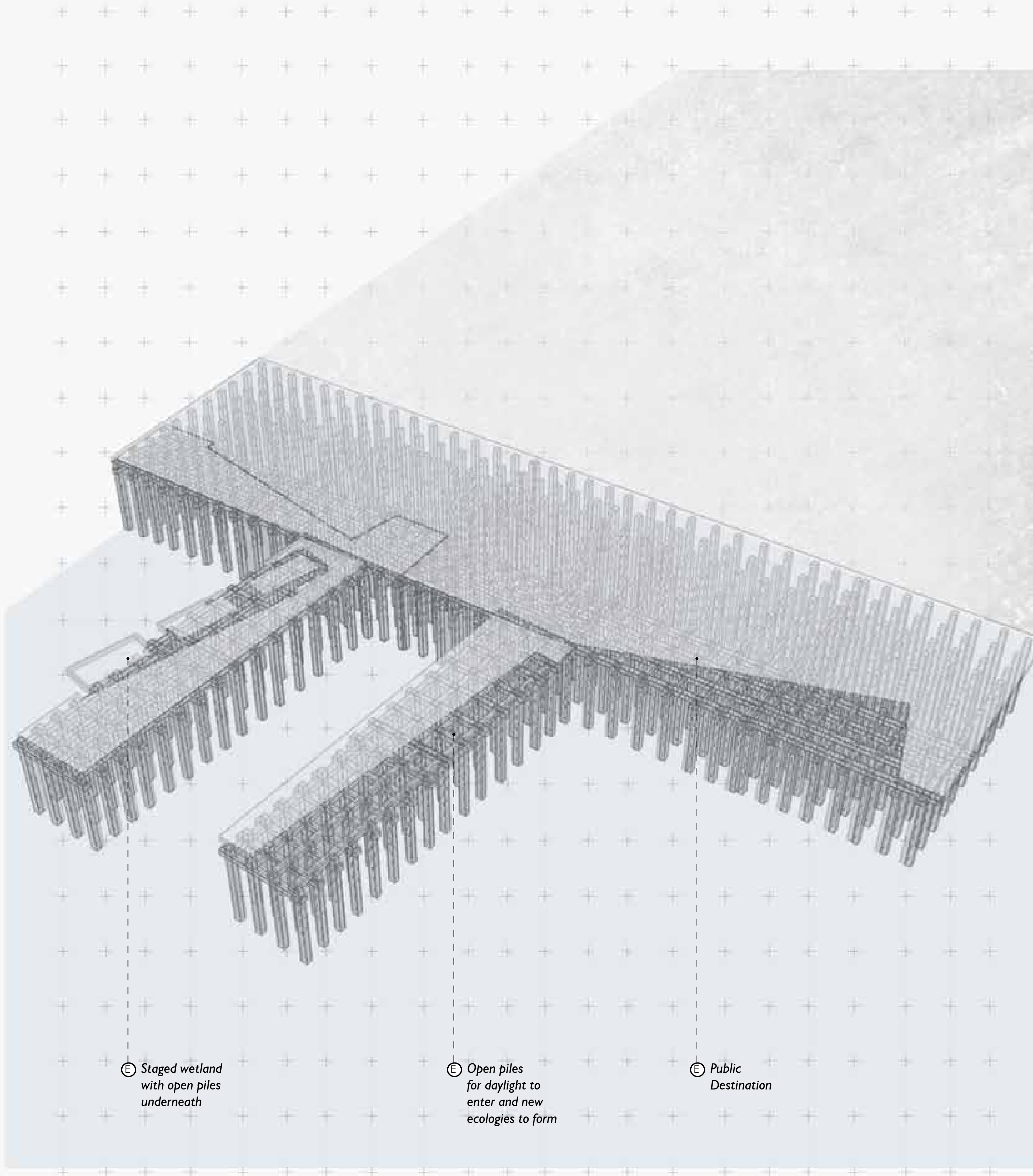
## SOLUTIONS.

INITIAL CONCEPTS.

*[ Light Entering Piled Wharf- Open Space ]*






* Conceptual diagrams, not to scale

Fig. 6.17- 6.19. Authors Own, Initial Testing of Technology of Site, 2019.

# 07

# Initial Exploration.

**CHAPTER SEVEN.**

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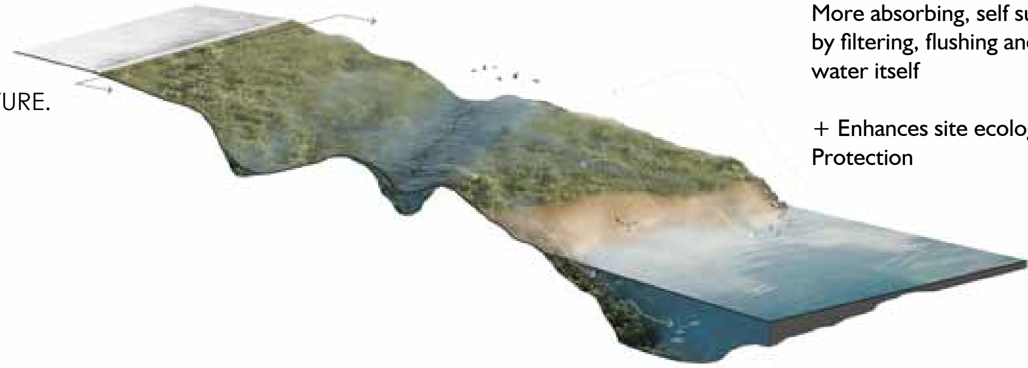
Fig. 7.01. Authors Own, Tidal Beach Waves, 2019.

## WHICH IS THE BETTER APPROACH?

As a design intent for better ecological design, the appreciation and importance of coastal edges must be identified and observed. In order to obtain this there are few strategy's to follow which allow protection of coastal harbours and land while providing space for public usability. Using terms "Soft Edge" and "Hard Edge" determines the engineered concept which could be applicable to a waterfront site. Although there are definite benefits to both solutions, it will be discussed which solution would provide better benefit to Wellington waterfront in regards to factors of erosion, sea level rise, storm surge, ecological habitats and public space.

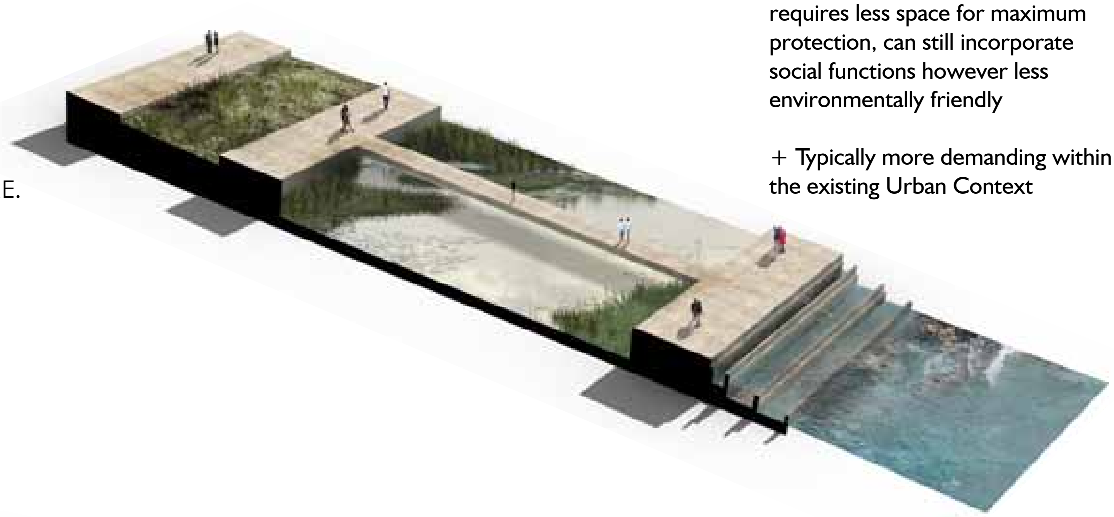
SOFT INFRASTRUCTURE.



More absorbing, self sufficient by filtering, flushing and retaining water itself

+ Enhances site ecology and Protection

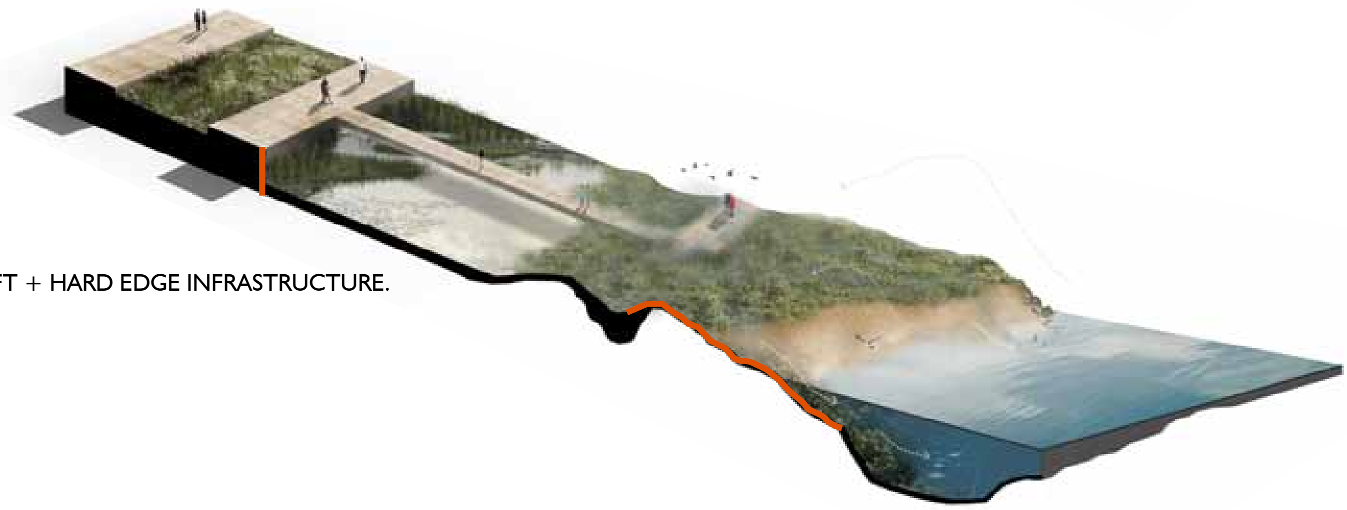
HARD INFRASTRUCTURE.



More suited for a waterfront, requires less space for maximum protection, can still incorporate social functions however less environmentally friendly

+ Typically more demanding within the existing Urban Context

SOFT + HARD EDGE INFRASTRUCTURE.



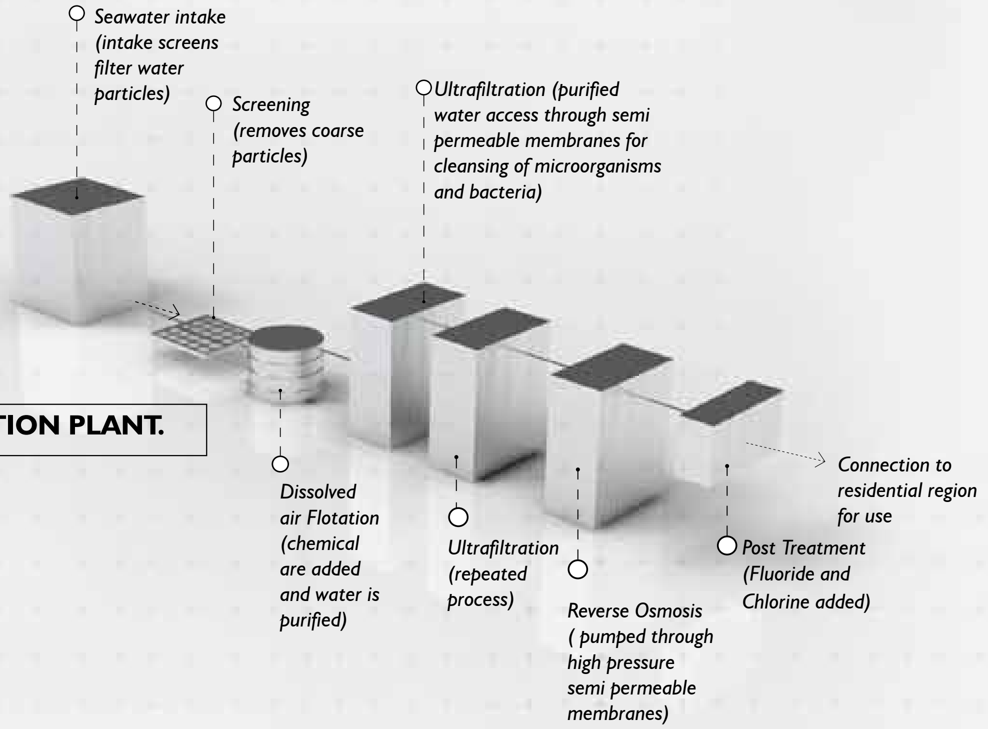
1 2 3 4 5

Fig. 7.02. Authors Own, Infrastructure Approaches for Initial Design, 2019.

Fig. 7.03. Authors Own, Initial Technologies Explored With, 2019. (Opposite Page)

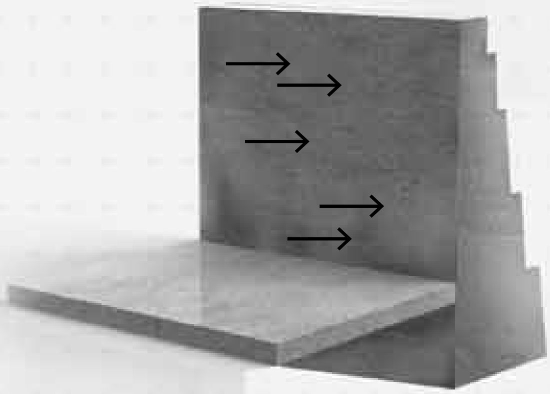
# Infrastructural Components Used.

## DESALINATION PLANT.




## WETLAND.


## SEAWALL.



**[ Pros ]**
**01** *Protects Urban areas from sea water, Tides and minor Storms*

**02** *Creates for good walkway edge*

**[ Cons ]**
**01** *Seawater force repeatedly pushed against wall can weaken and damage wall over time*

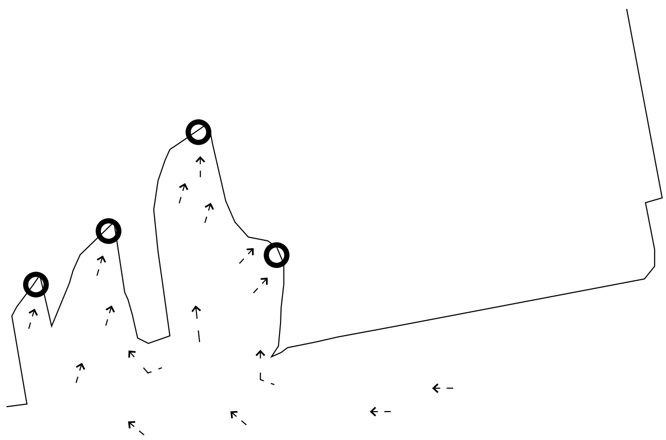
**02** *Doesn't protect against Storm Surges*

A set of technological components were used to test multiple functions working simultaneously to create a dynamic waterfront programme. These were used to understand which approach would be more beneficial to develop further design with, soft infrastructure, hard infrastructure or both.


**EXPLORATION 1.** SOFT EDGE EXPLORATION.

Exploration of Soft Edges, looking at mitigation of pollutants, creating living edges and drainage permeability

**Natural Coastal Systems.**
Working with these natural systems allows for the harbour to naturally prevent and protect inland from storms and flooding inundation. Systems have been proposed to work within an integrated urban environment, that not only work function within its engineered boundaries, but provide an opportunity for public to engage with the site more. It exposes opportunities for public to interact with nature,

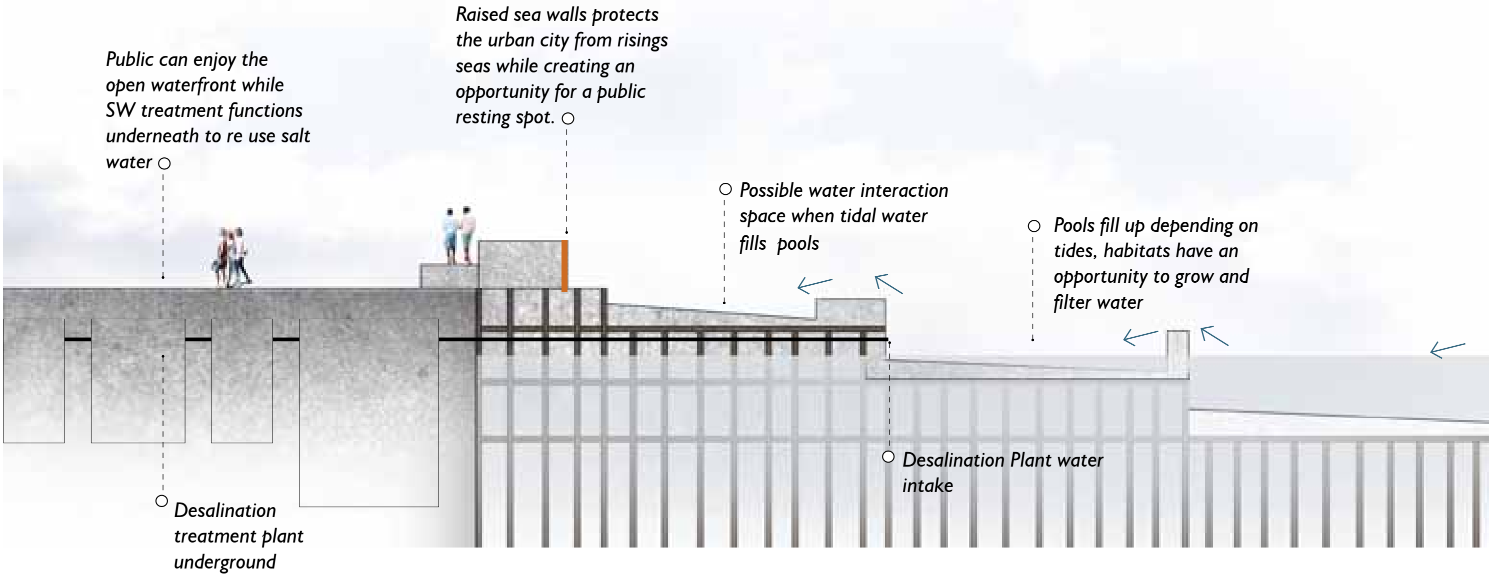


ACHIEVED PRINCIPLES OF;

- Breathable Wharf Ecologies
- Raised Waterfront
- Increased Social Destination Points

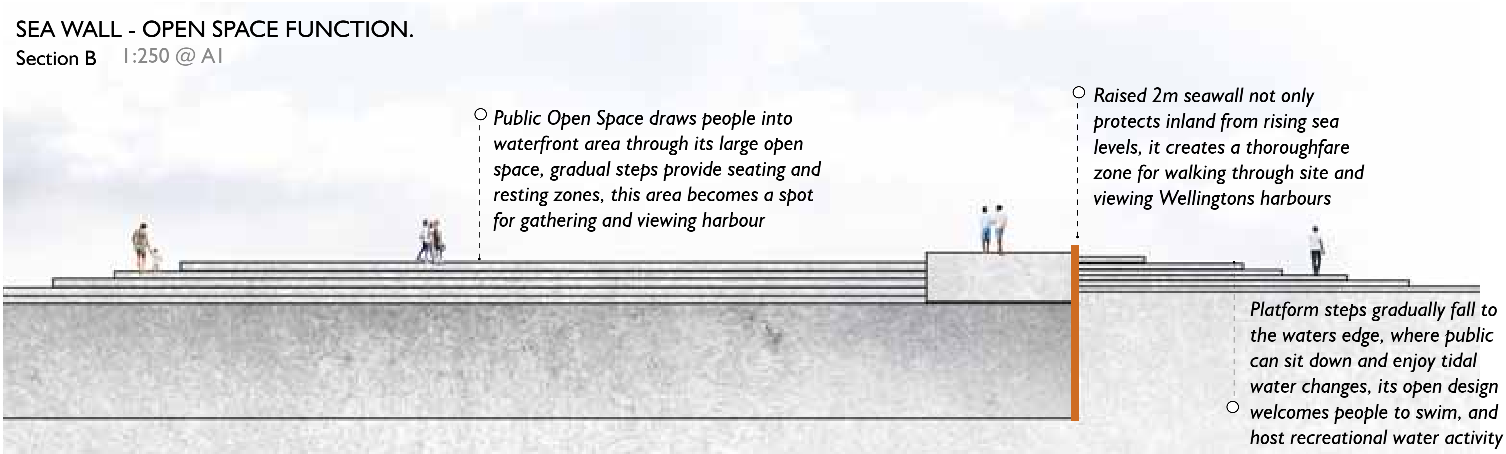
## DESALINATION - OPEN SPACE.

Section A 1:250 @ A1



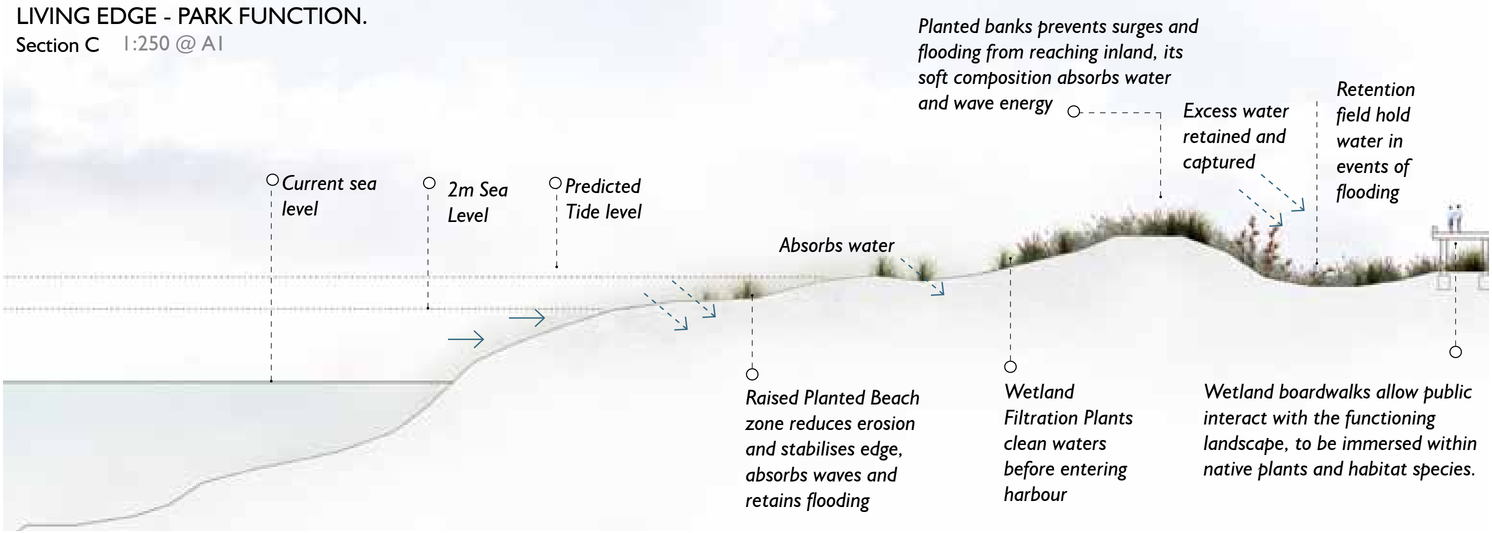

## SEA WALL - OPEN SPACE FUNCTION.

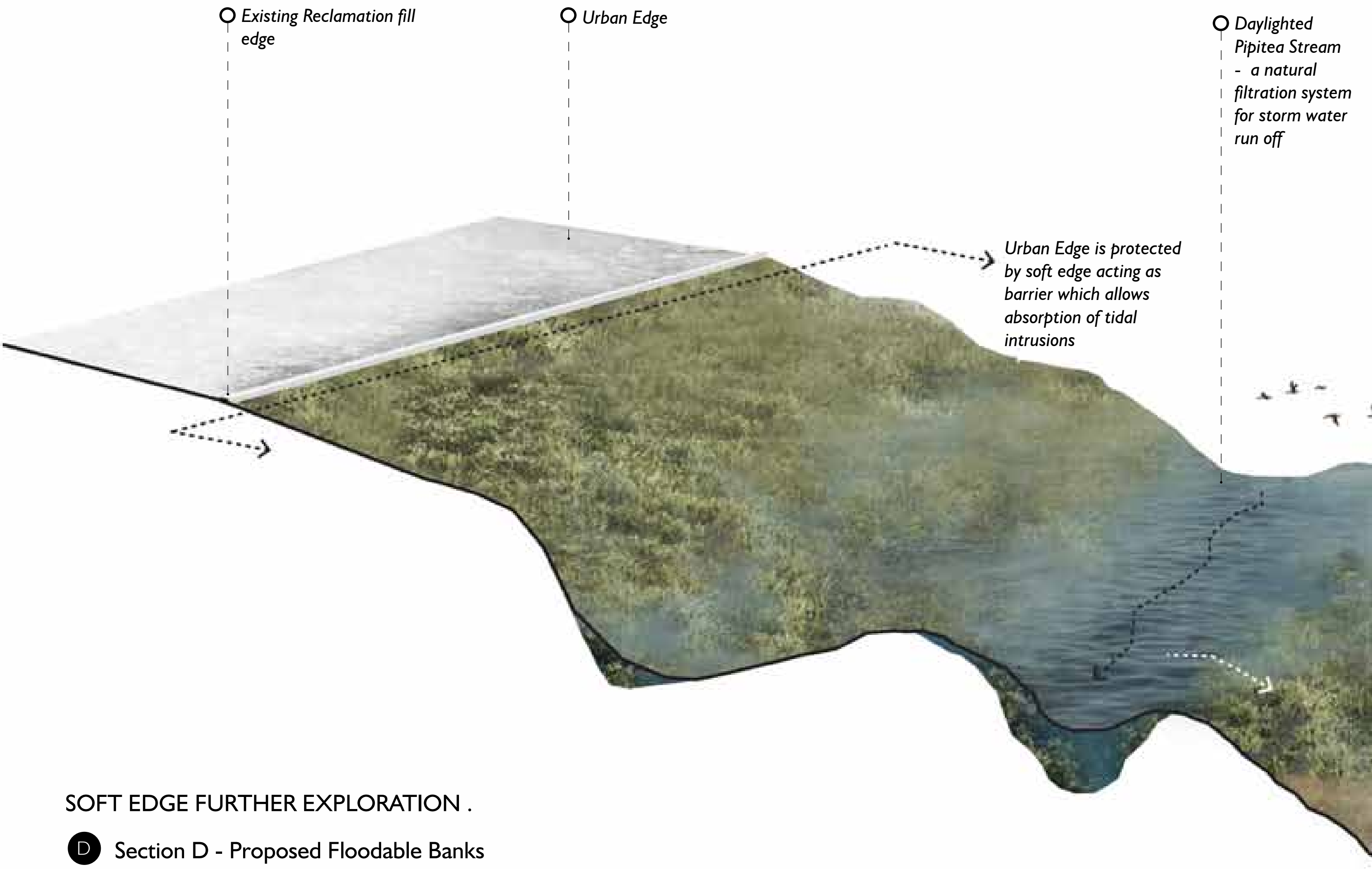
Section B 1:250 @ A1




## LIVING EDGE - PARK FUNCTION.

Section C 1:250 @ A1






SOFT EDGE FURTHER EXPLORATION .

D Section D - Proposed Floodable Banks

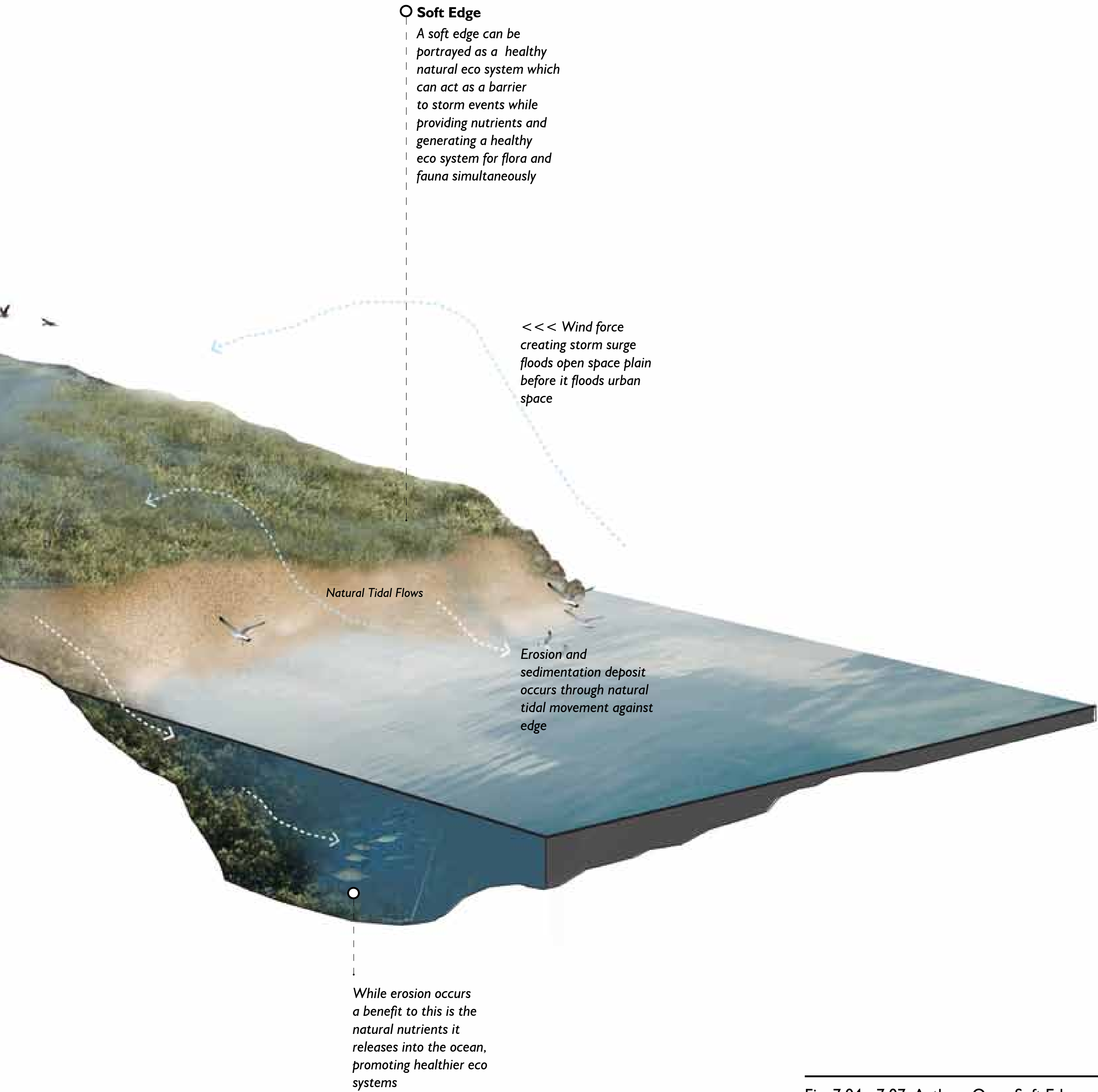
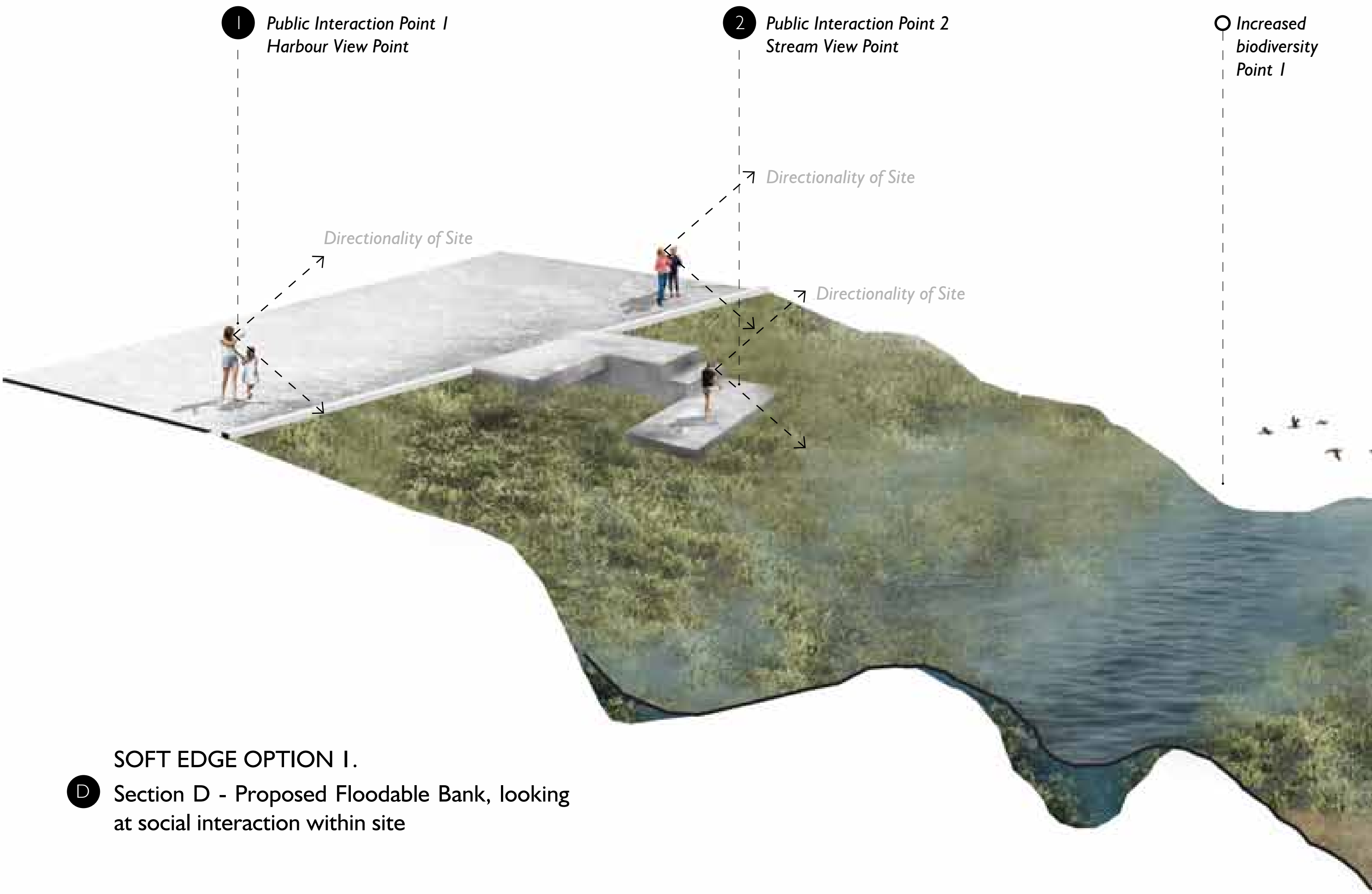



Fig. 7.04 - 7.07. Authors Own, Soft Edge Exploration, 2019. (Pages 168-169)

Fig. 7.08. Authors Own, Soft Edge Structure, 2019.




SOFT EDGE OPTION 1.

D Section D - Proposed Floodable Bank, looking at social interaction within site

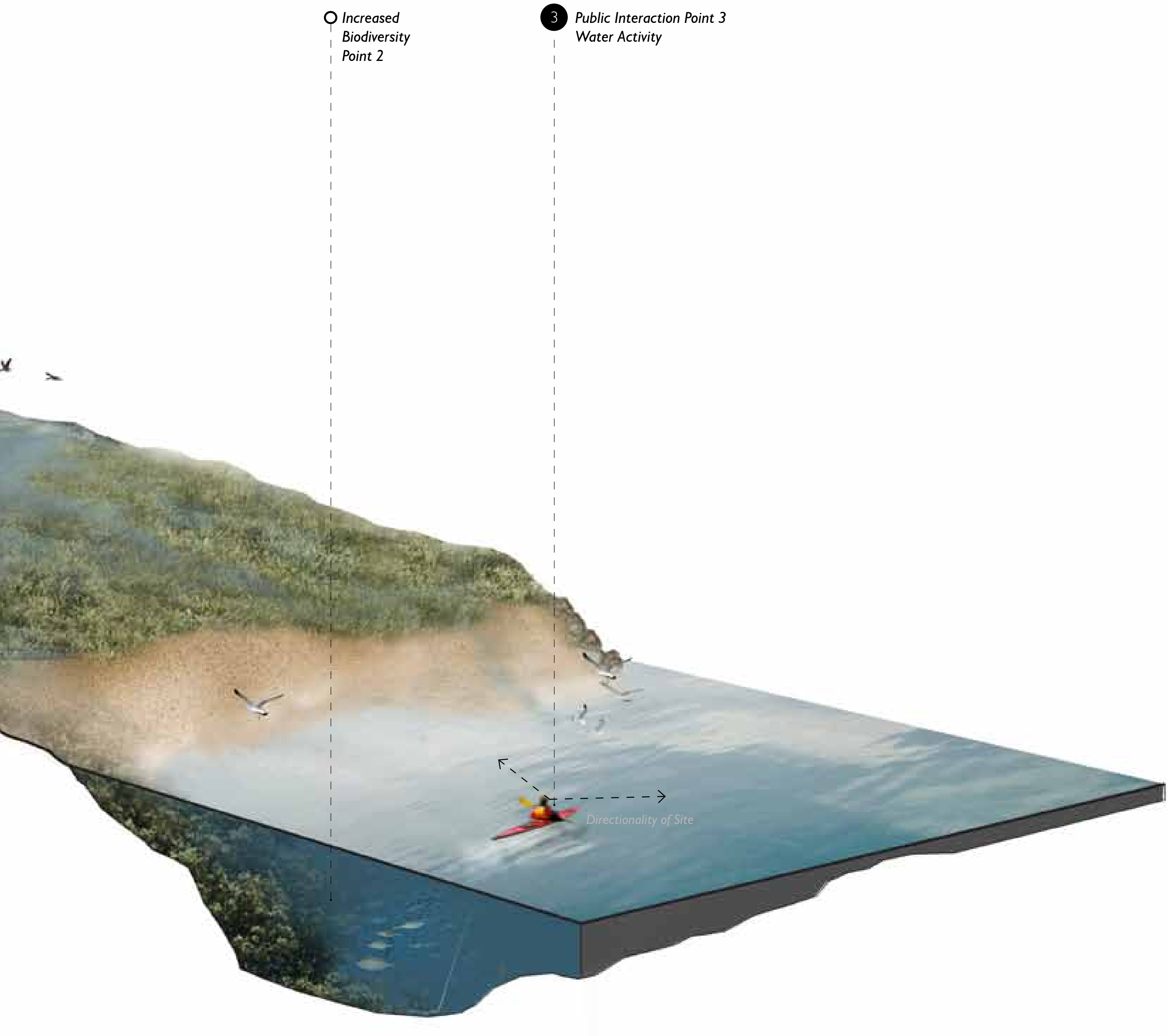
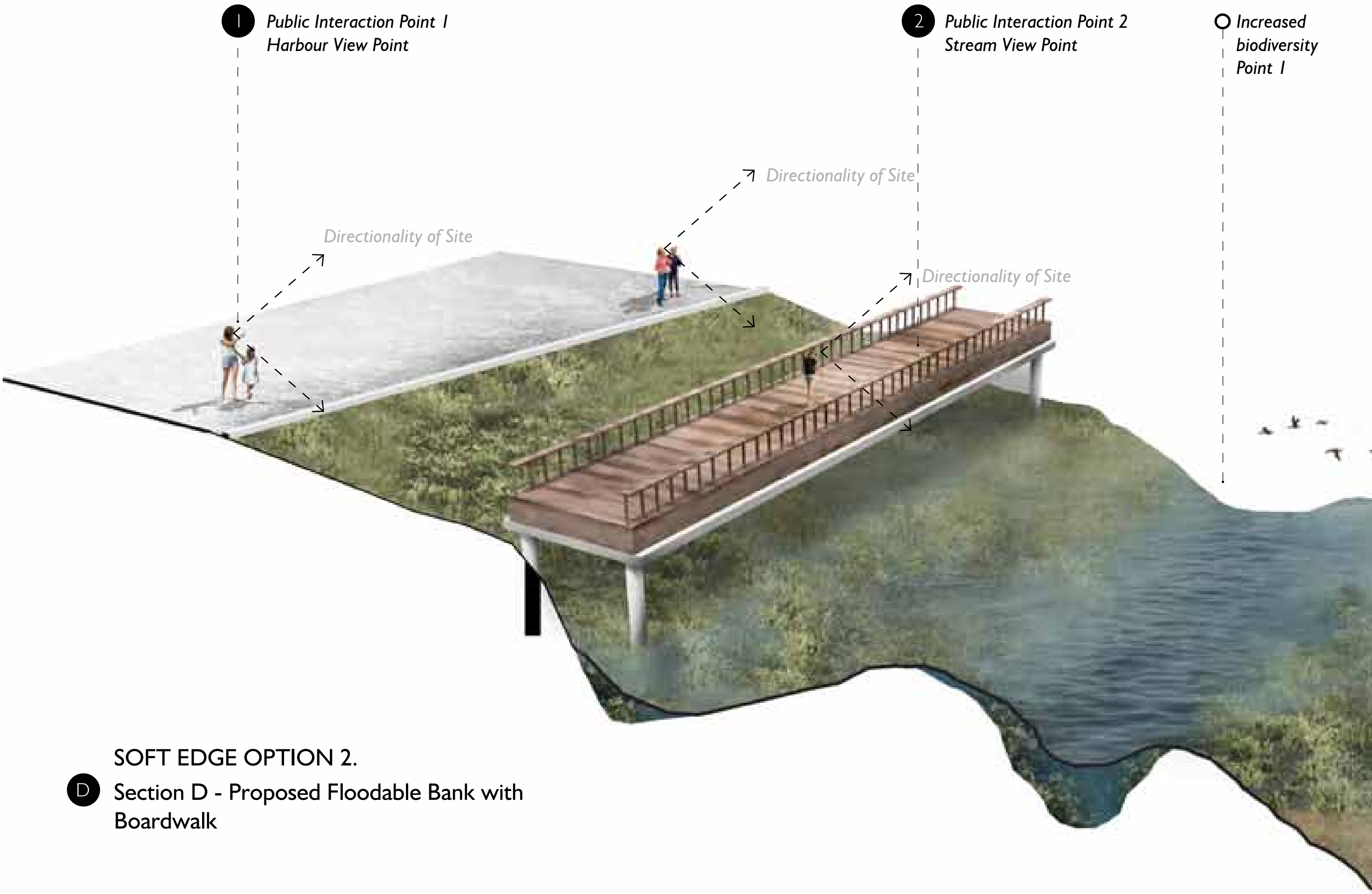



Fig. 7.09. Authors Own, Soft Edge
Conceptual Interaction Design, 2019.




SOFT EDGE OPTION 2.

Section D - Proposed Floodable Bank with Boardwalk

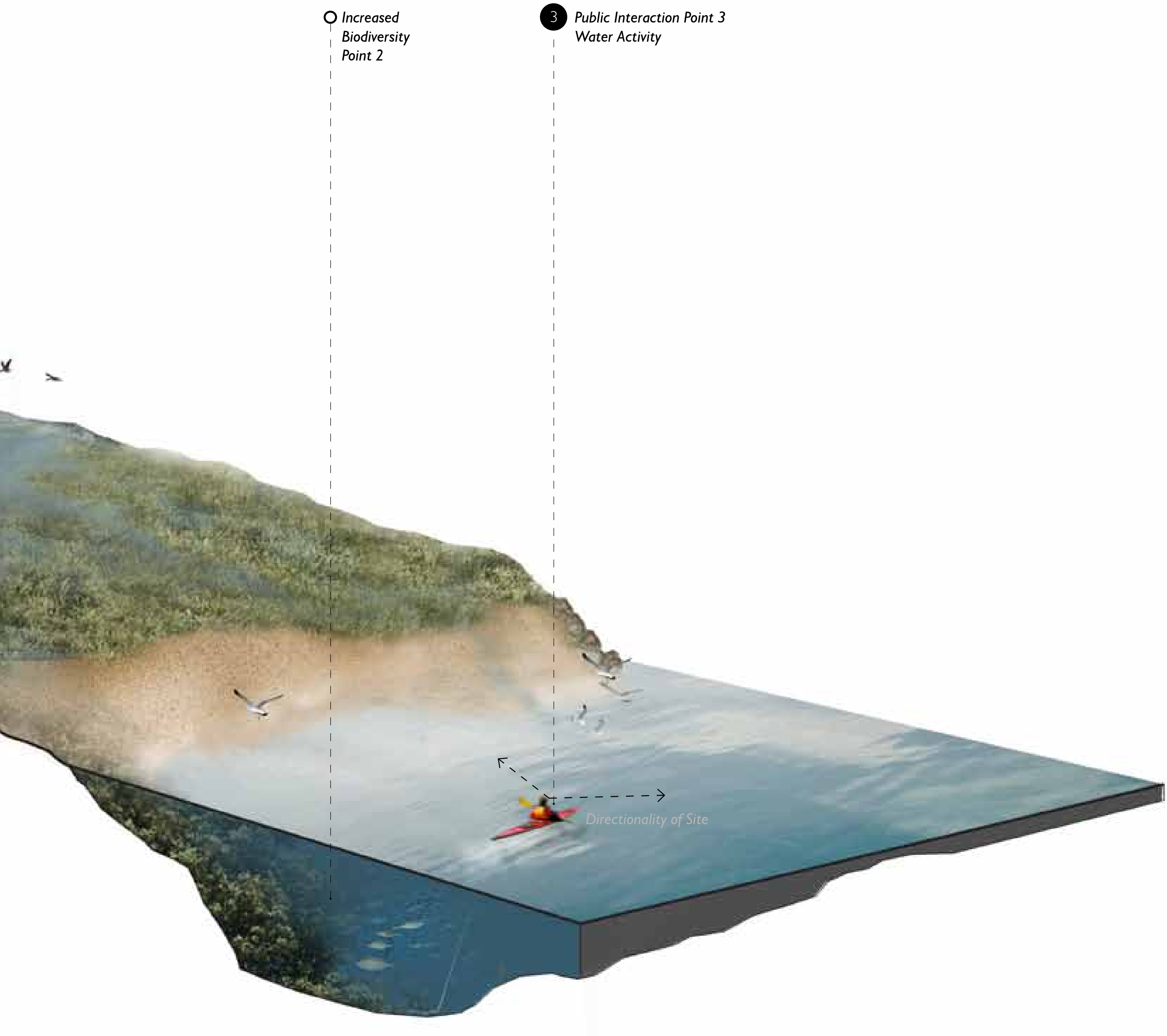
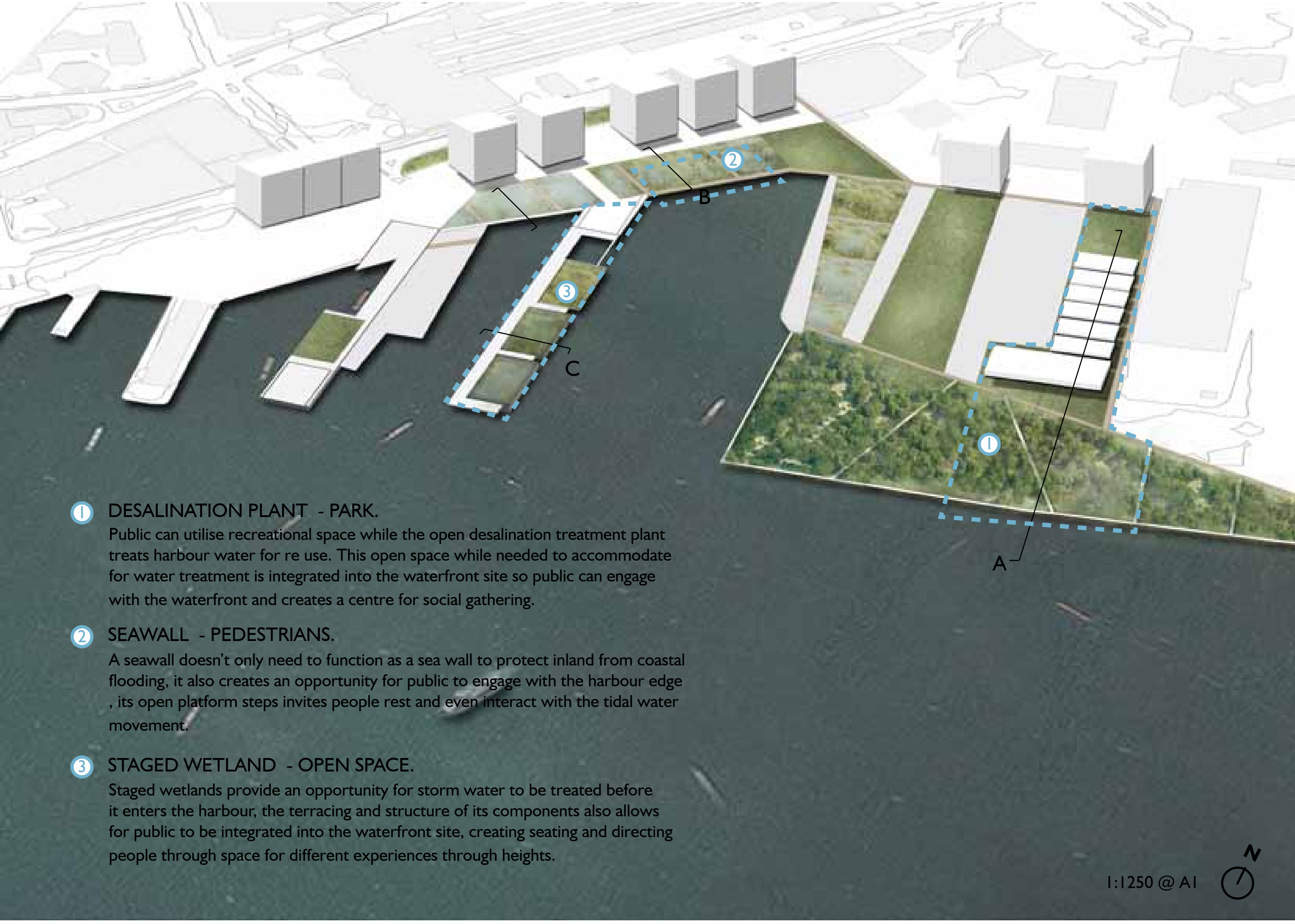



Fig. 7.10. Authors Own, Soft Edge
Conceptual Interaction Design 2, 2019.




1. DESALINATION PLANT - PARK.
Public can utilise recreational space while the open desalination treatment plant treats harbour water for re use. This open space while needed to accommodate for water treatment is integrated into the waterfront site so public can engage with the waterfront and creates a centre for social gathering.

2. SEAWALL - PEDESTRIANS.
A seawall doesn't only need to function as a sea wall to protect inland from coastal flooding, it also creates an opportunity for public to engage with the harbour edge , its open platform steps invites people rest and even interact with the tidal water movement.

3. STAGED WETLAND - OPEN SPACE.
Staged wetlands provide an opportunity for storm water to be treated before it enters the harbour, the terracing and structure of its components also allows for public to be integrated into the waterfront site, creating seating and directing people through space for different experiences through heights.

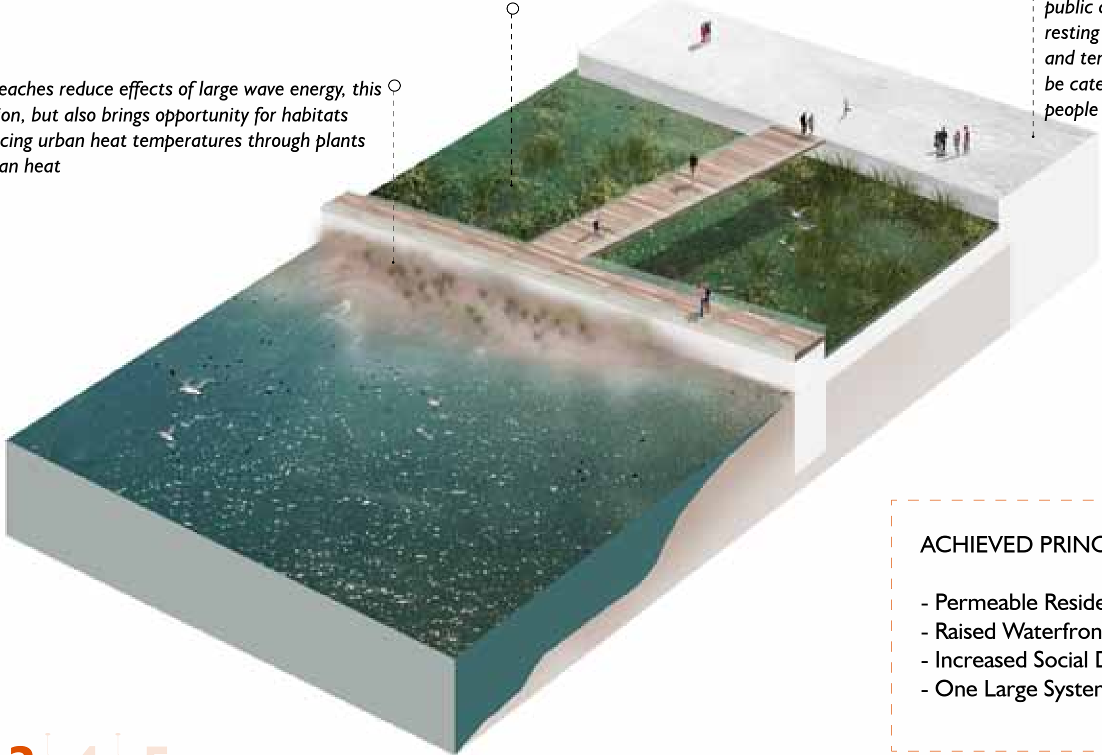
## **EXPLORATION 2.** HARD EDGE EXPLORATION.

Exploration of Hard Edges, looking at ecological functions working with static coastal protection systems

*A different waterfront experience is created through the palette of high and lush vegetation used to filter storm water, people are channelled through this area through boardwalks to engage within the site*

*Large open space has many benefits within waterfronts, public can utilise space for resting or recreation, events and temporary markets can be catered for, drawing more people to the site*

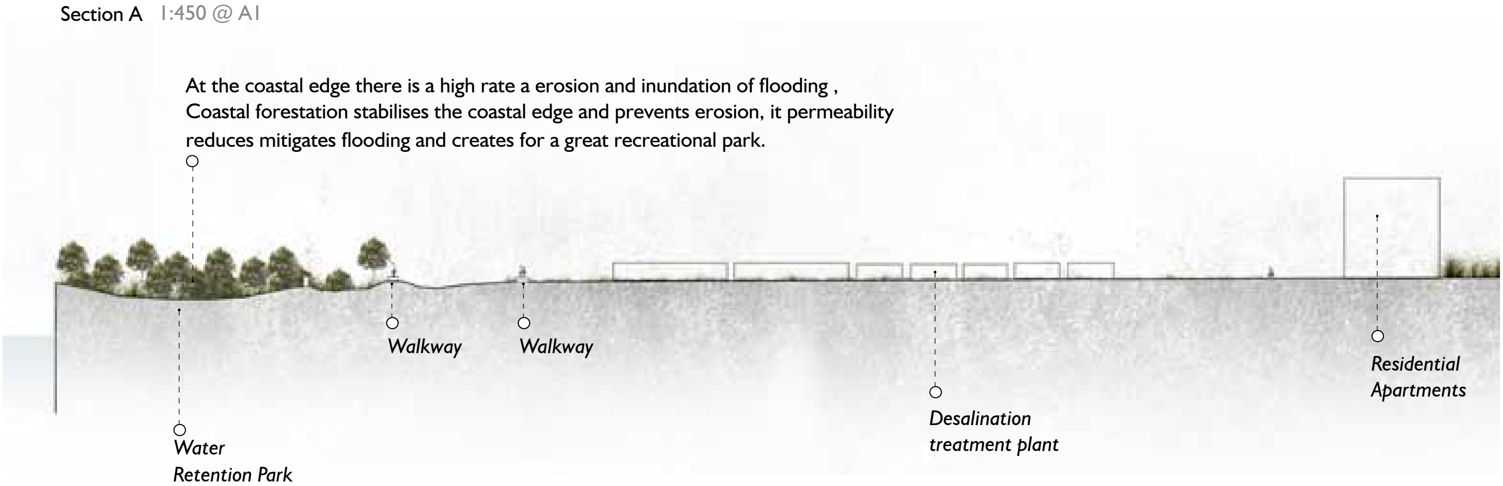
*Raised tidal beaches reduce effects of large wave energy, this prevents erosion, but also brings opportunity for habitats for form, reducing urban heat temperatures through plants absorbing urban heat*



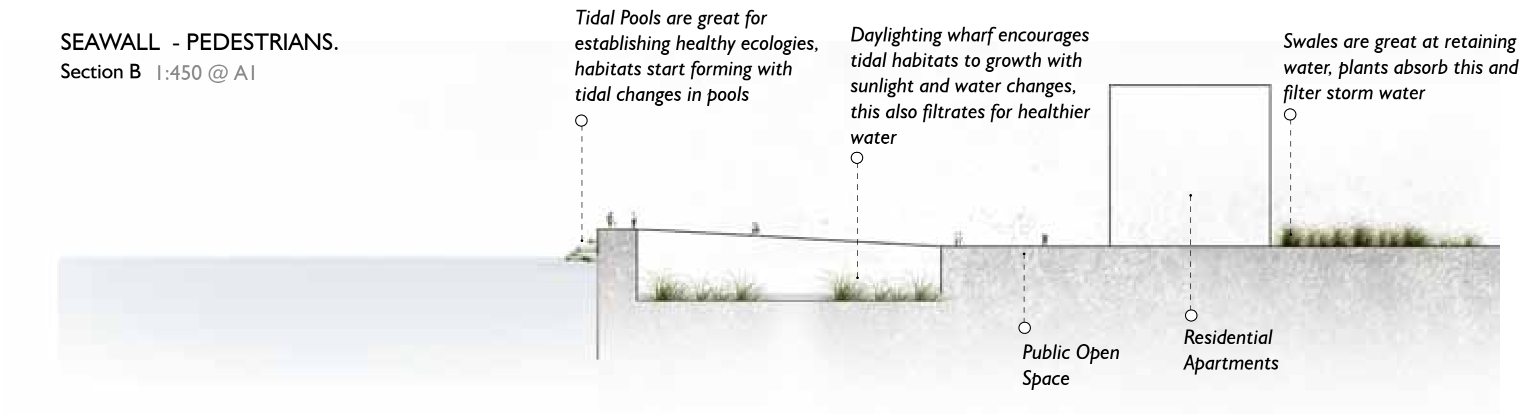
ACHIEVED PRINCIPLES OF;

- Permeable Residential Spaces
- Raised Waterfront
- Increased Social Destination Points
- One Large System

DESALINATION PLANT - PARK.
Section A 1:450 @ A1




SEAWALL - PEDESTRIANS.
Section B 1:450 @ A1




STAGED WETLAND - OPEN SPACE.
Section C 1:450 @ A1

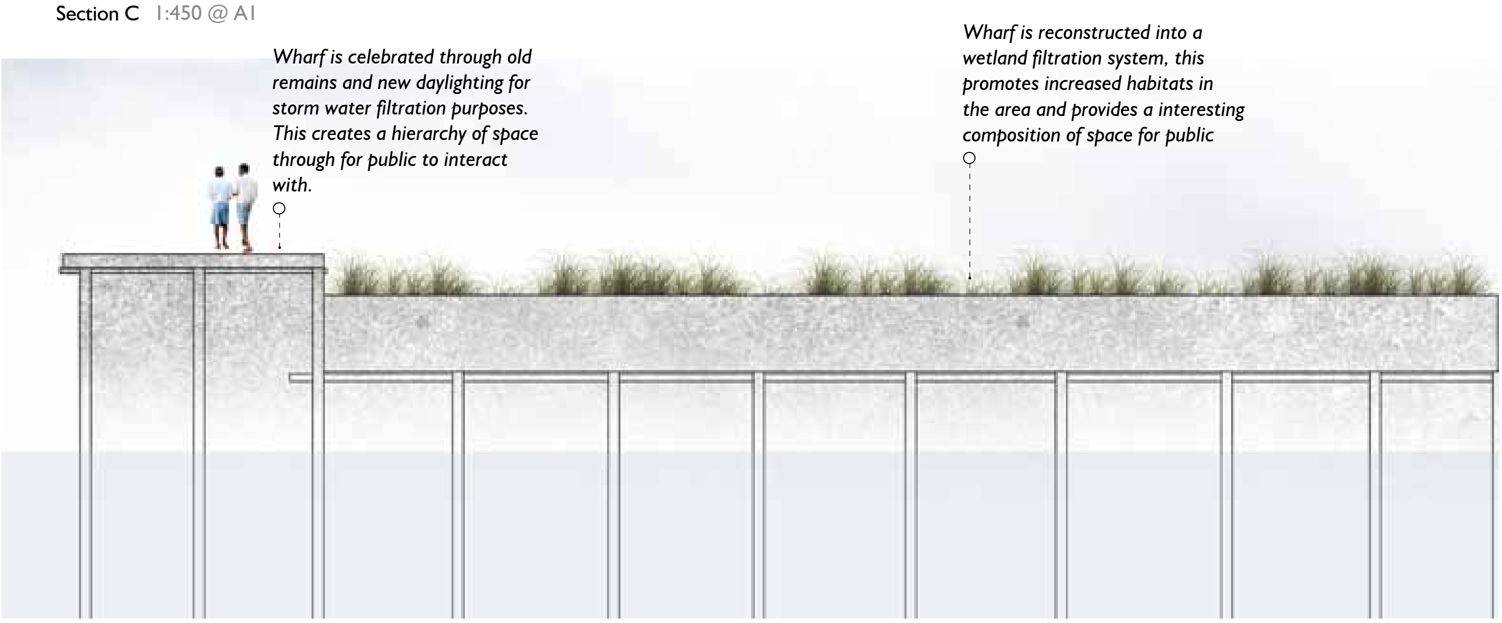
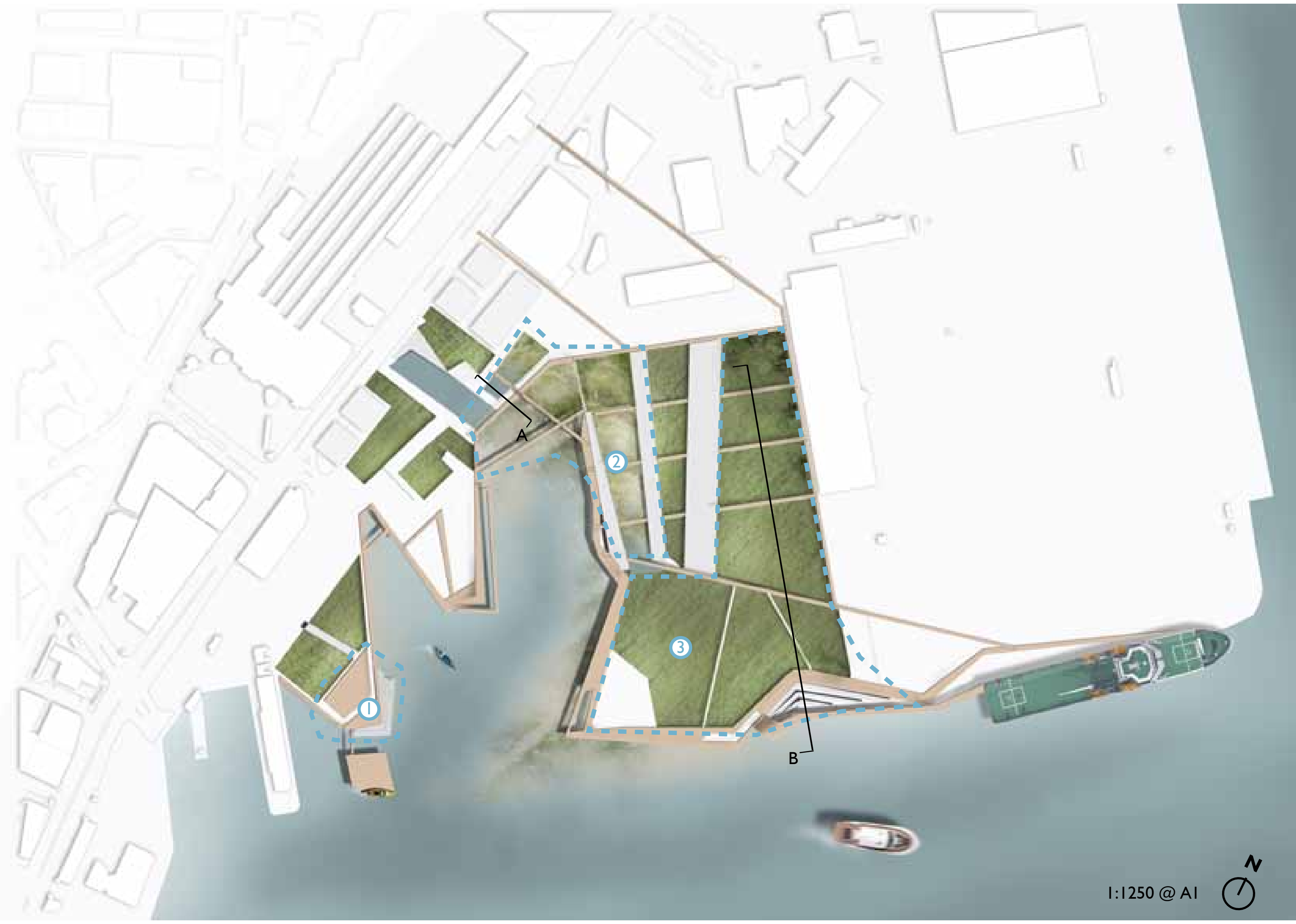



Fig. 7.11 - 7.15. Authors Own, Hard Edge Conceptual Design, 2019.




**EXPLORATION 3.** SOFT AND HARD EDGE EXPLORATION.

Exploration of Soft and Hard infrastructure to mitigate inundations of flooding while protecting and enhancing coastal habitatual and social public life on the waterfront

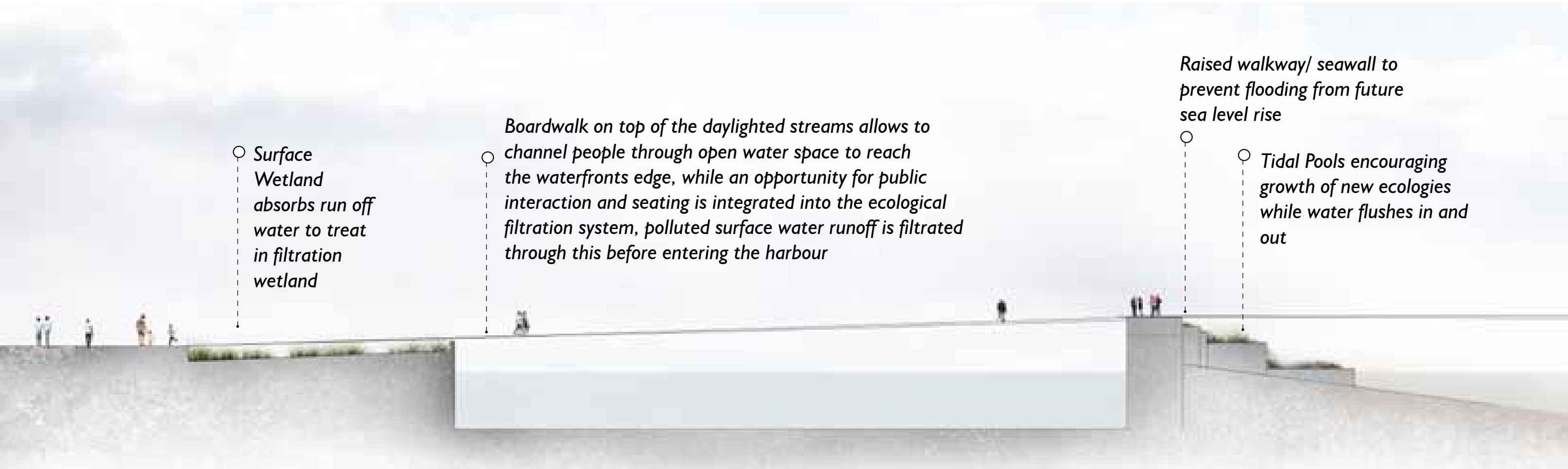
1. TIDAL STEPS - OPEN SPACE.
Tidal areas are great for common harbour habitats such as algae, oysters, snails to habitat and filtrate water. This also creates for a good recreational public zone, the large open platform steps draw people down to the water, where it invites people to swim, and recreational water activity to happen.

2. WETLAND - PEDESTRIANS.
Wetlands are great for treating polluted runoff Storm water, but it can also absorb excess surface water run off and mitigate flooding inundations. Wetlands use filtration plants to treat water before it gets discharged into the harbour. It also creates for great leisure walks for public being submerged within fields of planting, open water pools surrounding them and observe how water settles and filtrates over time.

3. DESALINATION PLANT - PARK.
This large space accommodates for desalination treatment of harbour water, however while the system is functioning, the open space creates for a great retention park. It allows public to enjoy the recreational space within a waterfront context. Its openness allows for possible event gatherings, but in event of rain has the ability to absorb run off water to mitigate further flood inundations.

WETLAND - PEDESTRIANS.

Section A 1:450 @ A1




DESALINATION PLANT - PARK.

Section B 1:450 @ A1

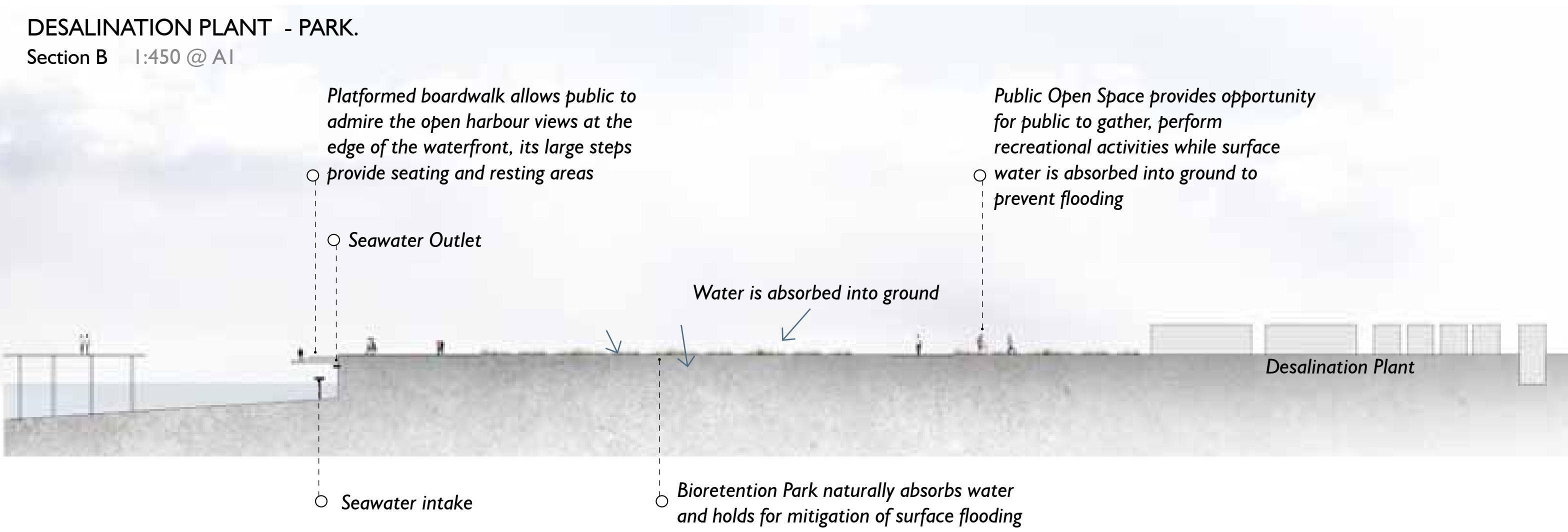



Fig. 7.16 - 7.18. Authors Own, Soft and Hard Edge Conceptual Design, 2019.

## FINDINGS.

Through testing, there has been a positive public integration within the waterfront space through all three approaches, there is a strong potential as addressed through hybrid technologies for public to engage and be integrated into the infrastructural design. While engineered systems can function, there is a great potential for designers to develop with this to create public orientated sites. Looking at the approaches in terms of addressing flooding, sea level rise and storm surge design, although implementing hard infrastructure has shown advantage in retaining water, there is limited opportunity for habitat creation and defence from climate events when factors such as wave heights, rainfall and capacity isn't predicted.

When looking at designing through soft edges, the initial exploration exposed ideas which largely increased the health of waterways, habitats and still provide natural defence from disasters. It is assumed for further development of design, this would however require a lot of space in order for the urban edge to be successfully integrated with the natural, as natural landscapes are always changing. While hard infrastructure has an advantage of working with height and less space, soft infrastructure requires the opposite, lots of room for adaptation and retention.

Both techniques have their benefits, because of which it is seen most beneficial to combine both methods for achieving a resilient design. It is assumed working with both soft and hard infrastructural design would achieve most benefit to the environment by protecting, increasing and restoring ecological functions, and integrating public interaction with waterfront site through hard infrastructure.

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# 08

# Design Exploration.

**CHAPTER EIGHT.**


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Fig. 8.01. Authors Own, Tidal Beach Waves, 2019.

## DESIGN OVERVIEW

This chapter carries on from initiating design approach. For the purpose of this thesis, it is assumed working with both soft and hard infrastructural design would achieve most benefit to the environment by protecting, increasing and restoring ecological functions, and integrating public interaction with waterfront site.  Through this chapter the progress of design is directed by its ability to achieve the core design principles outlined at the start of design phases. (See diagram)

The evolution of design development is a follows:

Concept 1
Concept 1.1 (Development of Concept 1)
Concept 1.2 (Development of Concept 1)

CONCEPT ONE SERIES 1

Concept 2

CONCEPT TWO SERIES 2

Concept 3
Concept 3.1 (Development of Concept 3)
Concept 3.2 (Development of Concept 3.1)
Concept 3.3 (Development of Concept 3.2)

CONCEPT THREE SERIES 3

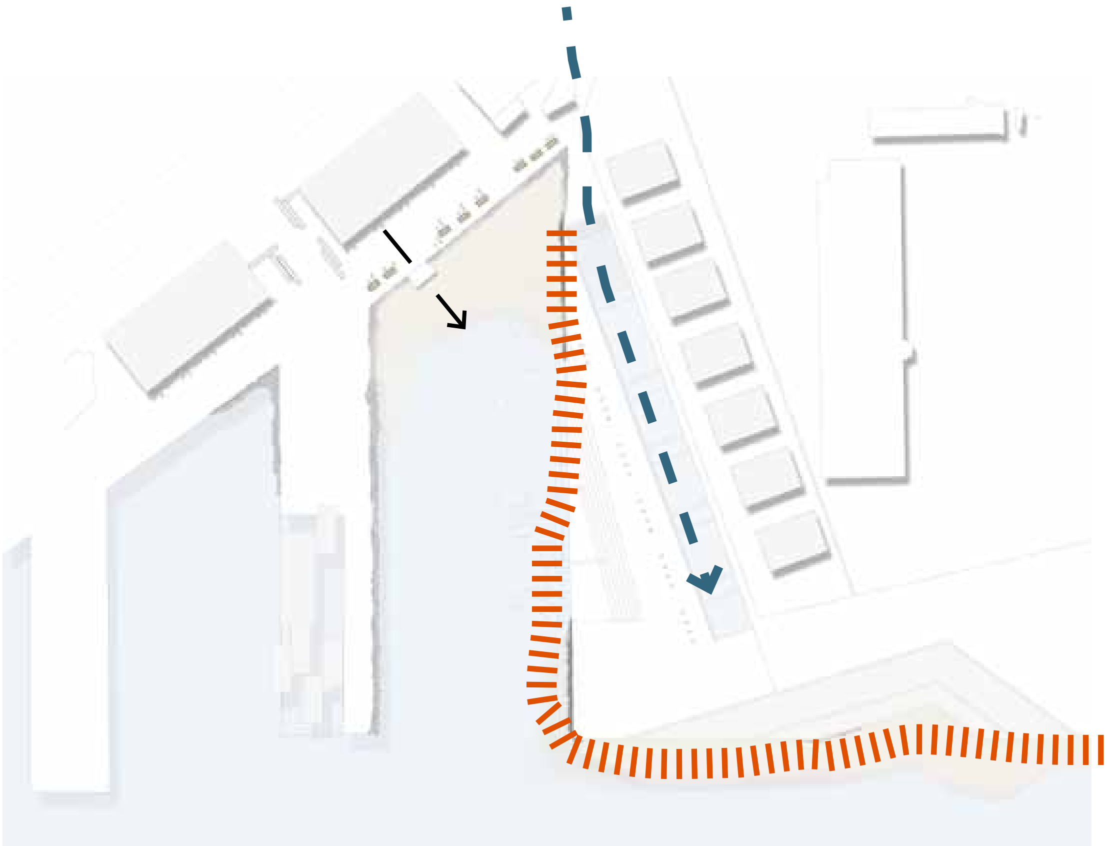
Refined Design


## DESIGN OBJECTIVES.

1. Bring back significance of Pipitea Stream and Treat SW through WSUD

2. Most Vulnerable edge, use this an opportunity for protection

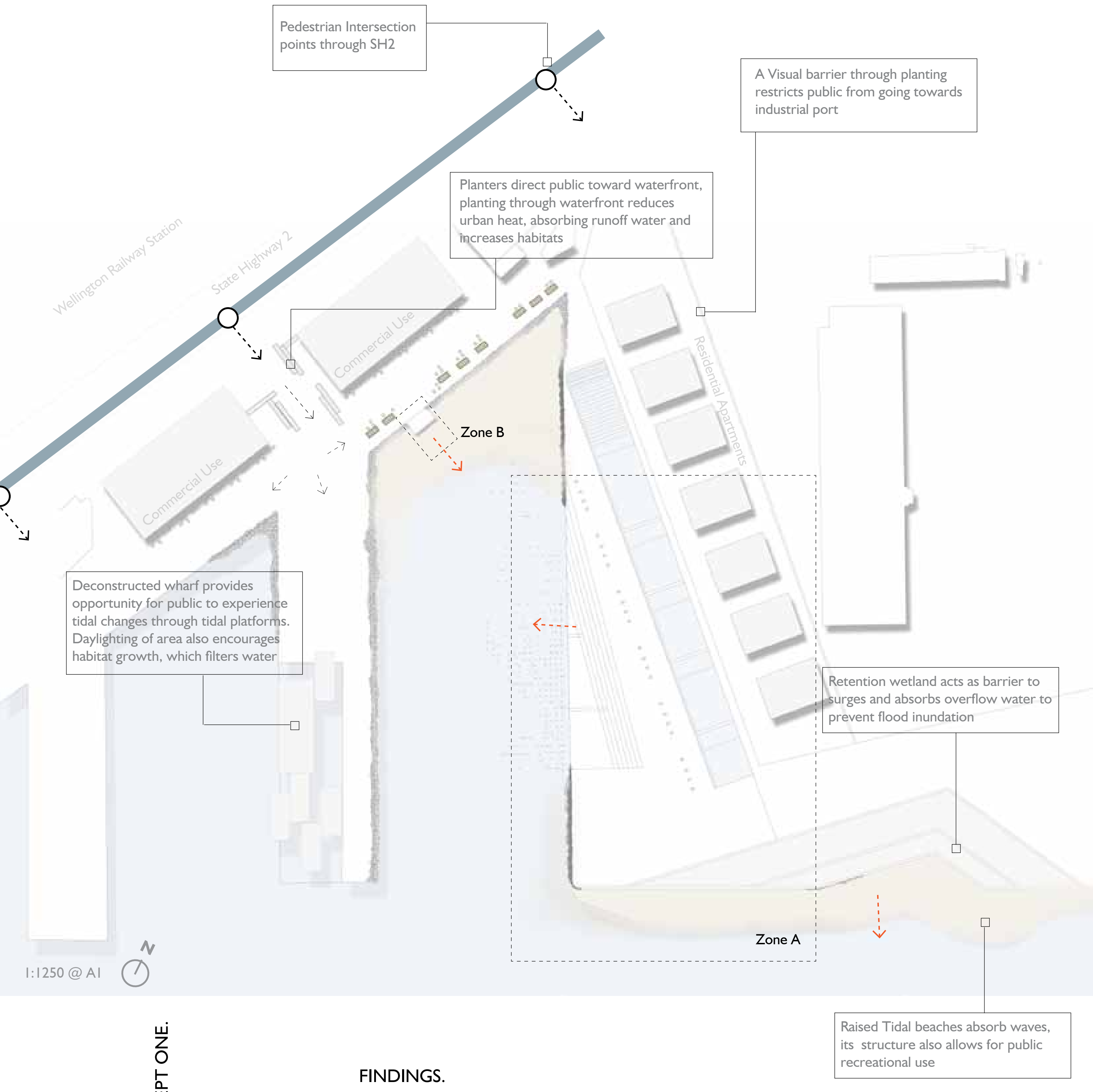
3. Increase access to water interaction



CONCEPT ONE.

# 01.

Fig. 8.02. - 8.03. Authors Own, Tidal Beach Waves, 2019. (Pages 184-185)




# 01. CONCEPT ONE.

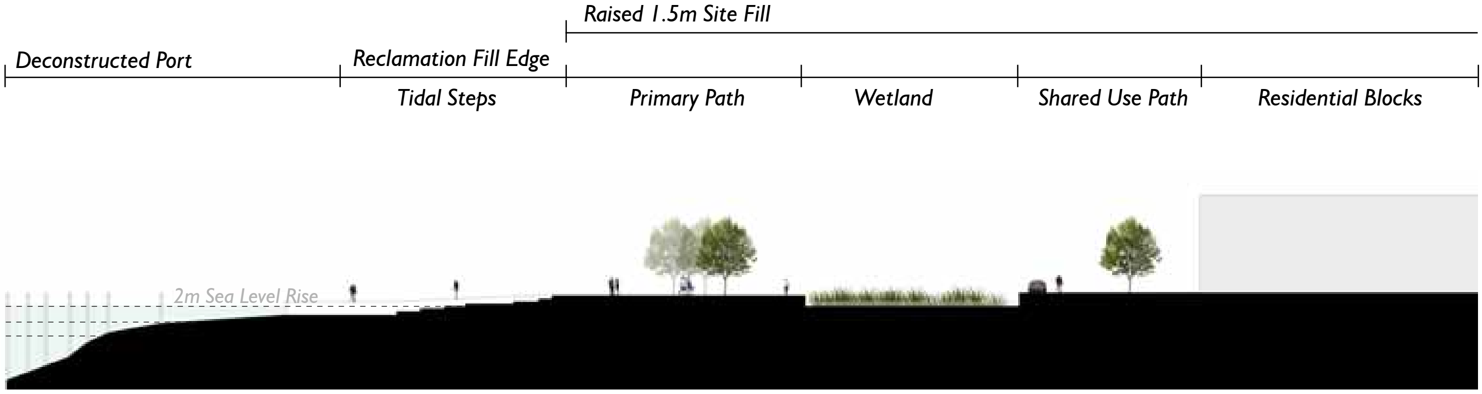
- New Access to Waters Edge
- Flood Adaption Design
- Multi Use Space
- Encourages Tidal Ecology Growth

## FINDINGS.

Through this design test, what was found to be really successful was the celebration of a declaimed port. This not only day lighted piles for new ecologies to grow, it allowed more users to experience the remains of ports, becoming destination points for resting, gathering, recreation to be integrated into what used to be an industrial space. However along with this, the on ground user experience would need to be refined depending on tidal changes and user ease for all people, (e.g. Wheel chair accessible).

What didn't work so well was the integration of wetland/flood protection and residential development on site. Due to economic reliance on Centerport, it was decided to let part of Centerport still function however the safety of residential and public involvement with this area is questionable. For further design development, this would need to be considered, how residential development can function within an active public waterfront along with waterfront programme. The SW system celebrates the former stream, however more recognition of stream structure and marsh qualities could be explored. Being within an urban setting, recognition of its past state has not be explored experientially.

NEXT STEPS.
-Refine Access points and access types dealing with raised tidal beaches/enable water interaction
-Celebration of stream
-Increased permeability


*Section A* 1:250 @ A1
*Proposed Waterfront Promenade*

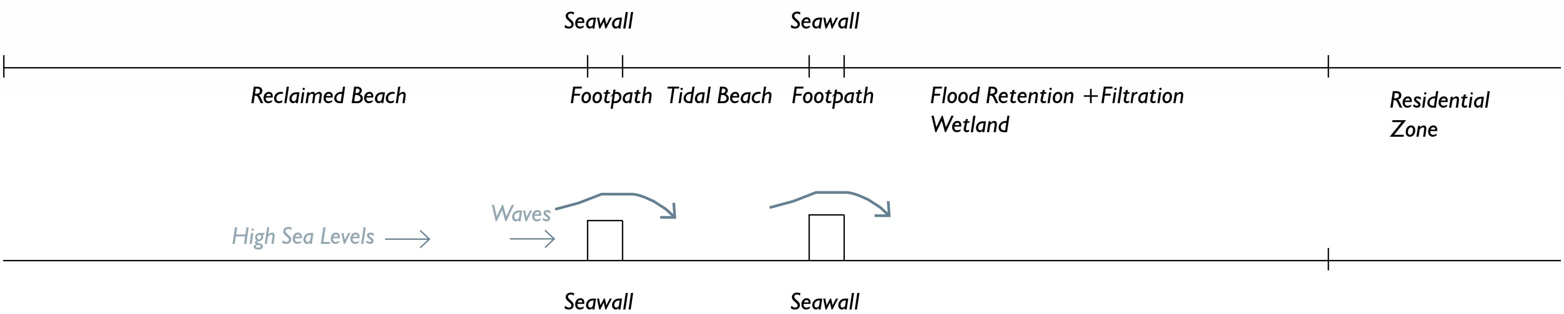
Fig. 8.04. - 8.06. Authors Own, Conceptual Scheme One, 2019.

Zone A

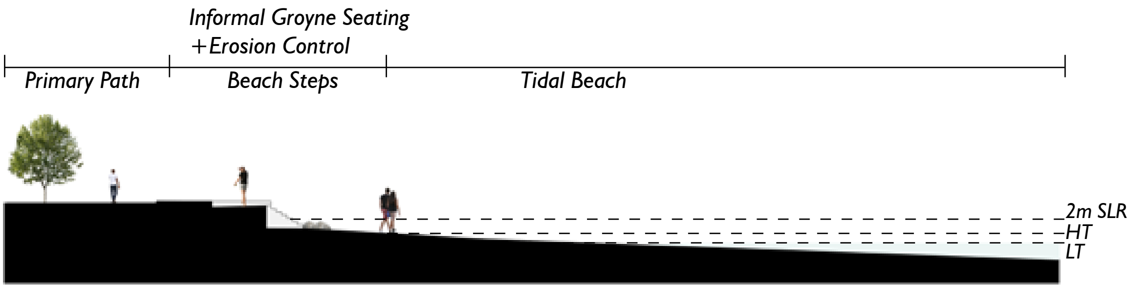
*BEFORE FLOOD EVENT*

*DURING FLOOD EVENT*

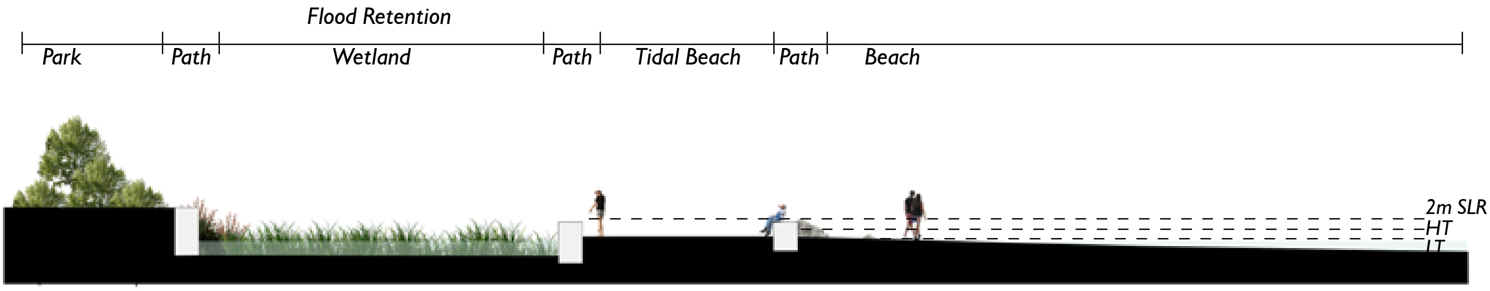
*AFTER FLOOD EVENT*




*User experience changes with tidal changes. Areas of site become accessible/non accessible, and event functions can change depending.*




Section B 1:250 @ A1




Section C 1:250 @ A1

Fig. 8.07. - 8.12. Authors Own, Conceptual Scheme One, 2019.

KEY ELEMENTS EXPLORED.

- Storm water Runoff Capture and Filtration
- Improved Connection and Access to water
- Edge condition + Access design

FINDINGS.

This concept focussed in particular on refining access typology to increase harbour interaction. What was seen to work well was accommodating two styles of access, having ramps and steps. Wide platform steps allowed for seating as well, and ramps depending on tides could launch kayaks.

Access Point 2 was found most successful typology, by integrating into the urban space, addressing coastal protection and a variety of usability. It connected more within the waterfront space, than segregated, this is assumed by which it would draw more people to connect with the harbours edge.

There is still a lot of potential for permeability on site and site adaptability especially with risks flood inundation, capturing run off water at source within SH2 and integration of the urban context with site (e.g. how it connects with the train station)

NEXT STEPS.

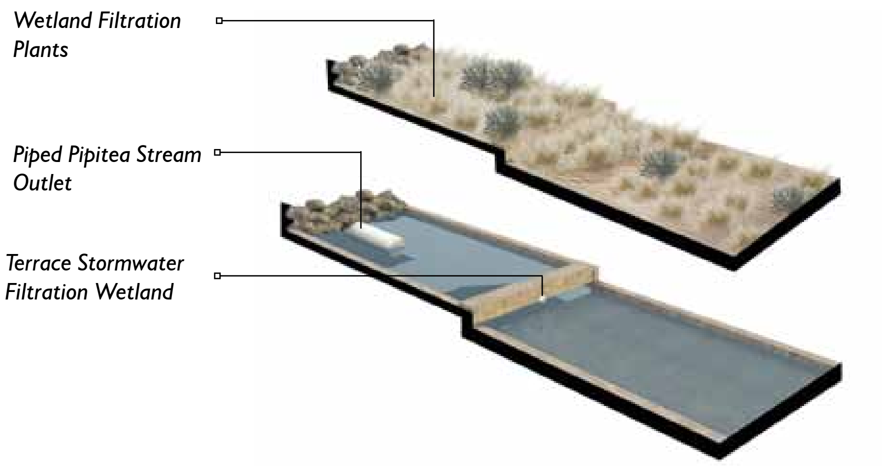
-Tidal inundation design
-Increased flood adaptability
-Connection with wider urban and waterfront context

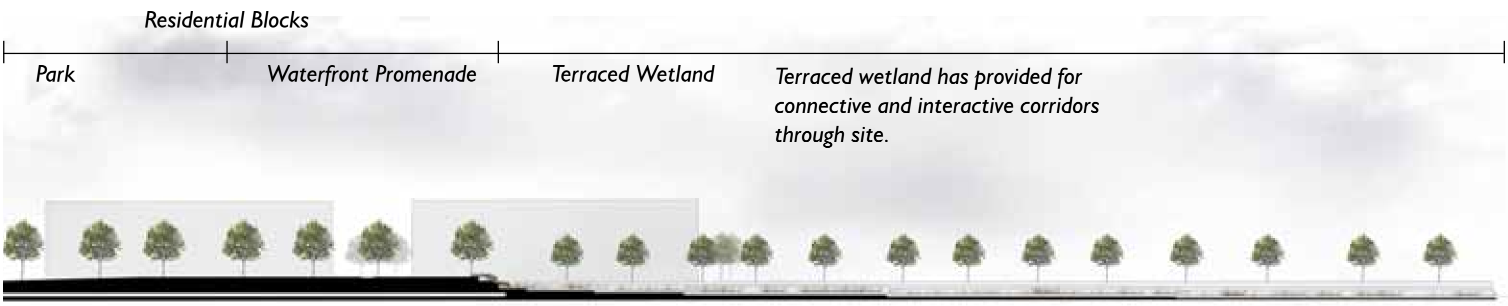
CONCEPT ONE.

# 01.1



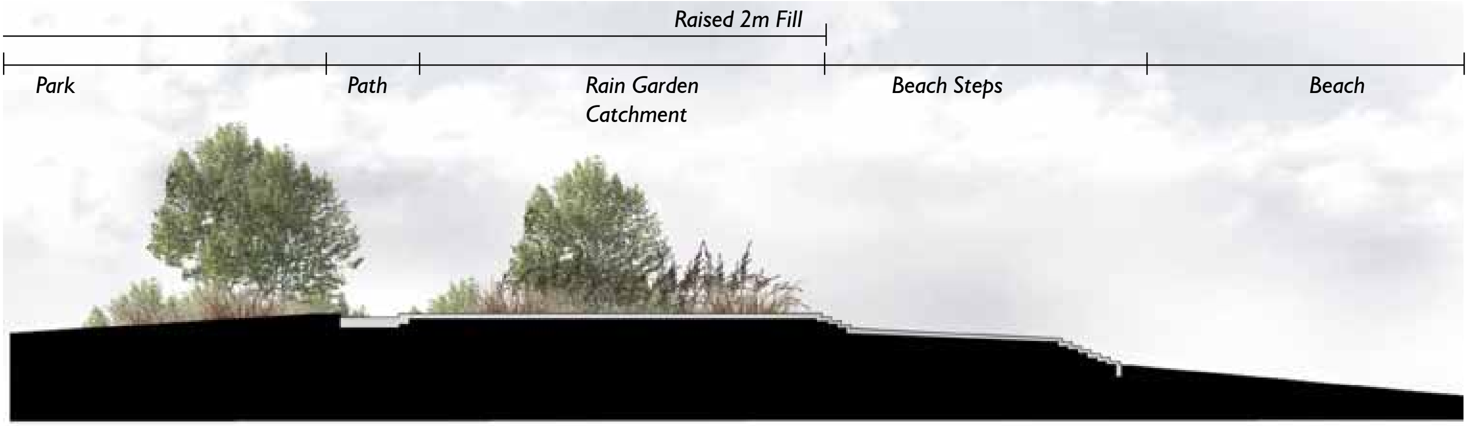
*Access Points*
*SH2*
*Surface Runoff Water Treatment*



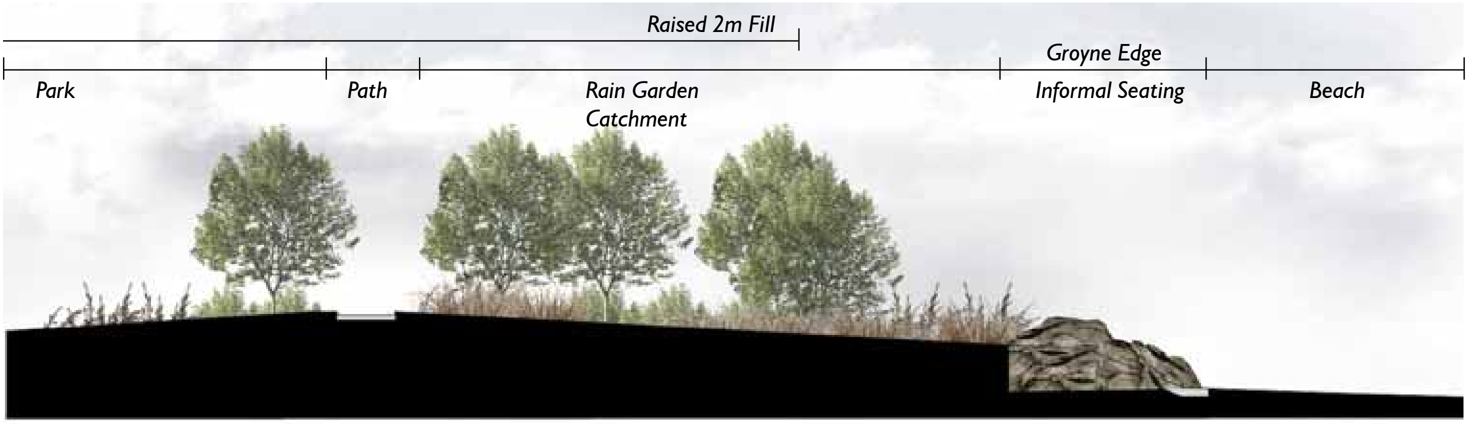




*Section A* 1:450 @ A1

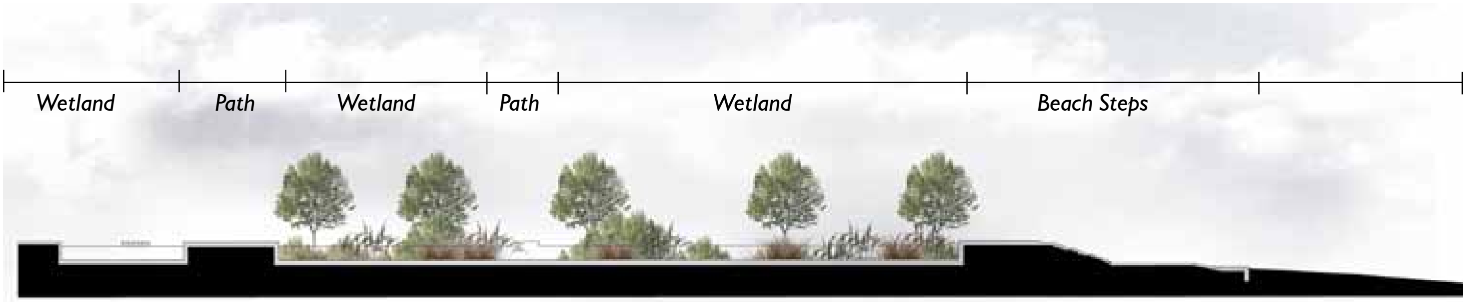
Fig. 8.13. - 8.16. Authors Own, Development of Conceptual Scheme One, 2019.



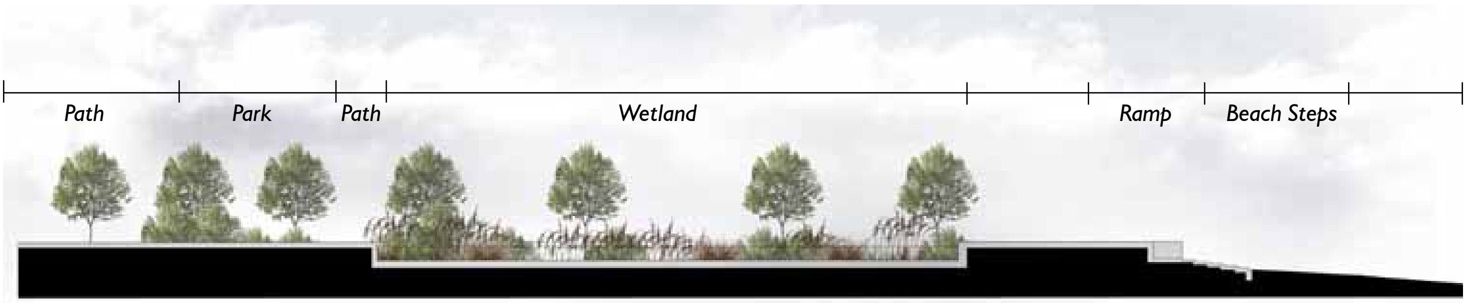

Section B 1:250 @ A1




Section C 1:250 @ A1




Section D 1:250 @ A1



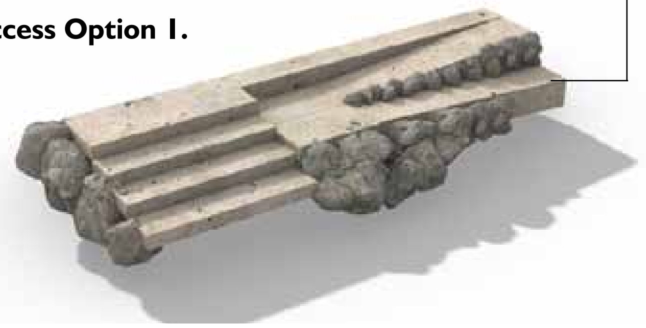

Section E 1:250 @ A1


Section F 1:250 @ A1

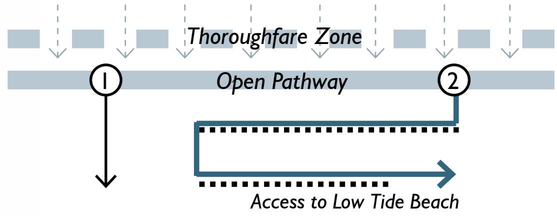
*Exploration of pedestrian circulation and access to beach options.*

*Paths leads to Coastal Beach then seamlessly diffuses into sand*

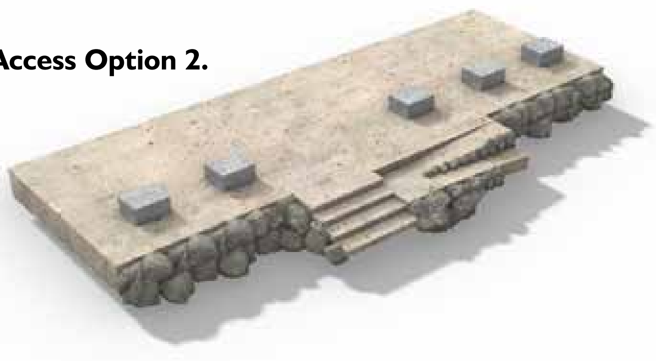
**Access Option 1.**



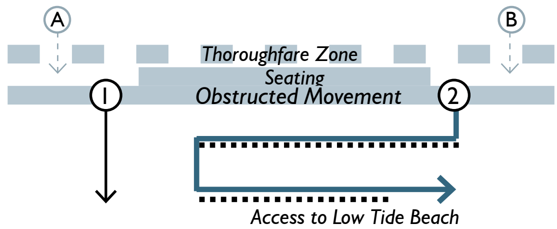
*2 Path Options*
*1. Steps to Low Tide Beach*
*2. Ramp to Low Tide Beach*




**Access Option 2.**

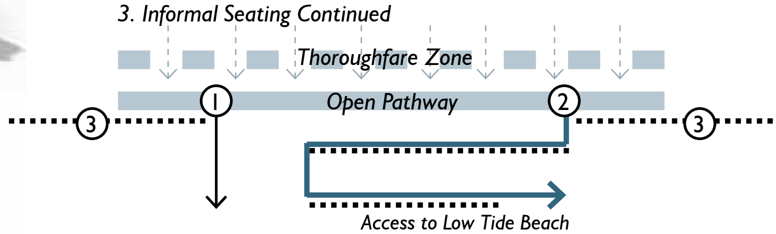


*2 Path Options*
*1. Steps to Low Tide Beach*
*2. Ramp to Low Tide Beach*
*AB. Focussed Paths to Beach*




**Access Option 3.**

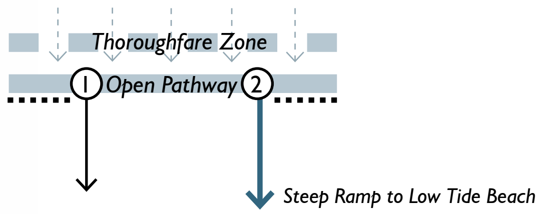
*2 Path Options*
*1. Steps to Low Tide Beach*
*2. Ramp to Low Tide Beach*
*3. Informal Seating Continued*



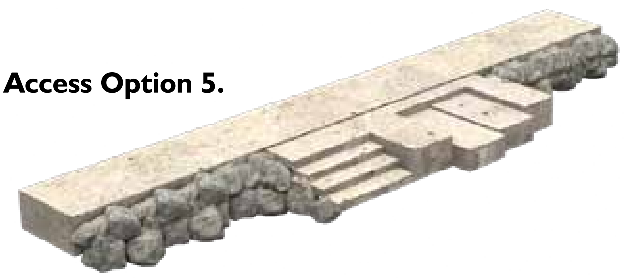

**Access Option 4.**

*Ramp leads to Coastal Beach then seamlessly diffuses into High Tide*

*1 Path Options*
*1. Steps to Low Tide Beach*
*2. Ramp intended for kayak loading*




**Access Option 5.**



*2 Path Options*
*1. Steps to Low Tide Beach*
*2. Block Steps*

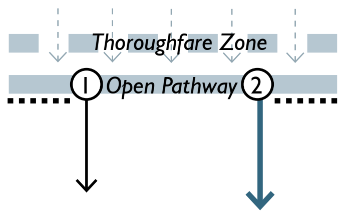
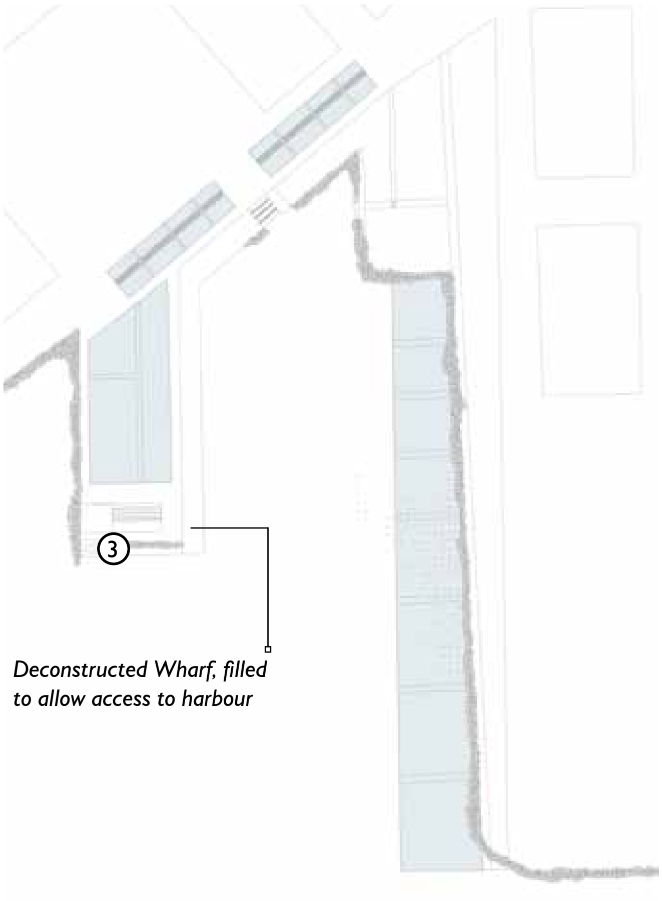


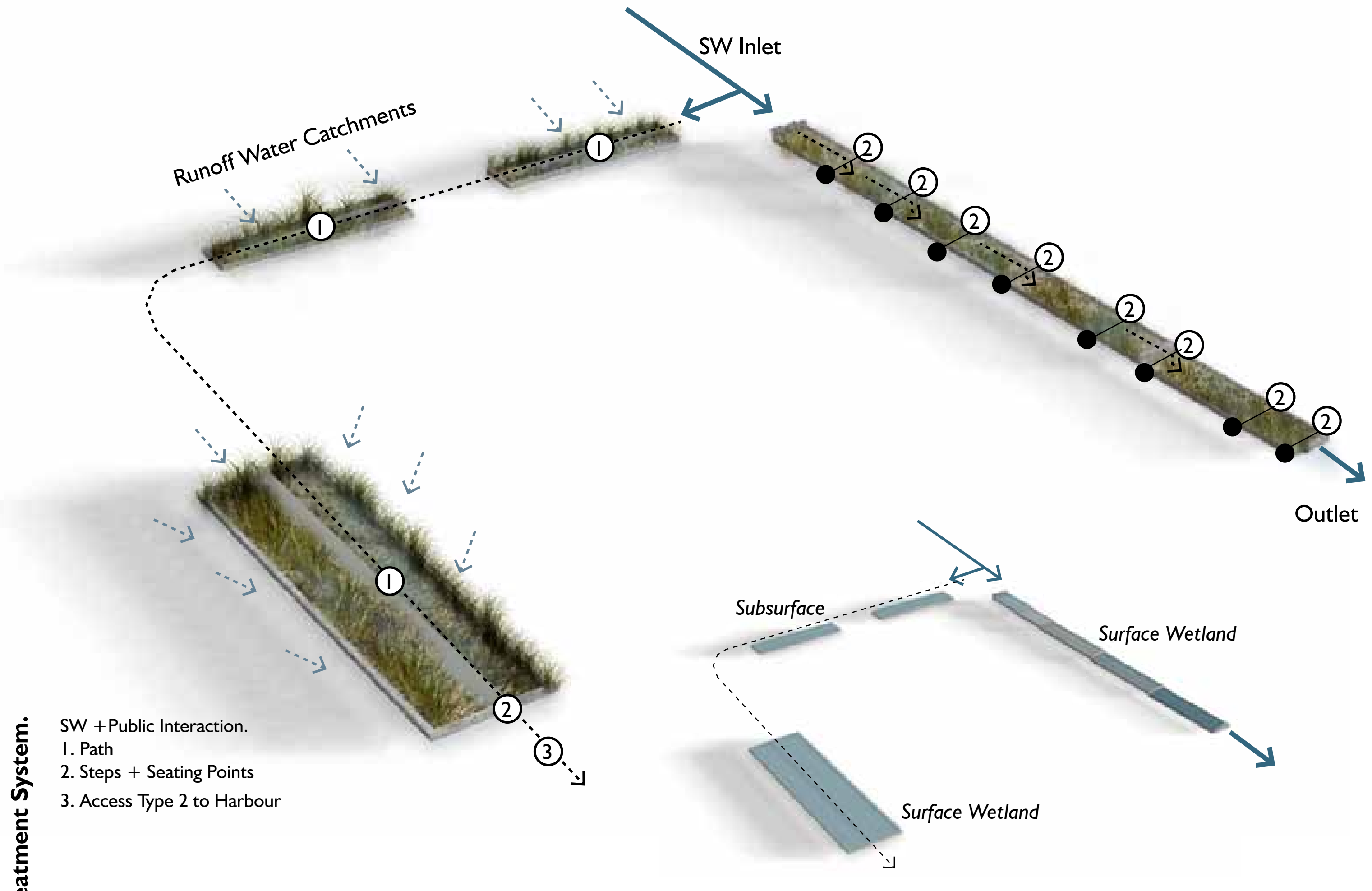

Fig. 8.17. - 8.26. Authors Own, Development of Conceptual Scheme One, 2019.




## WETLANDS

Wetlands create for good water retention and filtration, these have been implemented through site and capture surface runoff water. Small catchments have been put through site maximise runoff filtration, and water retention within flood occasion. These can be directed easily through site, treated and discharged in to the harbour.

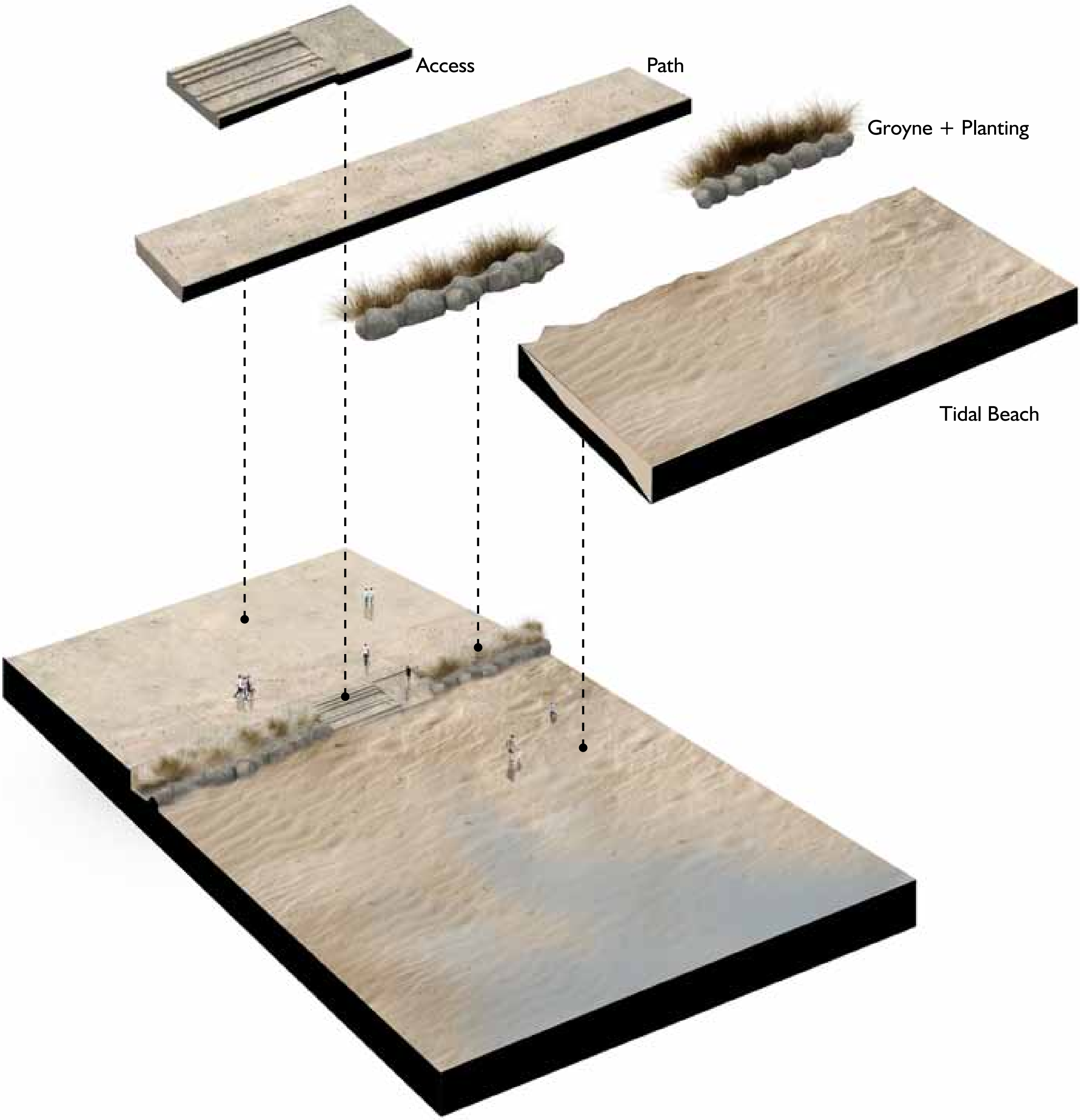
A combination of surface and subsurface wetlands have been designed to change user experience through site. Sub surface wetlands filter plants underground while users can still be directed to walk through zone. Surface wetlands expose filtered water, plants grow higher, immersing people within the zone, direct users to a certain view.




SW +Public Interaction.
1. Path
2. Steps + Seating Points
3. Access Type 2 to Harbour

STRUCTURE OF BEACH ACCESS

Recreational beaches create for good active space. These with groyne placement can create indirect micro ecology growth. Groyne structure for erosion control also creates for good informal seating. Beach zones also absorb wave energy and reduce impact a surges through shallow and soft ground, this allow protects flooding and erosion.




**Access Point 1.**

Fig. 8.27 - 8.29. Authors Own, Development of Conceptual Scheme One, 2019.

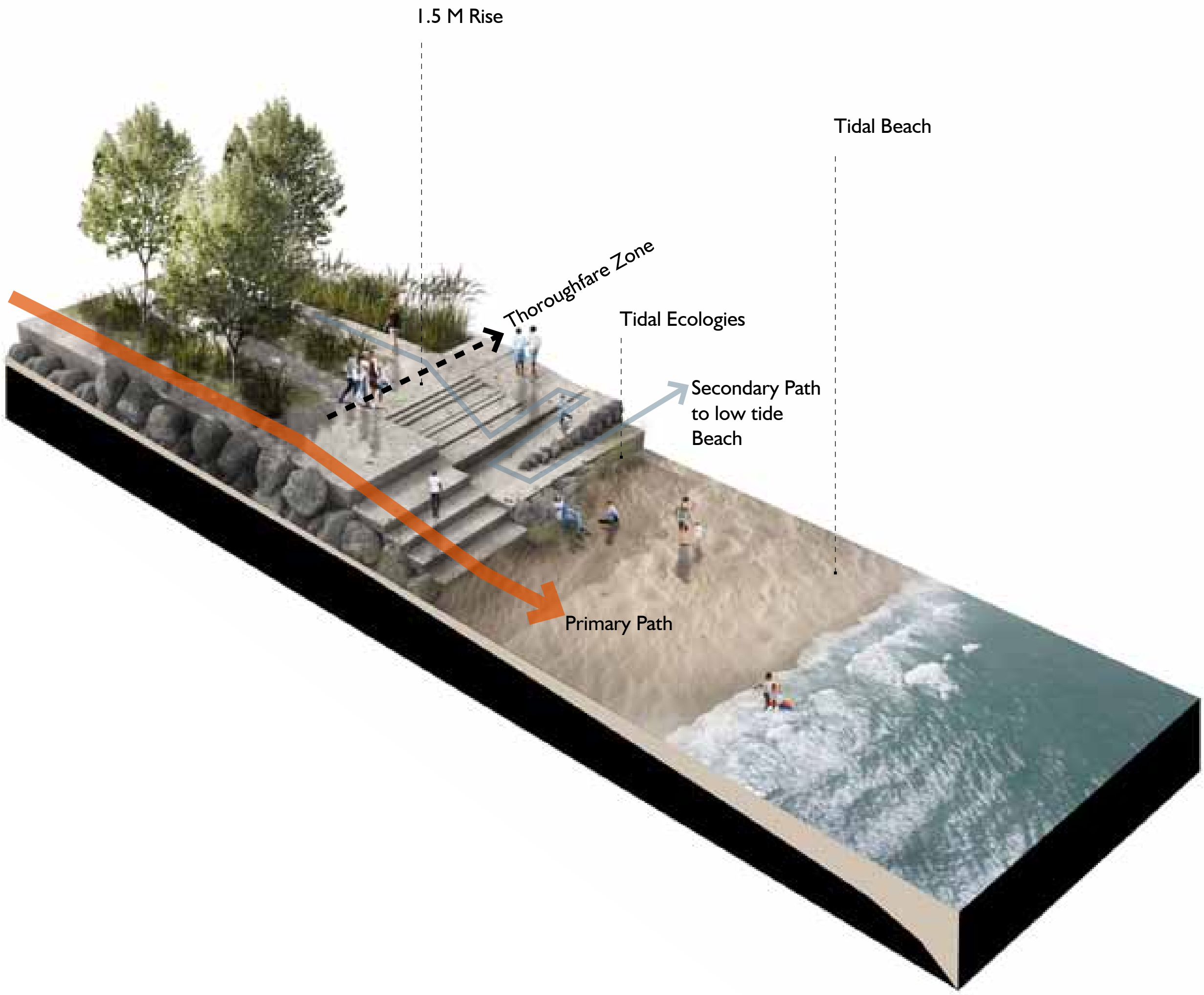
## Access Point 2.

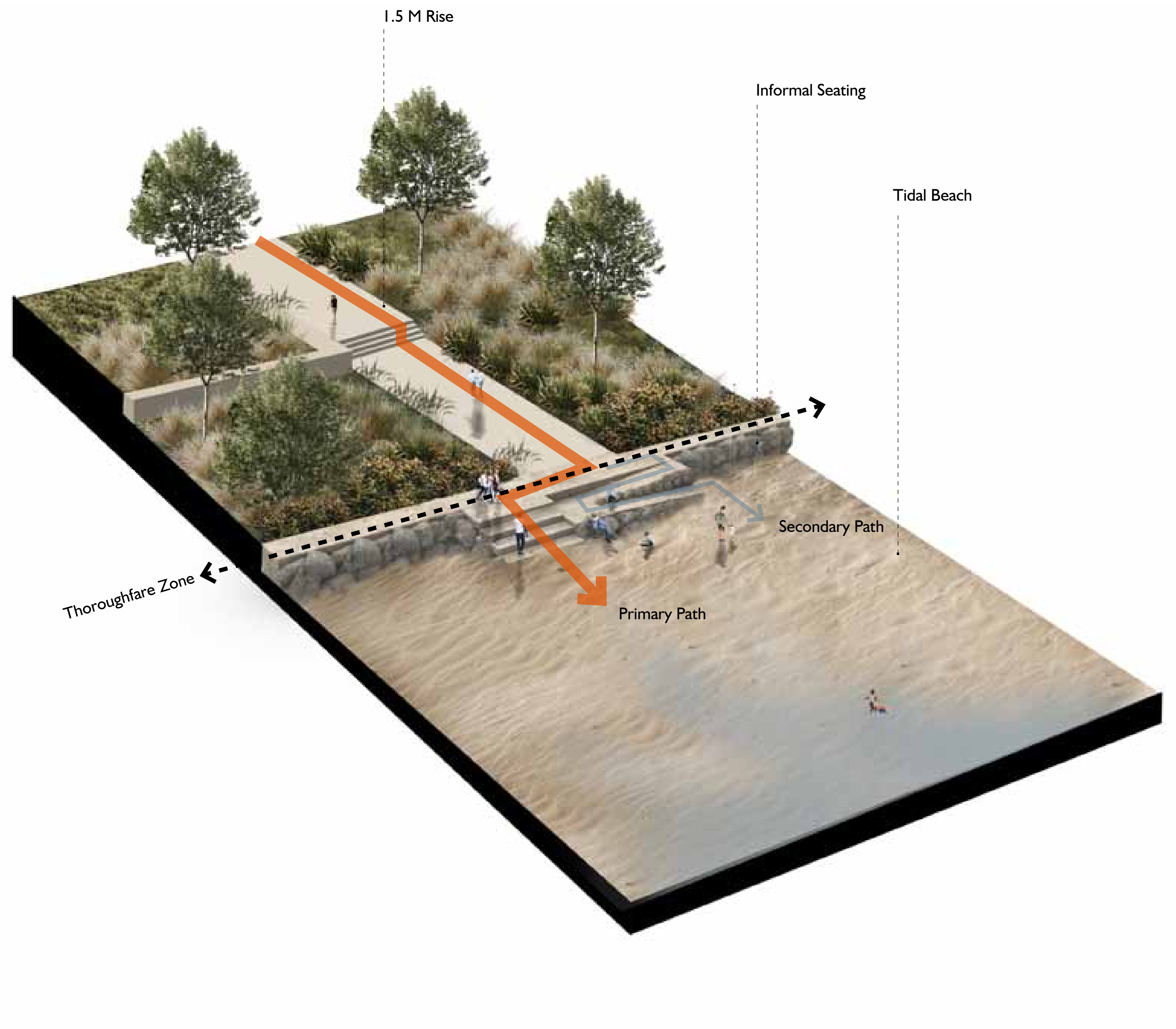
*Low Tide*

*High Tide*

Access Point 3.

Fig. 8.30 - 8.31. Authors Own, Development of Conceptual Scheme One, 2019.


1.5 M Rise
Tidal Beach
Thoroughfare Zone
Tidal Ecologies
Secondary Path
to low tide
Beach
Primary Path




**Access Point 3.**

Fig. 8.32 - 8.33. Authors Own, Development of Conceptual Scheme One, 2019.

KEY ELEMENTS EXPLORED.

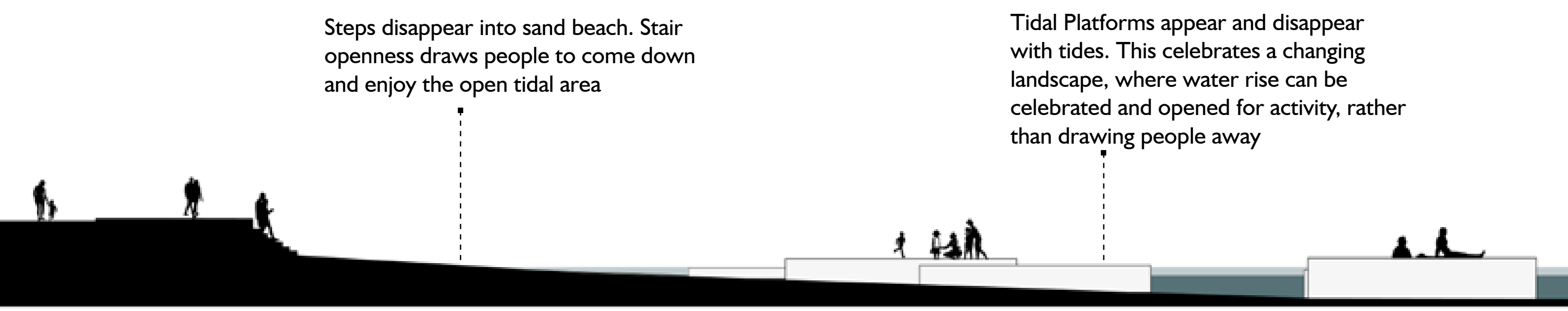
- Tidal and user interaction

FINDINGS.

A refinement of this raised beach design looks at exploring the potential user experience with site. One thing that was successful about this design was working within a tidal zone. There was great potential to develop on this, working with tidal movements, form can be created to reveal and conceal itself with tides. This creates a different and unique user specific experience.

NEXT STEPS.

- Wider site design implementation of tidal and user interaction
- Relation to Breathable coastal Ecologies
- Improved Flood mitigation

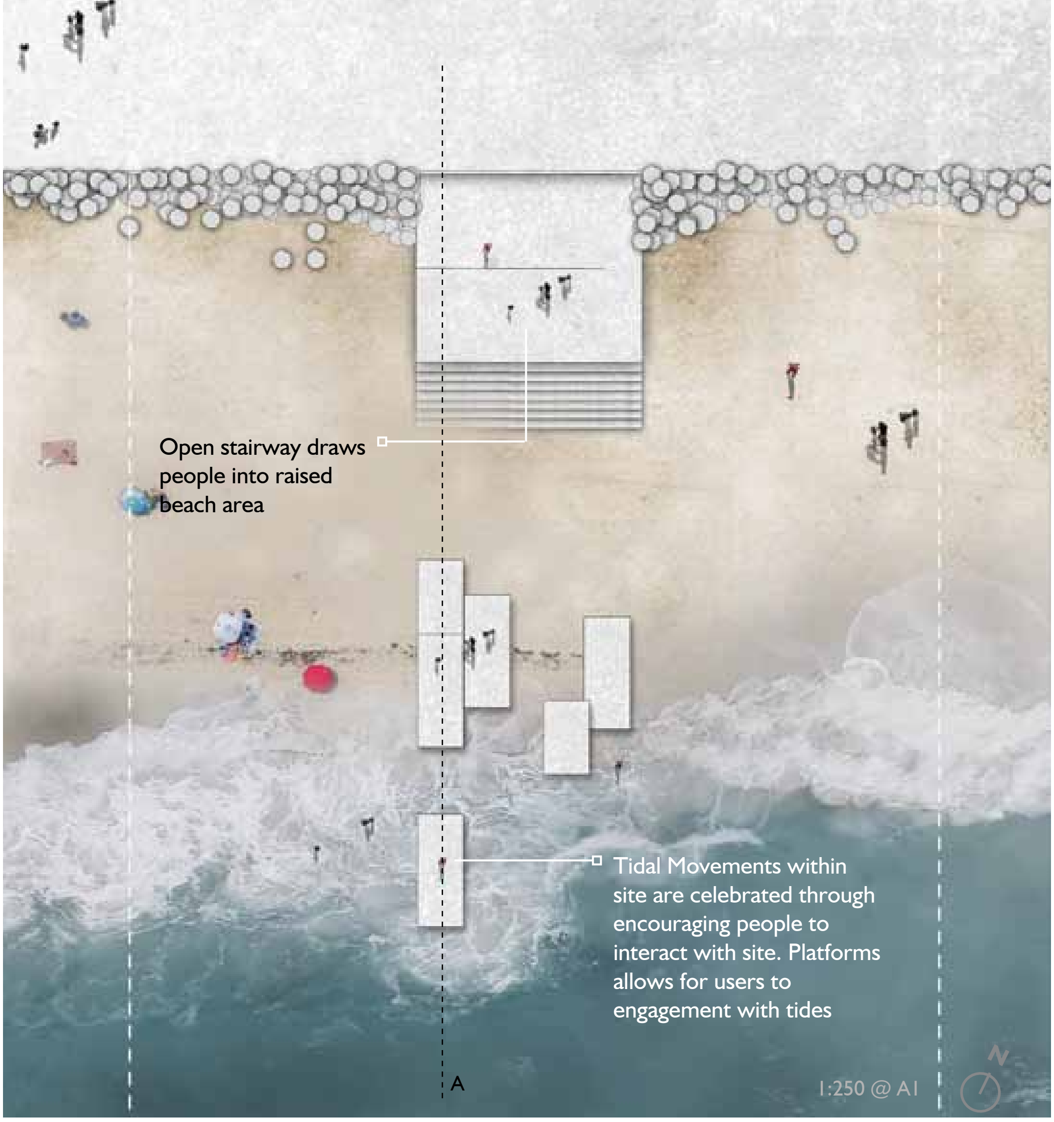



Section A 1:150 @ A1

CONCEPT ONE.

# 01.2

Fig. 8.34 - 8.36. Authors Own, Development of Conceptual Scheme One, 2019.


Open stairway draws
people into raised
beach area
Tidal Movements within
site are celebrated through
encouraging people to
interact with site. Platforms
allows for users to
engagement with tides
A
1:250 @ A1


High Tide allows for users to
swim to platforms
Tidal movements change the
user experience of site and
allow for public activities to
change
1:250 @ A1

FINDINGS.

This concept primarily focused on studying form of tidal designs within site. Tidal movement plays a significant role within site and the proposed design objectives. It provides many benefits to harbour and water health. For this reason integrating tidal movements and public use was developed into a key design system. This was found to be successful in drawing people in an area, while reducing the effects of large wave energy inundating site. For moving forwards with this approach, it would be beneficial to see how this works with the greater waterfront and urban context, for multifunctional programmes to function simultaneously.

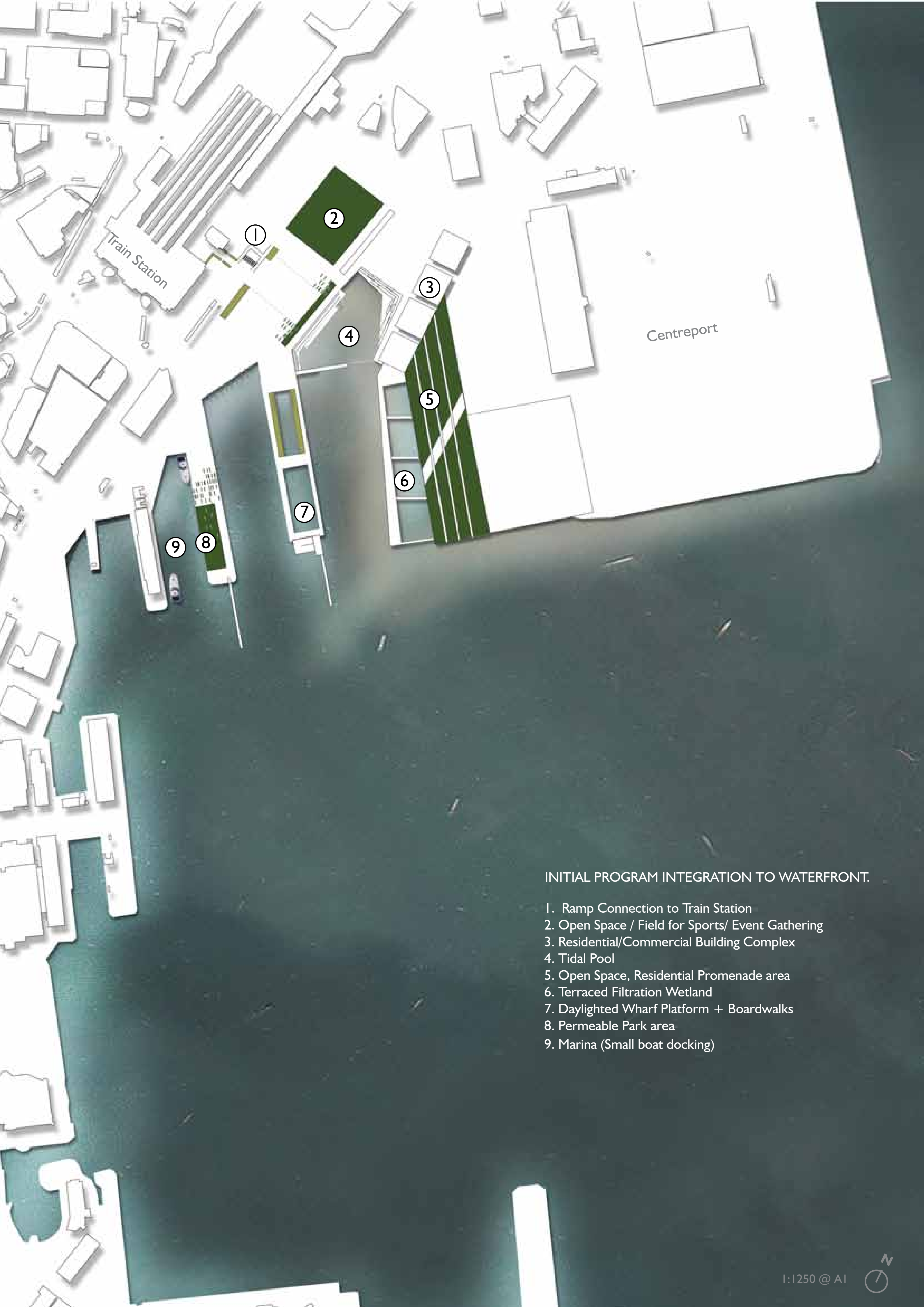
NEXT STEPS.

-Connection with wider waterfront and urban context
-Integrated and multifunctional programs working together
-Improved Flood mitigation

CONCEPT TWO.

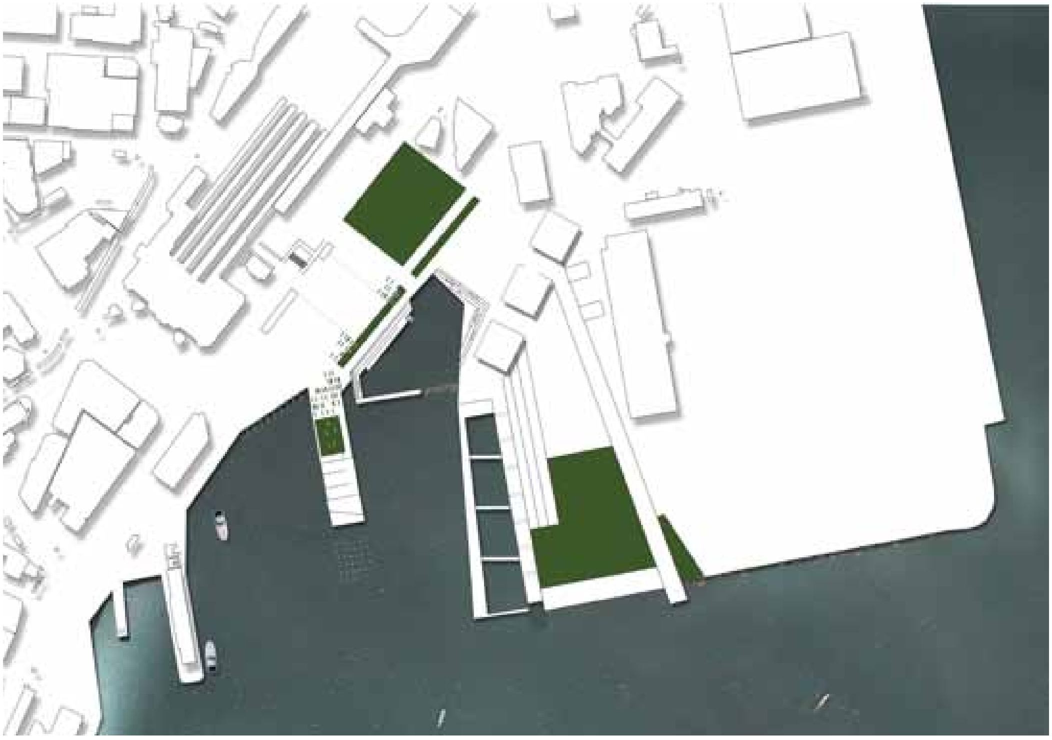
02.

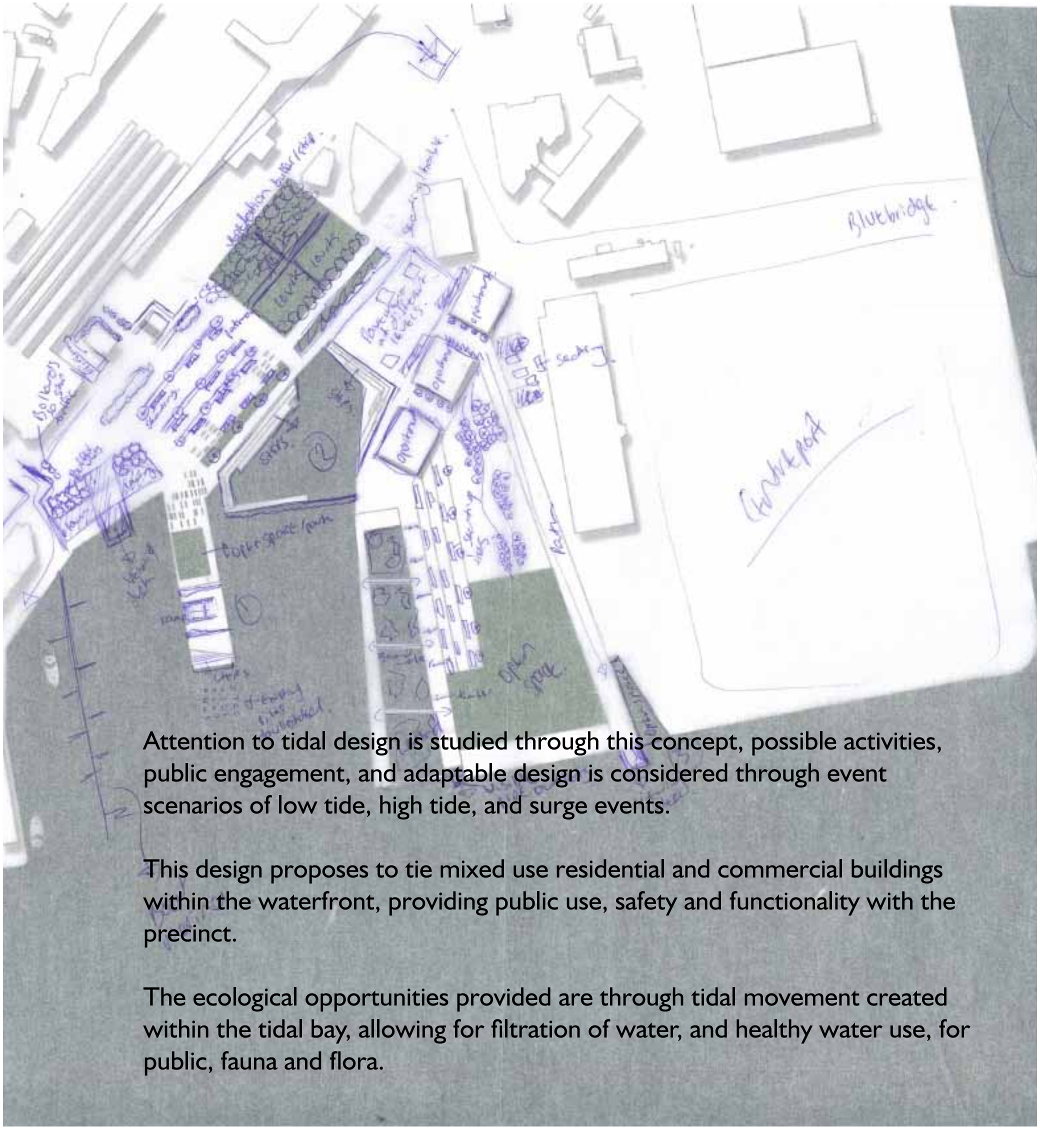
Fig. 8.37. Authors Own, Conceptual Scheme Two, 2019. (Opposite Page)




INITIAL PROGRAM INTEGRATION TO WATERFRONT.

1. Ramp Connection to Train Station
2. Open Space / Field for Sports/ Event Gathering
3. Residential/Commercial Building Complex
4. Tidal Pool
5. Open Space, Residential Promenade area
6. Terraced Filtration Wetland
7. Daylighted Wharf Platform + Boardwalks
8. Permeable Park area
9. Marina (Small boat docking)



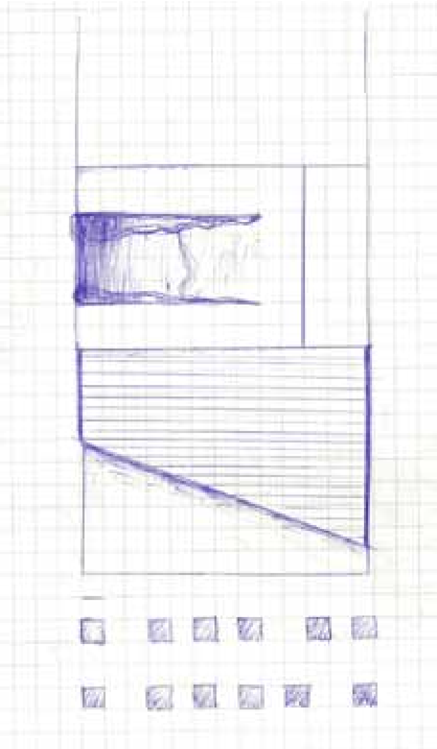


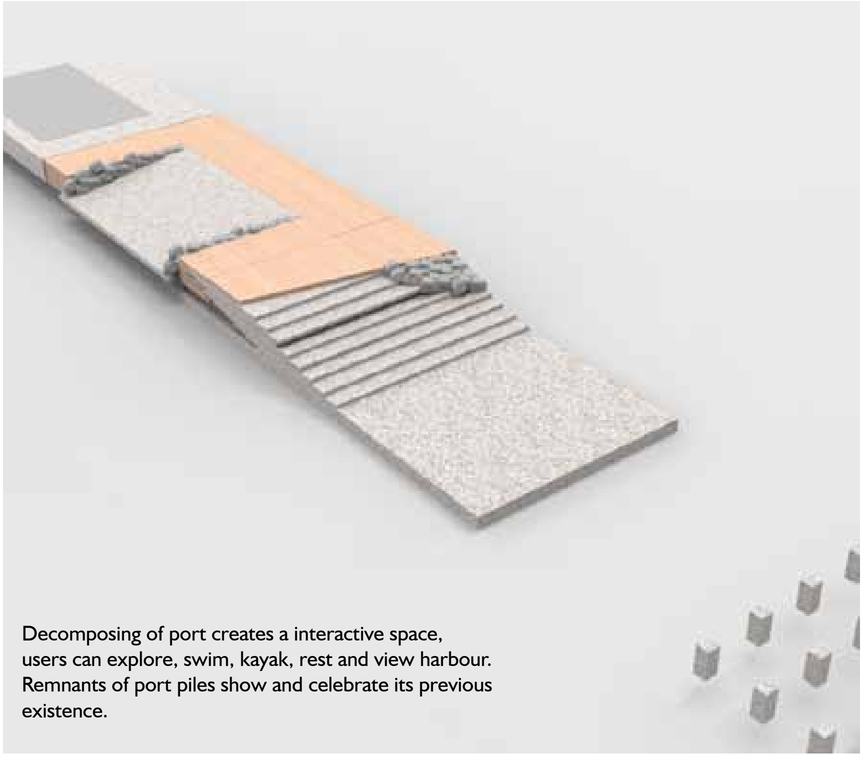

Attention to tidal design is studied through this concept, possible activities, public engagement, and adaptable design is considered through event scenarios of low tide, high tide, and surge events.

This design proposes to tie mixed use residential and commercial buildings within the waterfront, providing public use, safety and functionality with the precinct.

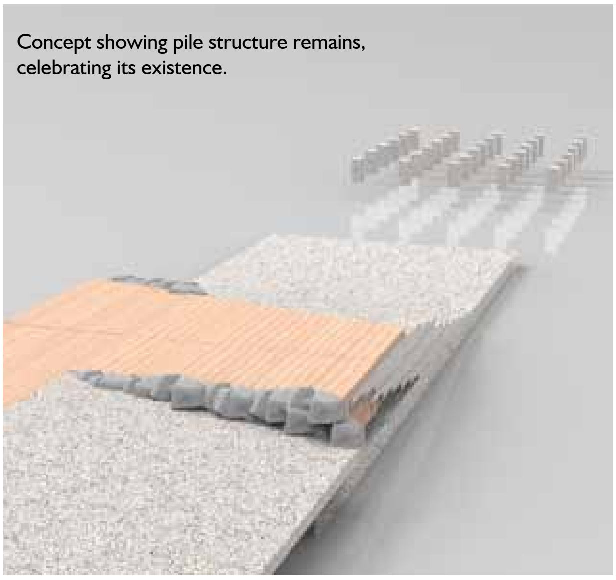
The ecological opportunities provided are through tidal movement created within the tidal bay, allowing for filtration of water, and healthy water use, for public, fauna and flora.

TIDAL INTERACTION AND EXPLORATION .





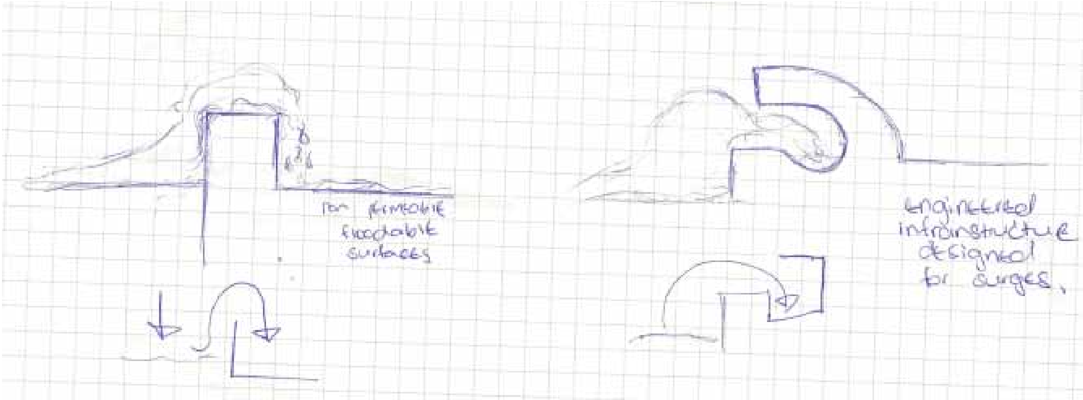
Decomposing of port creates a interactive space, users can explore, swim, kayak, rest and view harbour. Remnants of port piles show and celebrate its previous existence.

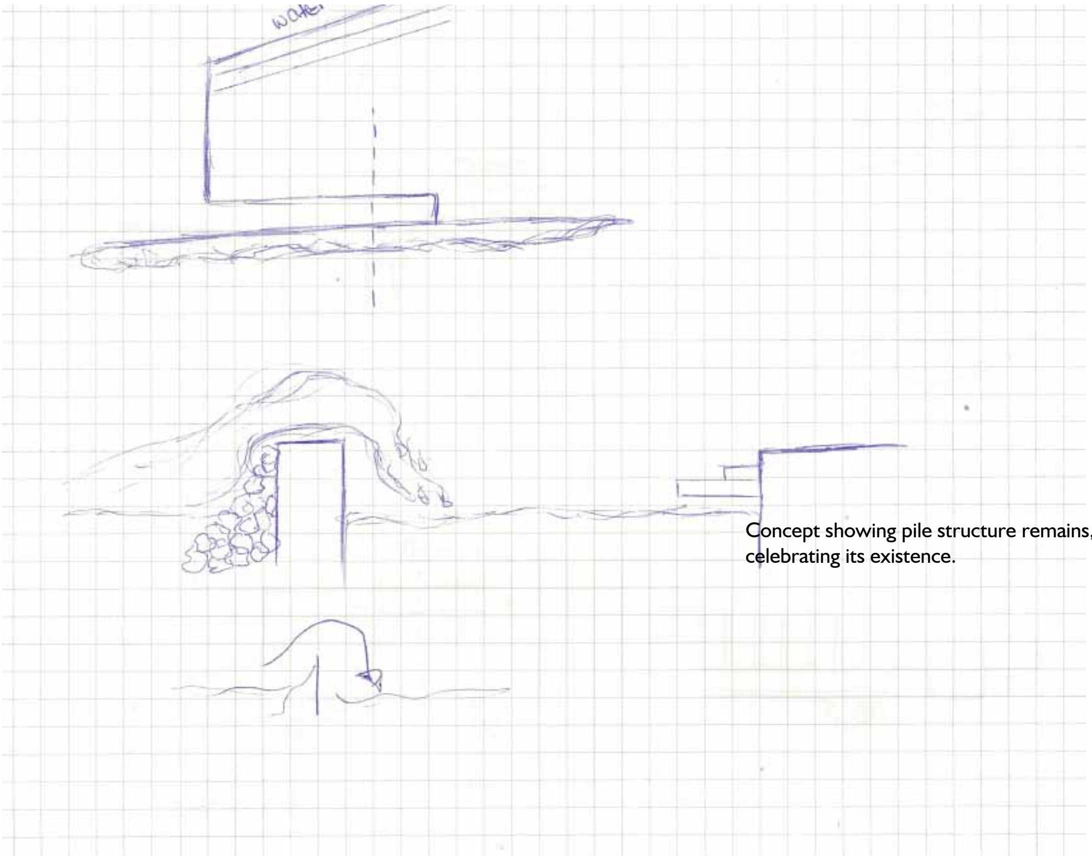


Concept showing pile structure remains, celebrating its existence.

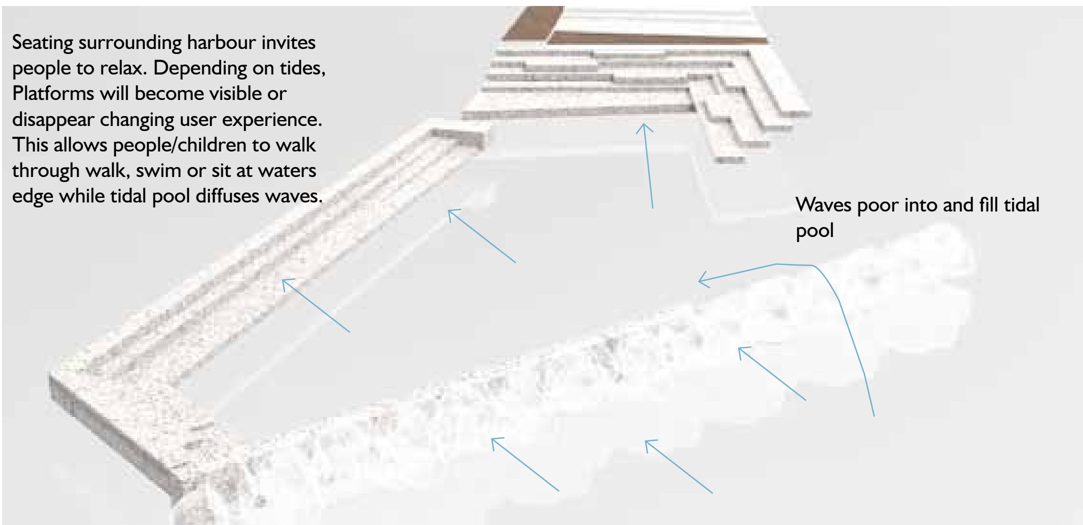
Steps down to Harbour edge to view, and rest

Fig. 8.38. - 8.43. Authors Own, Conceptual Scheme Two, 2019.



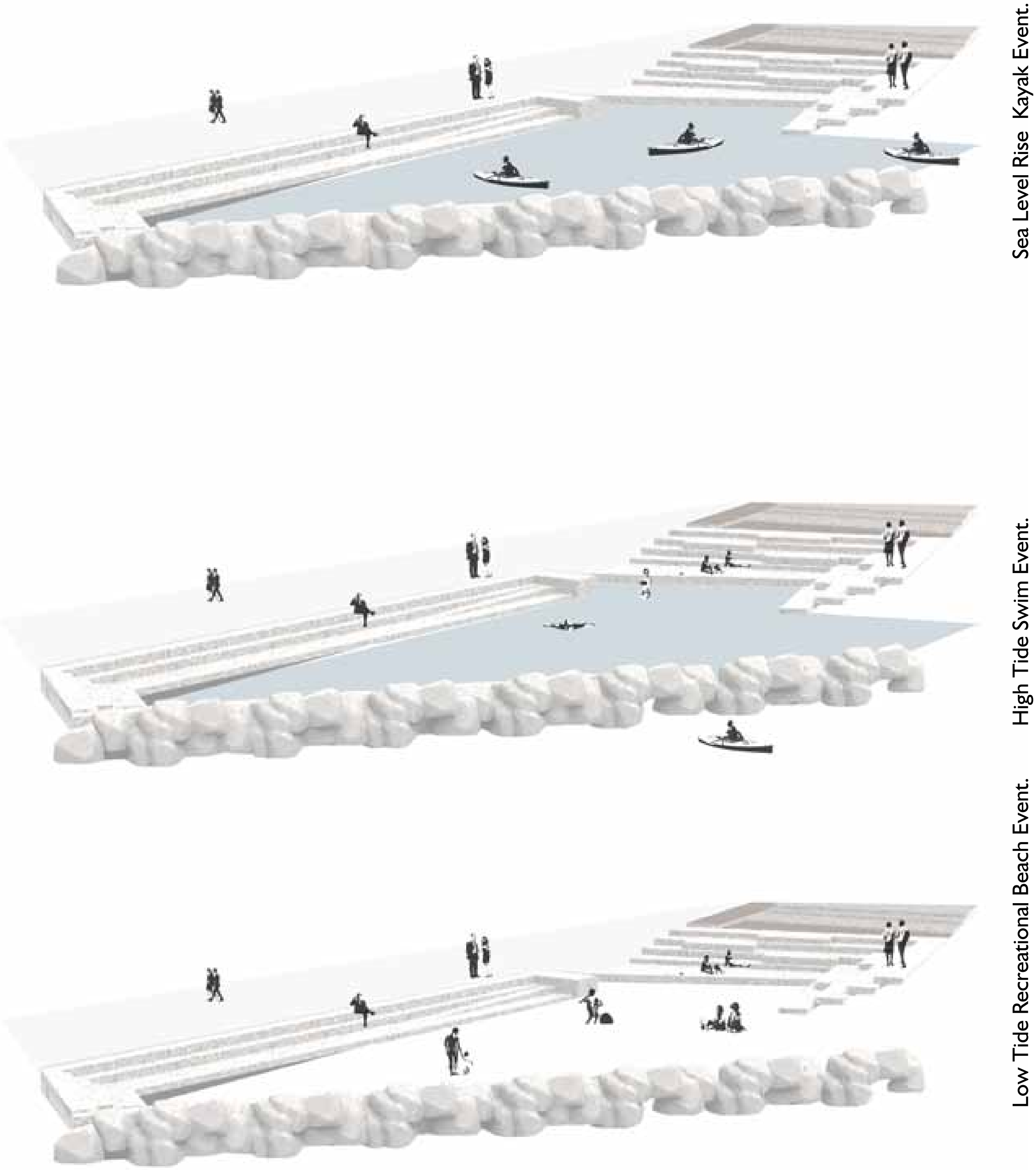




Concept showing pile structure remains, celebrating its existence.



Seating surrounding harbour invites people to relax. Depending on tides, Platforms will become visible or disappear changing user experience. This allows people/children to walk through walk, swim or sit at waters edge while tidal pool diffuses waves.

Waves poor into and fill tidal pool




**Event space changes with tidal movements.**

Fig. 8.44. - 8.47. Authors Own,
Conceptual Scheme Two, 2019.

KEY ELEMENTS EXPLORED.

FINDINGS.

- Filtration and Flood Protection of Waterfront
- Declamation and edge treatment of Site

Previous studies looking closely at certain objectives and testing form best suited to achieving resiliency either through accessibility, ecological or permeable approaches. Successful studies were chosen and brought together to develop site design addressing all principles and components. A main weakness found through the previous studies was the lack of ecological and natural processes that could be implemented to achieve resilient flood design. This concept identified potentials of engaging with adaptable site design which can be used by public and still function as a system to retain and prevent further flood and surge inundation. For this purpose the strategy of declaiming a part of Centerport was seen as a positive opportunity. Centerport, placed on the outer end of Wellingtons harbour receives most inundation to storms as it's positioned foremost to the open harbour. Because of this, inner harbour areas are protected from larger wave and inundations with Centerport being a structural barrier. Through edge studies as it was found soft edges absorb and can retain more water inundation, therefore there is potential for the vulnerable Centerport edge to become a foremost protective and ecologically regenerative barrier, than flooding. Integrating this industrial site into an adaptable system allows design to integrate public destination, flood protection and regenerative filtration systems to mitigate industrial and runoff pollutants that can function when a storm hits as well. For further design development, it would be worthy of studying adaptable and semi adaptable spaces with public integration for flood retention. Often the most positive natural systems are also best untouched by urban and human realms which adds an interesting notion to develop with.

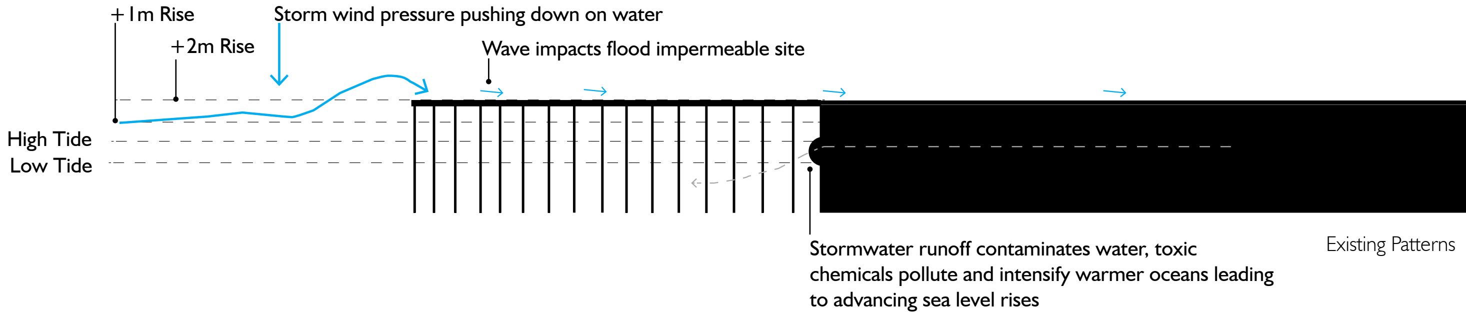
NEXT STEPS.

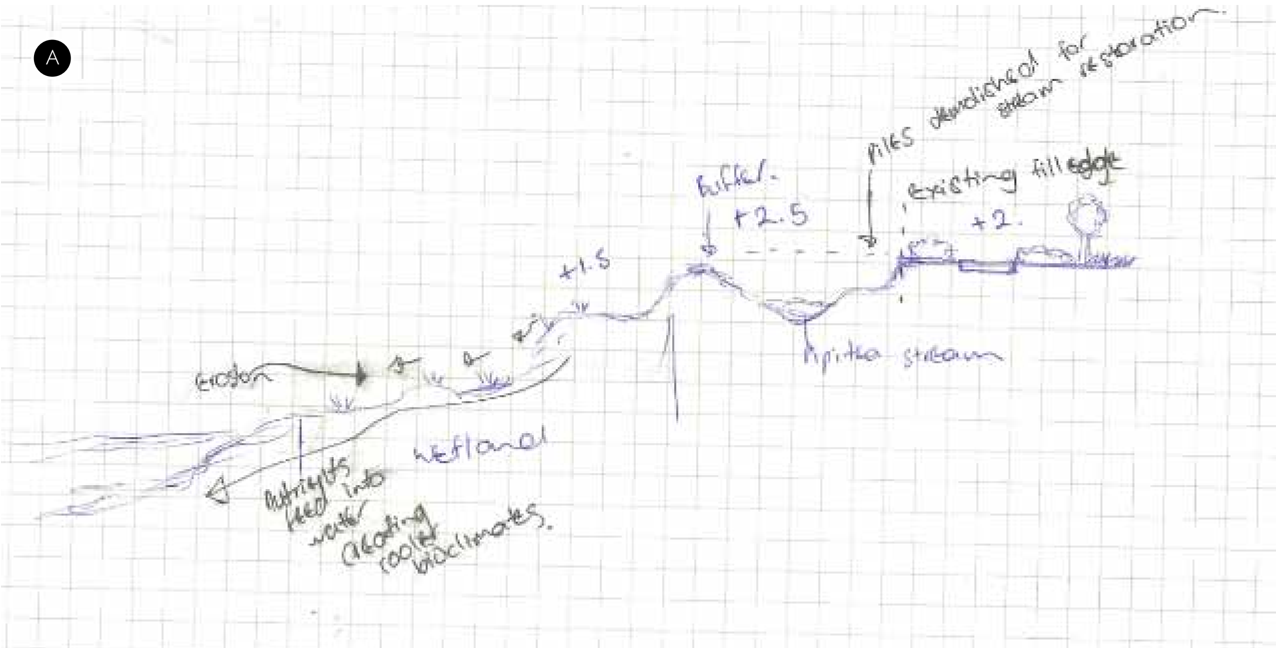
-Adaptable site zones in flood event

# 03. CONCEPT THREE.

Fig. 8.48. Authors Own, Conceptual Scheme Three, 2019. (Opposite Page)


Conceptual Diagram exploring form of a Floodable site.



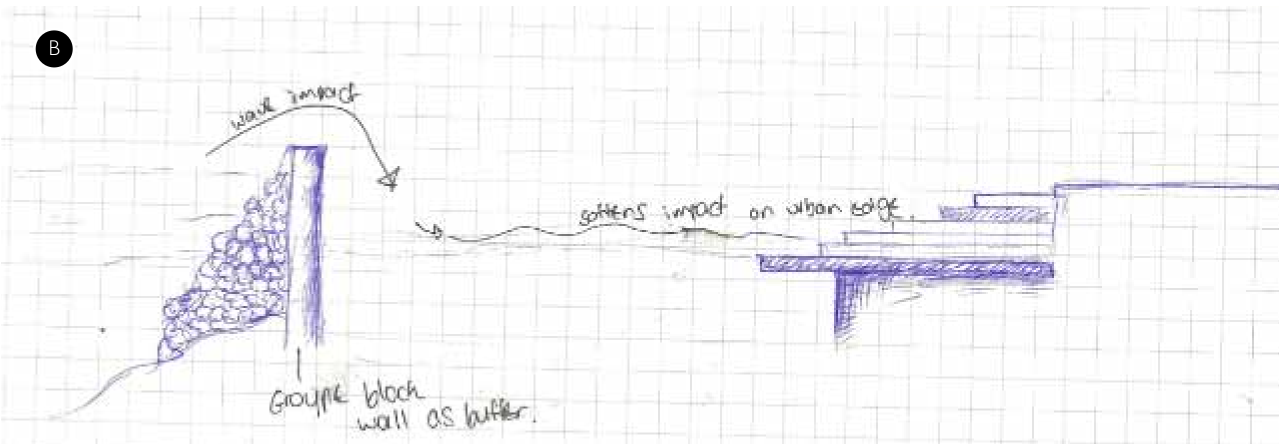
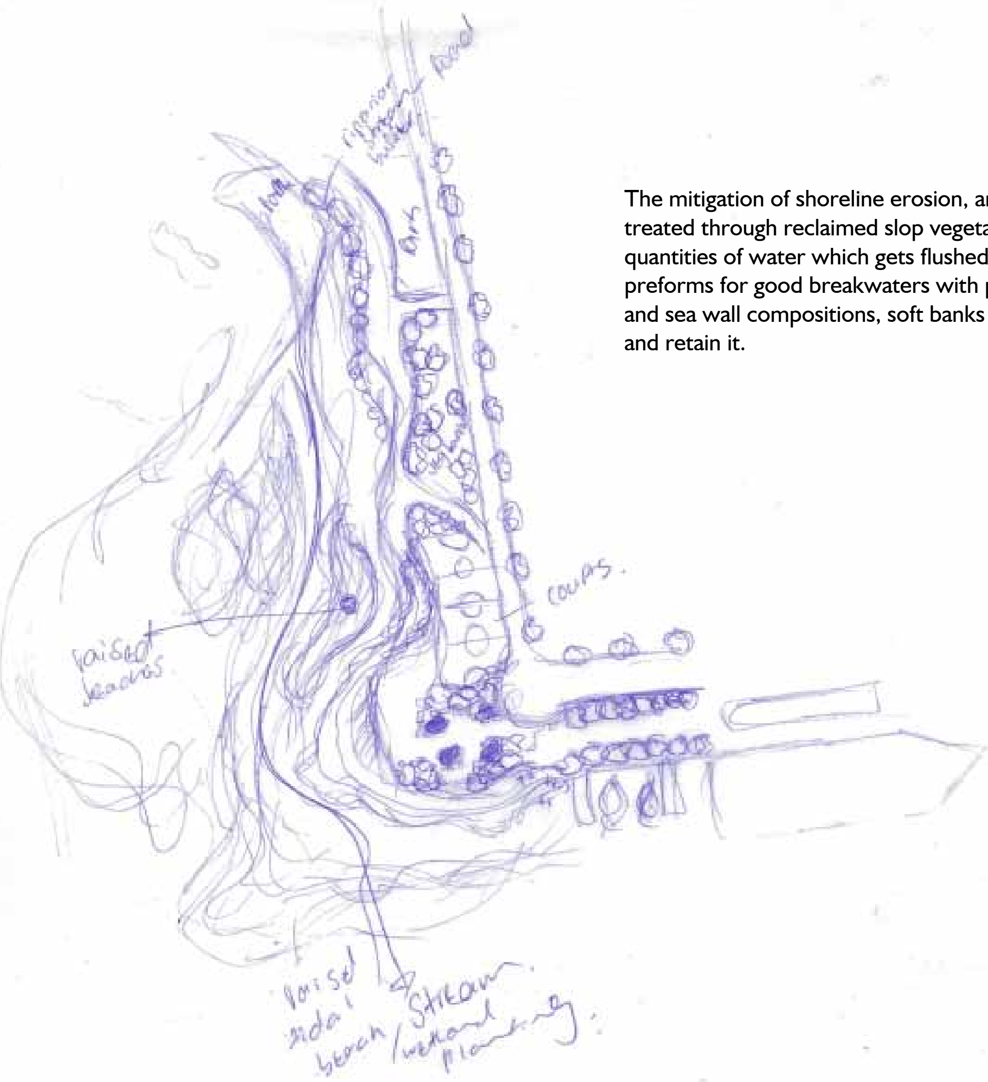
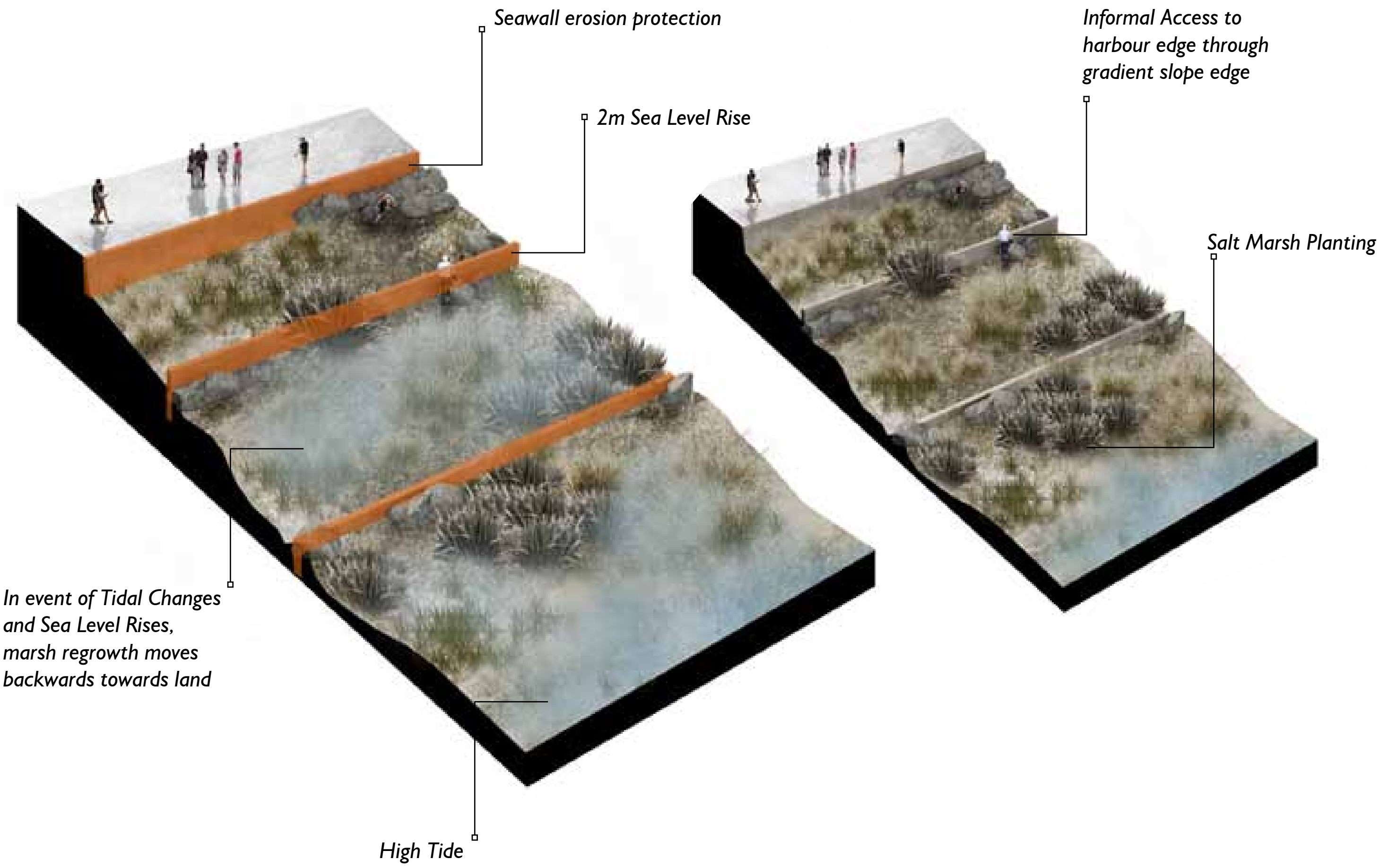



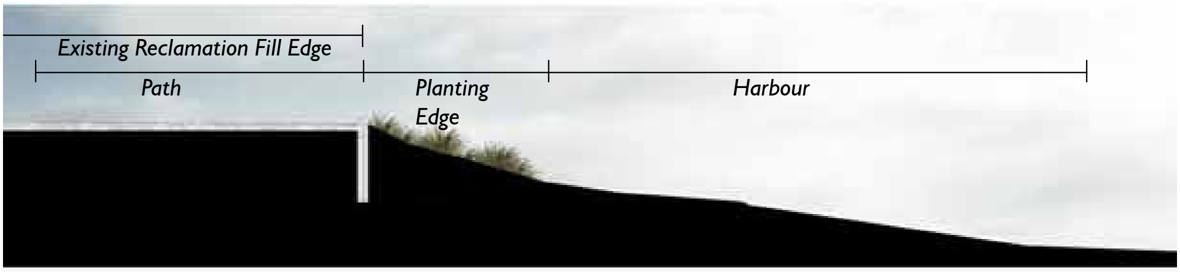

Fig. 8.49. - 8. 53. Authors Own, Conceptual Scheme Three, 2019.

The mitigation of shoreline erosion, and water runoff can be treated through reclaimed slop vegetation. This absorbs large quantities of water which gets flushed out depending on tides. It preforms for good breakwaters with planted vegetation, groyne and sea wall compositions, soft banks will absorb the wave energy and retain it.

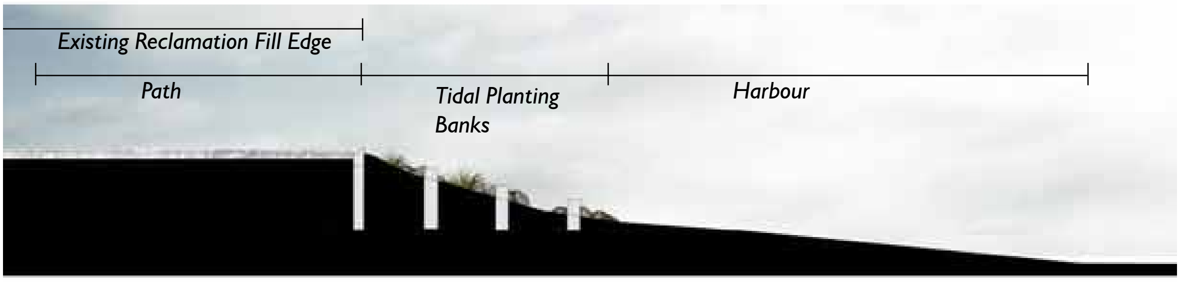




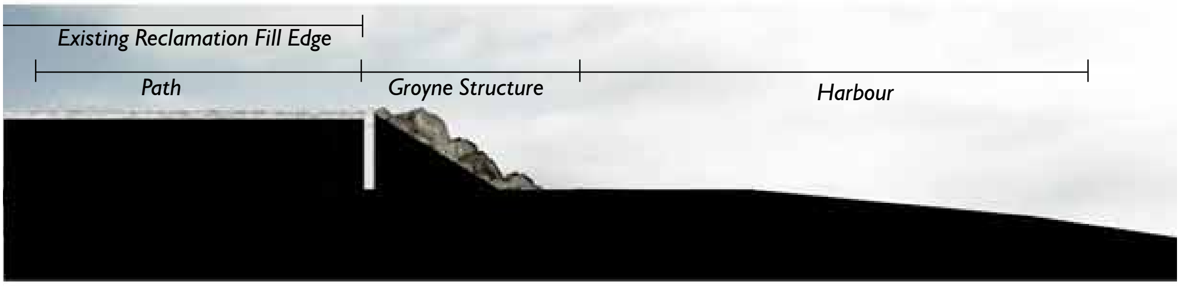
## **Edge Structure Exploration.** 1:150 @ A1



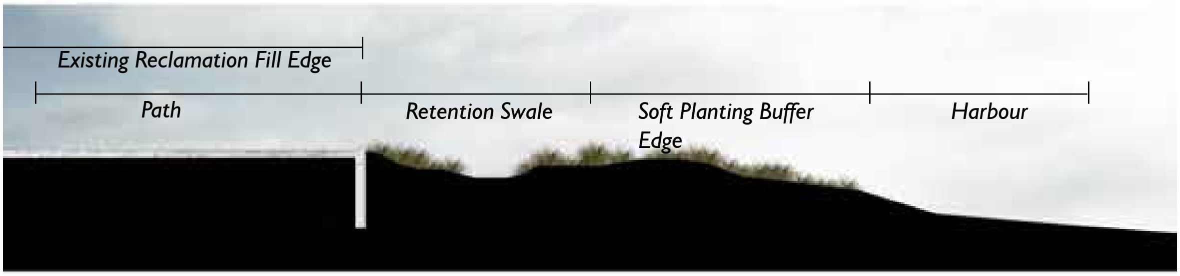

Section A. Option 1



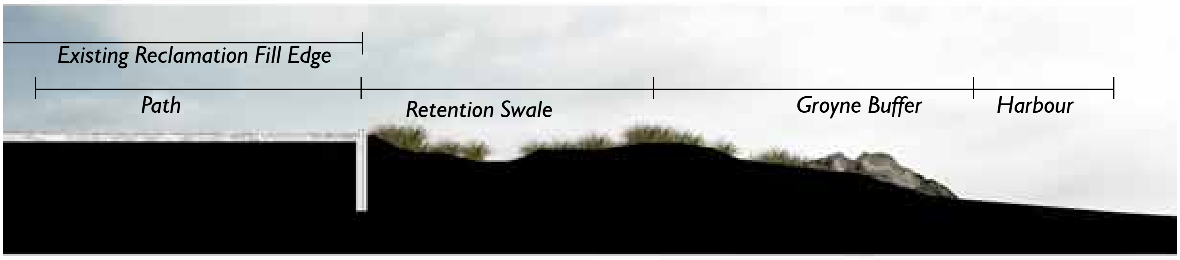

Section A. Option 2



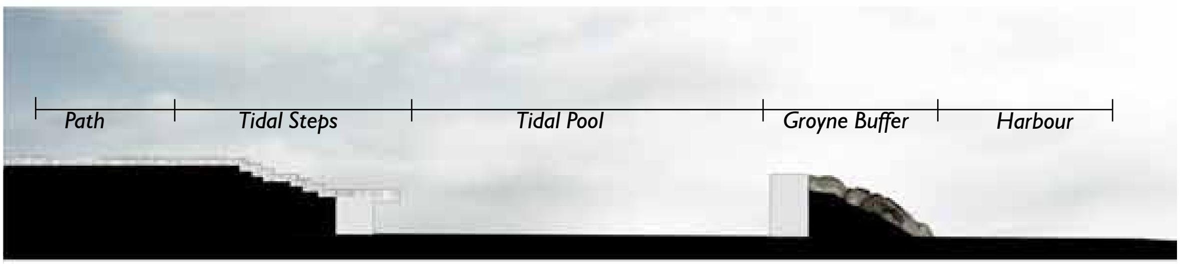

Section A. Option 3




Section B. Option 1



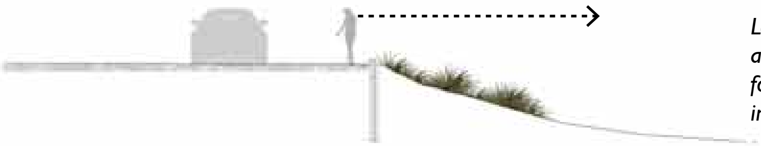

Section B. Option 2



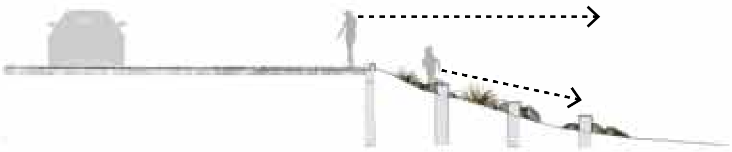

Section C. Option 1

## Public Experience.

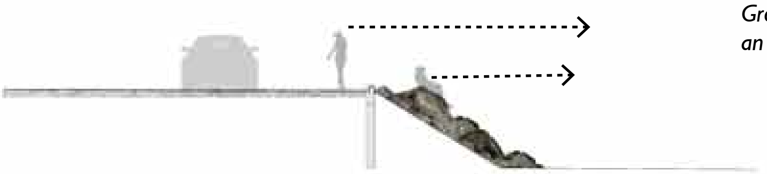
*Low Vegetation allows for direct vision through site, the soft bank absorbs wave action and retains water, this however doesn't allow for user interaction with harbour but visual qualities. Seating implemented would allow for resting zones with directed view*



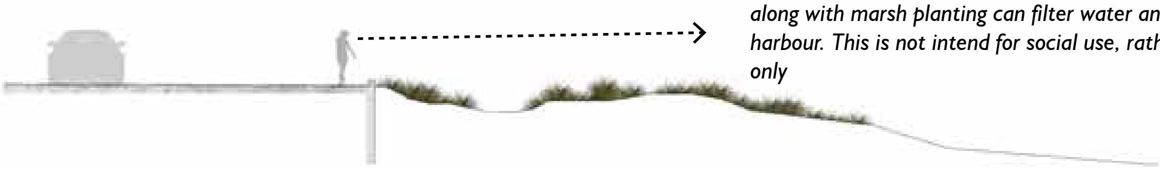
*Seawall Structure indirectly informs users of safe bank exploration. This a informal design objective depending of users will. Groyne and static sea wall structure allows for easement of access through more control surface grip. Static walls allow for tidal water retention.*



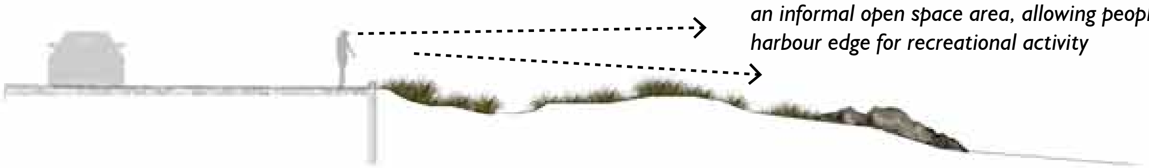
*Groyne Structure allows for good erosion control. This allows acts as an informal seating zone and access to water*



*Soft sloped vegetation can stabilise land and absorb large quantities of water which is good for flood mitigation. The retention basin along with marsh planting can filter water and flush back into harbour. This is not intend for social use, rather ecological system only*



*While planted marsh vegetation provides wave absorption, groyne structure allows for erosion control. In dry periods that can become an informal open space area, allowing people to walk down to harbour edge for recreational activity*



*Tidal pools allow for good recreational activity, it can also diffuse wave energy, acting as a tidal breaker. This static structure can also perform as a walkway, directing people to a certain destination.*

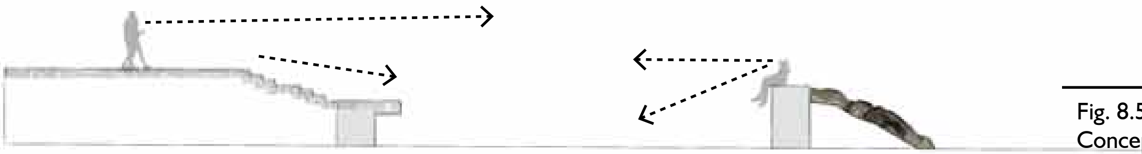


Fig. 8.54. - 8. 65. Authors Own, Conceptual Scheme Three, 2019.

KEY ELEMENTS EXPLORED.

-Flood Design
- Adaptable Public use and semi use Zones

FINDINGS.

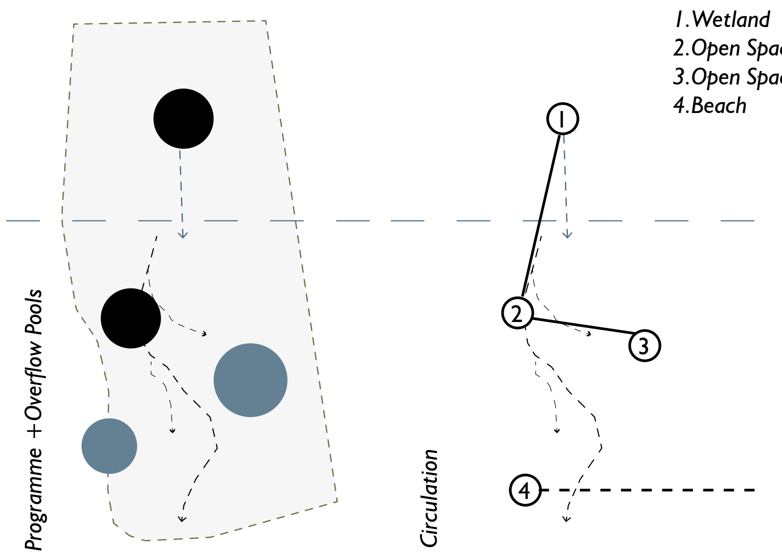
This research confronts the issues of climate change affecting New Zealand, Wellington in particular, as well as the chosen sites own existing problems. What was found successful through this design test was integration and celebration of the Pipitea stream. The structure of declaiming and daylighting the previous site exposes a WSUD opportunity for storm water filtration. It also reminds of the past culverted stream that used to run openly, protect naturally, clean naturally, and created a high habitual space. Such systems have been attempted to restore, in consideration for the environment and testing resiliency through the capacity site could handle using soft and hard infrastructural integration.

NEXT STEPS.

- Development of River structure, retention and semi-public use opportunities

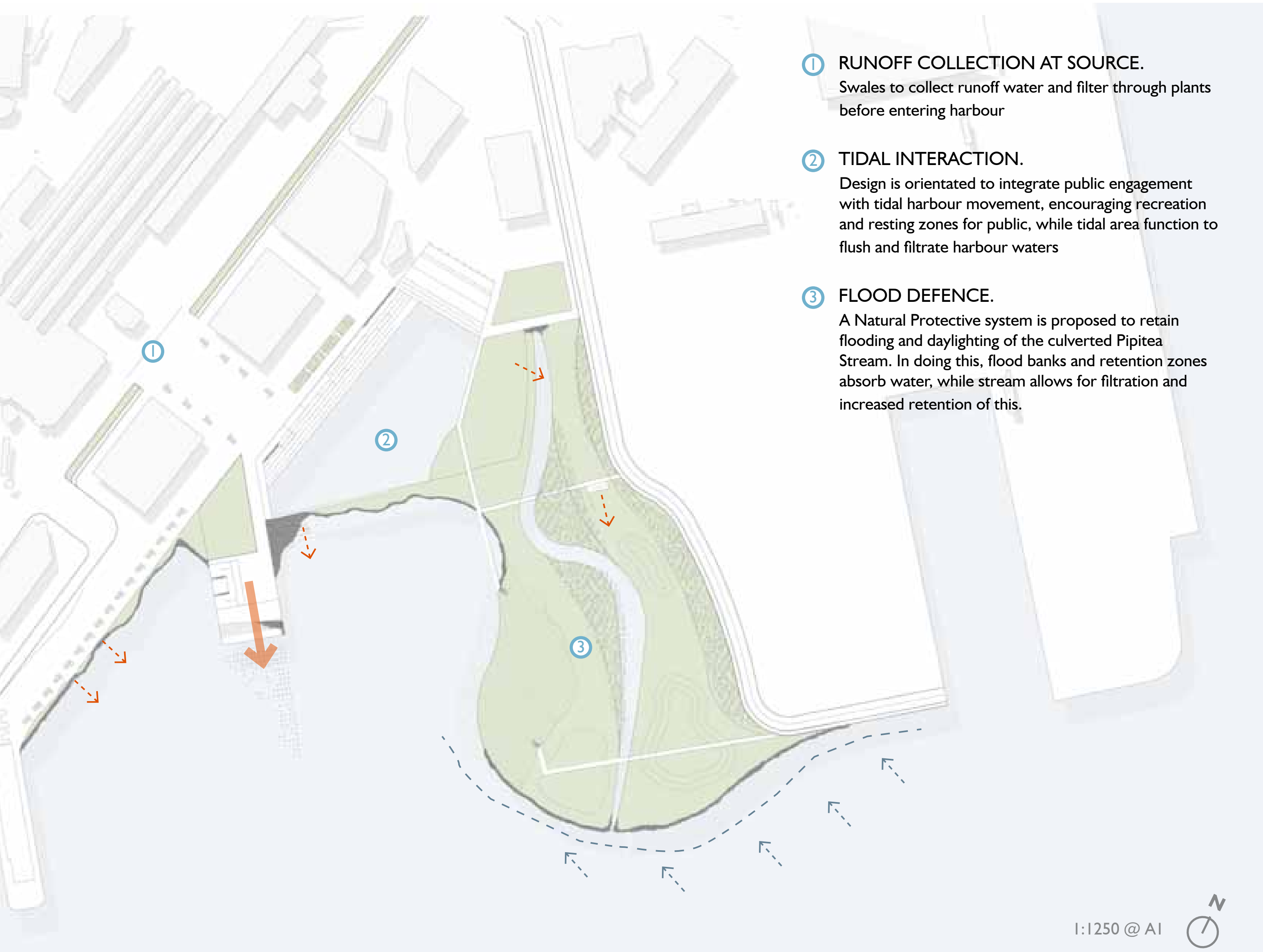
CONCEPT THREE.

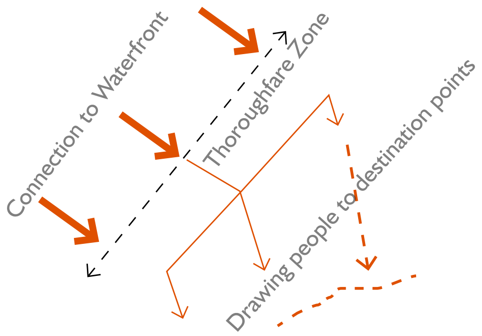
# 03.1



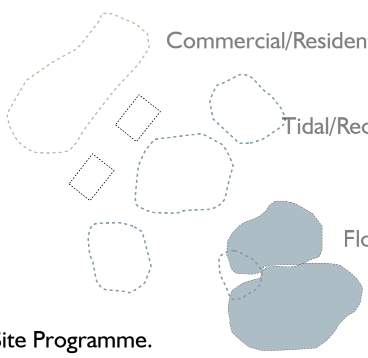

STUDY 6. CONCEPTUALIZING STREAM PROGRAMME AND FUNCTION

Fig. 8.66. - 8.68. Authors Own, Development of Conceptual Scheme Three, 2019.

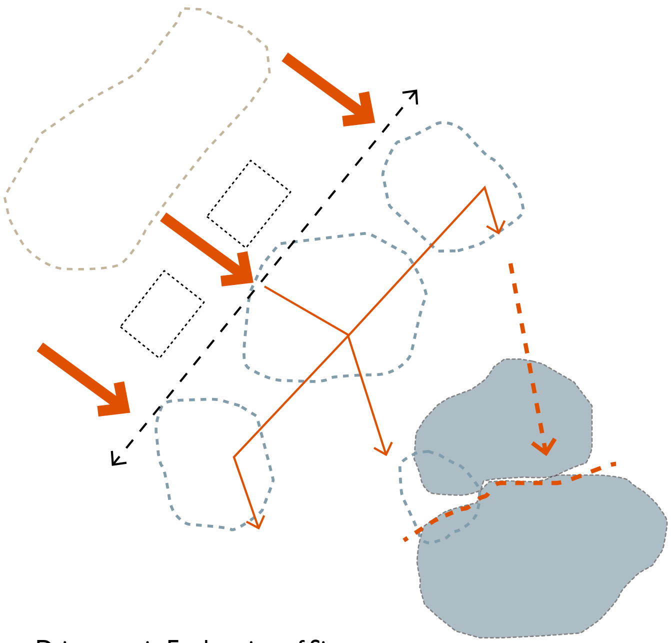



Site Circulation and Access.




Site Programme.



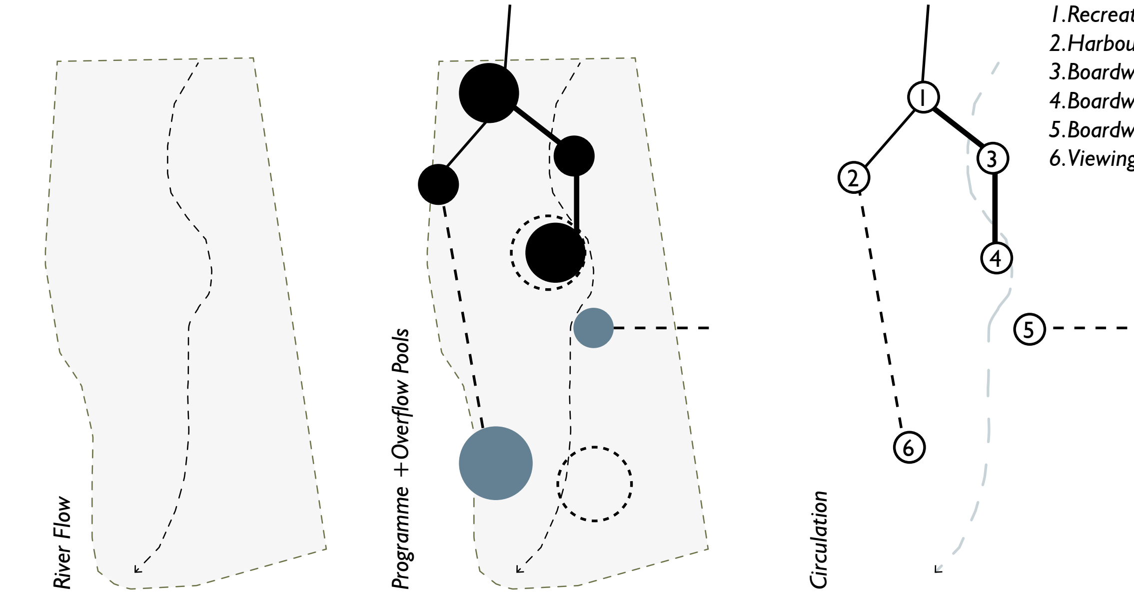
Driagramatic Exploration of Site
Accessibility and Programme Intergration

*River Formation Exploration.*

- Use all the time
- Unusable in Storm/Food Event
- Overflow Retention Zones/Possible river expansion areas

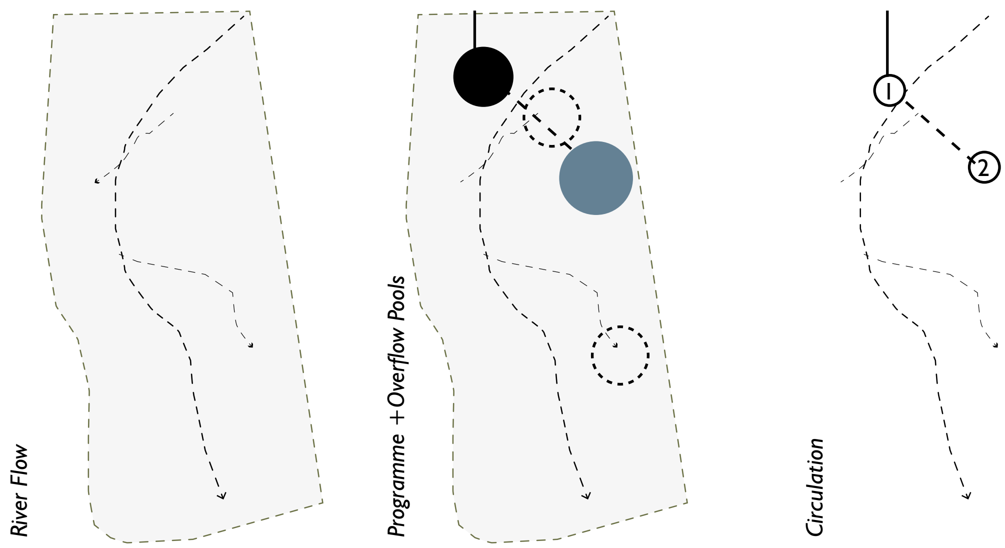
STUDY 1.

*1.Recreational Sports Field*
*2.Harbour Connection Steps*
*3.Boardwalk Platform*
*4.Boardwalk Platform*
*5.Boardwalk*
*6.Viewing Platform*



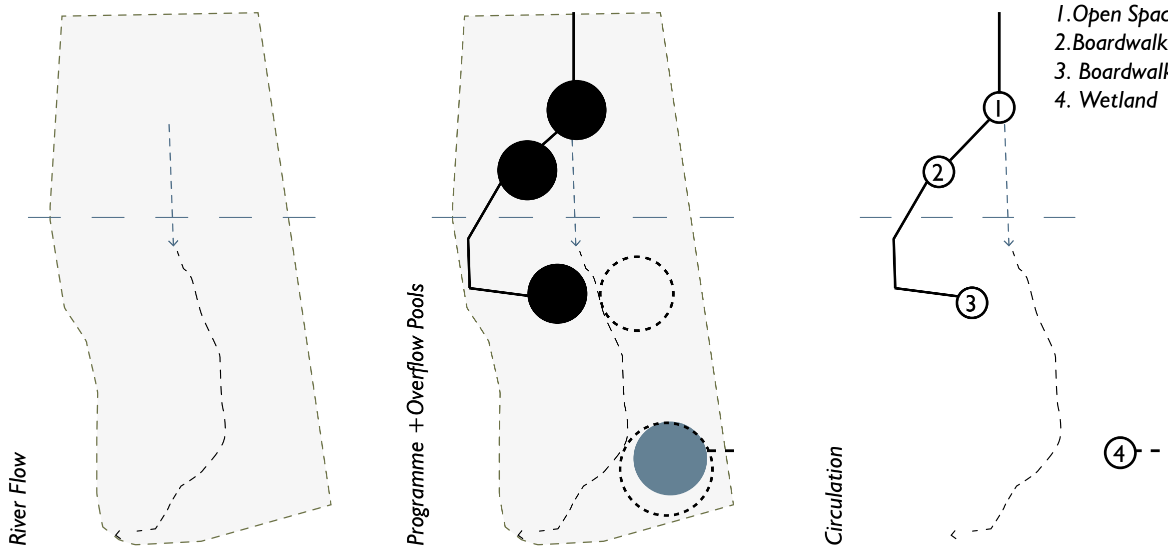

STUDY 2.

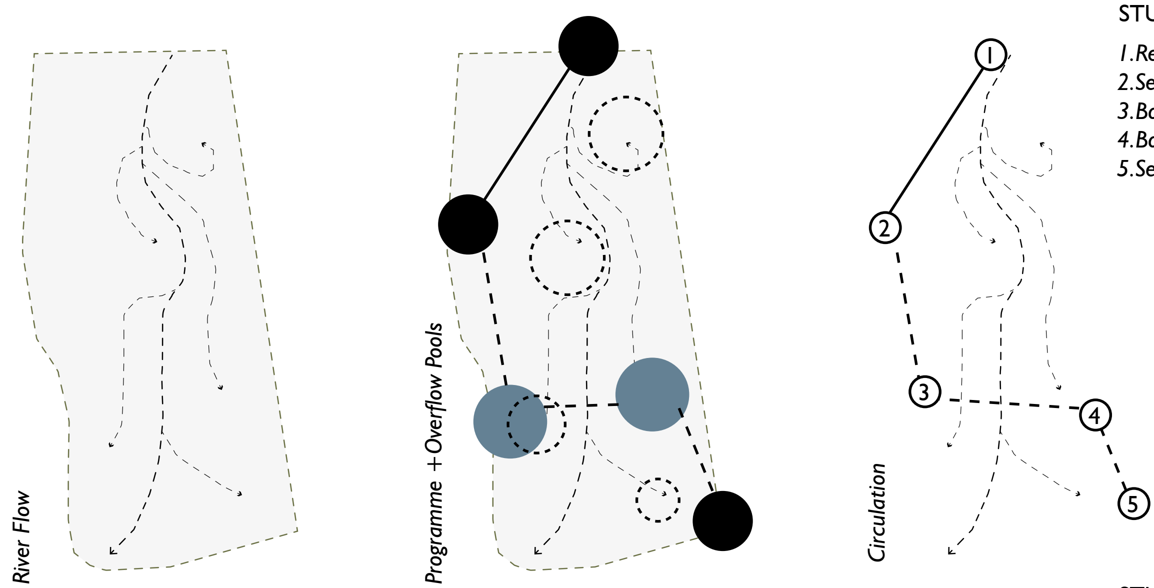
*1.Open Space*
*2.Wetland*




STUDY 3.

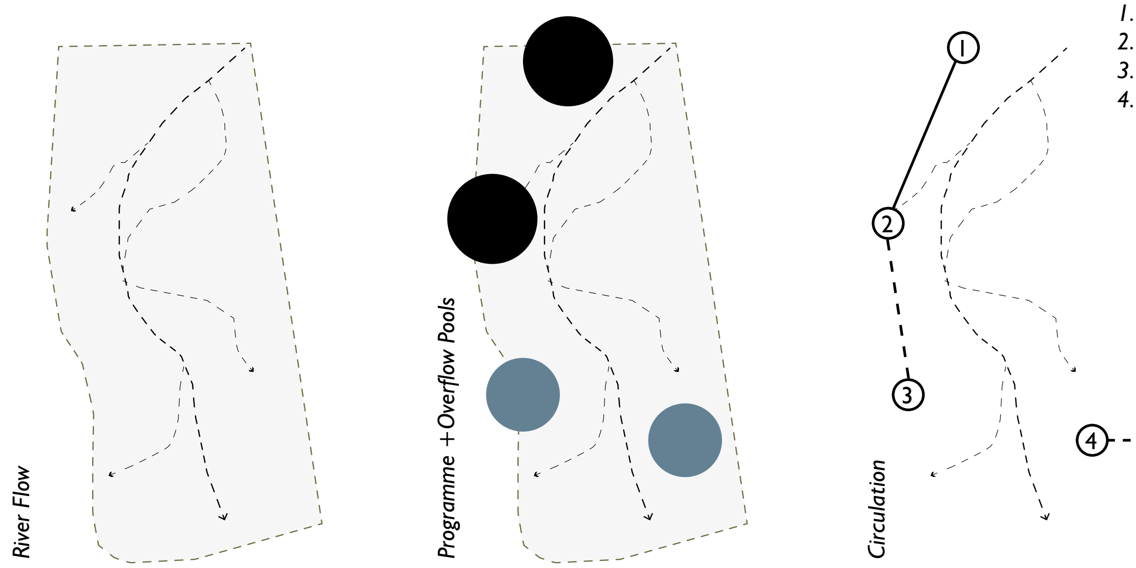
*1.Open Space*
*2.Boardwalk Platform*
*3. Boardwalk Platform*
*4. Wetland*





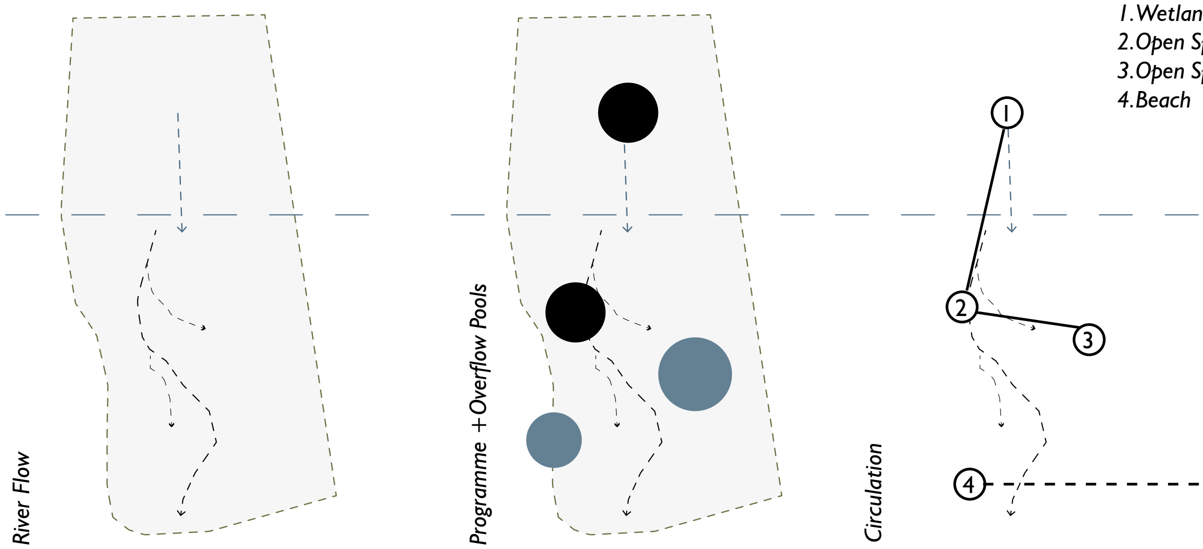

STUDY 4.

*1.Recreational Sports Field*
*2.Seating Area*
*3.Boardwalk Platform*
*4.Boardwalk Platform*
*5.Seating Area*




STUDY 5.

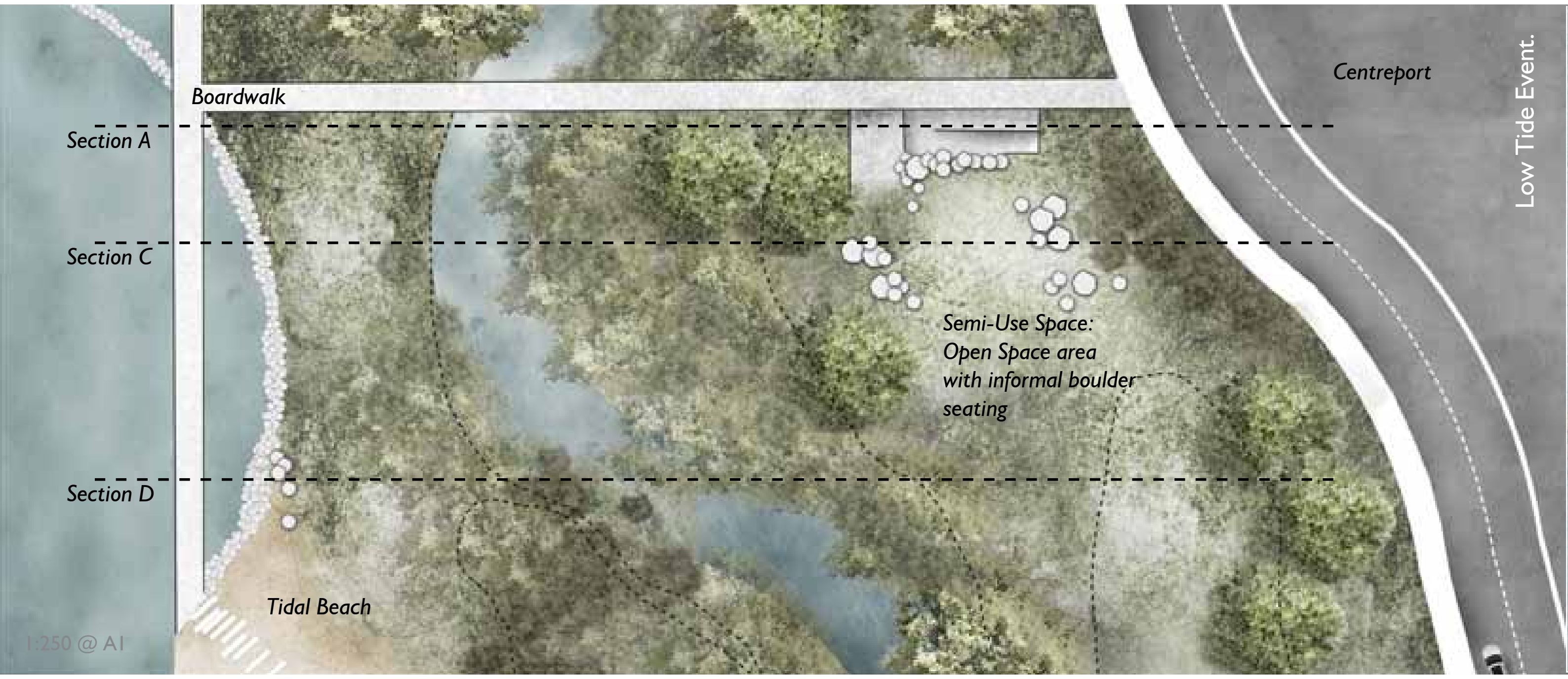
*1.Open Space Park*
*2.Boardwalk*
*3.Tidal Beach*
*4.Open Space*

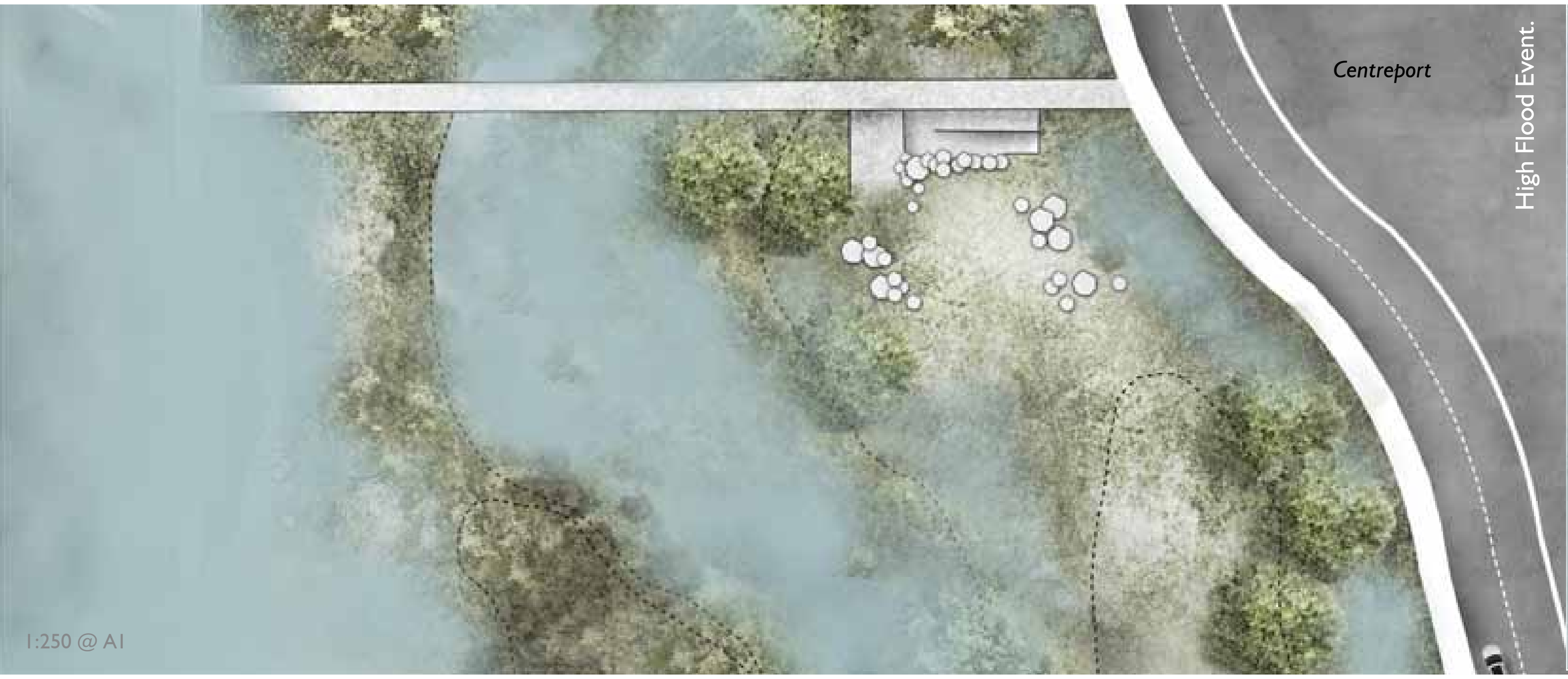


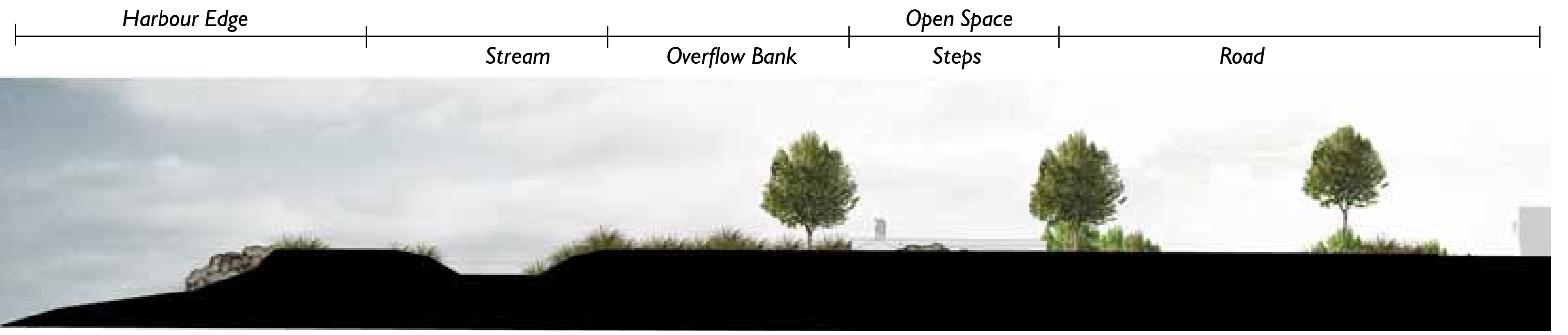

STUDY 6.

*1.Wetland*
*2.Open Space*
*3.Open Space*
*4.Beach*

Fig. 8.69. - 8.74. Authors Own, Development of Conceptual Scheme Three, 2019.



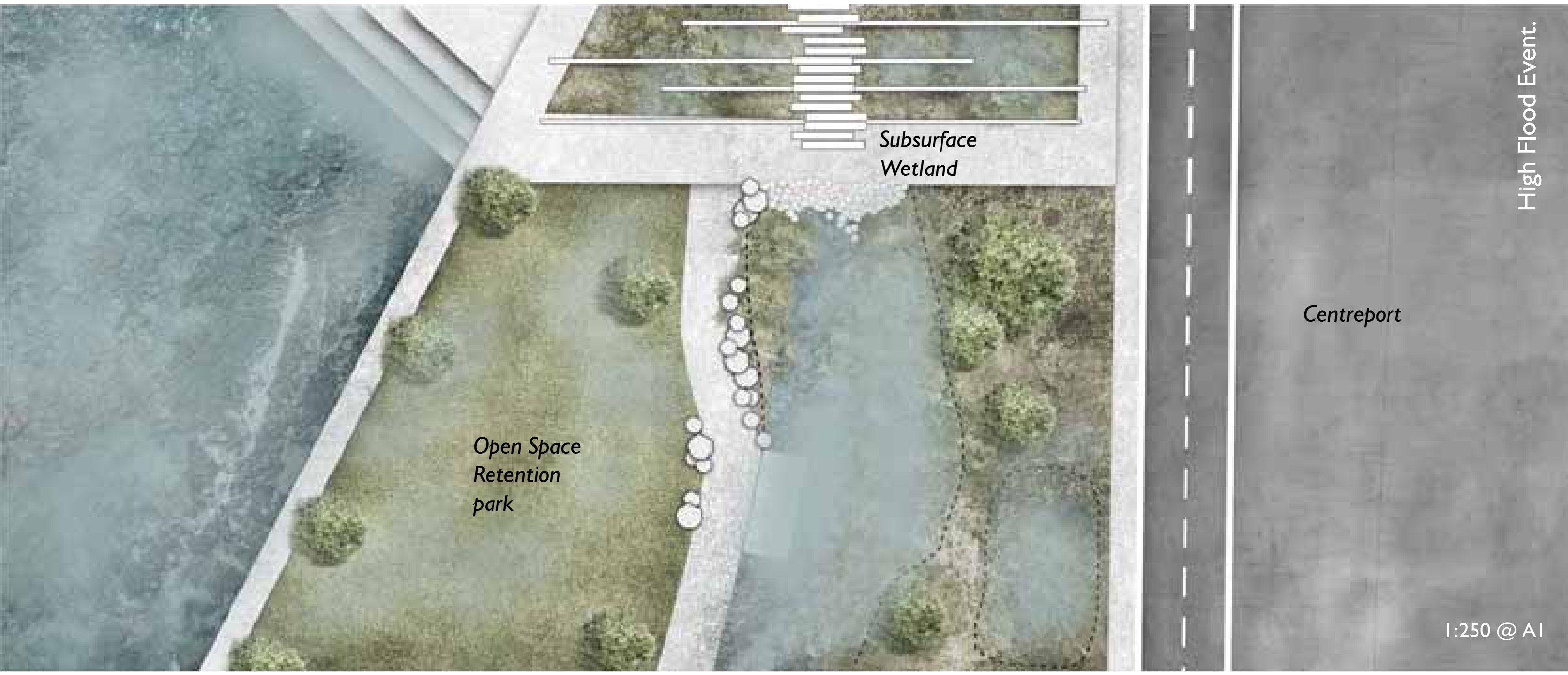



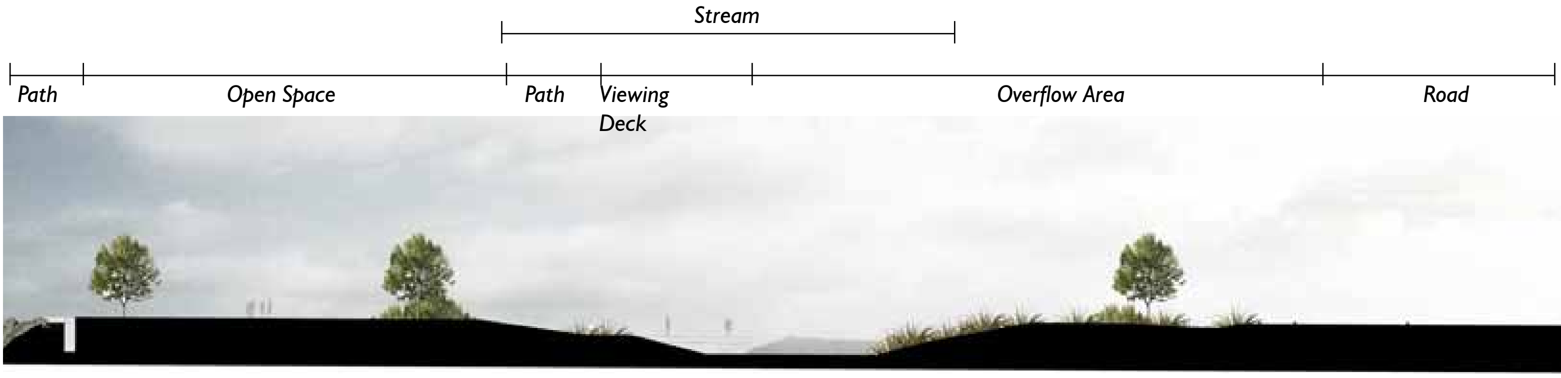

Section A

1:250 @ A1


Section A. Edge Structural Systems

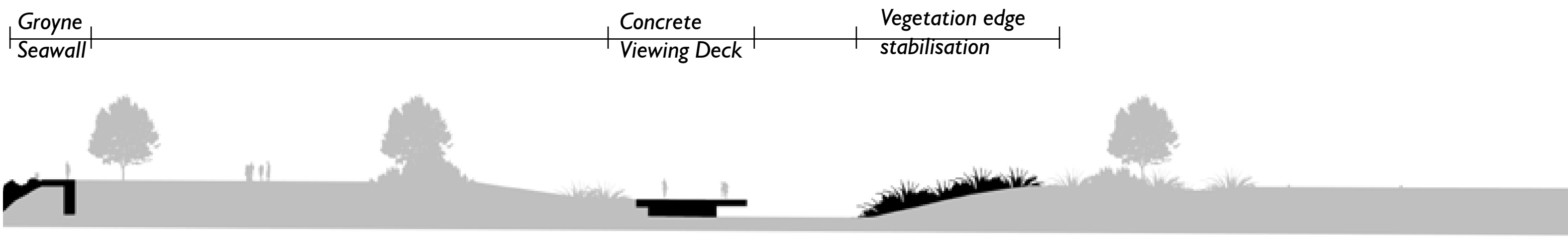
1:250 @ A1

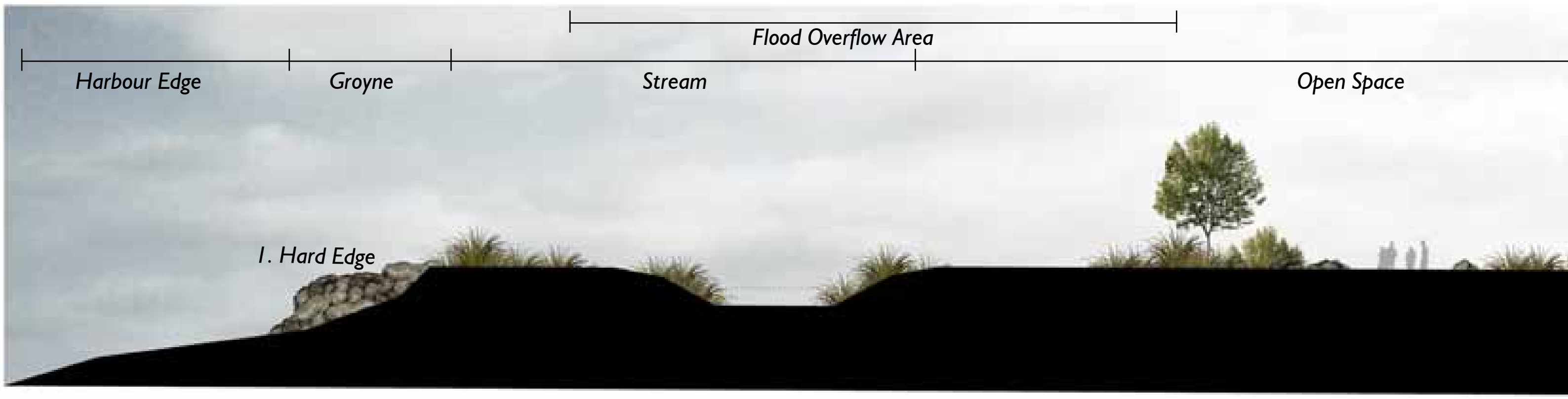

Section B

1:250 @ A1

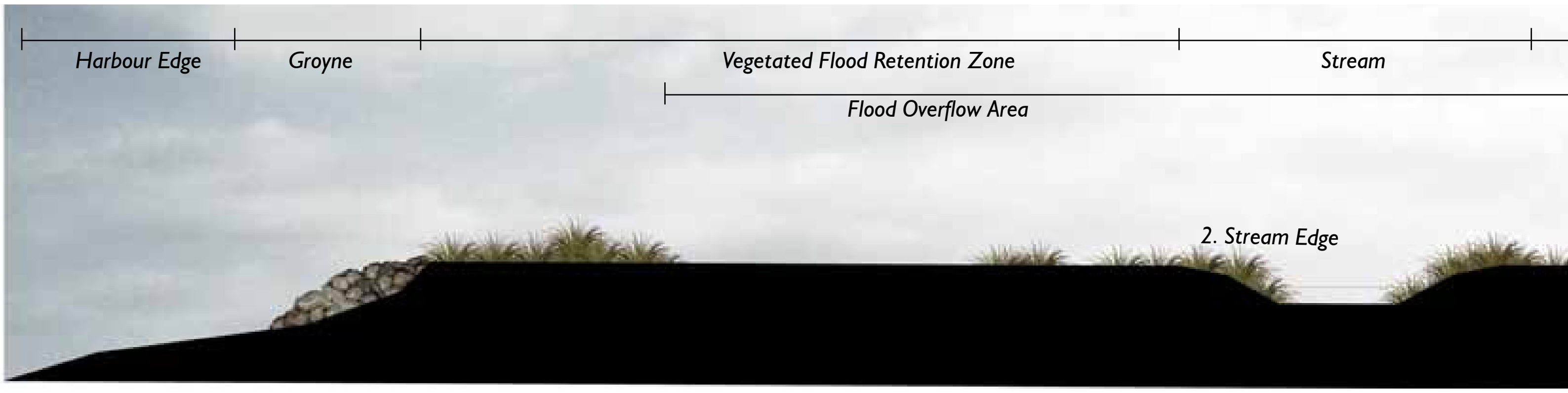



Section B. Edge Structural Systems

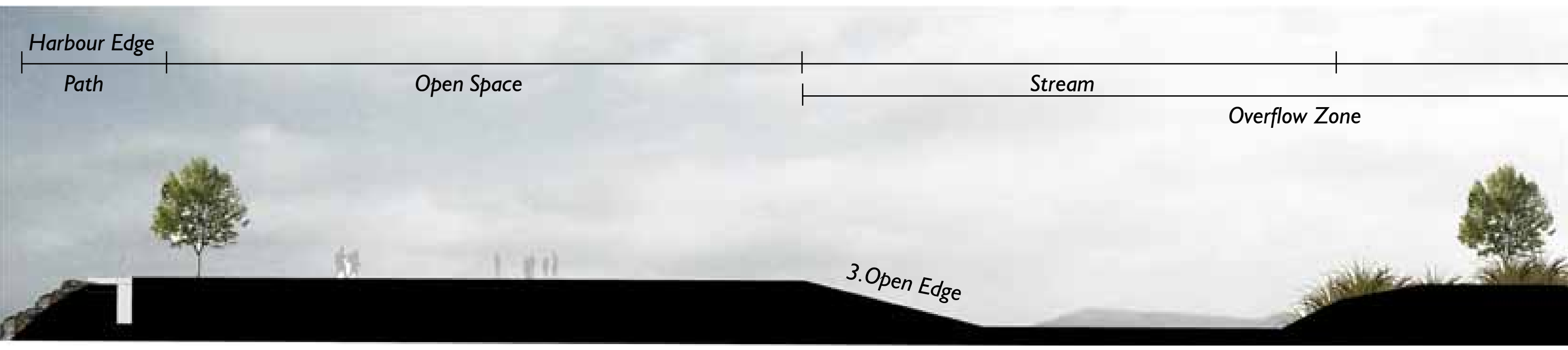
1:250 @ A1



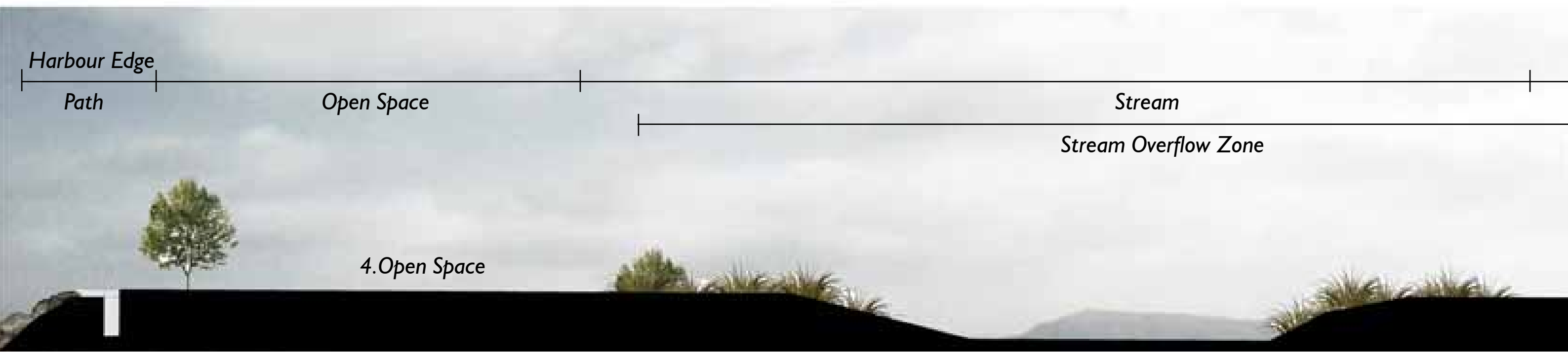

Section C




Section D

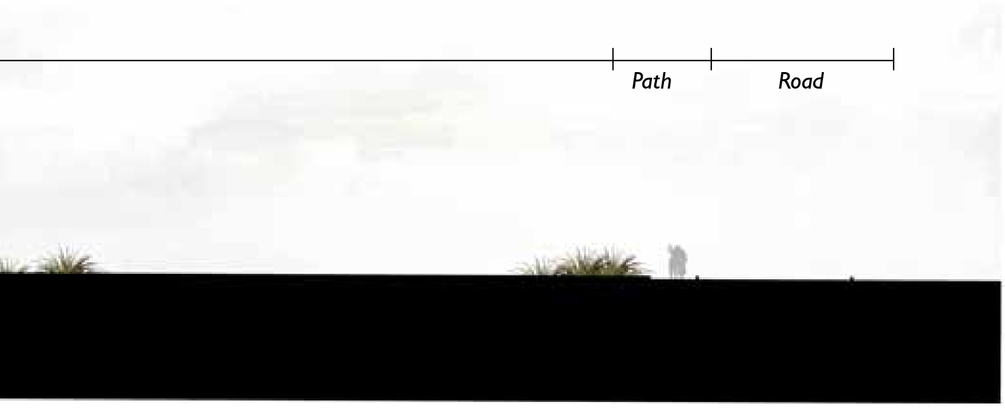



Section E



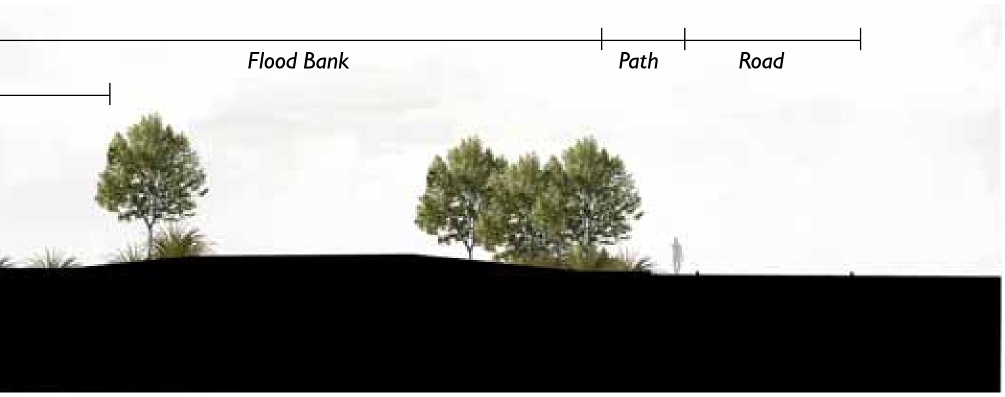

Section F

*The River Structure.*



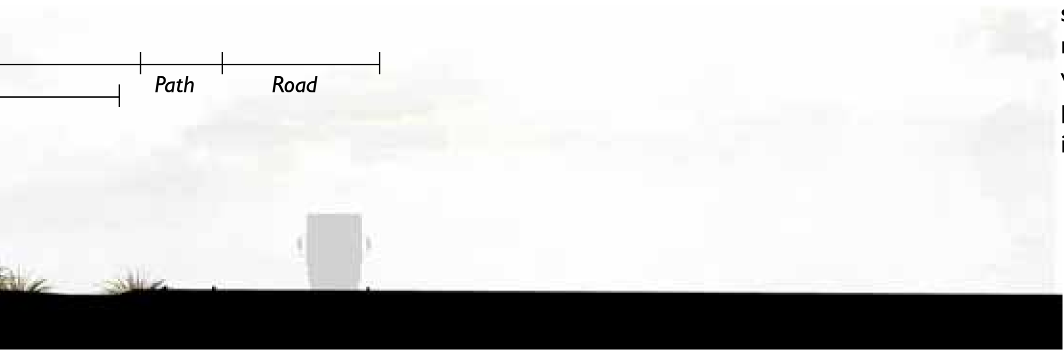

1:250 @ A1

1. HARD EDGE. The groyne structure acts for good erosion control with the harbour edge, while a contrast is seen with stream stabilisation through sloped planting. As the harbour edge absorbs high wave movement, this allows a static mitigation structure that also multifunctions as informal seating as access to the harbour.



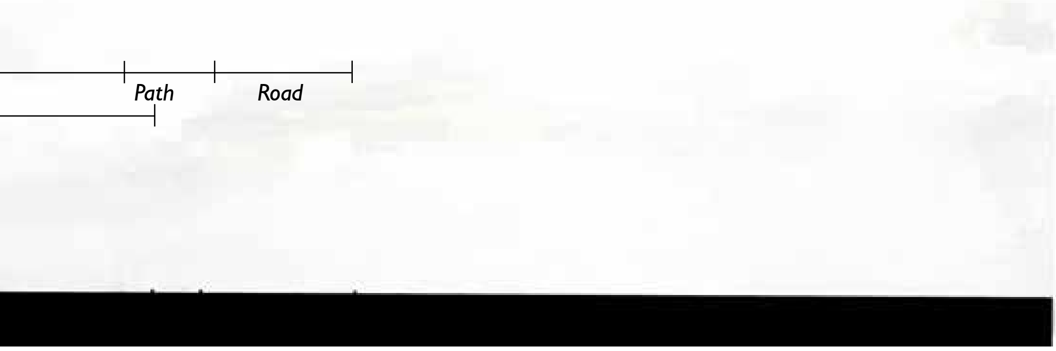

1:250 @ A1

2. STREAM EDGE. Contrasting with the static harbour edge, the stream doesn't deal with high wave inundations therefore extra stabilising isn't needed. The planted slope vegetation creates a stable barrier for the stream while absorbing high water levels in flood events.




1:250 @ A1

3. OPEN EDGE. The sloped open stream edge allows for people to move closer to the stream. With low water velocity through this zone, people can enter the stream for an immersive nature experience.

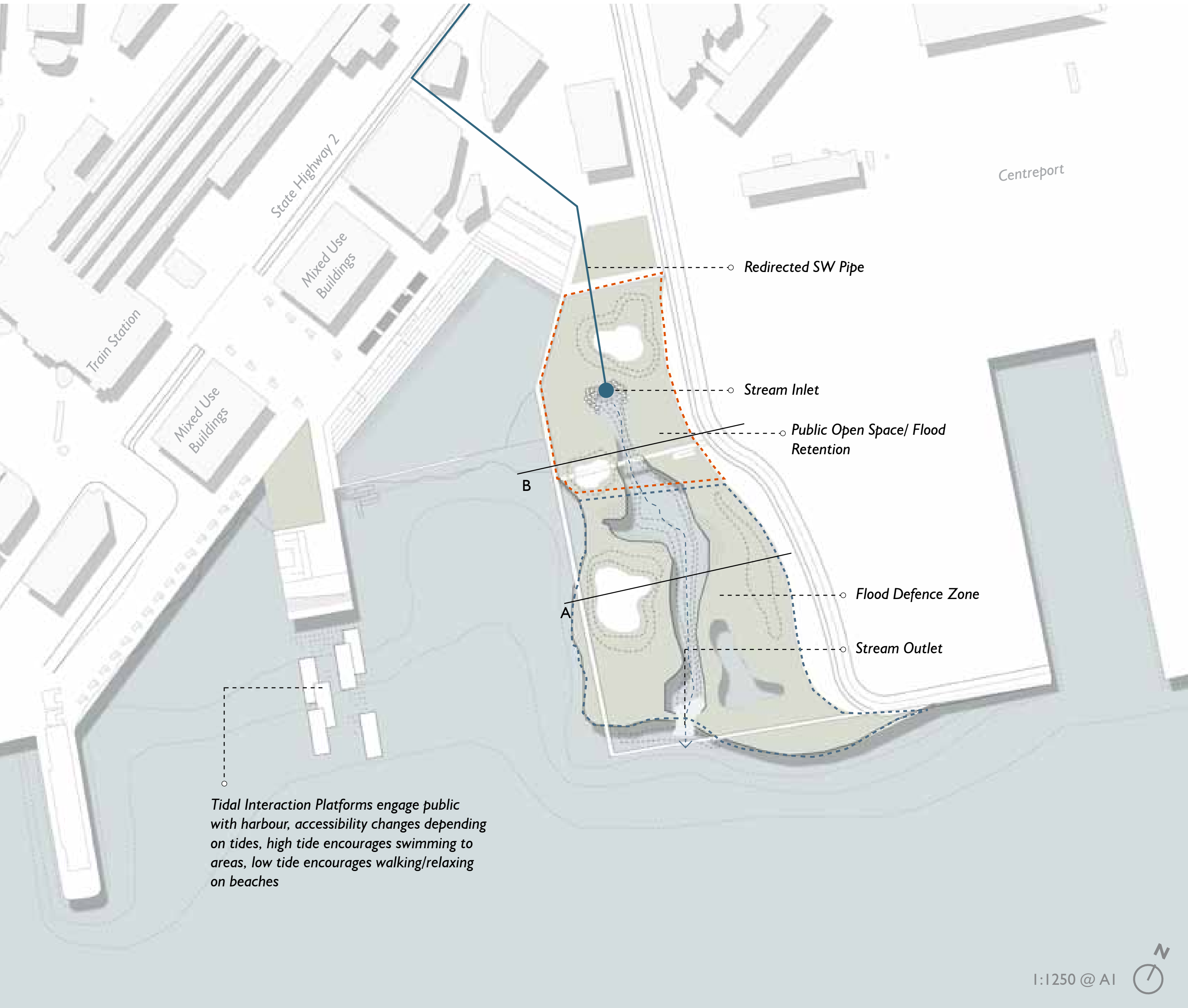



1:250 @ A1

4. OPEN SPACE. Open space creates for a good permeable and adaptable space in event of flood events. It can absorb water and during fine weather can function as recreational space.

Fig. 8.75. - 8.82. Authors Own, Development of Conceptual Scheme Three, 2019. (Pages 218-219)

Fig. 8.83. - 8.86. Authors Own, Development of Conceptual Scheme Three, 2019.




## FINDINGS.

A refinement of stream structure was identified from previous conceptual form studies, this however was refined further into breaking down catchment and filtration structures. What was seen successful through this design was the open space provided for adaption to flooding. Large banks were utilised to mitigate wave energy and re direct runoff into retention ponds. This created a successful use of flood adaptive design where public could access certain areas of open space, and some areas untouched for natural protection and preservation of habitual environmental sites. A large area was needed for this in order to provide the most beneficial outputs natural systems could provide, as they are always changing forms and shape. With this in mind the flow and outlets were carefully considered, however there is still potential to tie within the urban fabric, integrating WSUD and transitioning in to stream. Inlet and outlet functions can be studied for further development.

## NEXT STEPS.

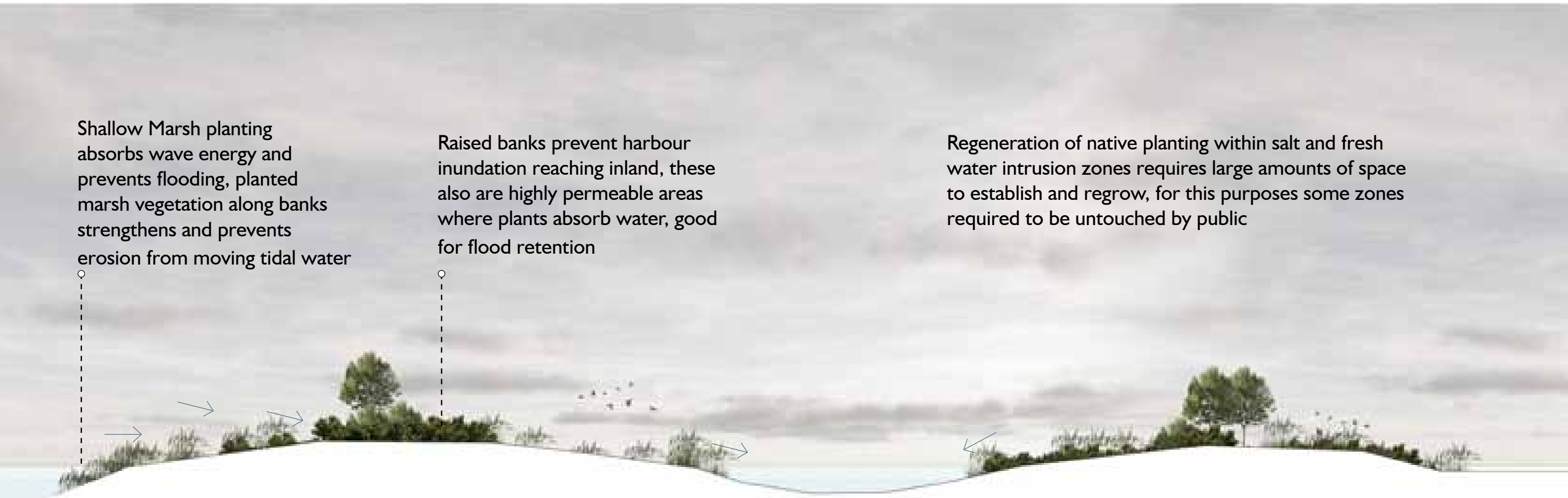
-Connection with urban fabric, SW treatment transition to stream
-WSUD connection with existing urban context for flood mitigation
-Road structure and access to waterfront + WSUD integration to capture water from source

CONCEPT THREE.

# 03.2

STREAM STRUCTURE.

Section A. Habitat Oriented Zone. 1:150 @ A1

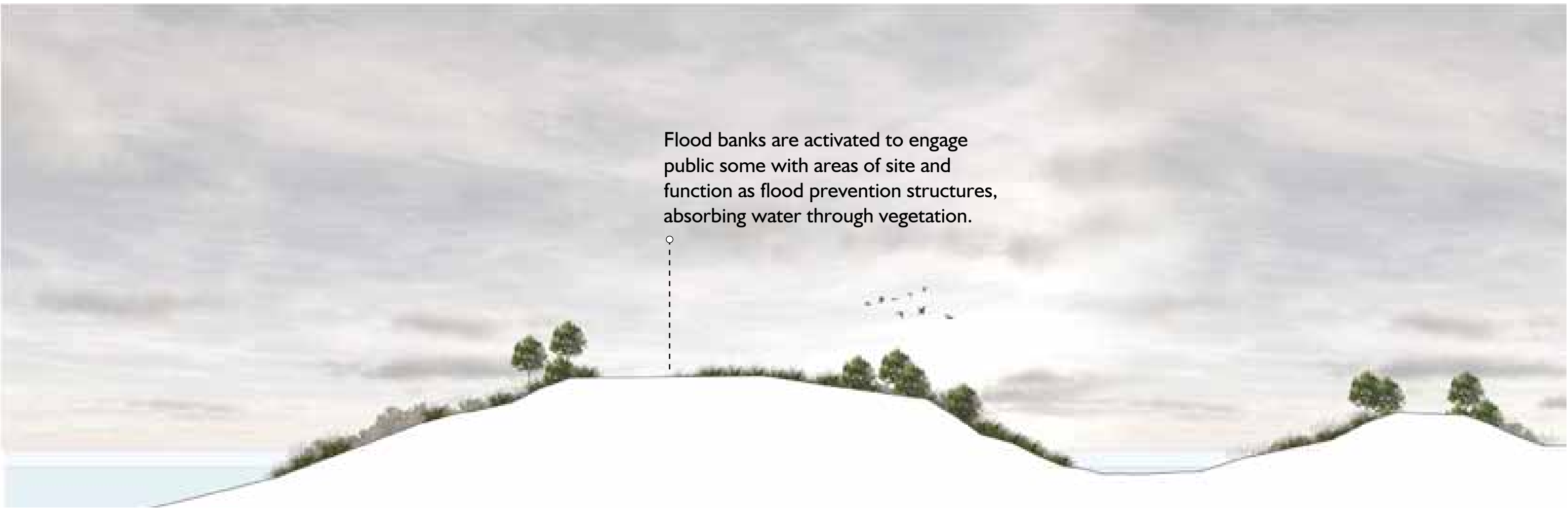



*Salt Water* *Fresh Water*

*Marsh edge* | *Flood Bank* | *Marsh edge* | *Stream* | *Marsh edge* | *Flood Bank*

STREAM STRUCTURE.

Section B. Public Oriented Zone. 1:150 @ A1




*Salt Water* *Fresh Water*

*Tidal Marsh* | *Flood Bank/Open Space* | *Marsh* | *Stream* | *Marsh* | *Flood Bank/ Open Space*

Fig. 8.87. - 8.89. Authors Own, Development of Conceptual Scheme Three, 2019.


1:1250 @ A1

**Urban to Harbour Structure Iteration 1.**

Access to Site

Access to Water

SH2

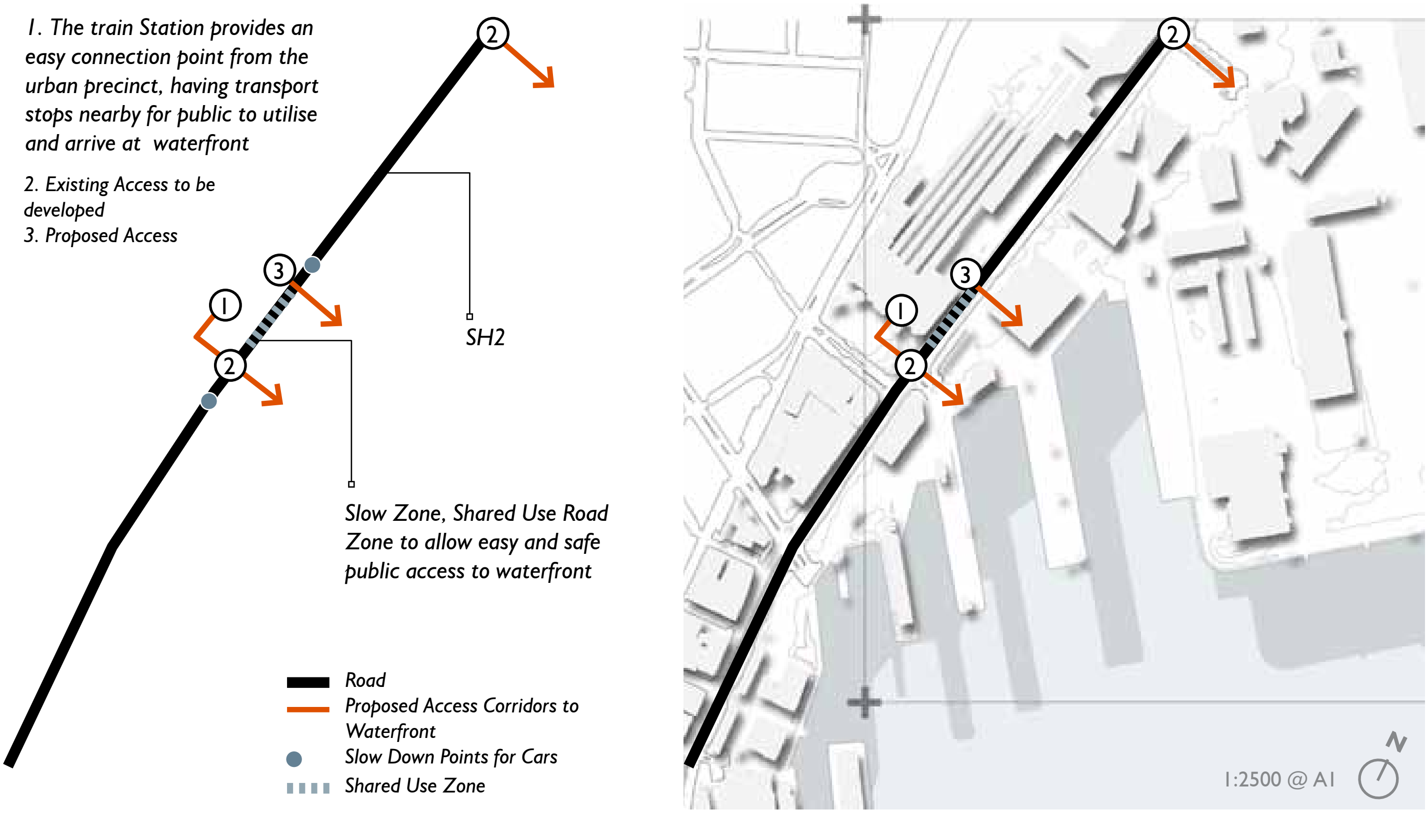
## FINDINGS.

Through conceptual studies, ideas have been developed and forms have been tested to move further with. Through this process there was a lot of identifying, going back and refining. In doing this what was found successful was identifying certain potentials of design and further testing them through form. Once something was seen to show full potential of achieving a design aspect, it was further used as a key design component. Through this conceptual development, it was found successful of integrating and understanding user interaction, this was further explored and increase the interactional with ecological systems and public use. The stream integration was is also shown as a positive system reflecting the potential of site adaptability if priority is given back to nature. This not only is a self-sufficient and protective system, it created unique user experiences.

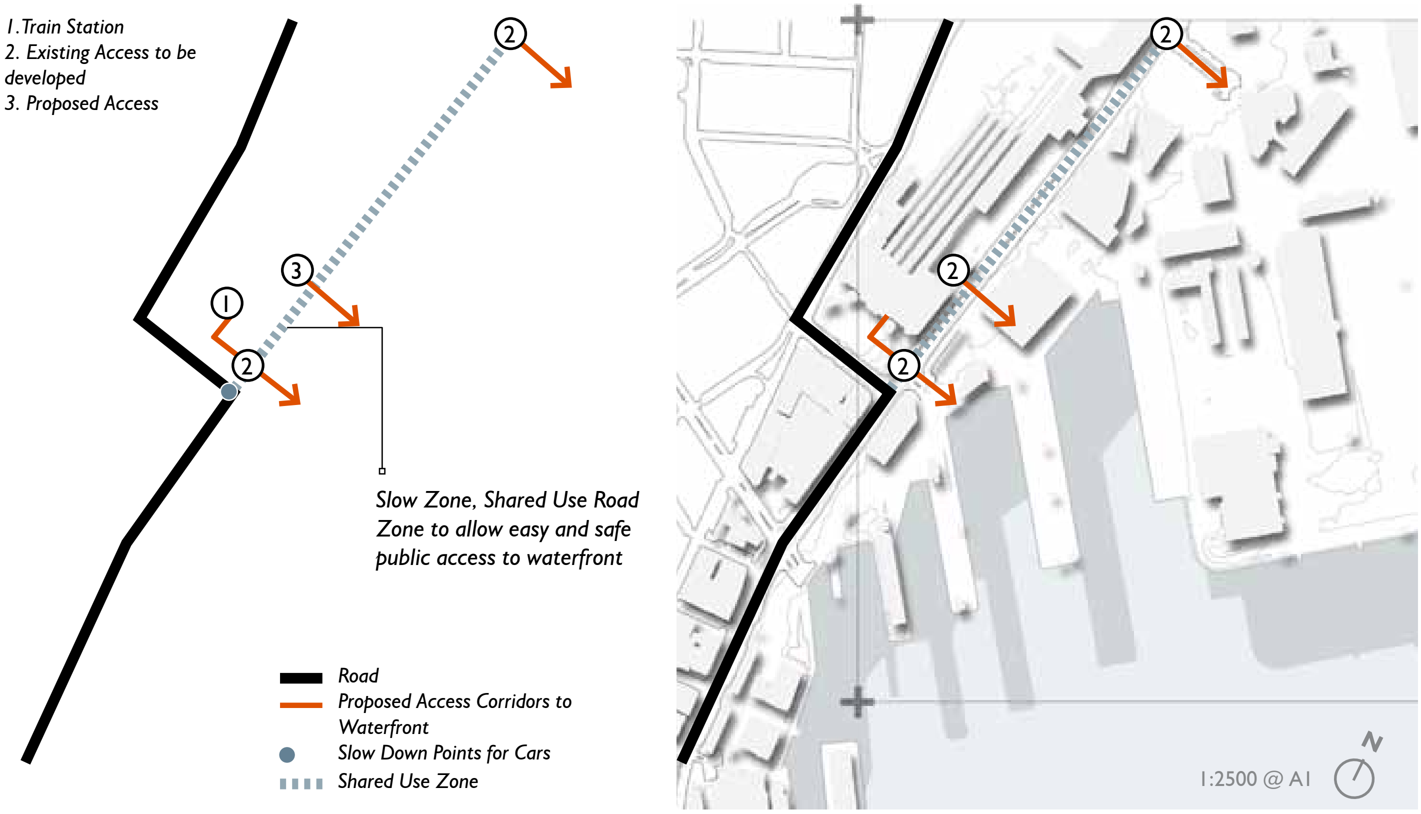
## NEXT STEPS.

- Public Interaction with Flood Park could be improved
- Refine Tidal Zones for enhanced public and water interaction

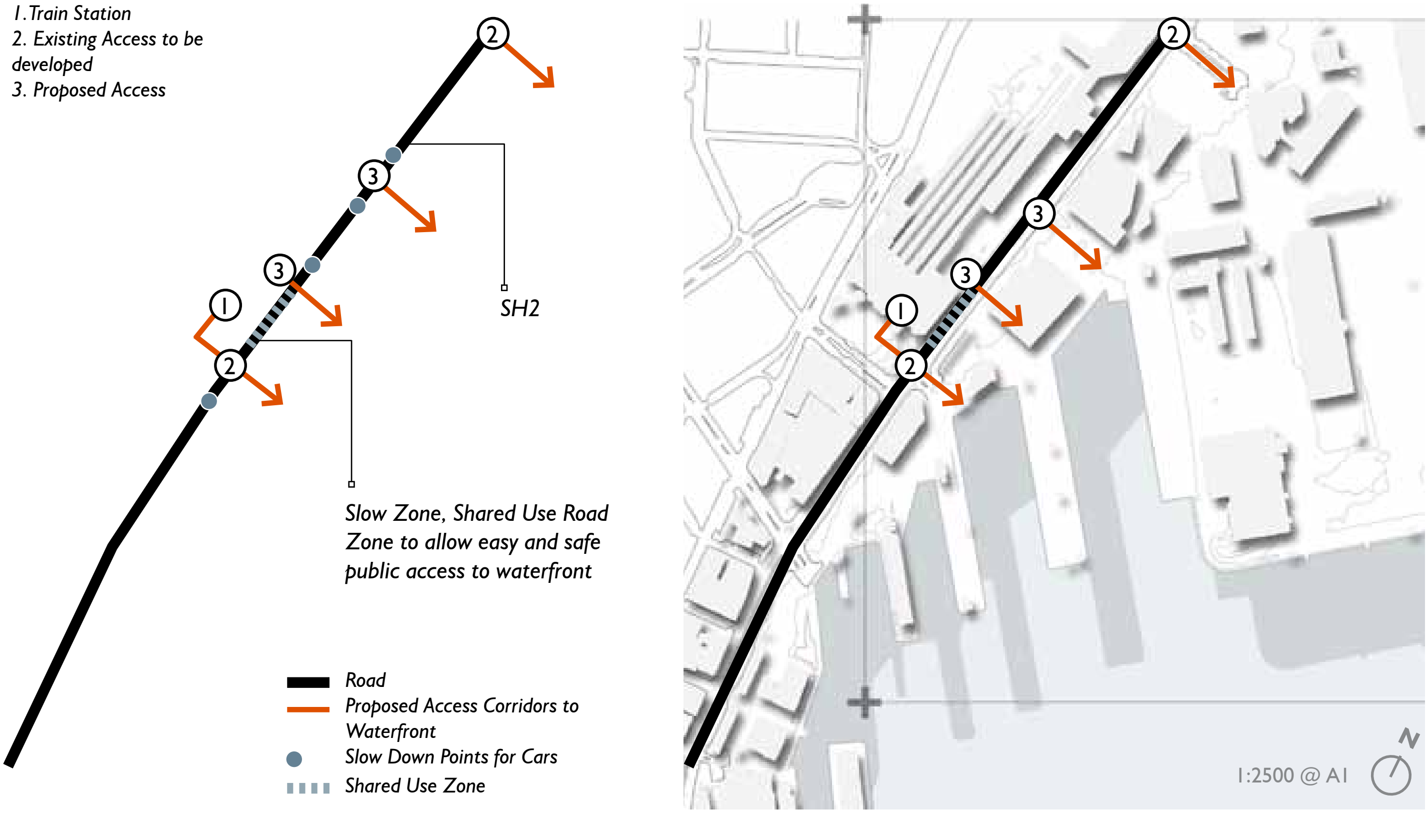
## Urban to Harbour Structure Iteration 1.




## Urban to Harbour Structure Iteration 2.



**Urban to Harbour Structure Iteration 3.**




**Urban to Harbour Structure Iteration 4.**

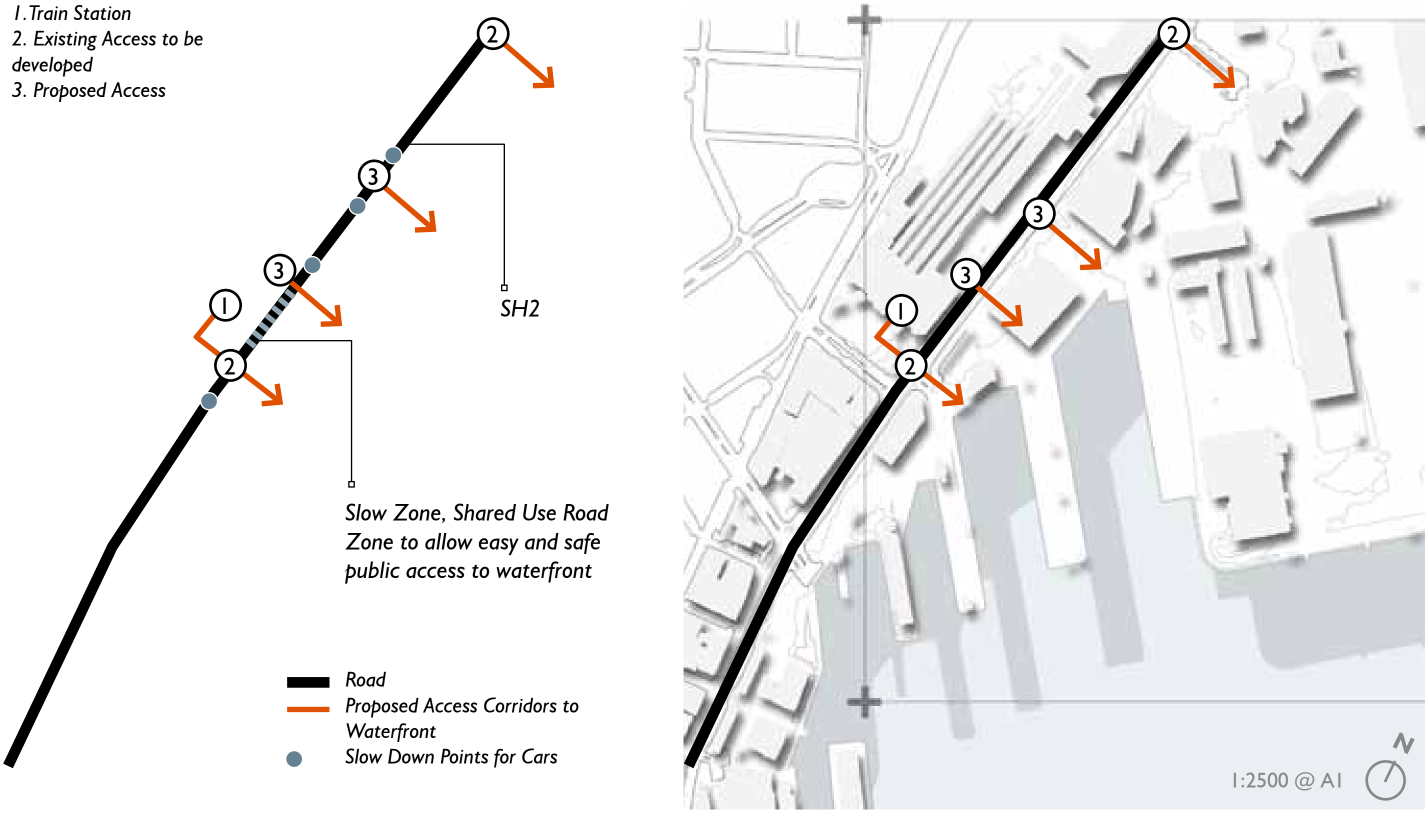



Fig. 8.90. Authors Own, Development of Conceptual Scheme Three, 2019. (Page 215)

Fig. 8.91. - 8.94. Authors Own, Development of Conceptual Scheme Three, 2019.

# 09

## Refined Design.

**CHAPTER NINE.**

| | |
|---|---|
| Refined Design | 228 |
| Masterplan | 230 |
| Structural Design Systems | 242 |
| Stream Structure | 250 |
| SW Design | 266 |
| Zoning | 278 |
| Coastal Edge Types | 324 |
| Findings | 346 |
| Reflection | 348 |

Fig. 9.01. Authors Own, Tidal Beach Waves, 2019.

## REFINED DESIGN.

This thesis addresses the implications climate change, in particular flooding/ storm surge and sea level rise could pose on Wellington's vulnerable and ecologically indefensible site. Through the design process it was studied how Wellington could best adapted to the arising conditions, and provide a positive site opportunity to embrace the conditions. Waterfront resiliency and adaptable flood design was studied within the purpose of enabling a multifunctional use of space. In order to achieve this, design principles were placed to deal with the current sites conditions of an unused and industrial port space prone to flooding and being a massive contributor to harbour pollution.

| Design Principles | |
|---|---|
| Breathable Wharf Ecologies<br>Social Destination Points<br>One Large Infrastructural System<br>Permeable Residential Space<br>Raised Seawall | Design Principles |

The refined design looks at the potential of social and ecological boundaries working together. While natural and engineered systems are functioning, there is a positive opportunity created for public interaction with space that encourages users to enjoy the waterfront and maximise harbour and tidal interaction. With this, the design is broken into three main functioning components that addresses the aims of this thesis;

ABSORBENT STREETS – Planting buffers throughout streets create for good water absorption. This helps in events of high rainfall and flooding, to absorb excess water and direct to another location easily. By implementing and increasing the permeability of these areas, run off can be captured at source to reduce further pollution entering harbour.

TIDAL POOLS – These create for good public use, encouraging public interaction with water depending on tidal levels. It also works as good water retention in flood events being an embodied structure within site.

FLOODABLE PARKS – Wetlands create for good water retention, these can also filter and transport water to different locations, similarly with streams which withhold large quantities of water in events of flood, due to rain and vegetation absorption. The floodable park is a central design feature, it is an important water catchment body as its natural composition allows for self-sustaining water drainage. Theorists such as Kate Orff emphasize the importance of natural systems such as this, which naturally defend and protect environments through its self-sustaining bodies.


03
02
01

01 - Absorbent Streets
02 - Tidal Pools
03 - Floodable Park

DEVELOPED DESIGN.

1:1250 @ A1

Fig. 9.02. Authors Own, Refined Masterplan, 2019.

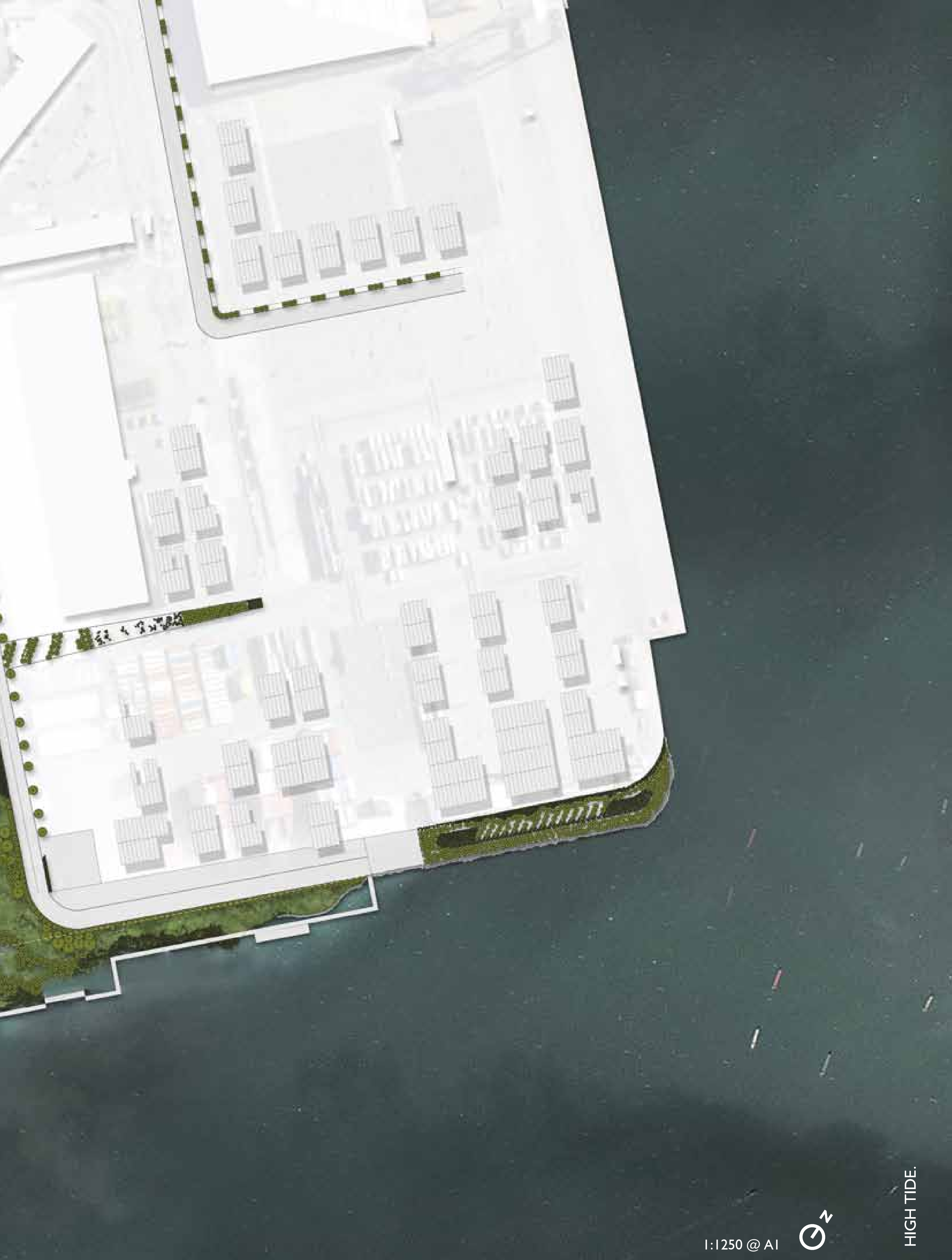



Fig. 9.03. Authors Own, Design in High Tide, 2019.


Fig. 9.04. Authors Own, Design in High Flood Event, 2019.

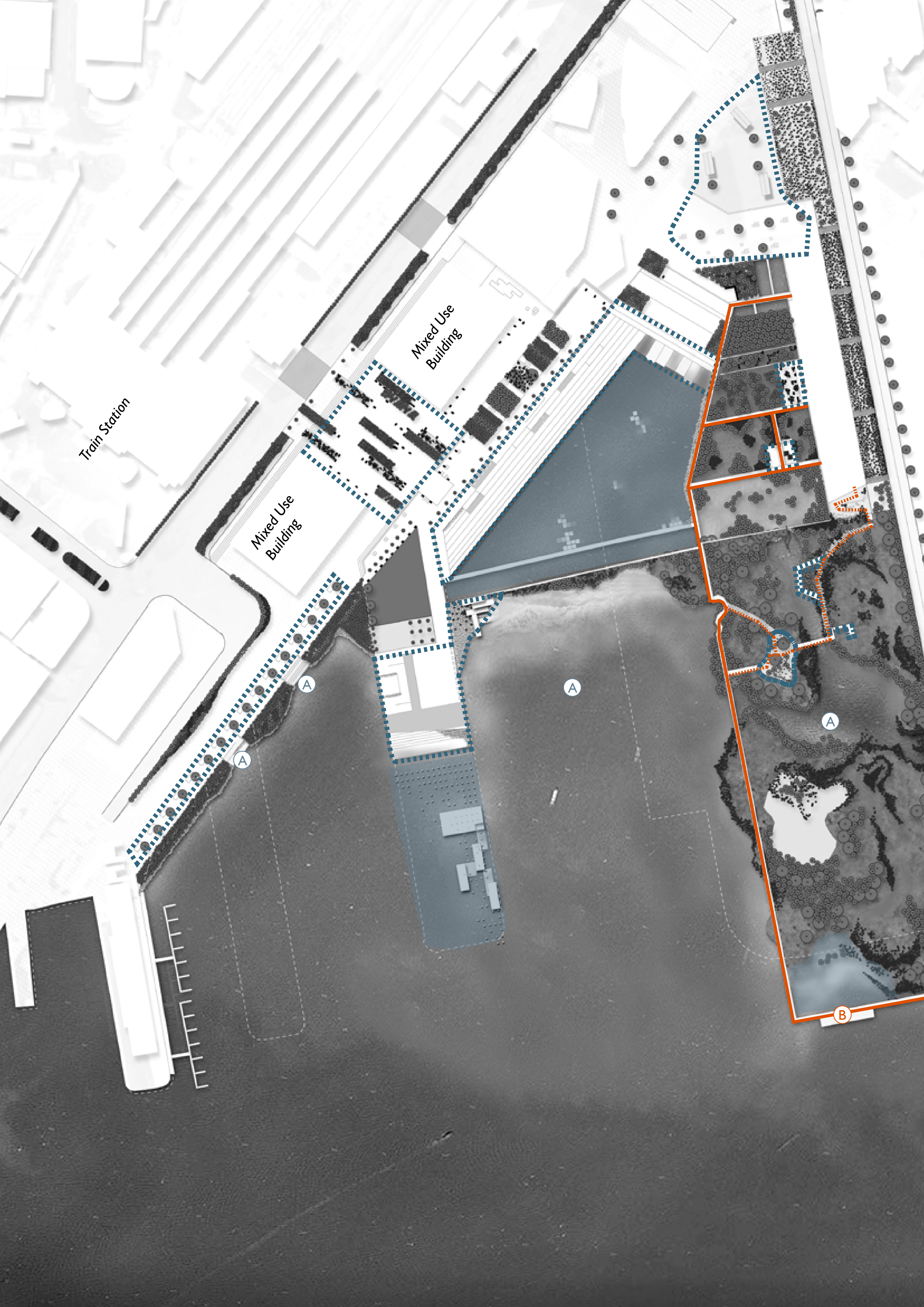
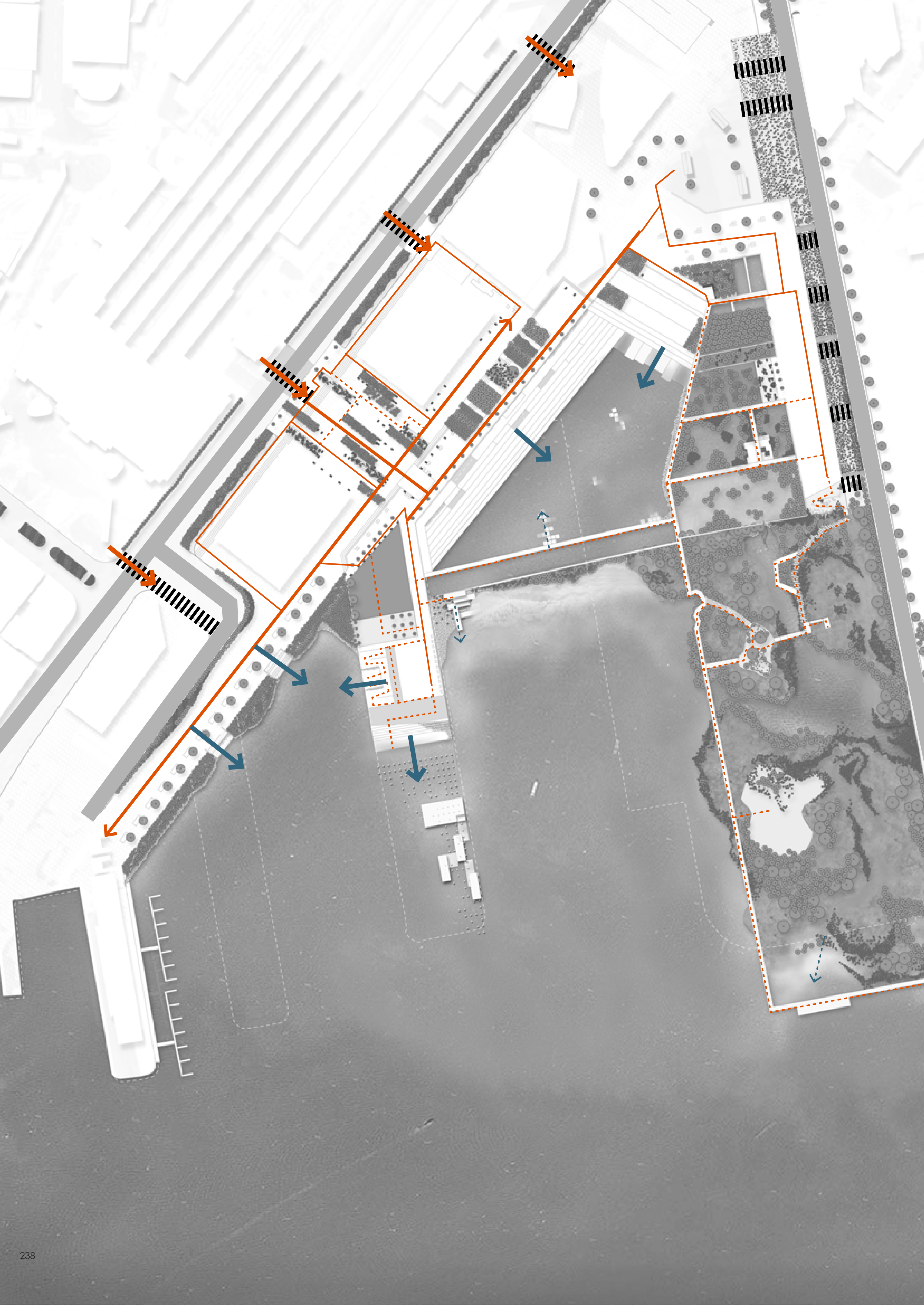
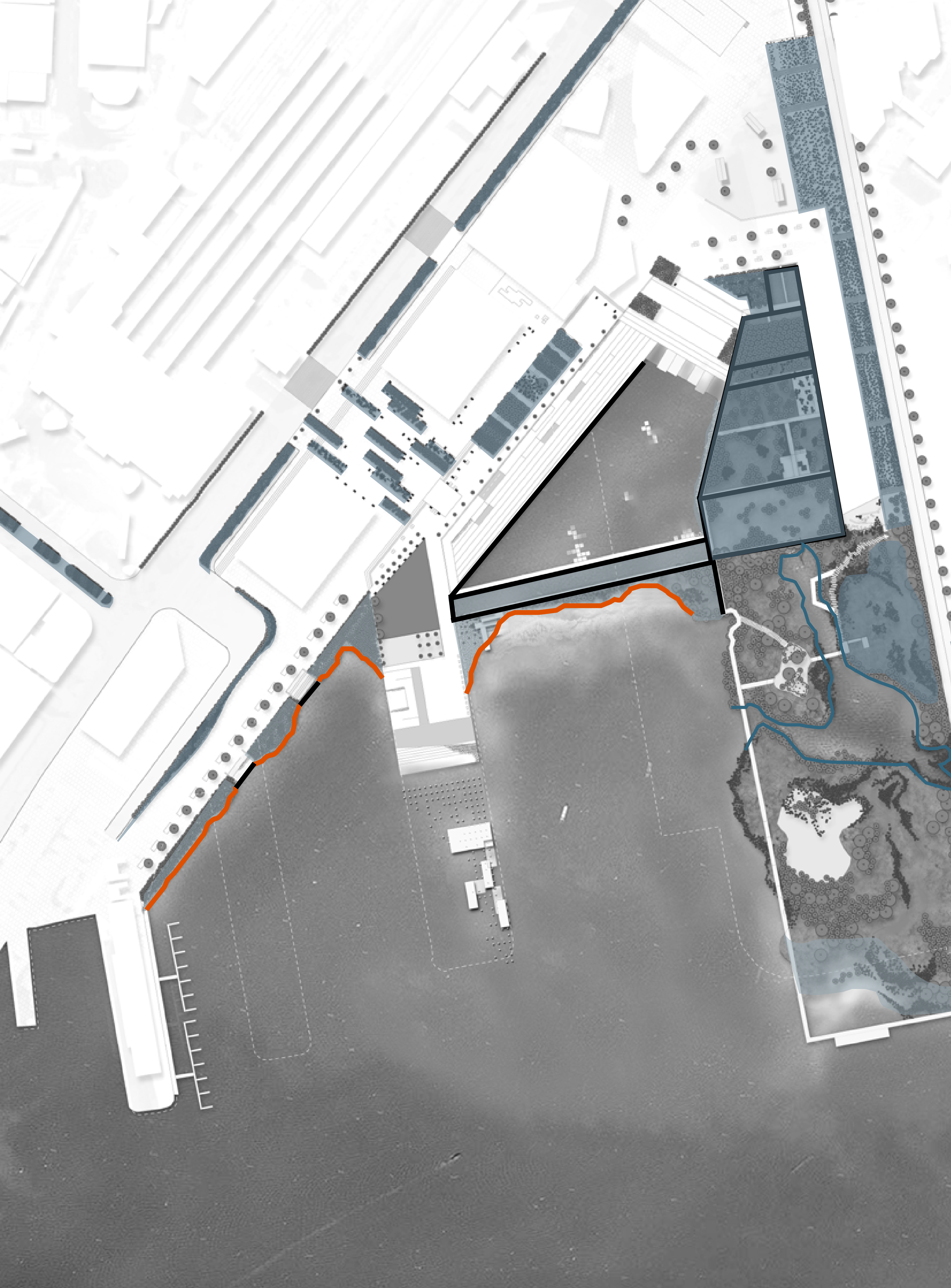

Train Station
Mixed Use Building
Mixed Use Building
A
A
A
A
B


Fig. 9.05. Authors Own, Design Activities, 2019.



ACCESS & CIRCULATION.


Fig. 9.06. Authors Own, Design Access and Circulation, 2019.



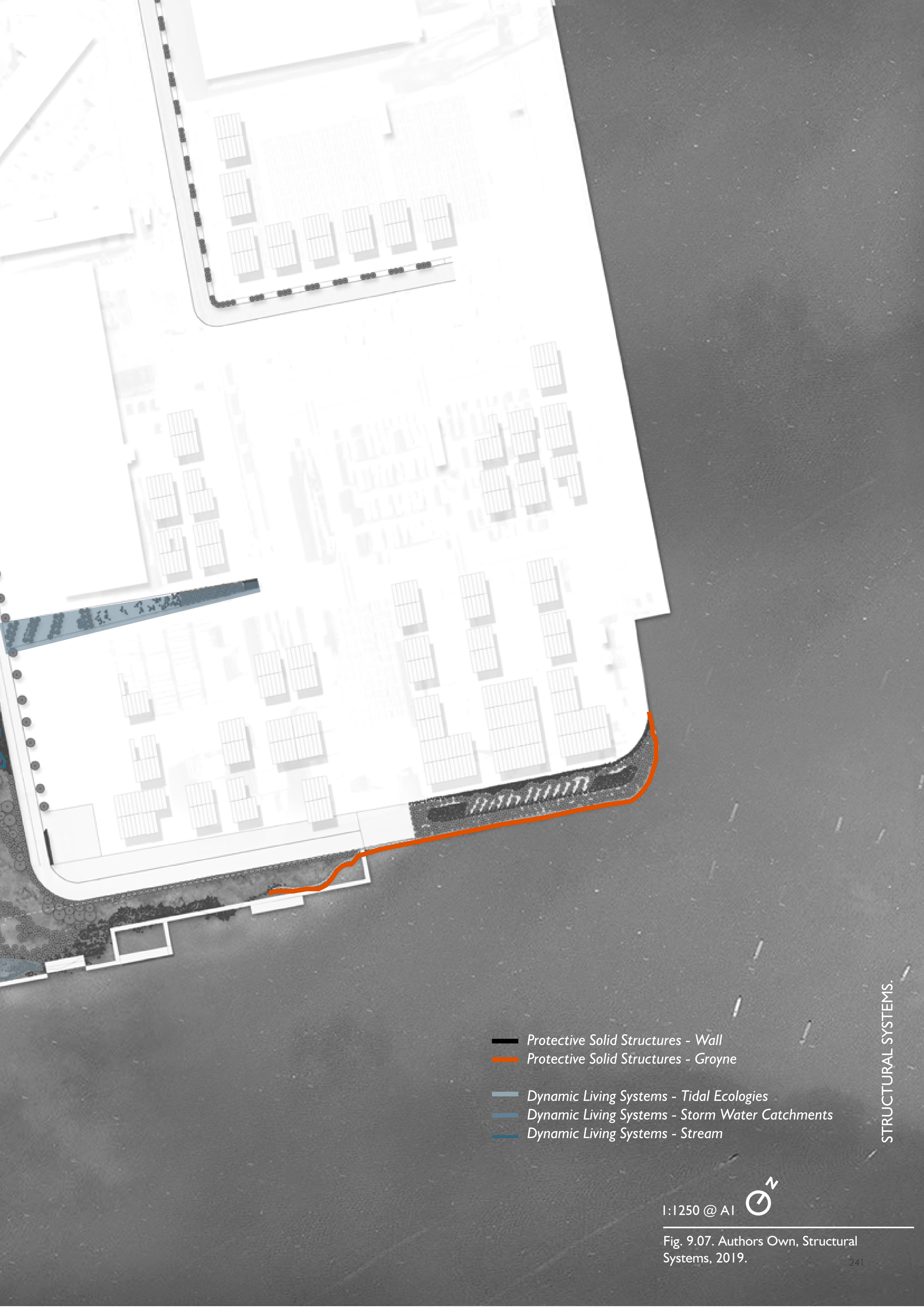





Fig. 9.07. Authors Own, Structural Systems, 2019.

Event 1 - Walk through coastal marsh edge.

STRUCTURAL SYSTEMS

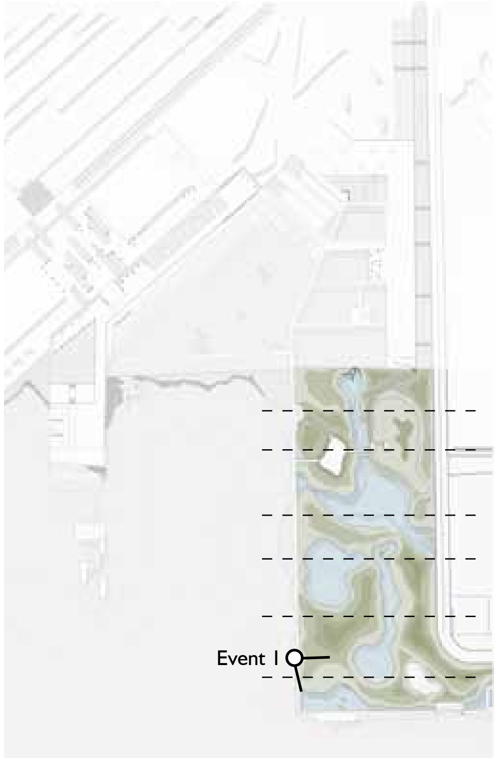
Two pivotal harbour edge structural methods are composed within design. Natural edges and hard static edges. A primary aim within the scope of this thesis is to encourage public interaction with site and increased harbour interaction. This is designed for through the edge composition through both methods.

HARD EDGES

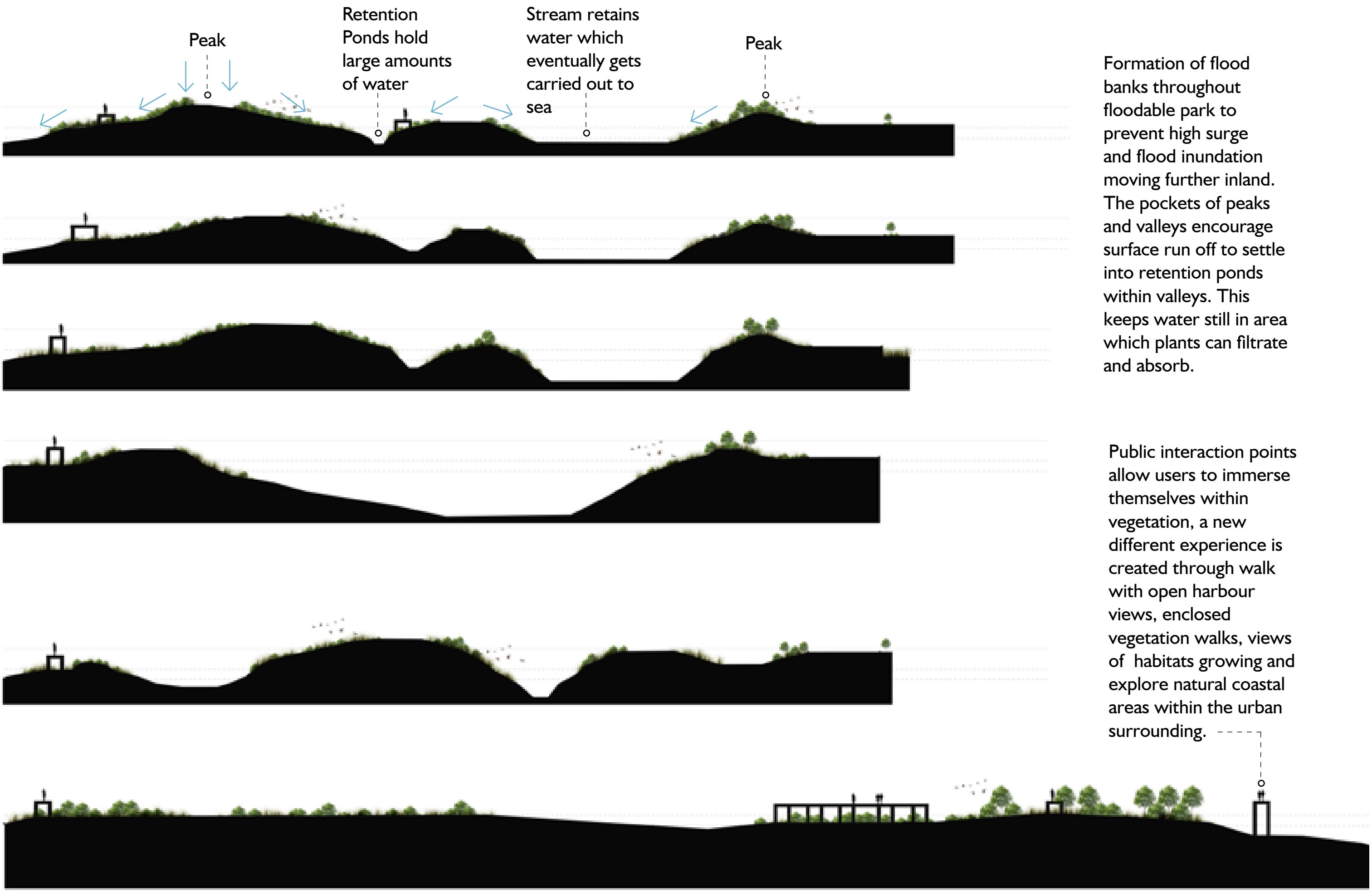
Although these have more negative environmental impact, the limited use of it on site allows for maximised social interaction, having seawalls becoming boardwalks to funnel people to a certain destination or tidal walls and steps to proving adapting and informal areas of seating and access to the harbours edge. The significance of exposing these static structures reflects past sites industrial, and bulk material use.

SOFT EDGES

This thesis has looked into multiple solutions of water management, systems which can hold large quantities of water and filter this, while improving the biodiversity and water that's being let into the harbour. Natural systems are good for this, from natural ground planes that absorb water, they also maximise the public experience of being connected to nature. This also has low impact on the environment. Vegetation associated with this also while improving the biodiversity and habitat life allows for diverse user experience through heights of plants. Tall vegetation embodies people and directs users to look upwards, while shorter vegetated areas allows users to see right through site. Large tree structures shelter people from wind due to being on the western side. Planting stabilises the ground, absorbs water and also performs well with user experience. Designing with shallow depth vegetation structures, this allows for stream planting to grow and filtrate water as well. It has a diverse ecological and social relation, the boundaries within soft edges aren't formed, therefore this provides room for informal meandering of space, maximising diverse user experience through site. This self-sustaining and low environmental impact system is ideal for improving harbour edge and water conditions.




Location Plan.

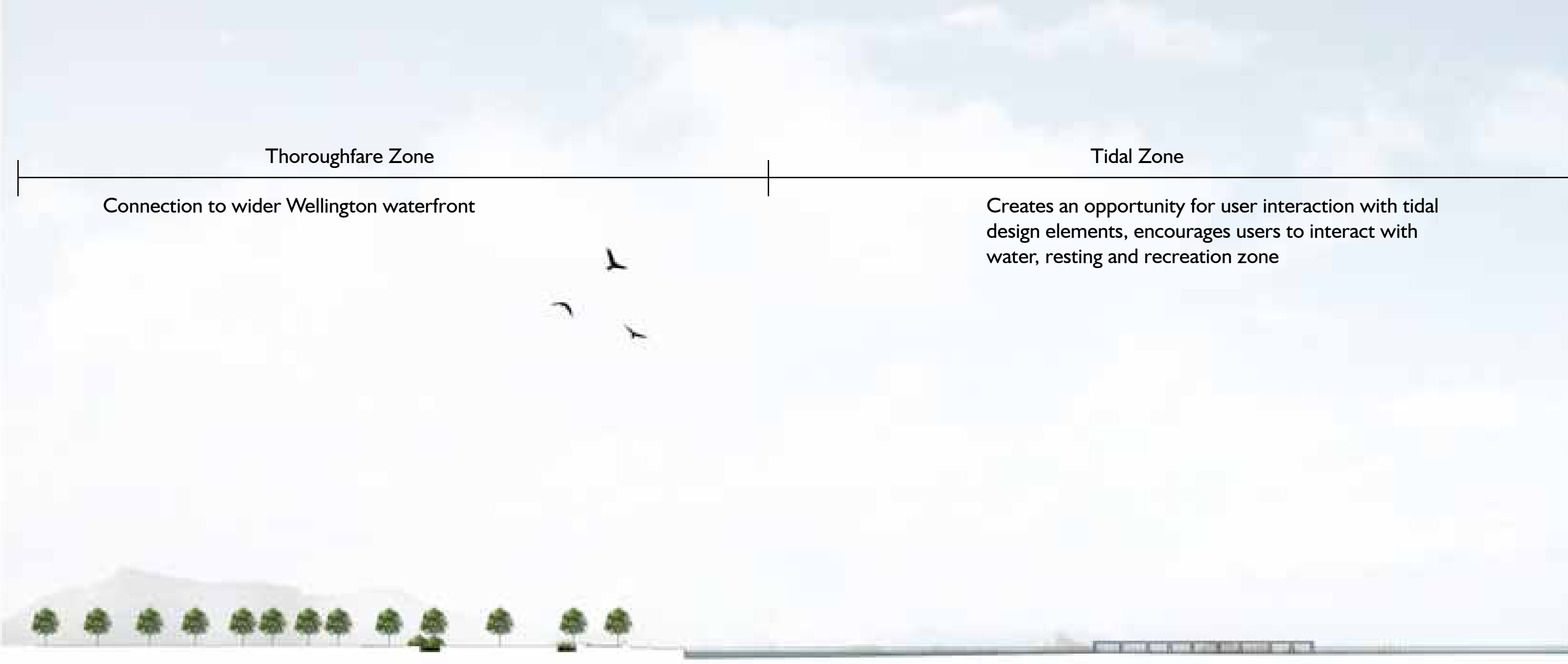


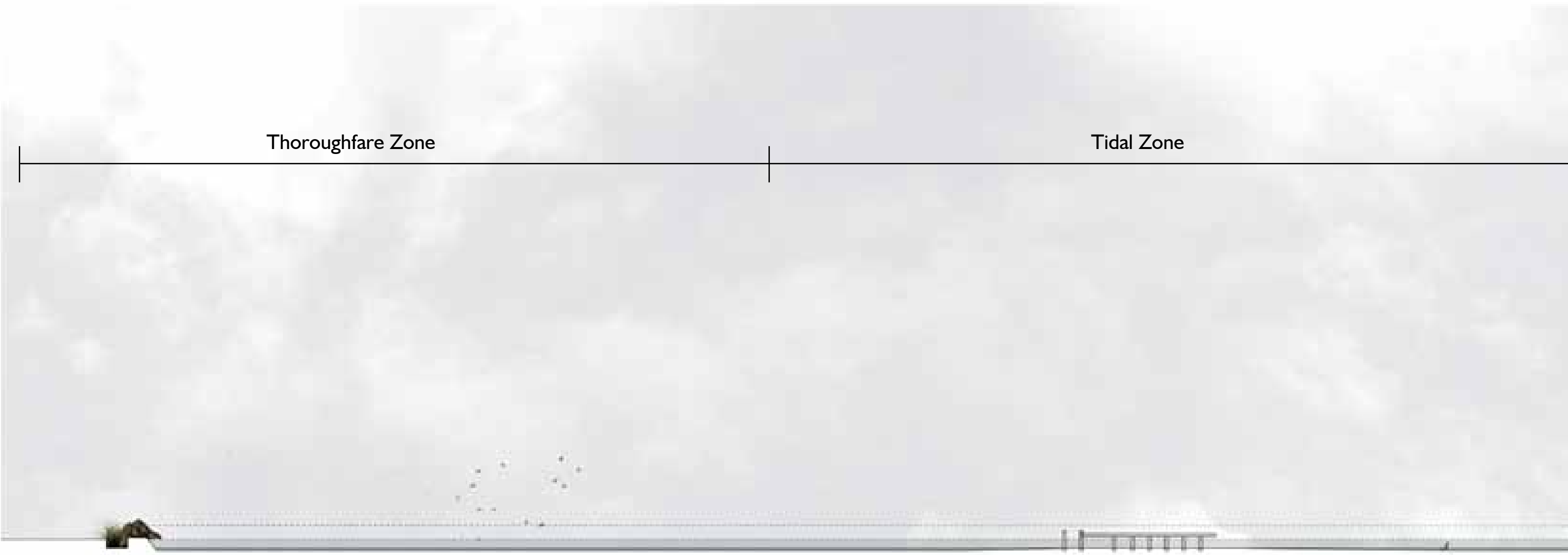

1:250 @ A1

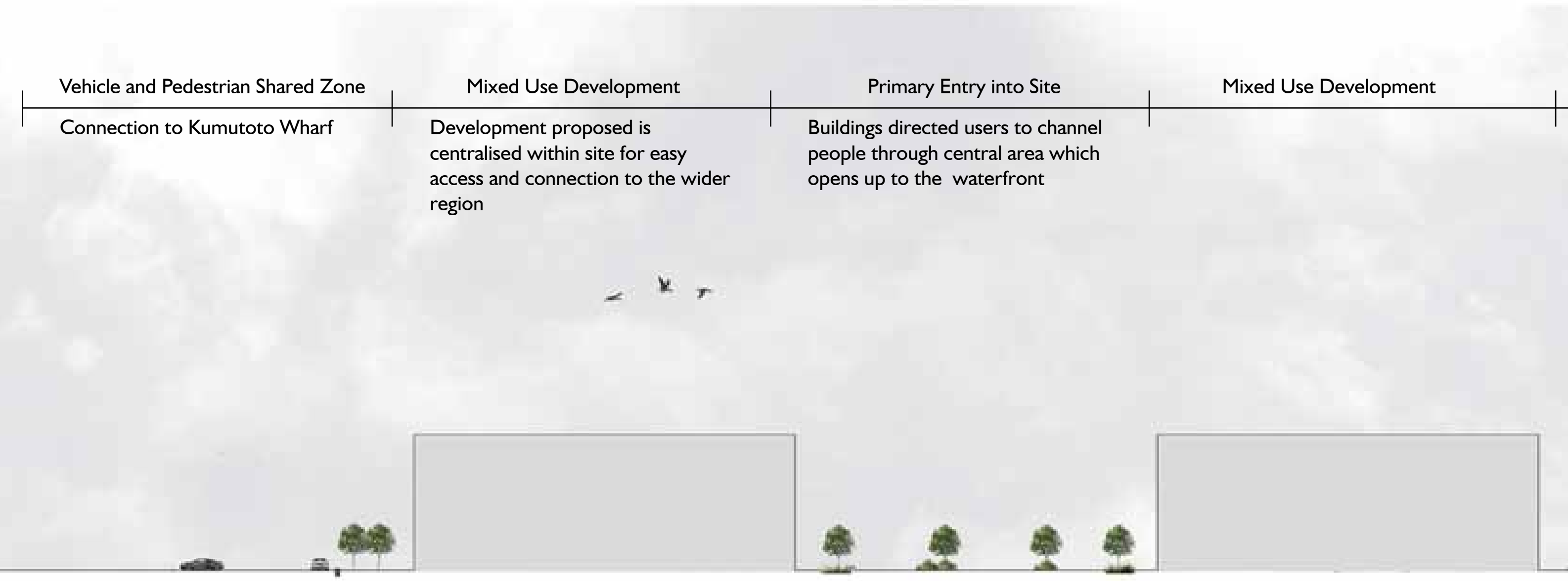
Fig. 9.08. Authors Own, Coastal Marsh Illustration, 2019.

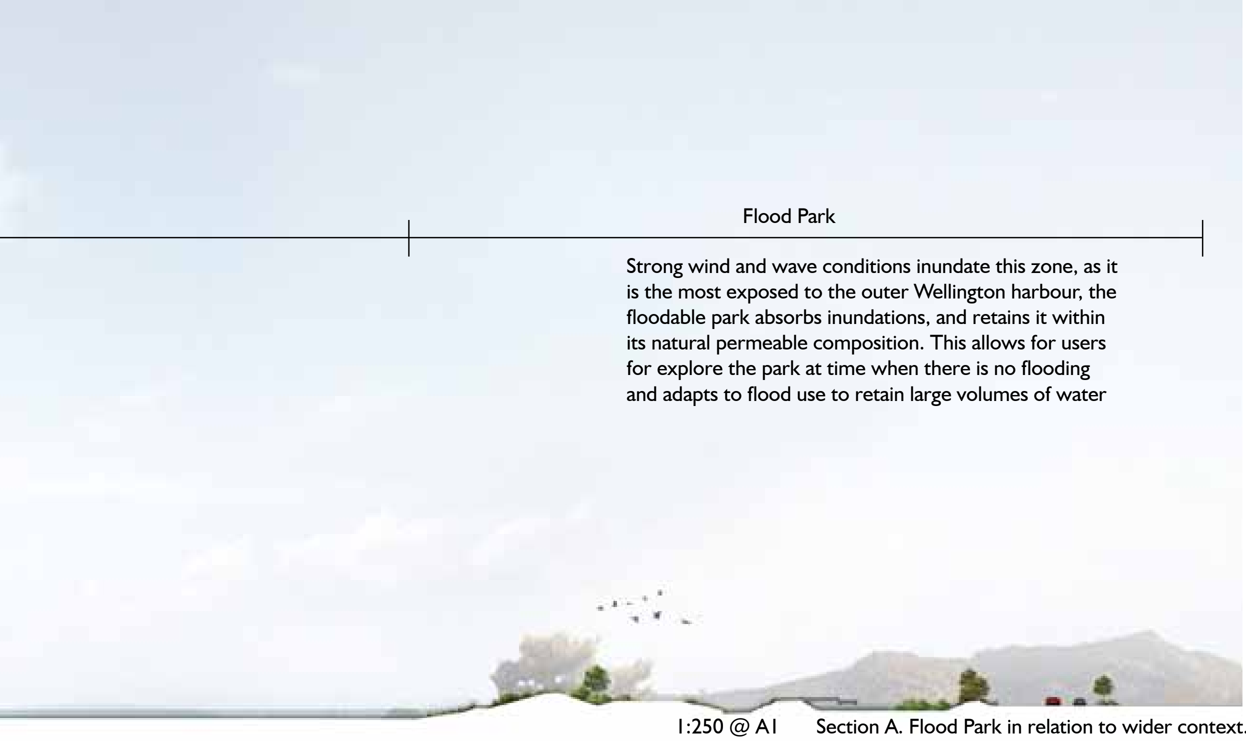
Fig, 9.09. Authors Own, Sectional exploration through Floodable Park, 2019.

SITE COMPONENTS INTEGRATION.

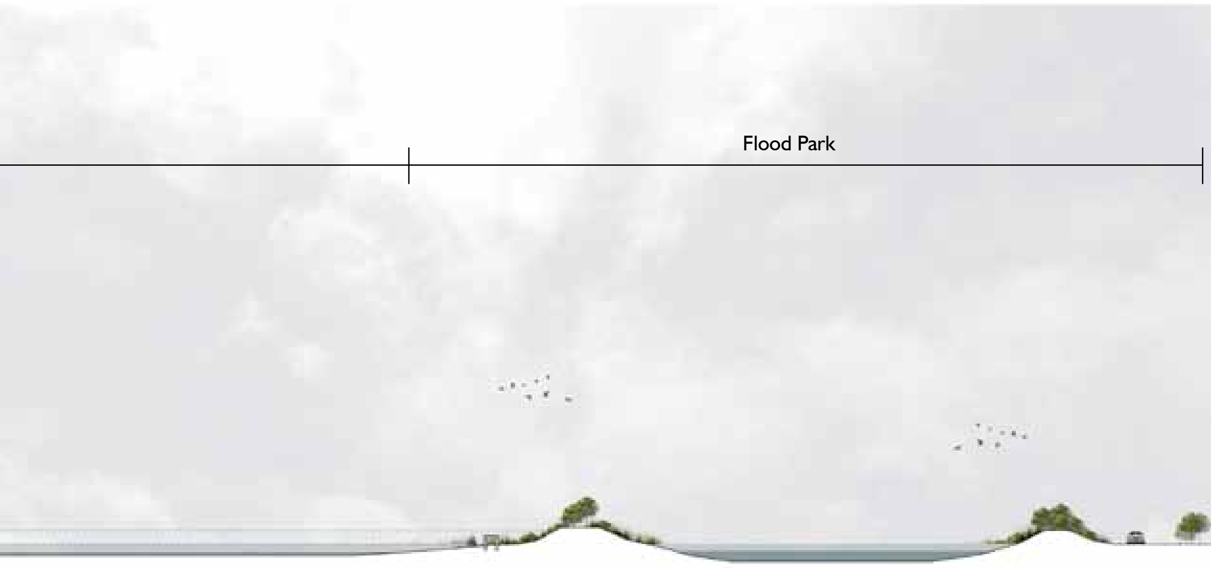


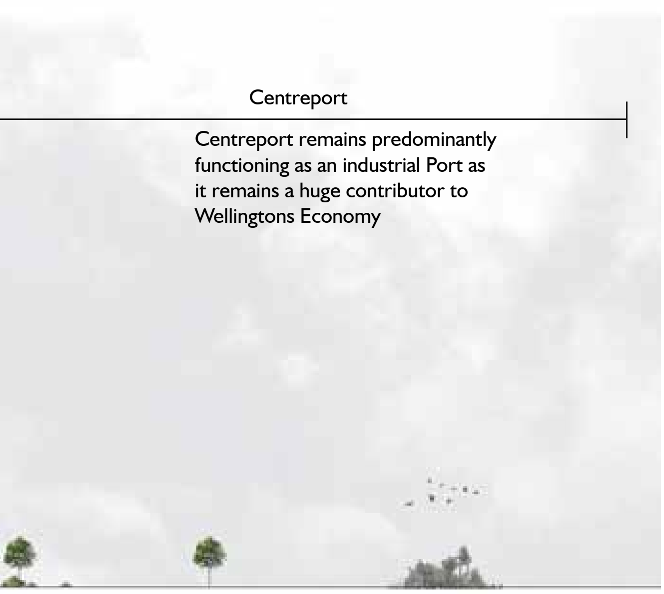






1:250 @ A1 Section A. Flood Park in relation to wider context.




1:250 @ A1 Section B. Flood Park bank protection.




1:250 @ A1 Section C. Proposed mixed use buildings on site.

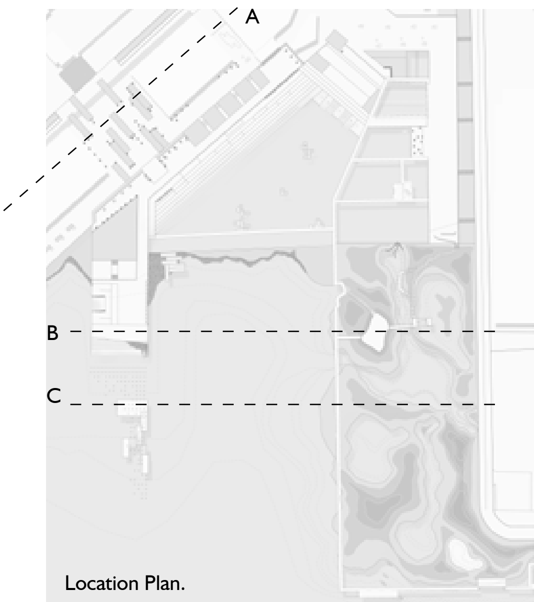
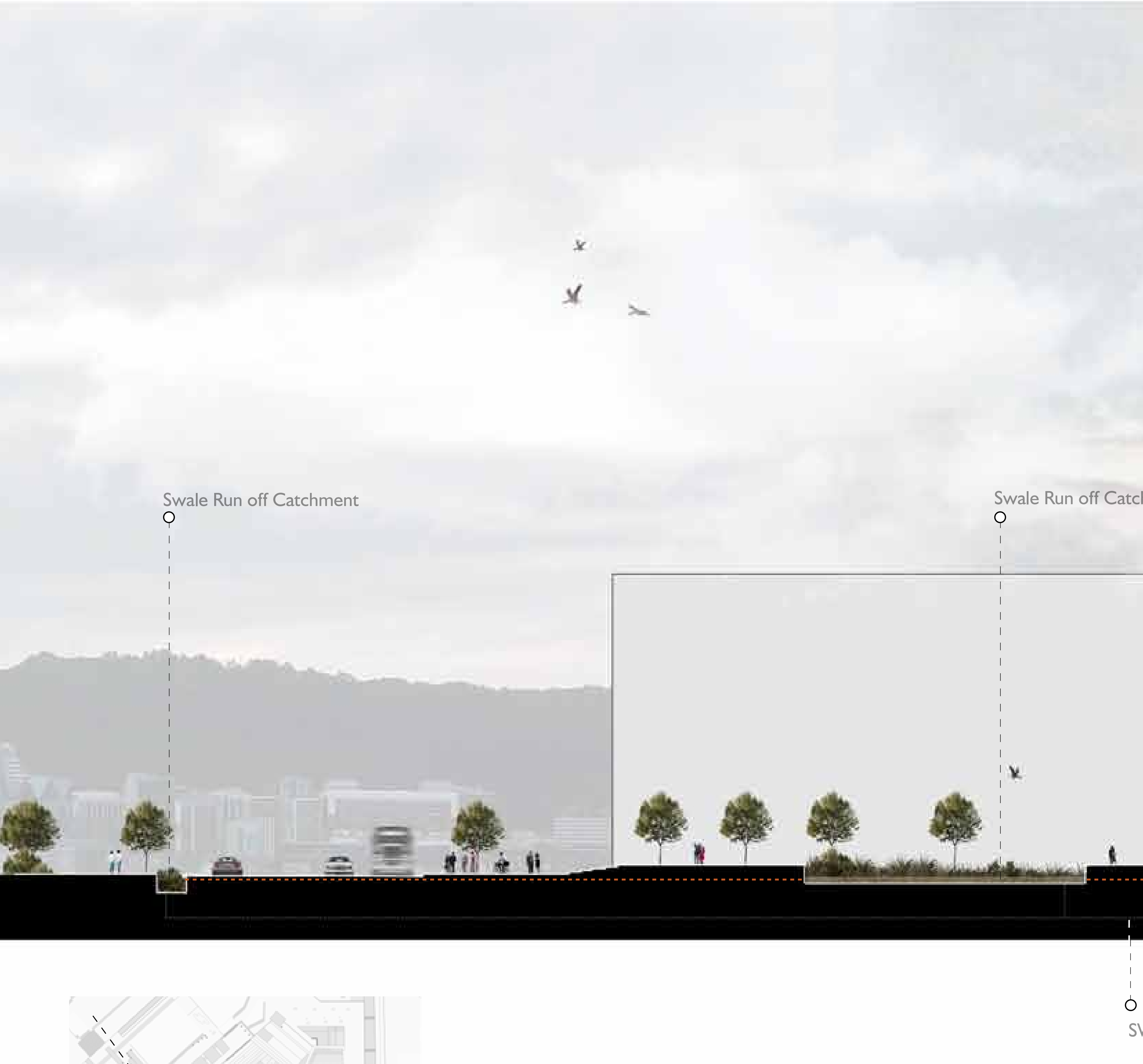
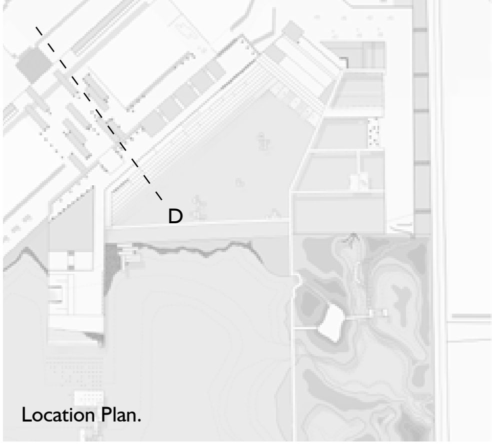



Fig. 9.10. - 9.12. Authors Own. Exploration through Site, 2019.



Location Plan.


Section D. New and Old Site Topography.

1:250 @ A1

Fig. 9.13. Authors Own. Sectional Cut showing old and new topography, 2019.

1:1000@ A1


Fig. 9.14. Authors Own. Plan View showing old and new elevations, 2019. (Pages 248-249)

## Event 2 - Kayaking through stream.

Fig. 9.15. Authors Own. View through daylighted Pipitea Stream, 2019.
Fig. 9.16. Authors Own. Stream Structure, 2019. (Opposite Page)

## Stream Structure.

- Marsh Planting Zone
- Flood Banks
- Retention Ponds

*1. SW Outlet into stream*
*2. Steam and salt water harbour interaction*
*3. Meandering Zone - Open Space*
*4. Meandering Zone - Wetland Viewing Deck*
*5. Meandering Zone - Boardwalk/Fishing Zone*
*6. Meandering Zone - Kayak through stream*
*7. Informal/Semi Use Zones - Open Space*
*8. Informal/Semi Use Zones - Beach*

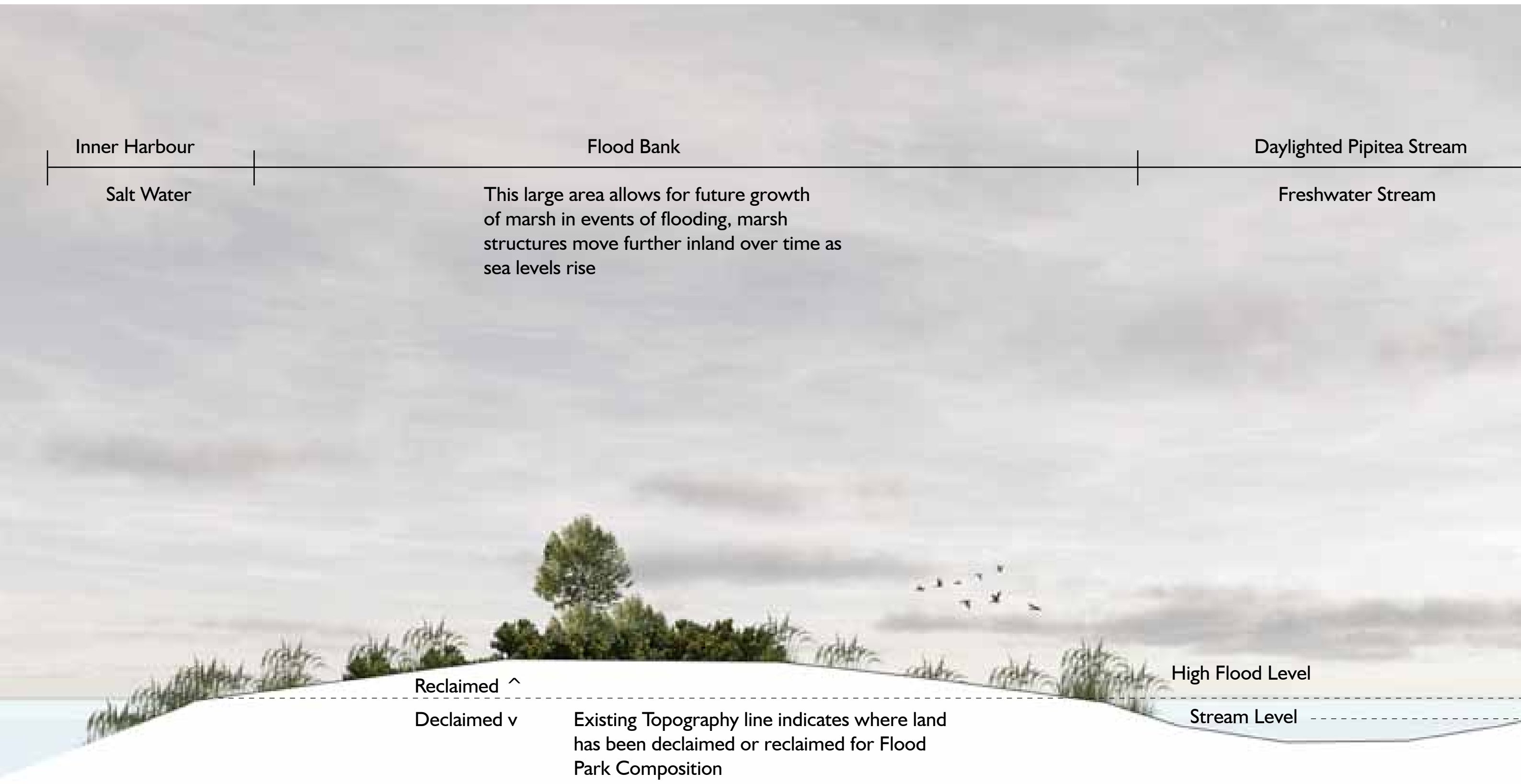
The stream has been integrated with the new SW filtration system which down pours into the open harbour stream mouth. From this point fresh water has contact with salt with intrusion which species a different mixture of plant species to handle to water balance. A Corten steel pipe structure jets out of the treatment wetland, carrying its over flow water to down pour into the stream. This structure exposes the elements what underground pipe work would carry out to the harbour, has been designed to expose to public. This Storm water flow is a central element of the design, functioning in multiple ways. Its connection right from the treatment wetland connects to the piped Pipitea Stream. Being a significant history and ecological element of site, it has been reintegrated into design, pouring out clean treated water into the harbour. Its journey from urban wetland to stream signifies and celebrates the streams present and past history, maintaining its urban form through a treatment wetland, then pouring down to its former river state out to harbour.

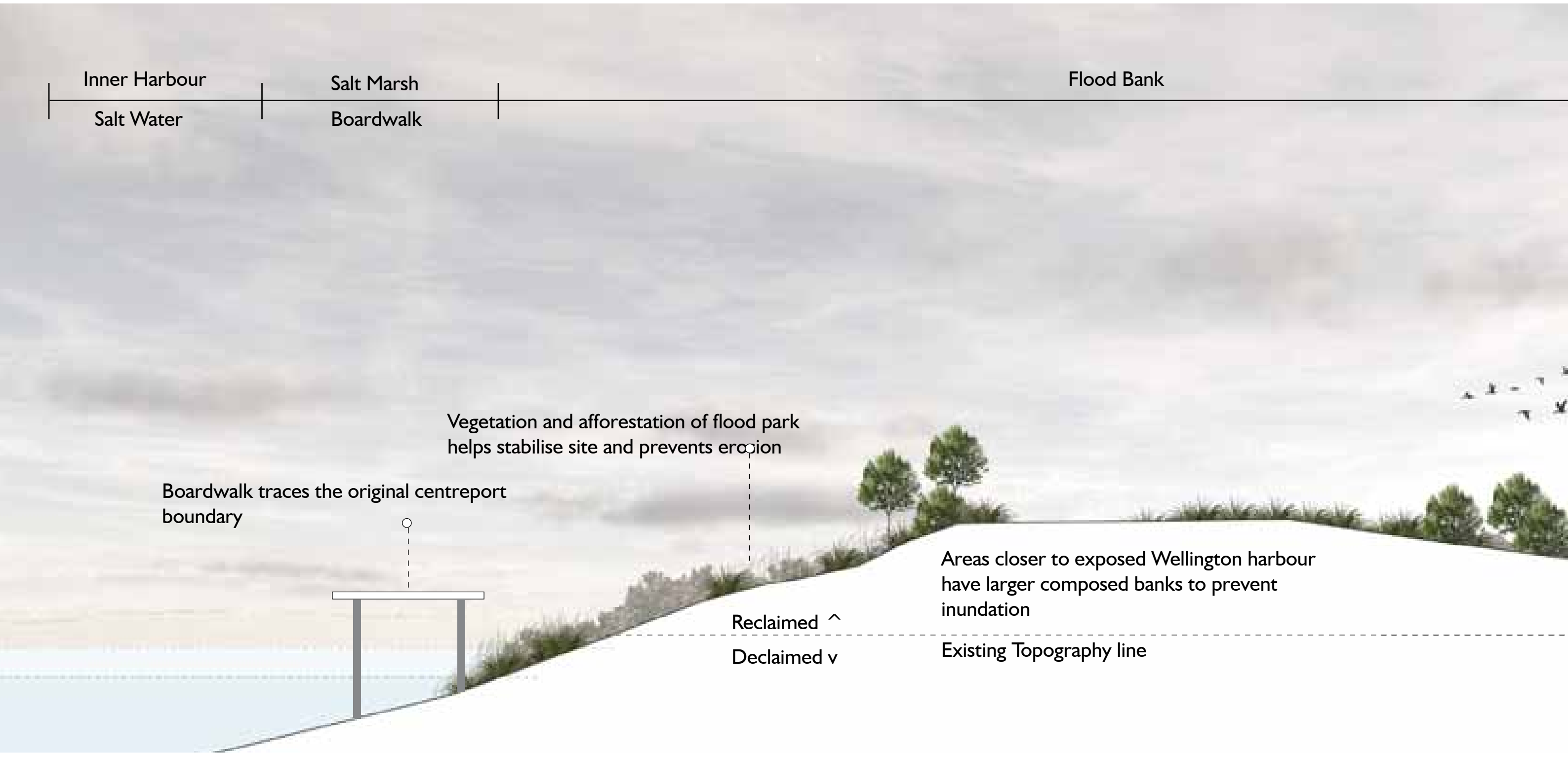
STREAM FUNCTIONS

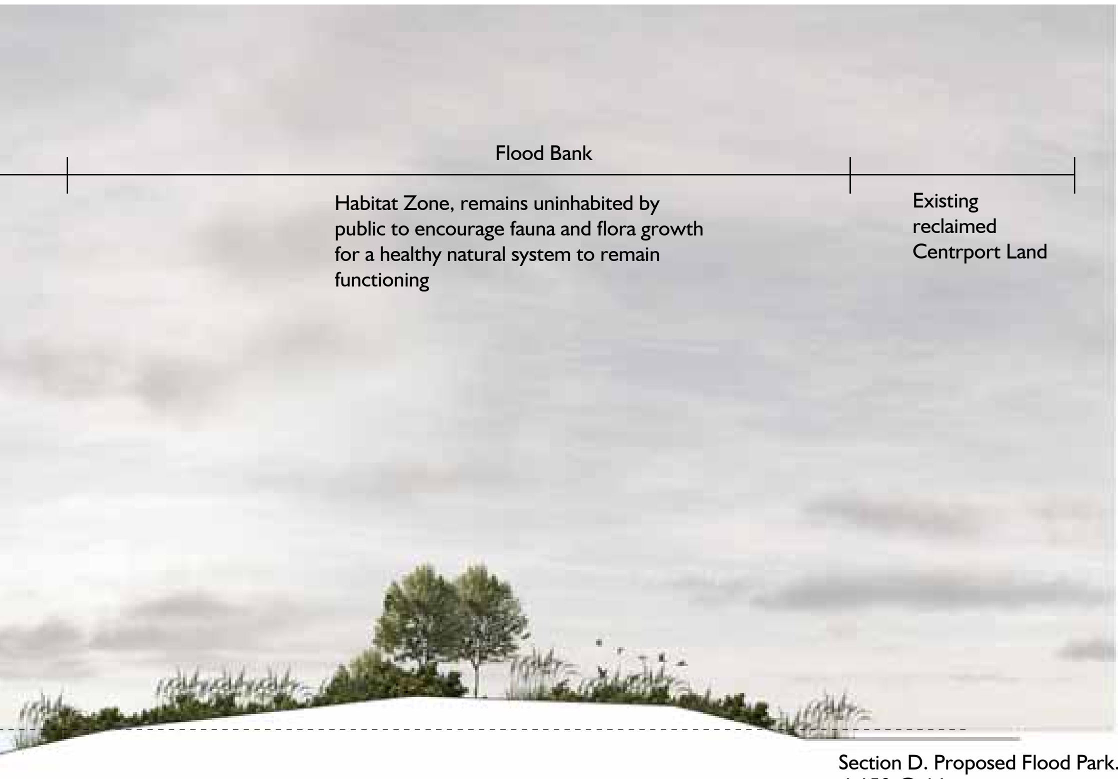
The stream body is a key design element, functioning in multiple ways. Its urban wetland to stream journey celebrates the former piped Pipitea stream, while its river body allows for water filtration and flood protection simultaneously. Retention ponds have been formed within the outer river body to catch access water in event of flood, and capture high wave inundations in events of storm surge. Large flood banks structures are embodied within this, acting as a barrier to high wave impacts and future sea level rise flood protection. The ecological make up of space allows for nutrients and harbour ecologies to thrive while providing public site interaction. Three principal public intentions are enabled within the site, zones for all time use, semi use (not accessible during floods) and non-accessible zones for preserved areas to withhold its inherent biodiversity.


1:750 @ A1

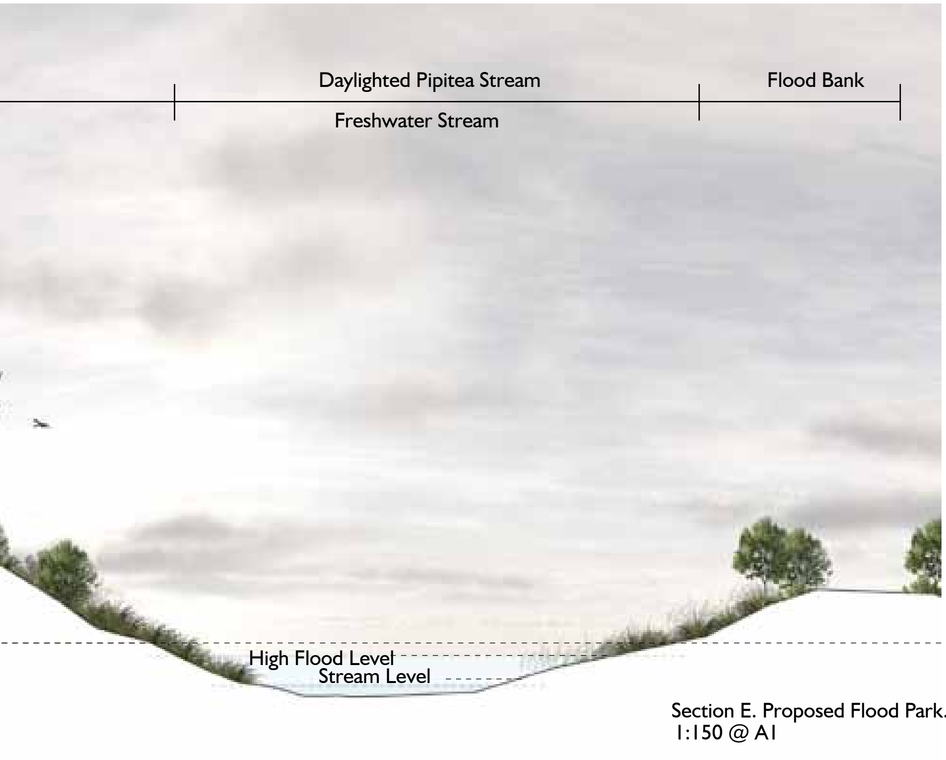
## STREAM STRUCTURE.



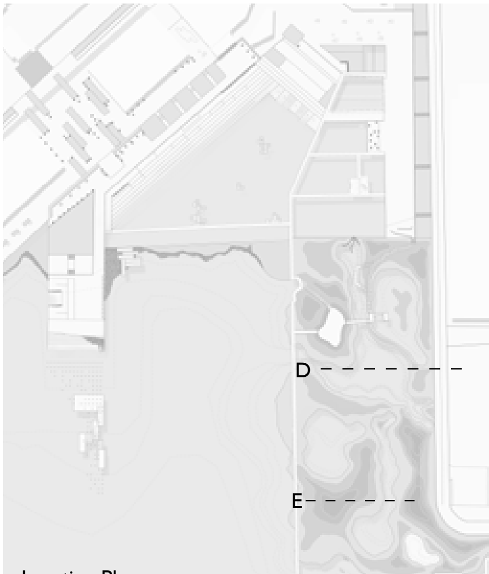






Section D. Proposed Flood Park.
1:150 @ A1

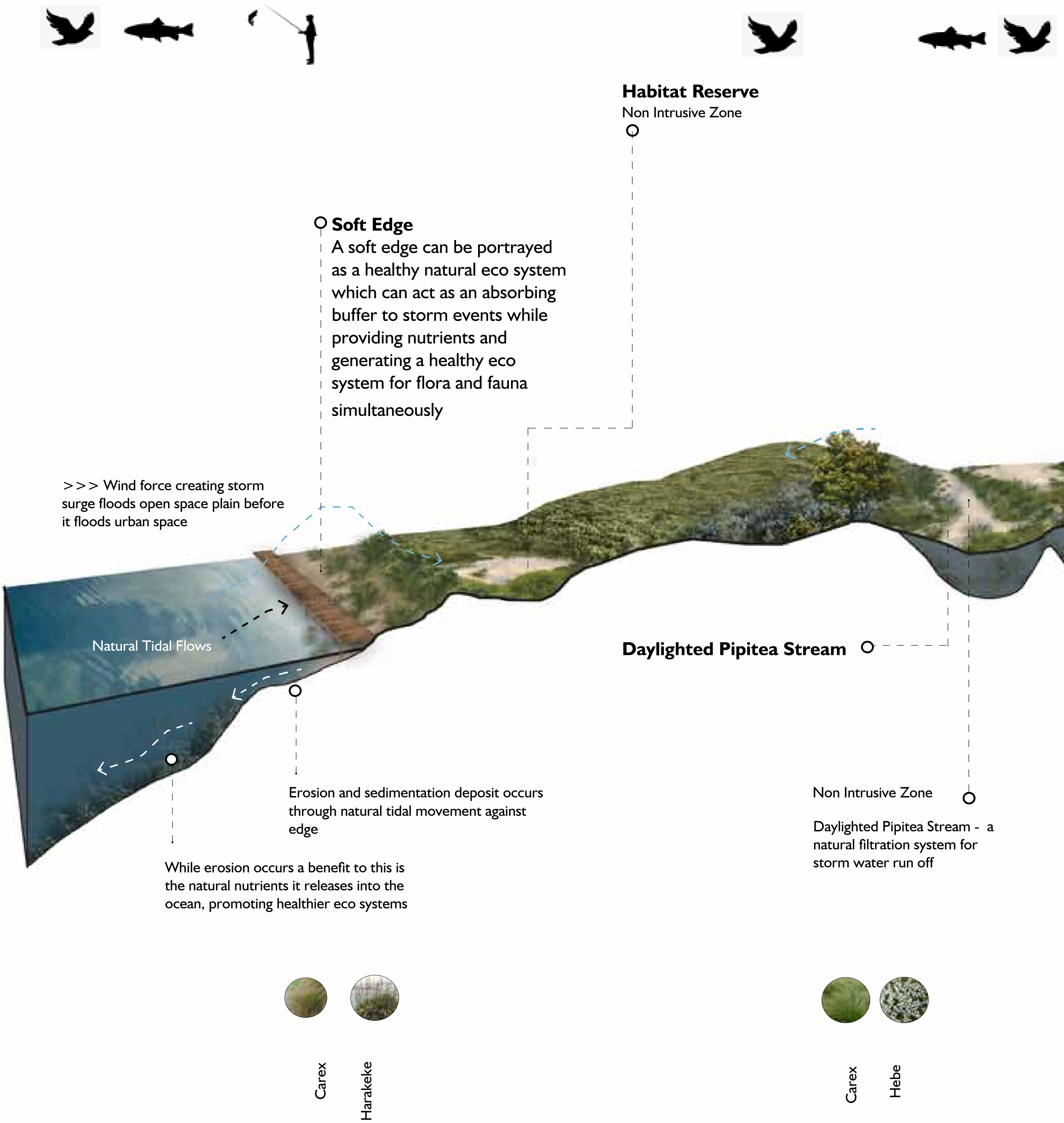



Section E. Proposed Flood Park.
1:150 @ A1




Location Plan.

Fig. 9.17. - 9.18. Authors Own, Sectional exploration of Stream Structure, 2019.


Habitat Reserve
Non Intrusive Zone
Soft Edge
A soft edge can be portrayed as a healthy natural eco system which can act as an absorbing buffer to storm events while providing nutrients and generating a healthy eco system for flora and fauna simultaneously
>>> Wind force creating storm surge floods open space plain before it floods urban space
Natural Tidal Flows
Daylighted Pipitea Stream
Erosion and sedimentation deposit occurs through natural tidal movement against edge
While erosion occurs a benefit to this is the natural nutrients it releases into the ocean, promoting healthier eco systems
Non Intrusive Zone
Daylighted Pipitea Stream - a natural filtration system for storm water run off
Carex
Harakeke
Carex
Hebe

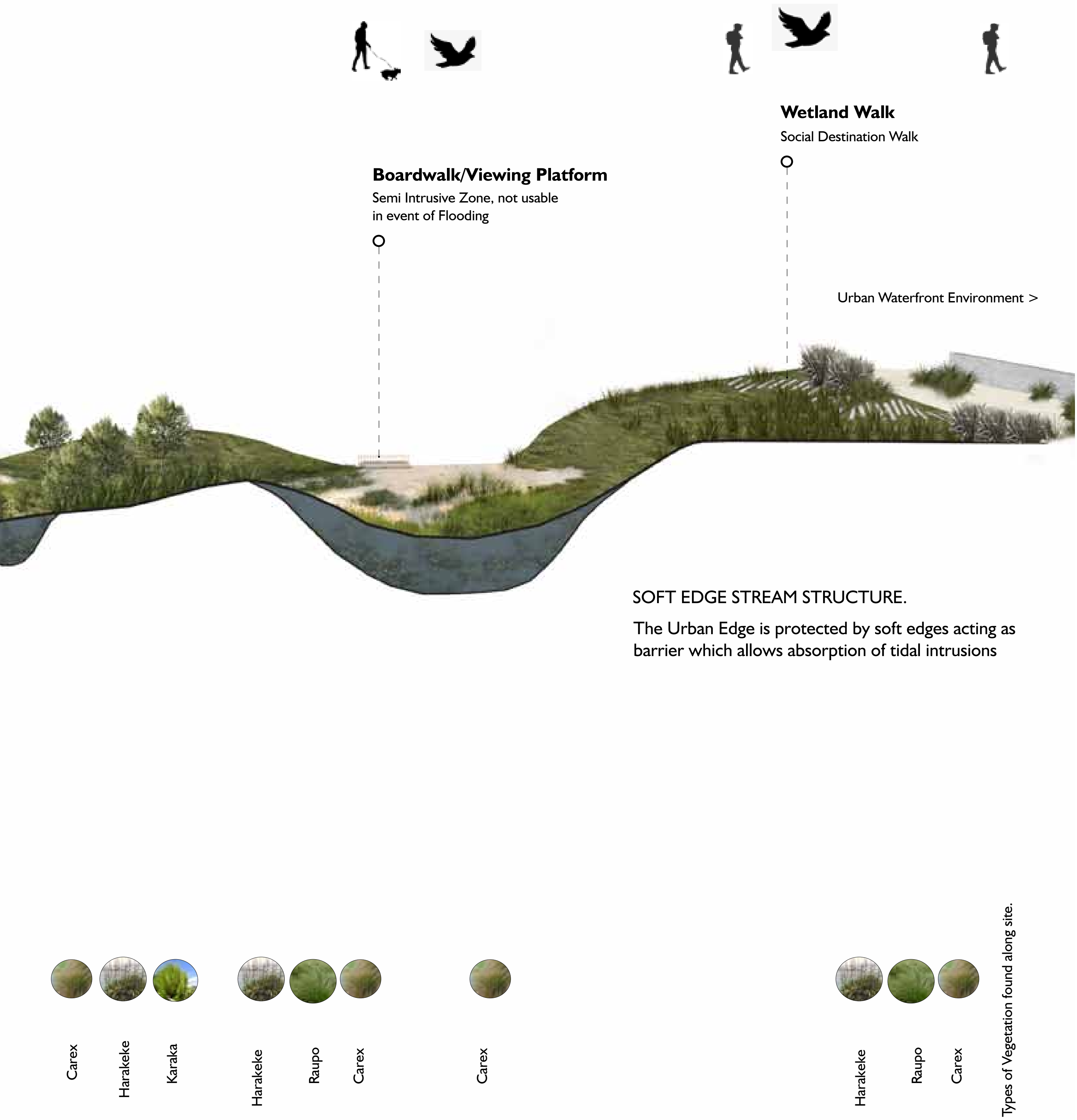



Fig. 9.19. Authors Own, Sectional exploration of Stream, 2019.

Event 3 - Boardwalk through retention wetland.

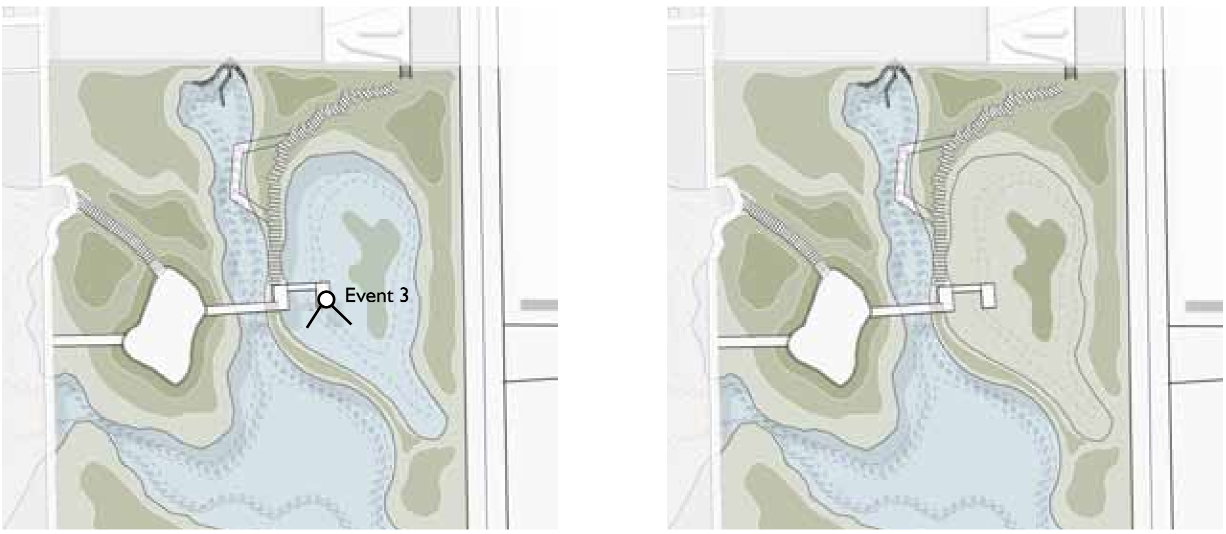



Fig. 9.20. - 9.21. Authors Own, Boardwalk in normal and Flood Event, 2019.

**Event 4 - Boardwalk through coastal edge.**

Fig. 9.22. Authors Own, Boardwalk on Normal day with Public Use, 2019.

**Event 4 - Boardwalk through coastal edge in storm event.**

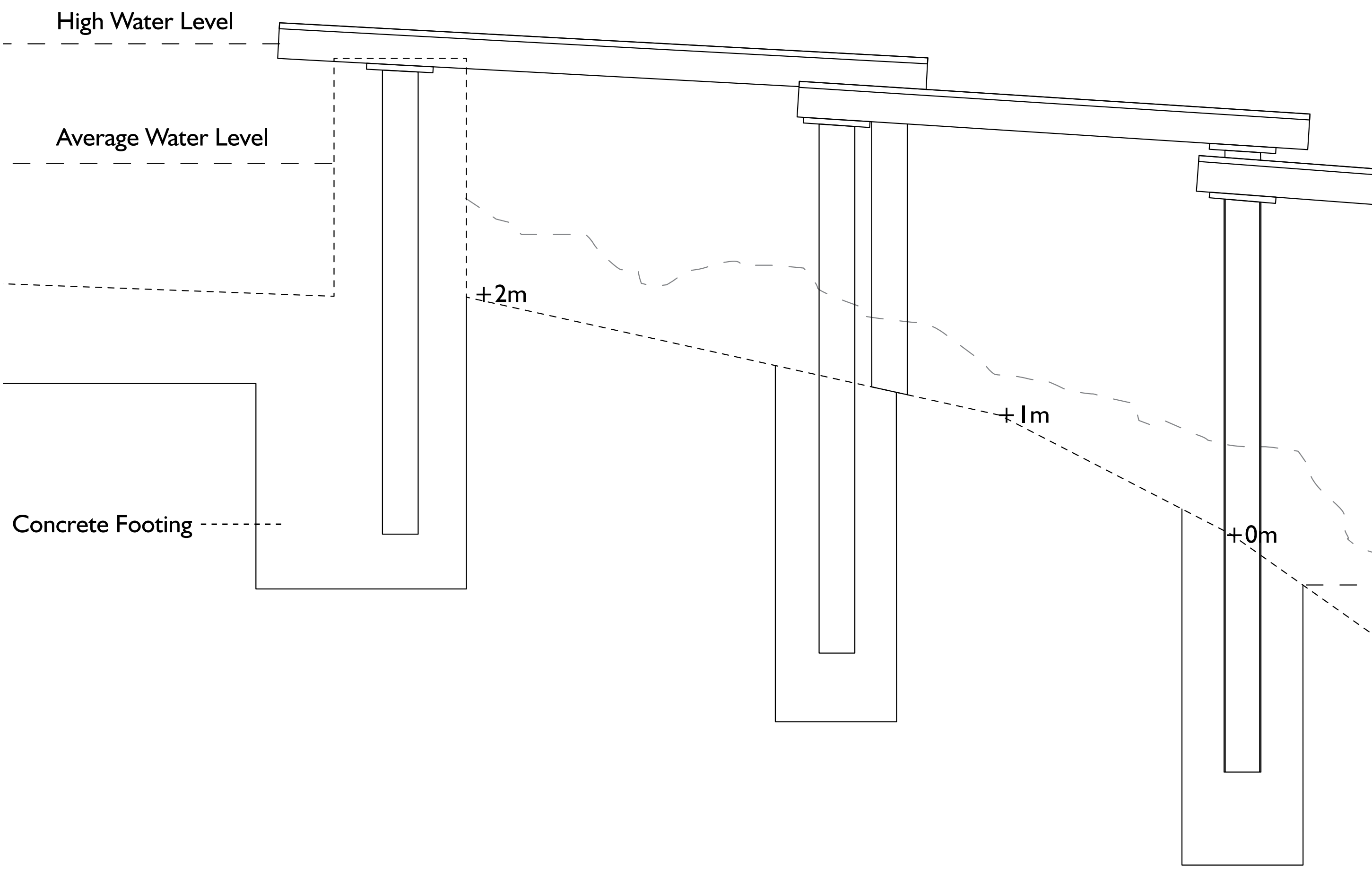
Fig. 9.23. Authors Own, Boardwalk in Storm Event, 2019.

Event 5 - SW Outlet into Stream.


Location Plan.

Fig. 9.24 -9.25. Authors Own, SW Outlet Pouring into Pipitea Stream, 2019.

**SW PIPE OUTLET.**
1:50 @ A3



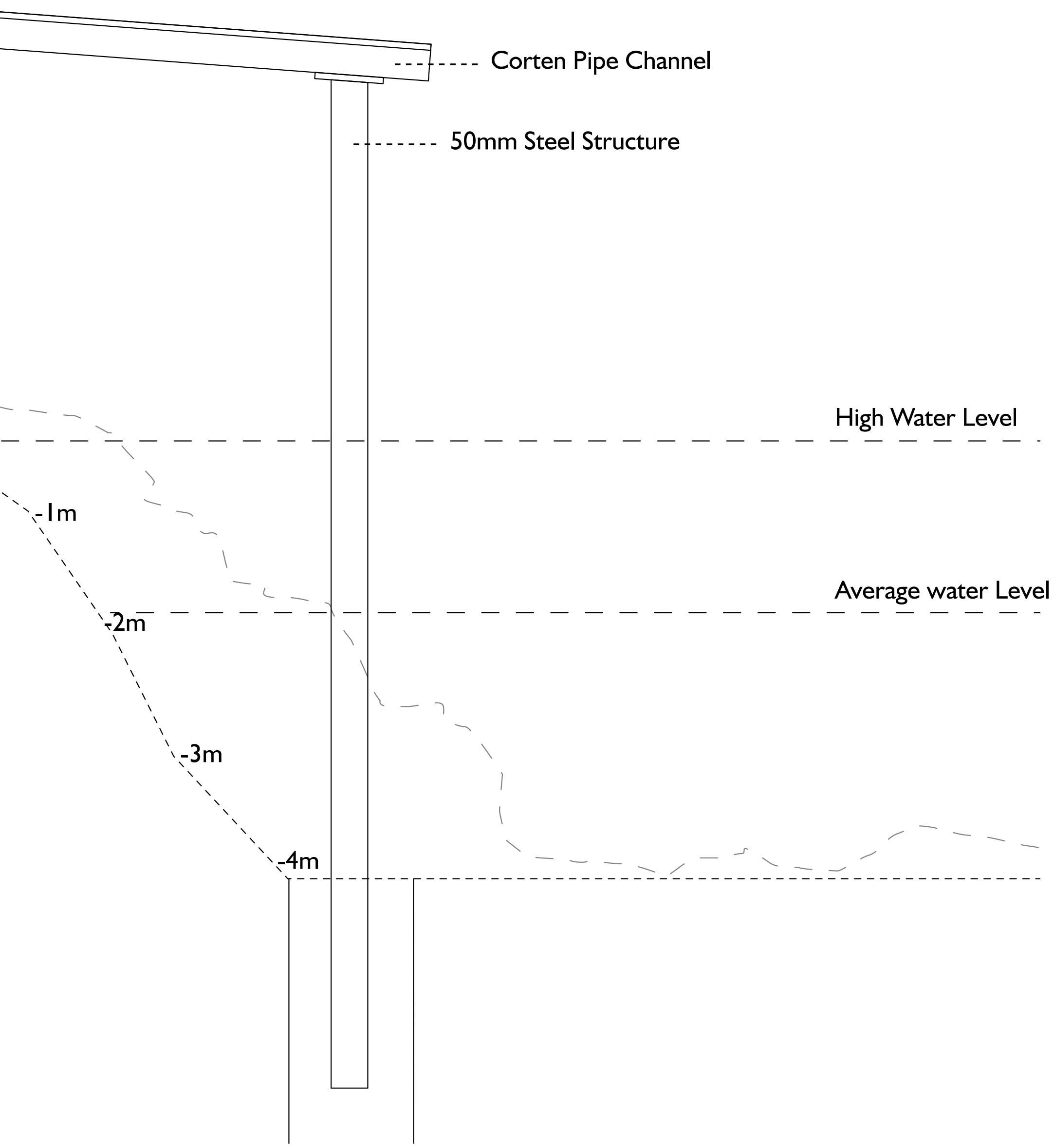



Fig. 9.26. Authors Own, SW Outlet Pouring into Pipitea Stream Section, 2019.

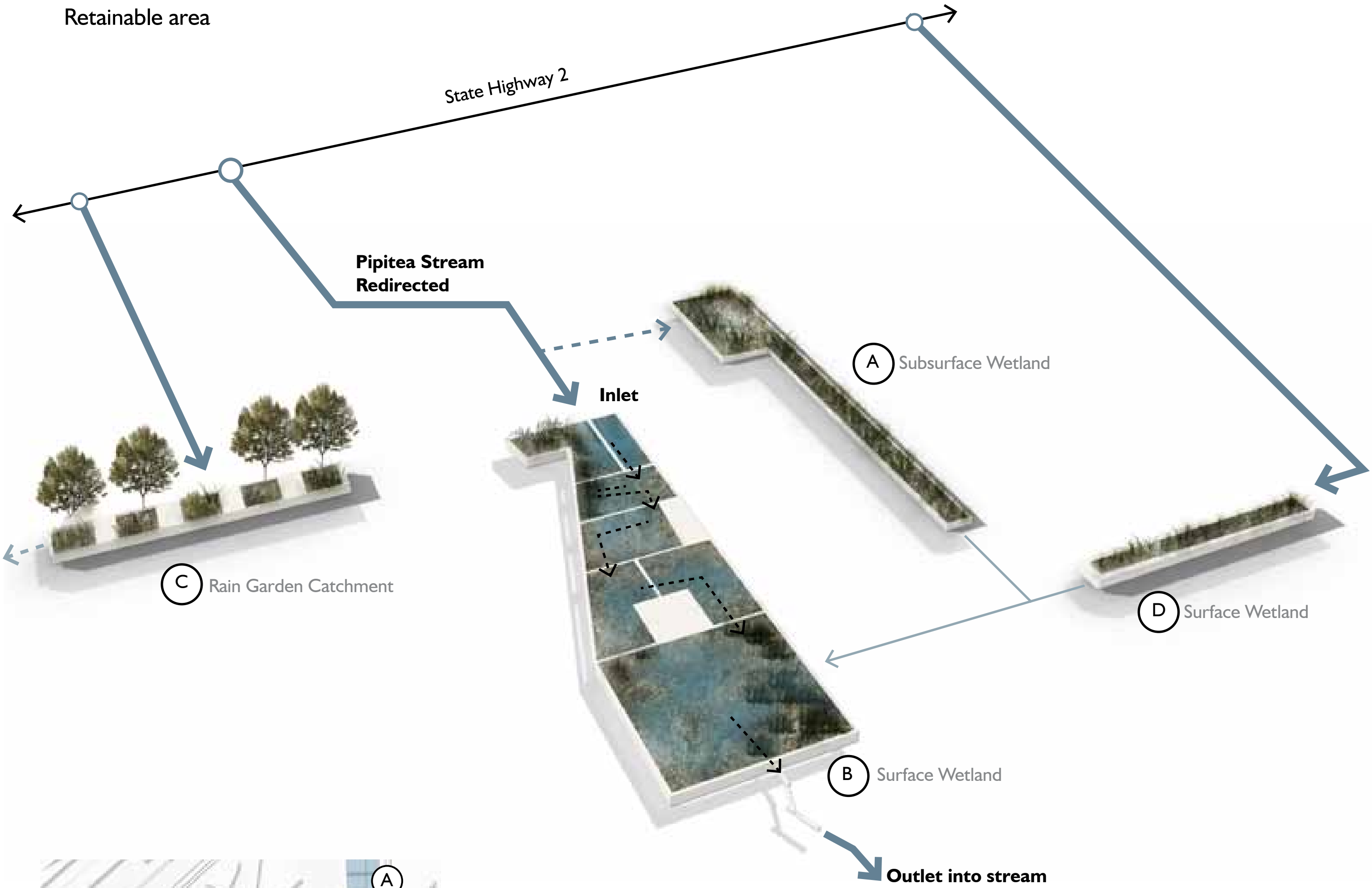

State Highway 2
+1M
+2M
+0M
-1M
-2M
-3M
-4M
+5M
+4M
+3M
+2M
+1M
+0M
-1M
-2M
-3M
-4M
1:1000 @ A1
N
PERMEABLE ZONES

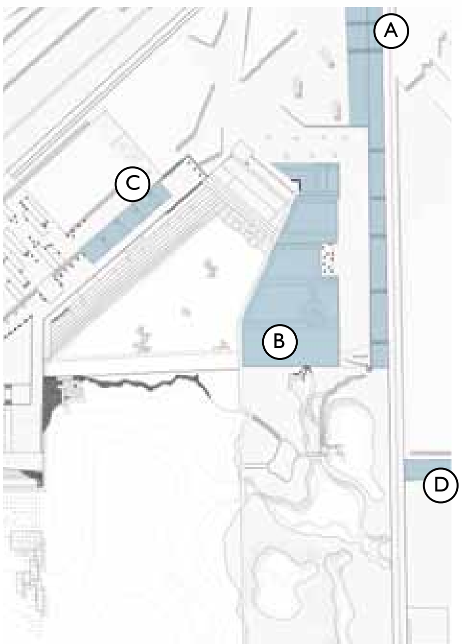
INCREASED PERMEABILITY AND STORM WATER DESIGN.

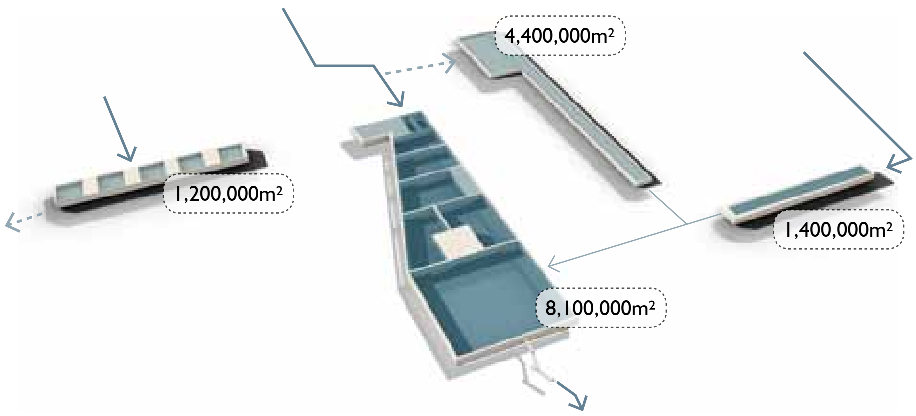
PRIMARY STORMWATER TREATMENT NETWORK

SECONDARY STORMWATER NETWORK

15,100,000 m² of Runoff and Retainable area



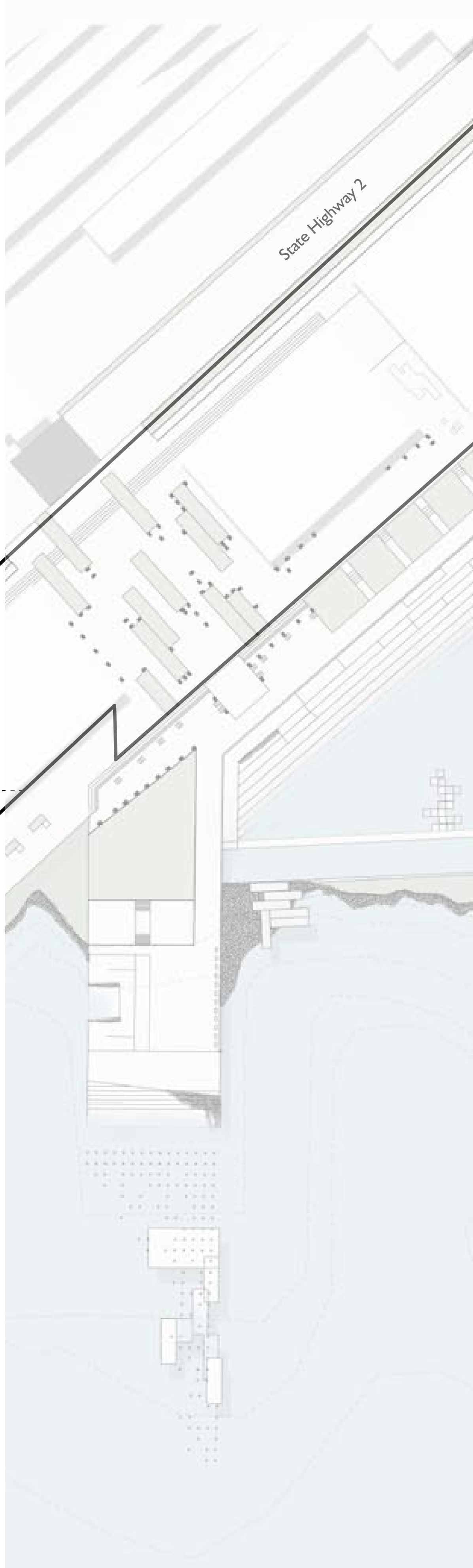






STORM WATER NETWORK.

Swale/Rain gardens connecting into existing SW pipe networks




## TREATMENT WETLAND.

1:1000 @ A1

PERMEABLE ZONES

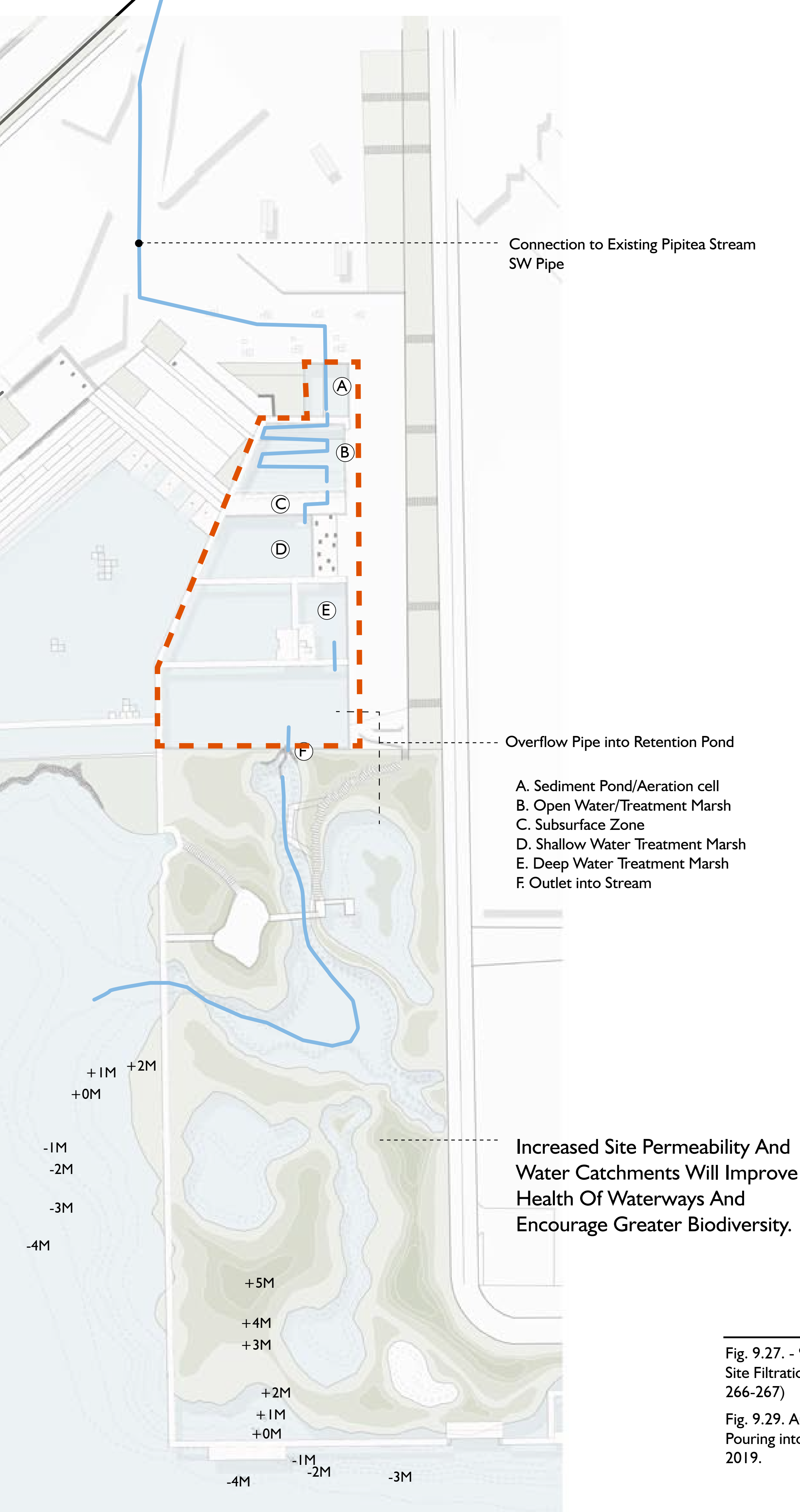


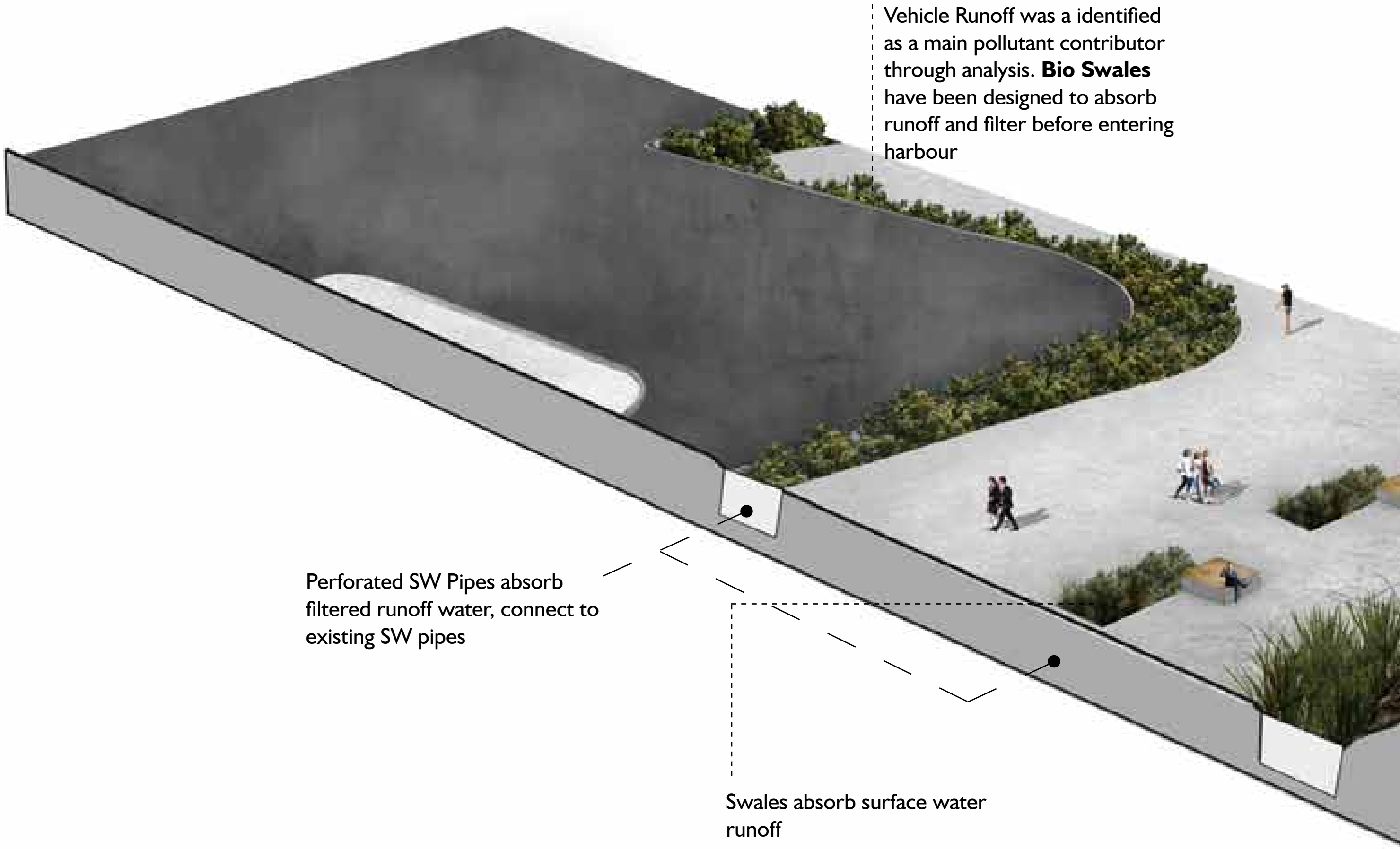

Fig. 9.27. - 9.28. Authors Own, Site Filtration System, 2019. (Pages 266-267)

Fig. 9.29. Authors Own, SW Outlet Pouring into Pipitea Stream Section, 2019.

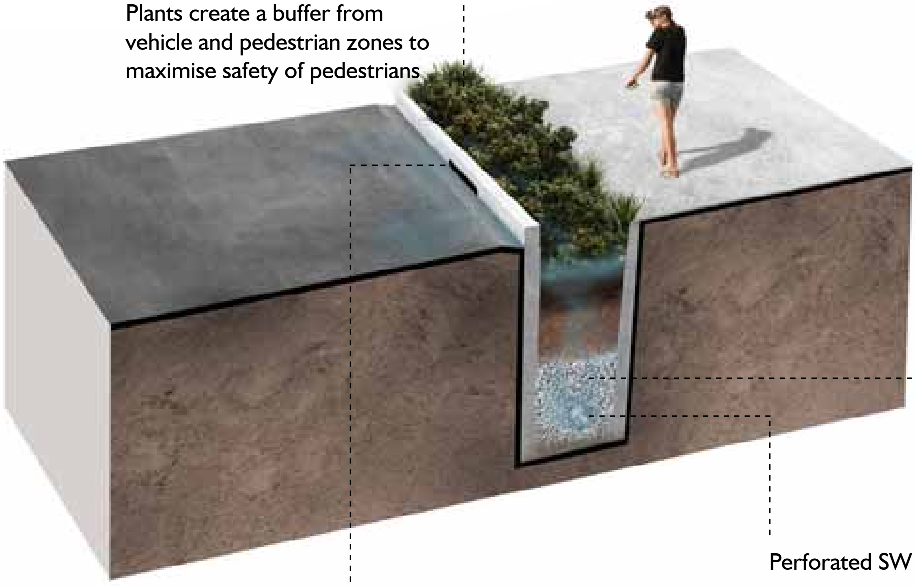
INCREASED PERMEABILITY AND STORM WATER DESIGN.

## BIO SWALES.

Vehicle Runoff was a identified as a main pollutant contributor through analysis. **Bio Swales** have been designed to absorb runoff and filter before entering harbour




Location Plan.



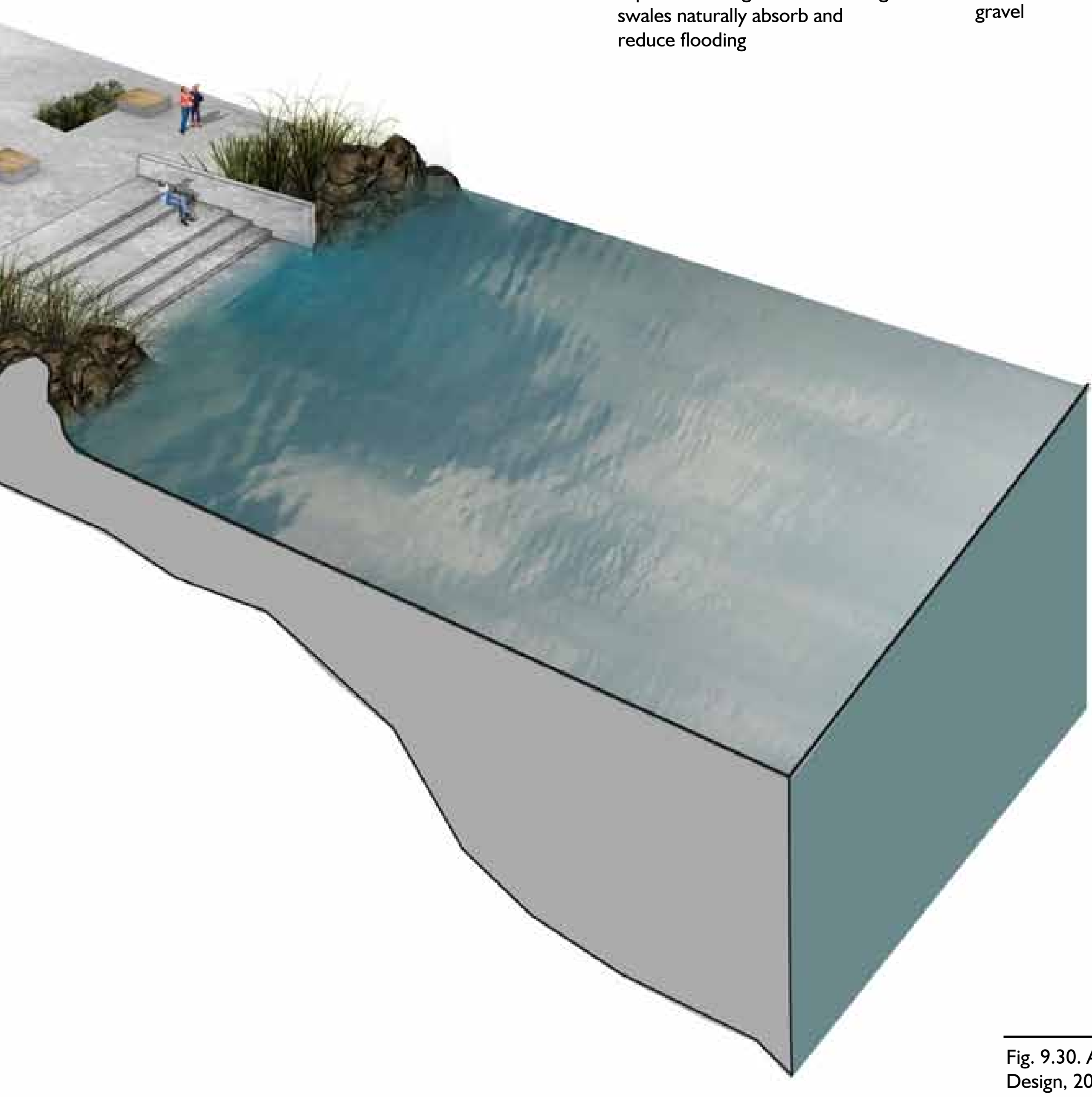
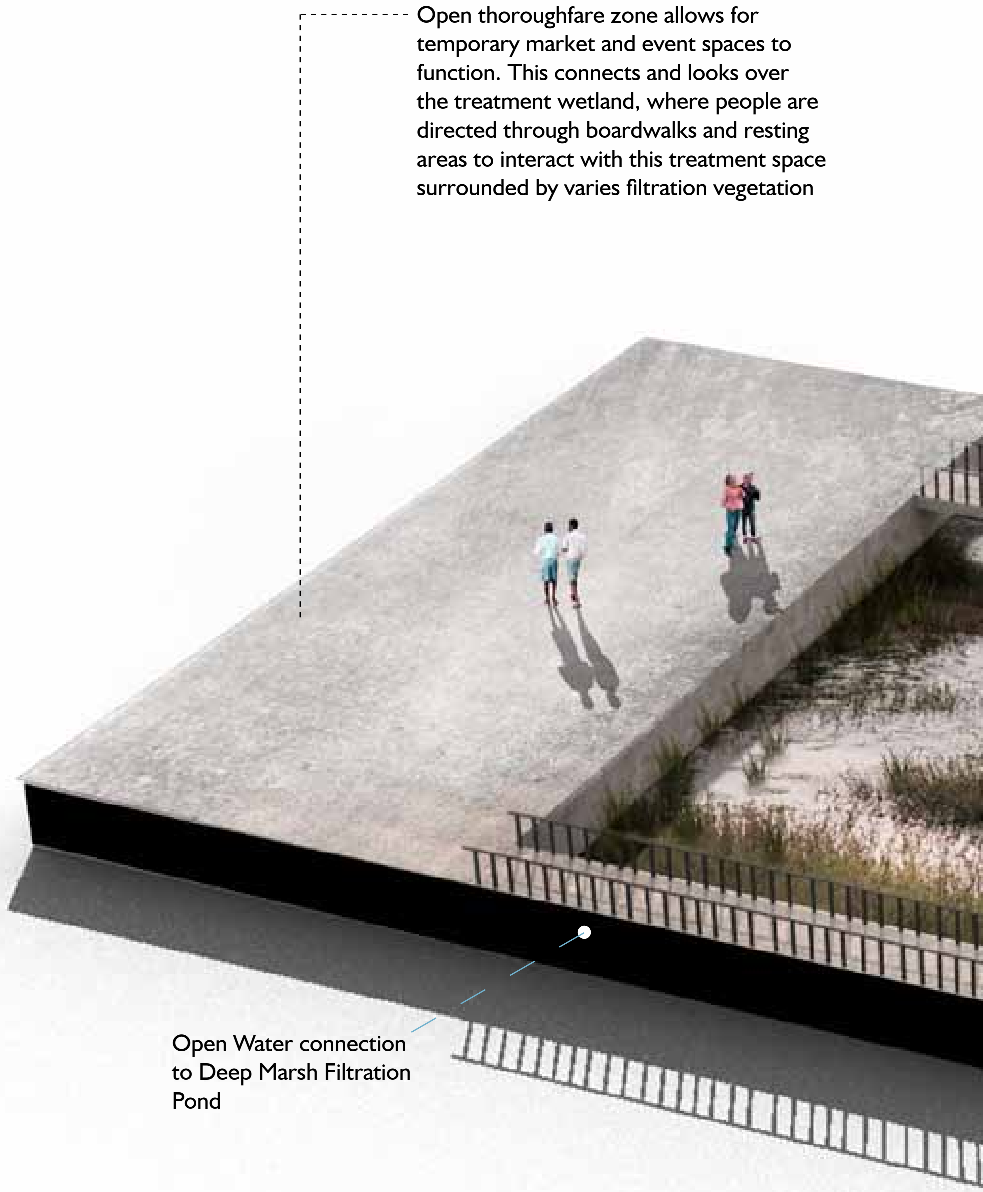



Fig. 9.30. Authors Own, Swale Design, 2019.





Location Plan.

INCREASED PERMEABILITY AND STORM WATER DESIGN.

## TREATMENT WETLAND.

Social Interaction Zone with Ecological Functions

Resting zones allows for great public interaction and gathering within space while the wetland infrastructure works to treat runoff SW

Boardwalks allow for great leisure walks through the surrounding vegetation

Fig. 9.31. Authors Own, Treatment Wetland Design, 2019.

Increased Water health and biodiversity is encouraged through design to minimise the pollution and toxins entering and damaging the environment. Through design the daylighting of the Pipitea stream is celebrated firstly through a treatment wetland, filtrating water before its discharge into harbour. Wetlands are also great at retaining large amounts of water and surface drainage in events of flooding within the flood prone site.

Location Plan.

INCREASED PERMEABILITY AND STORM WATER DESIGN.

## TREATMENT WETLAND.

Daylighting of Piped SW network and Pipitea Stream

Inlet/Settlement Pond

Culverted Pipitea Stream SW Pipe Outlet into Treatment Wetland System

SW pipe is shown in comparison to the dayligted treatment wetland to celebrate its transition from culverted to opened flow. This is a proposed pipe connection to the culverted Pipitea stream SW pipe, to reintroduce the former stream, waterway health and increased biodiversity

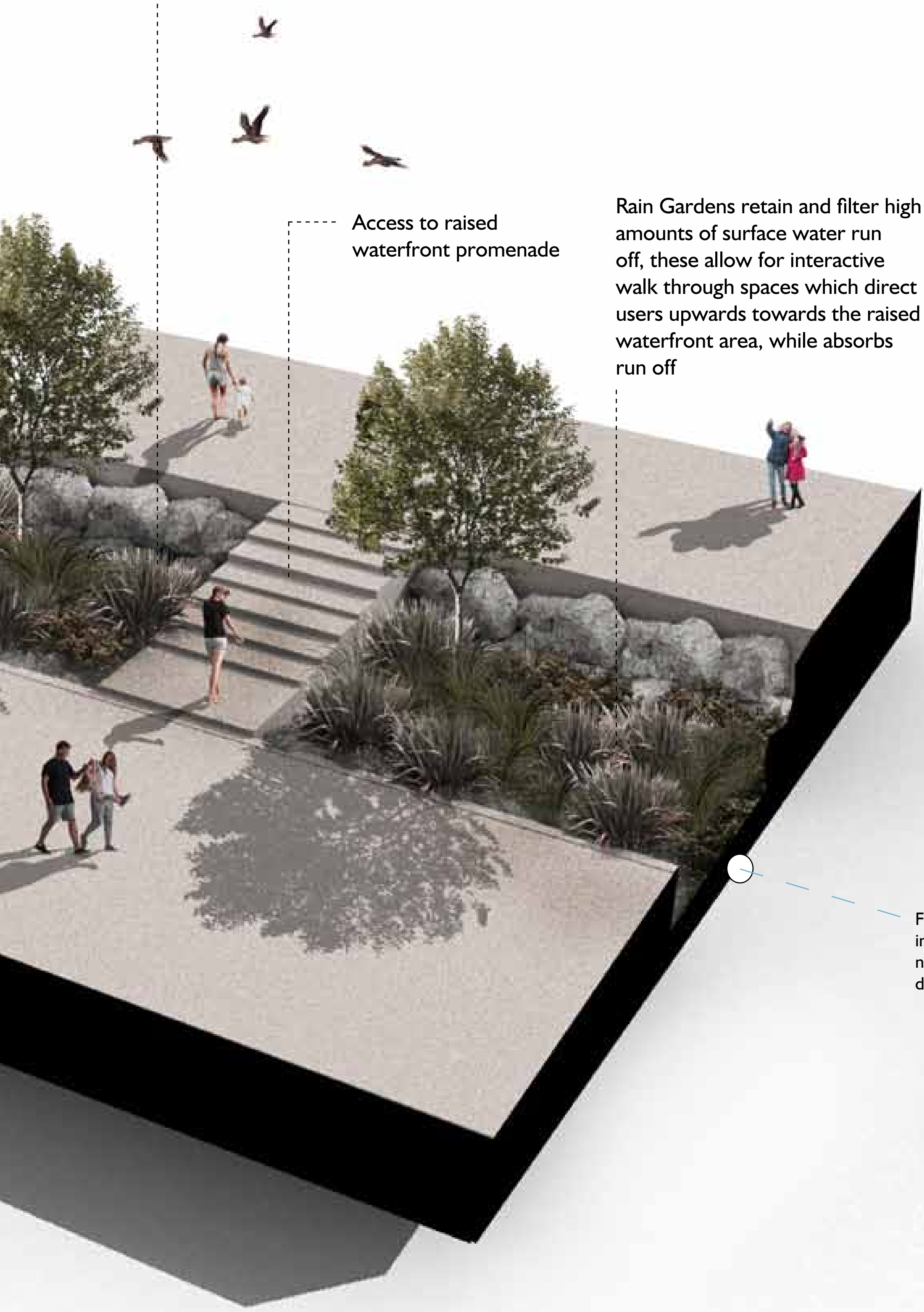
Fig. 9.32. Authors Own, Treatment Wetland Design, 2019.


Location Plan.

INCREASED PERMEABILITY AND STORM WATER DESIGN.

## RAIN GARDEN CATCHMENT.

Social Interaction Zone with Filtration Functions



Access to raised waterfront promenade

Rain Gardens retain and filter high amounts of surface water run off, these allow for interactive walk through spaces which direct users upwards towards the raised waterfront area, while absorbs run off

Filtered Rain Water filters into perforated SW pipe network again for later discharge into harbour

Fig. 9.33. Authors Own, Rain Garden Design, 2019.

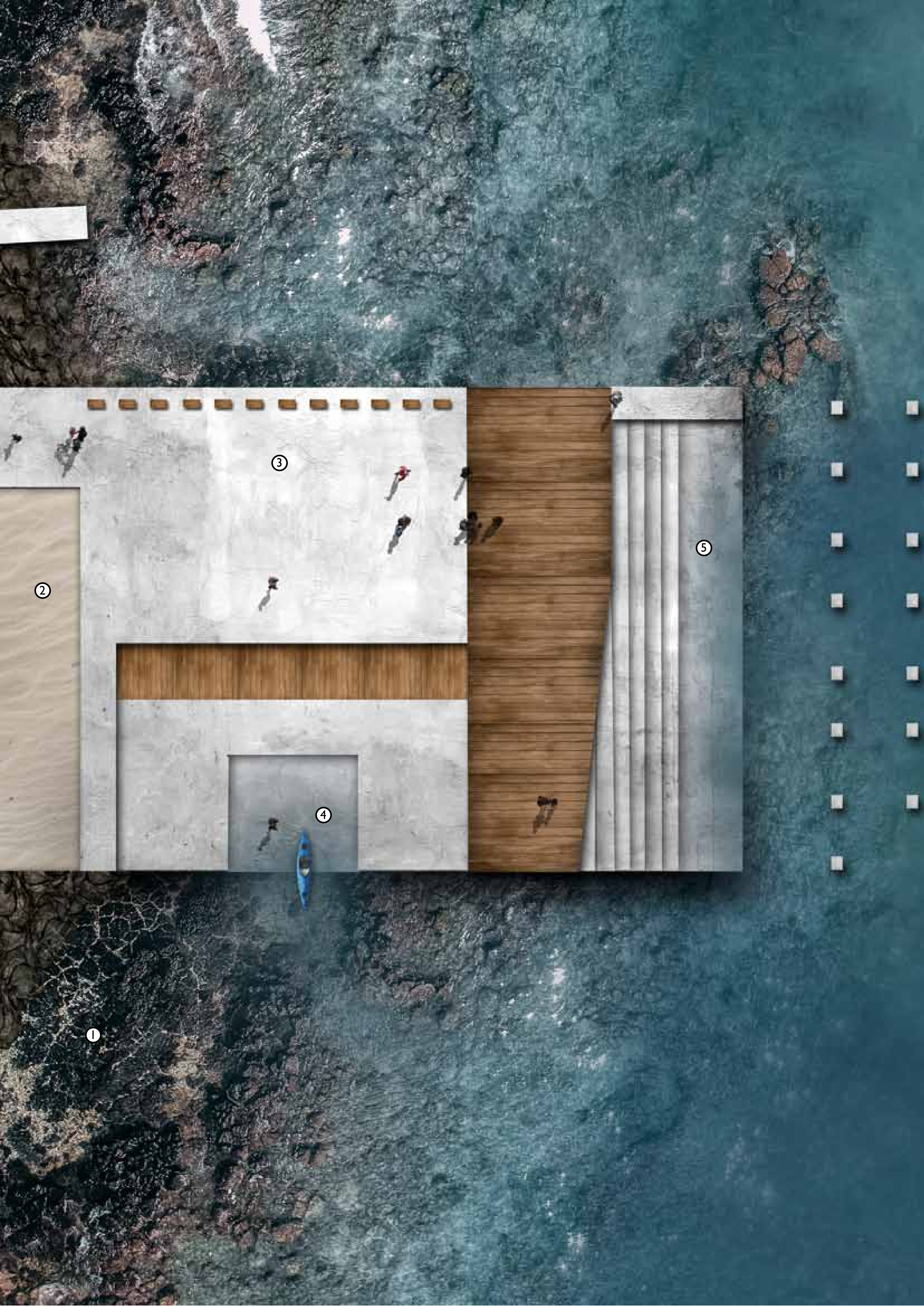

Zone 2
Zone 3
Zone 1


EXPLORATION OF ZONES.

Zone 1. Tidal Steps
Zone 2. Tidal Pools
Zone 3. Ecological Tidal Habitats
Zone 4, Coastal Boardwalk

1:1250 @ A1

Fig. 9.34. Authors Own, Site Zones, 2019.



1
2
3
4
5

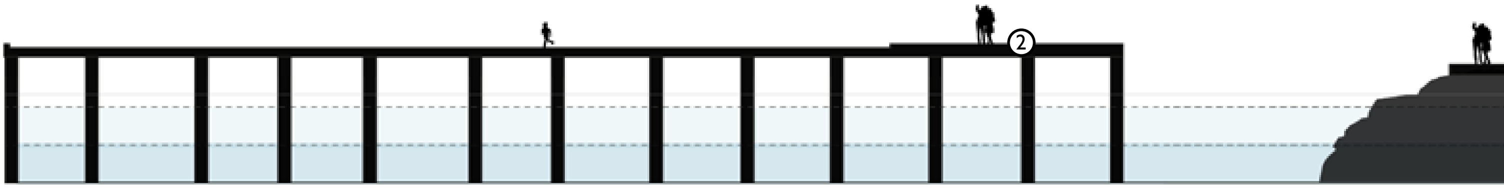

## Tidal Steps.

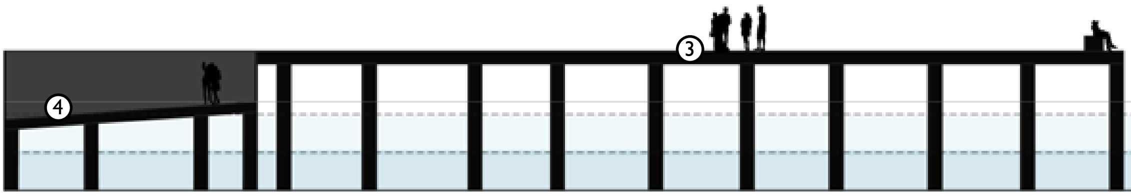
1. Rock Beds  encourage growth of filtration habitats
2. Permeable sand pit for recreational use
3. Open thoroughfare and temporary event space zone
4. kayak launch point
5. Tidal steps  appear and disappear with tidal movements, creating unique water experiences
6. Old Wharf Piles exposed to celebrate history of former port
7. Tidal Platforms celebrate the water movements, as platforms appear and disappear. Visually placed in front of waterfront open space draws users to swim to area. This emphasises the area is a safe and swimmable  recreational zone

1:150 @ A1

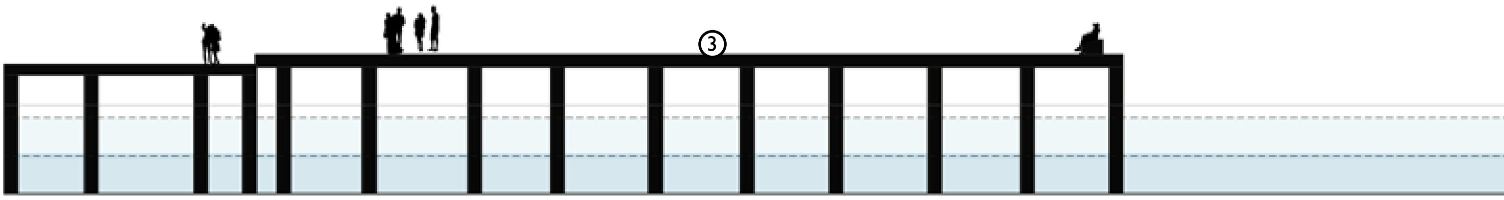
N

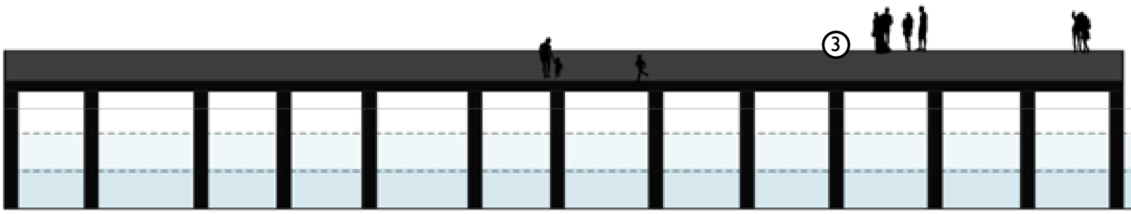
Fig. 9.35. Authors Own, Zone 1, 2019.



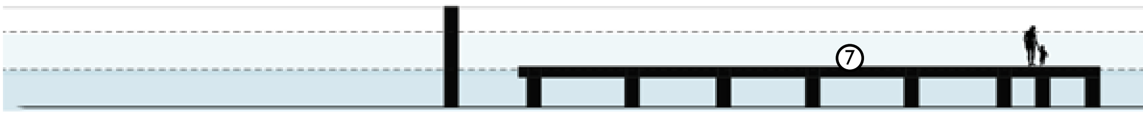

Steps down to water level draws people to go into water, this indicates its a safe region to swim in

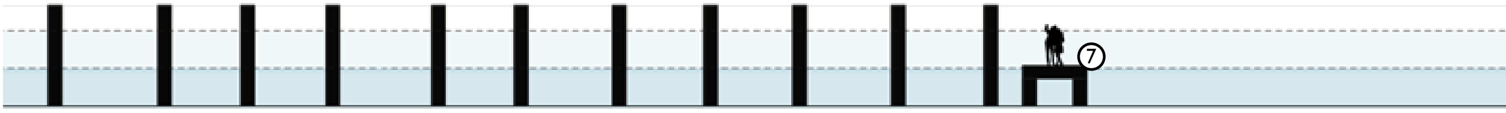


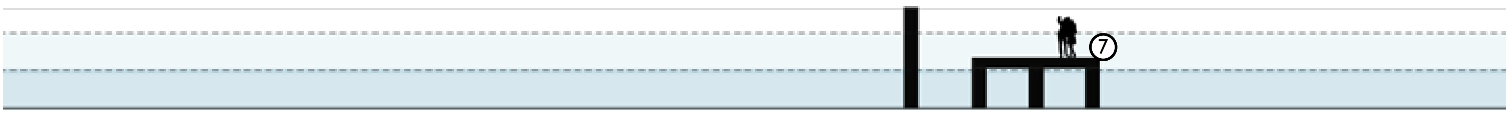

Open space allows users to walk through different levels of waterfront, engaging with harbour edges and water

Tidal Platforms built upon existing piles allows users to engage with tidal movements





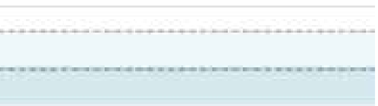



Piles disappearing into deeper harbour waters reflects the inundation sea level rise could bring


1:150 @ A1 Section A.

1:150 @ A1 Section B.

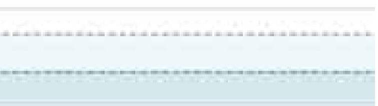
1:150 @ A1 Section C.



1:150 @ A1 Section D.

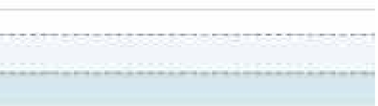
1:150 @ A1 Section E.

1:150 @ A1 Section F.



1:150 @ A1 Section G.

1:150 @ A1 Section H.

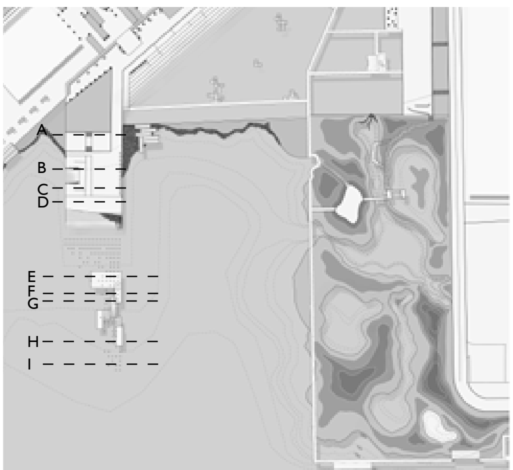


1:150 @ A1 Section I.

TIDAL STEPS ZONE.

1. Rock Beds encourage growth of filtration habitats
2. Permeable sand pit for recreational use
3. Open thoroughfare and temporary event space zone
4. Kayak launch point
5. Tidal steps appear and disappear with tidal movements, creating unique water experiences
6. Old Wharf Piles exposed to celebrate history of former port
7. Tidal Platforms celebrate the water movements, as platforms appear and disappear. Visually placed infront of waterfront open space draws users to swim to area. This emphasises the area is a safe and swimmable recreational zone

EXPLORATION THROUGH TIDAL STEPS ZONE.




Location Plan.

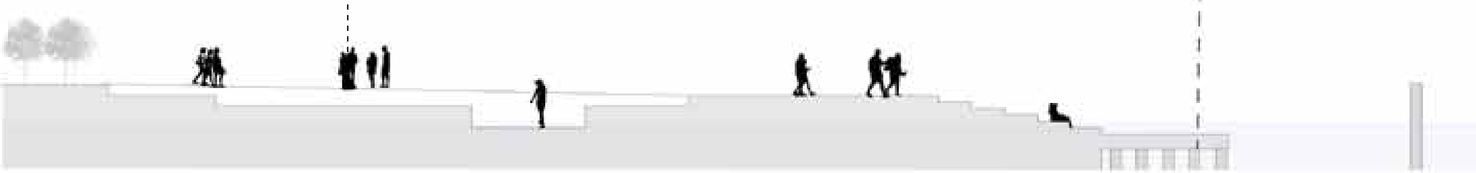
Fig. 9.36. Authors Own, Zone 1 Sectional Exploration, 2019.

SOCIAL TIDAL ZONE.

**TIDAL STEPS.**

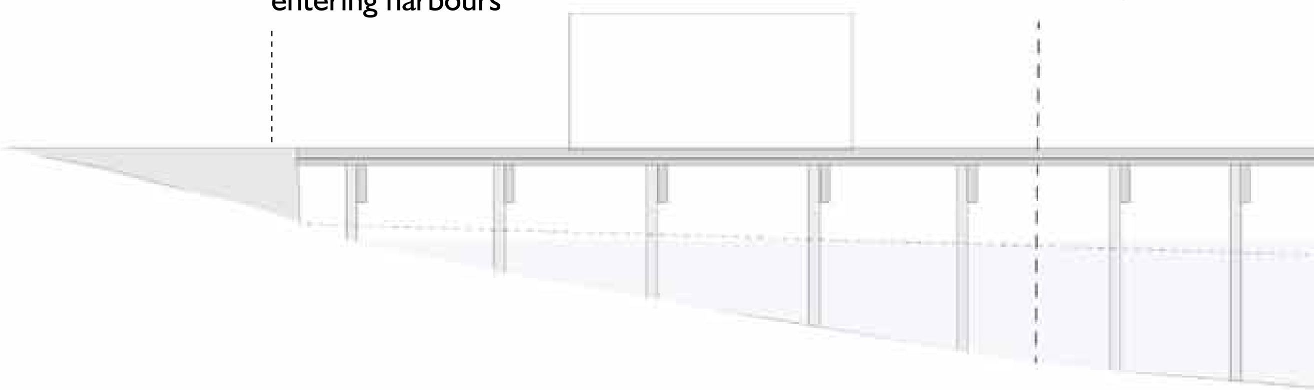
Tidal movements change the interactivity of users within space. In high tides, steps will disappear under water, creating an enjoyable resting experience. Open steps merging into water draw people towards pool to swim, rest and enjoy space

Large steps provide harbour views and resting areas



Industrial site, limits public interaction with harbour. Use of vehicles increases toxic runoff entering harbours

-8m
Existing Sea Bed



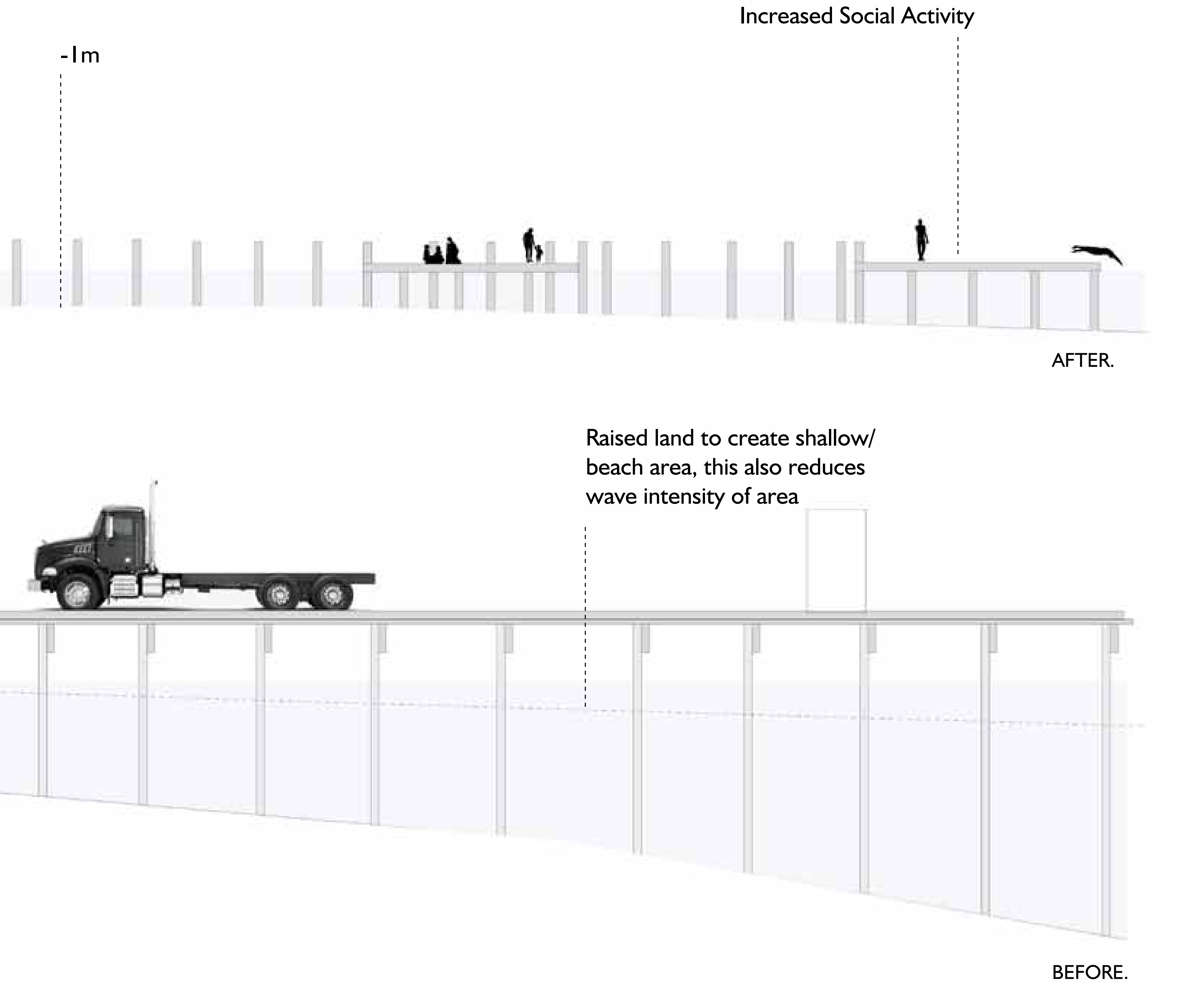
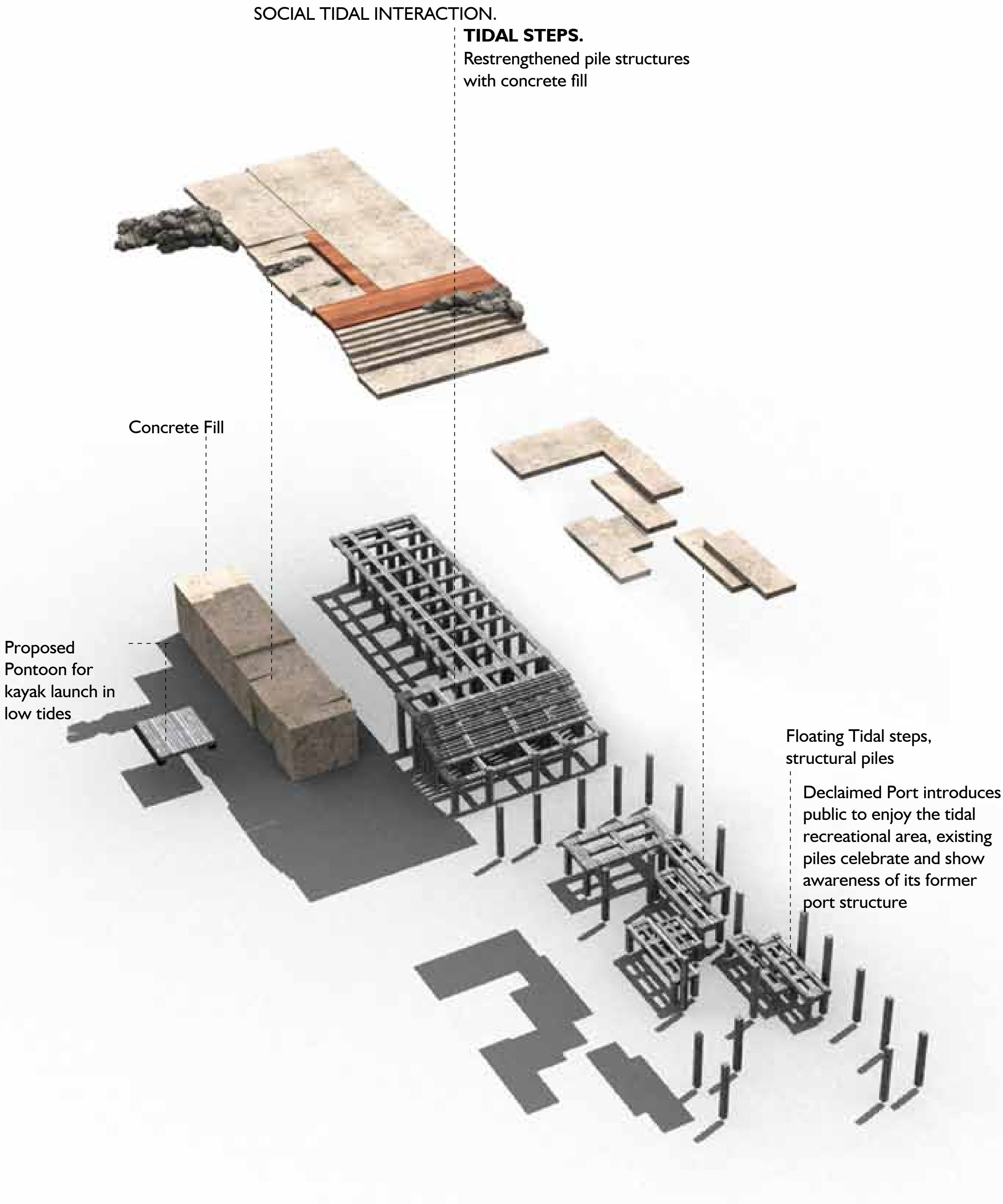


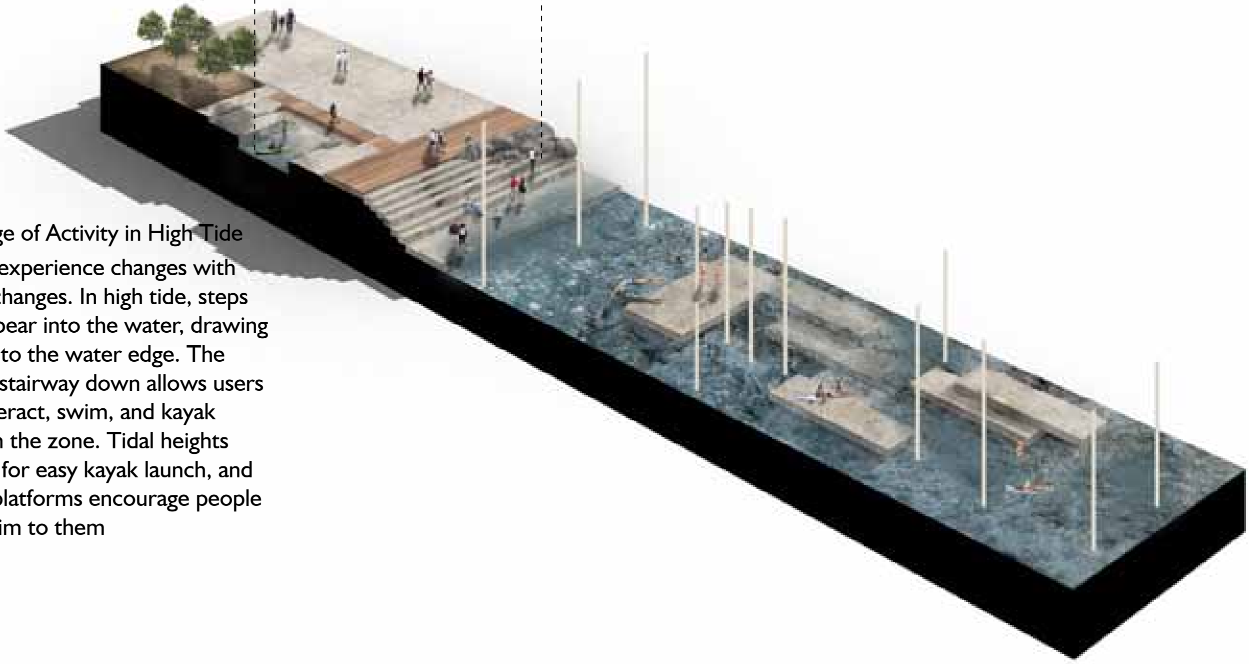

Fig. 9.37. Authors Own, Tidal Steps Sectional Before and After, 2019.


SOCIAL TIDAL INTERACTION.
**TIDAL STEPS.**
Restrengthened pile structures
with concrete fill
Concrete Fill
Proposed
Pontoon for
kayak launch in
low tides
Floating Tidal steps,
structural piles
Declaimed Port introduces
public to enjoy the tidal
recreational area, existing
piles celebrate and show
awareness of its former
port structure

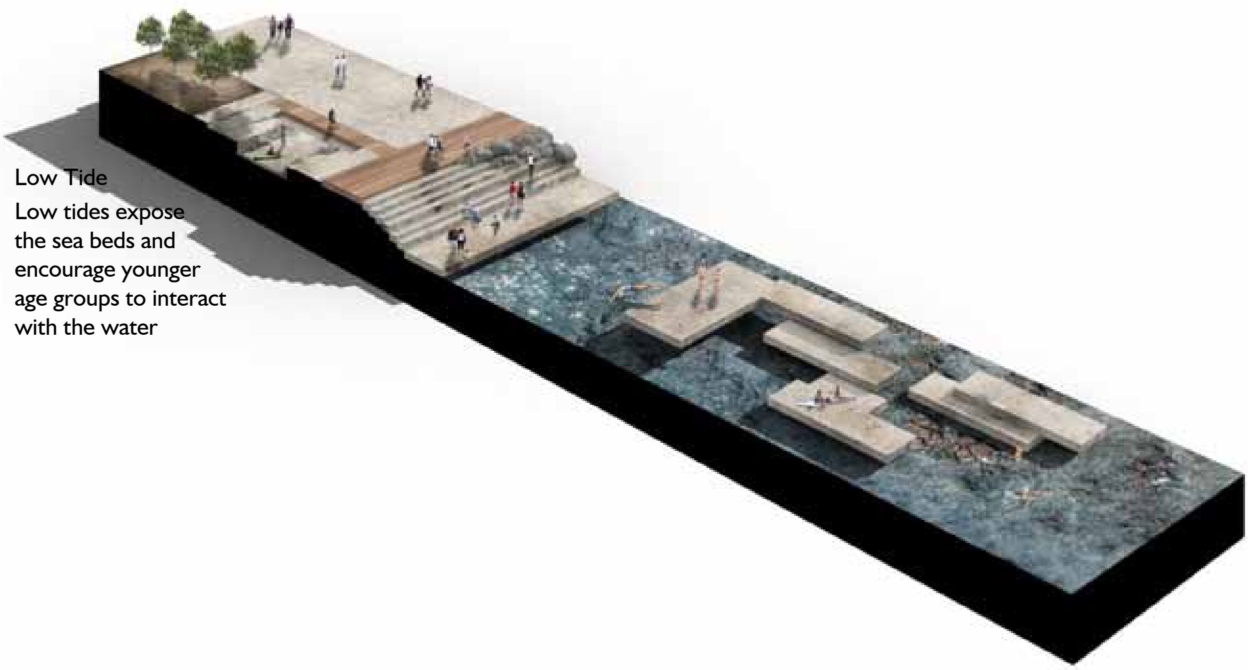
SOCIAL TIDAL INTERACTION.

Kayak launch, the ramp gently slopes down for water to fill. This allows easy access for small boats on the water

**TIDAL STEPS.**
Providing increased public access and interaction with the waters edge.



Change of Activity in High Tide
User experience changes with tidal changes. In high tide, steps disappear into the water, drawing users to the water edge. The open stairway down allows users to interact, swim, and kayak within the zone. Tidal heights allow for easy kayak launch, and tidal platforms encourage people to swim to them



Low Tide
Low tides expose the sea beds and encourage younger age groups to interact with the water

Fig. 9.39. Authors Own, Social Tidal Interaction, 2019.

Fig. 9.38. Authors Own, Tidal Steps Exploded, 2019. (Opposite Page)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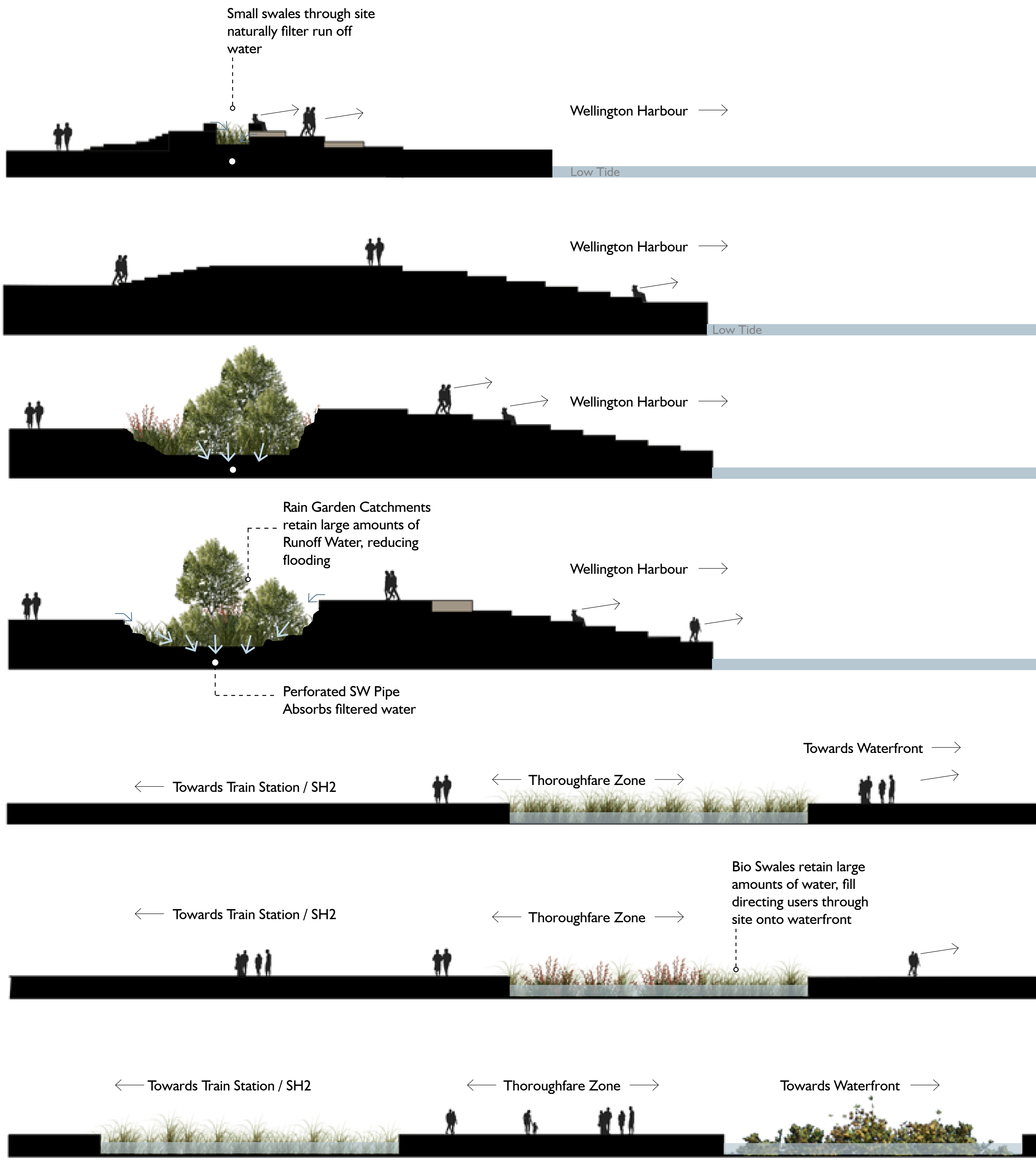
1. Mixed Use Buildings (Residential and Commercial
2. Open Through fare zone draws users into space through surrounding planters funnelling people
3. Permeable Swales absorb run off water
4. Ramp to raised waterfront edge
5. Stairway to raised waterfront edge
6. Rain Garden catchment collecting run off water
7. Tidal steps going down to tidal pools allows users to rest, creates a gathering zone for spending time
8. Tidal pool flushes waves into it, it allows for users to swim within shallow waters.
Tidal Pools.

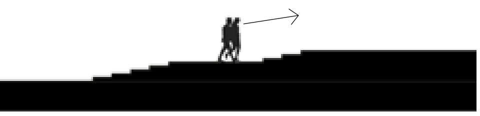

Small swales through site naturally filter run off water
Wellington Harbour
Low Tide
Wellington Harbour
Low Tide
Wellington Harbour
Rain Garden Catchments retain large amounts of Runoff Water, reducing flooding
Wellington Harbour
Perforated SW Pipe Absorbs filtered water
Towards Waterfront
Towards Train Station / SH2
Thoroughfare Zone
Bio Swales retain large amounts of water, fill directing users through site onto waterfront
Towards Train Station / SH2
Thoroughfare Zone
Towards Train Station / SH2
Thoroughfare Zone
Towards Waterfront

Section A.
1:200 @ A1

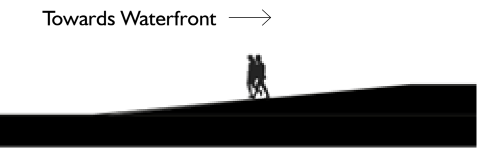
Section B
1:200 @ A1

Section C.
1:200 @ A1

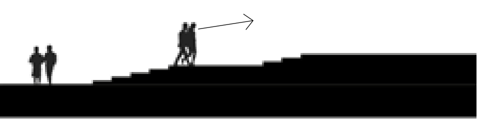
Section D.
1:200 @ A1



Section E.
1:200 @ A1




Section F.
1:200 @ A1



Section G.
1:200 @ A1

TRANSITION THROUGH TIDAL POOL AREA.


Fig. 9.40. Authors Own, Zone 2, 2019. (Previous Page)

Fig. 9.41. Authors Own, Zone 2 Sectional Exploration, 2019.


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Fig. 9.42. Authors Own, Zone 3, 2019.

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SOCIAL TIDAL ZONE.

**TIDAL POOL.**

Tidal movements change the interactivity of users within space. In high tides, steps will disappear under water, creating an enjoyable resting experience. Open steps merging into water draw people towards pool to swim, rest and enjoy space

Small water inlets allow high tidal flows to enter tidal pool, this helps retain water within tidal pools instead of draining out constantly.

Walkway / Seawall

Tidal Breakers reduce wave energy from reaching inland. This also allows for safer water interaction and recreation with less wave movement

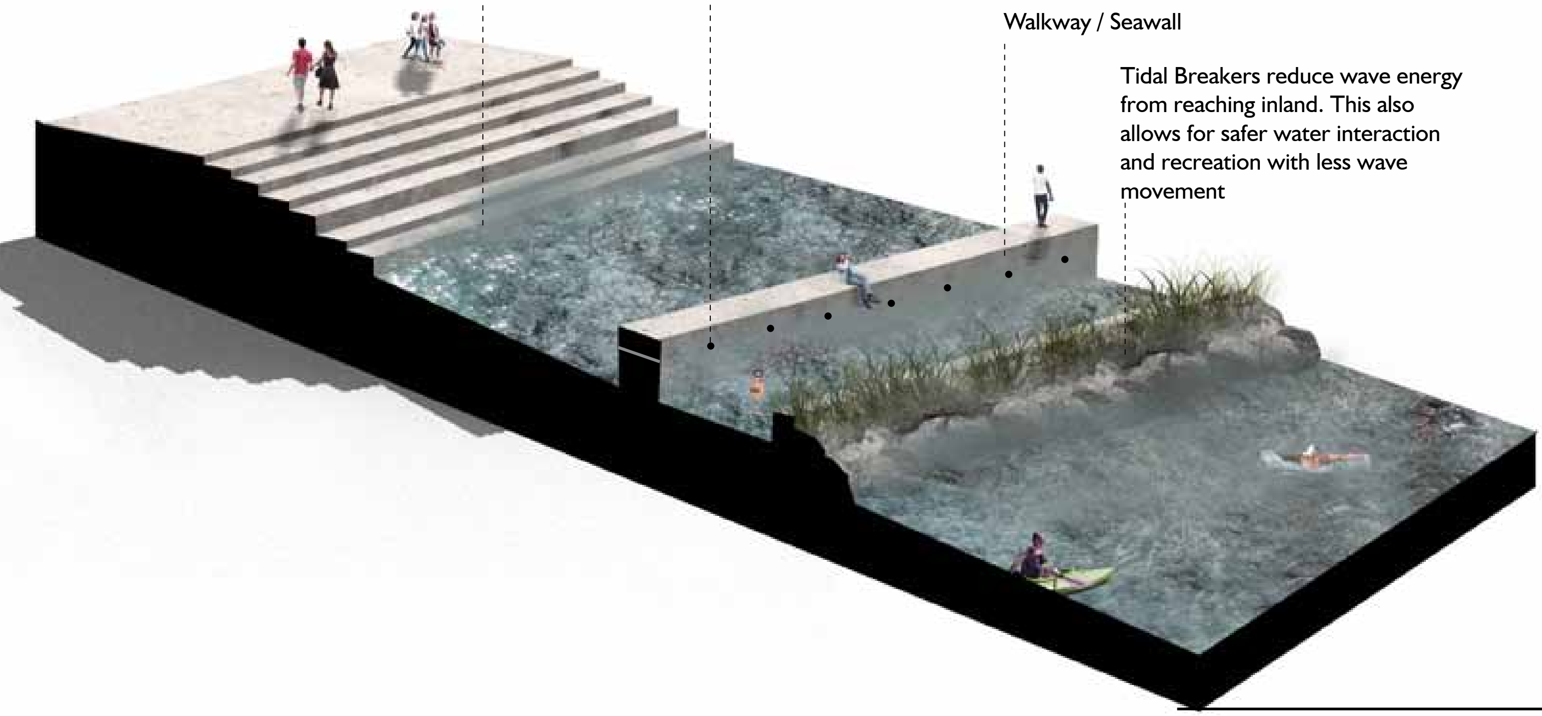

Fig. 9.43. Authors Own, Tidal Pools, 2019.


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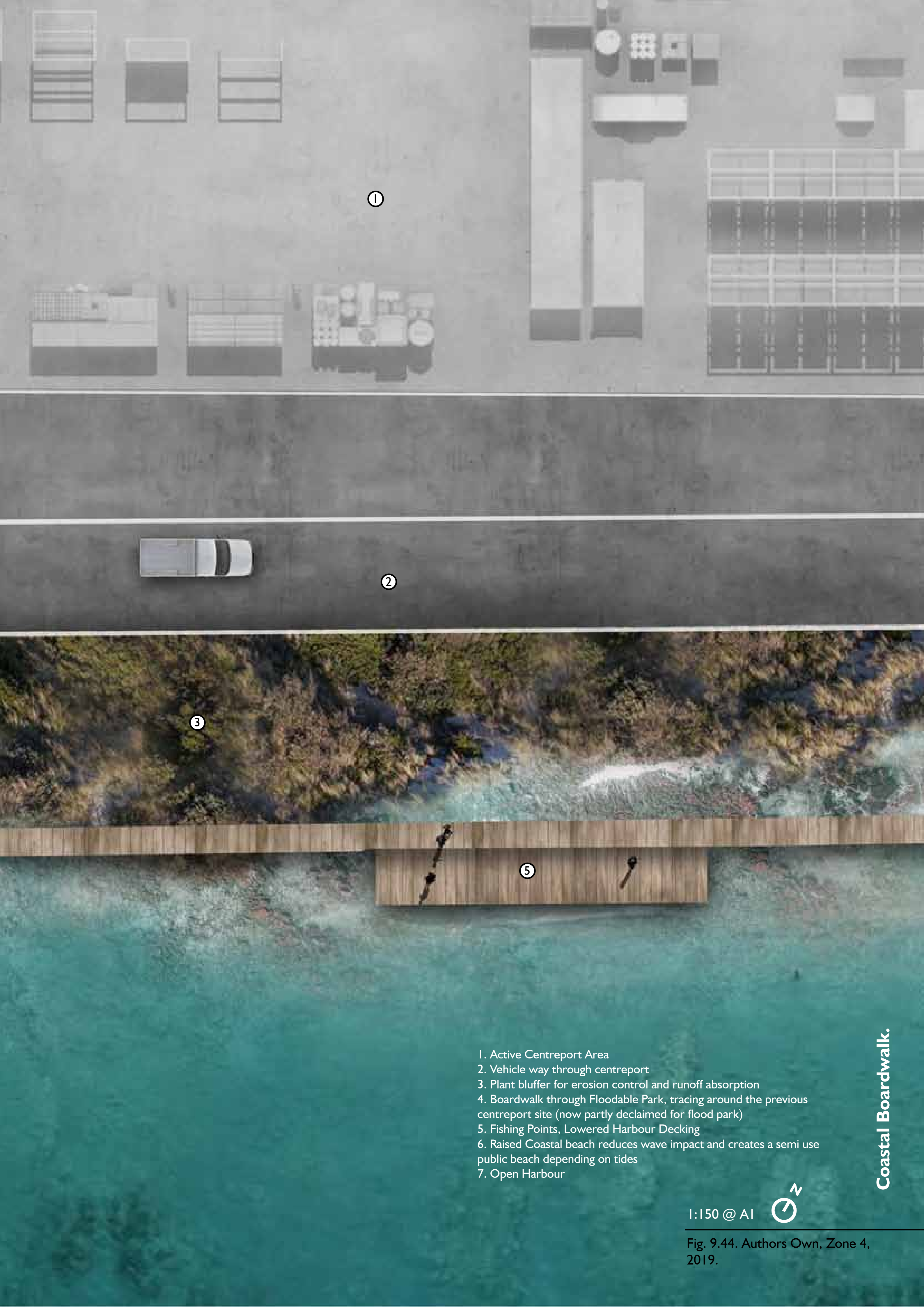



## Coastal Boardwalk.

1. Active Centreport Area
2. Vehicle way through centreport
3. Plant bluffer for erosion control and runoff absorption
4. Boardwalk through Floodable Park, tracing around the previous centreport site (now partly declaimed for flood park)
5. Fishing Points, Lowered Harbour Decking
6. Raised Coastal beach reduces wave impact and creates a semi use public beach depending on tides
7. Open Harbour

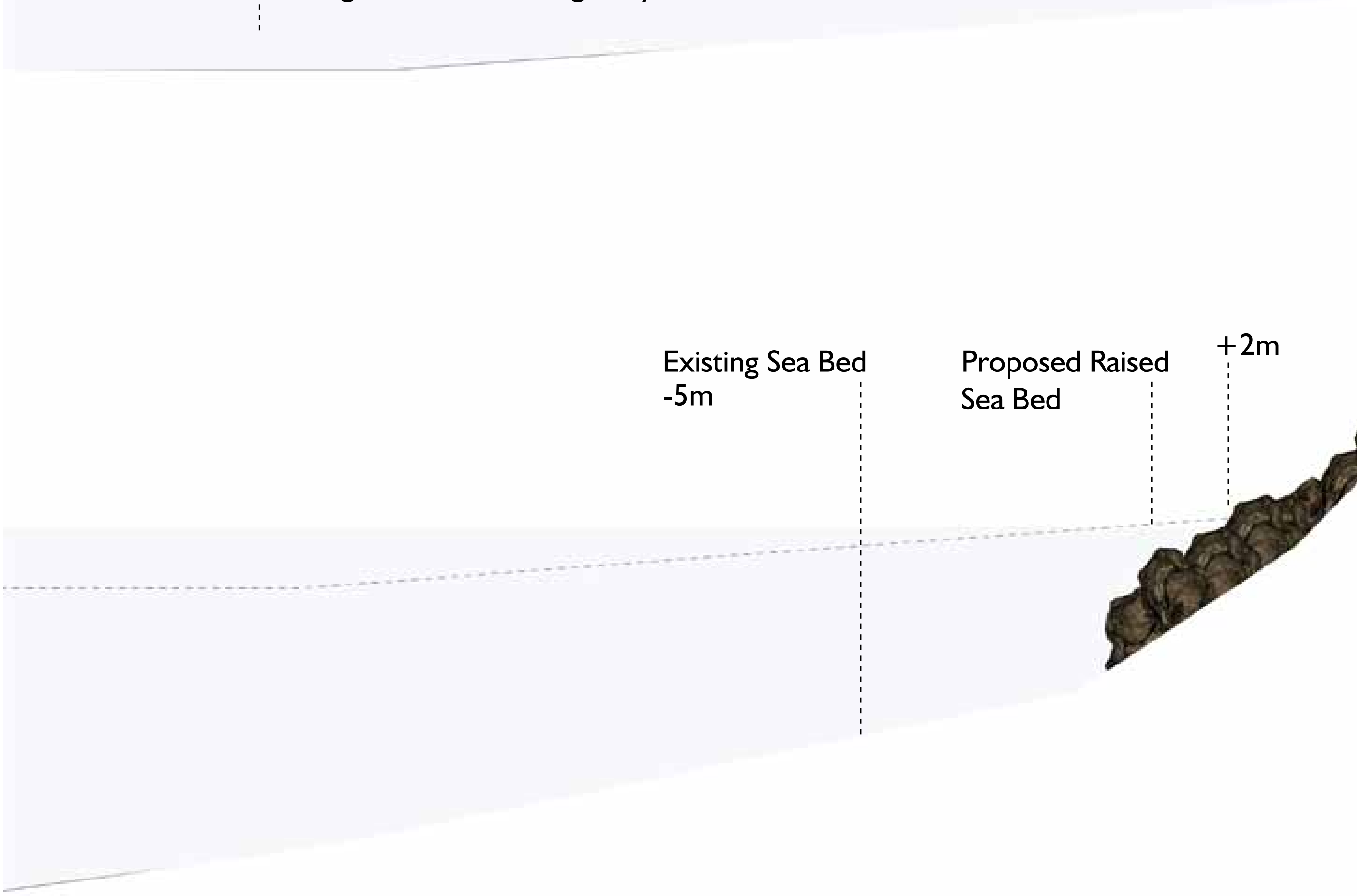
1:150 @ A1

Fig. 9.44. Authors Own, Zone 4, 2019.

PROTECTIVE EDGES.

## COASTAL EDGES.

A soft coastal edge has been implemented to allow absorption of tidal waters, in event of inundation this will help retain and reduce wave energy from disrupting further site. The floodable park allows water to flow into retention basins, retaining large quantities of storm water. Its permeability also attracts tidal ecologies and promotes habitats to flourish through its self sustaining body



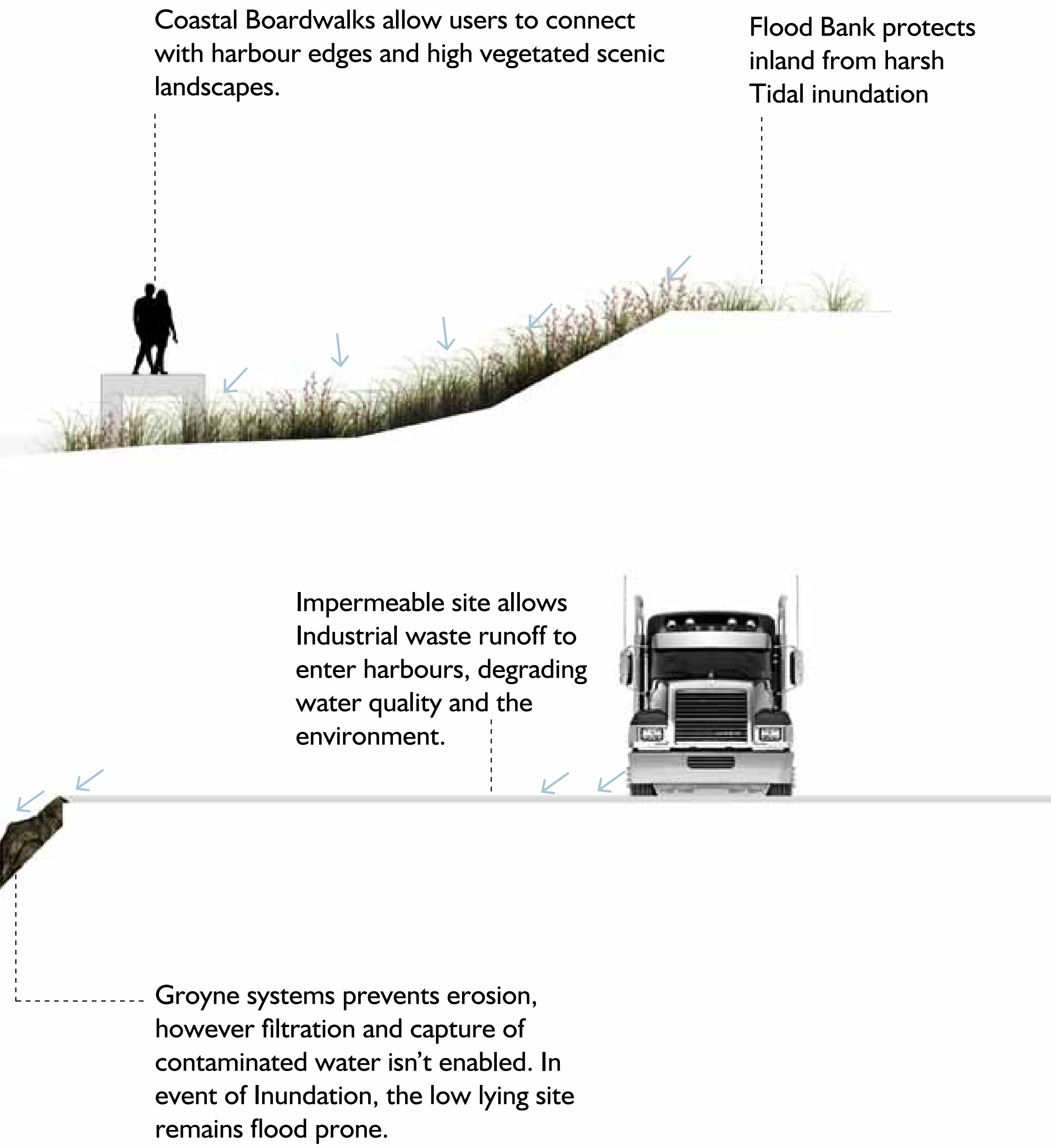
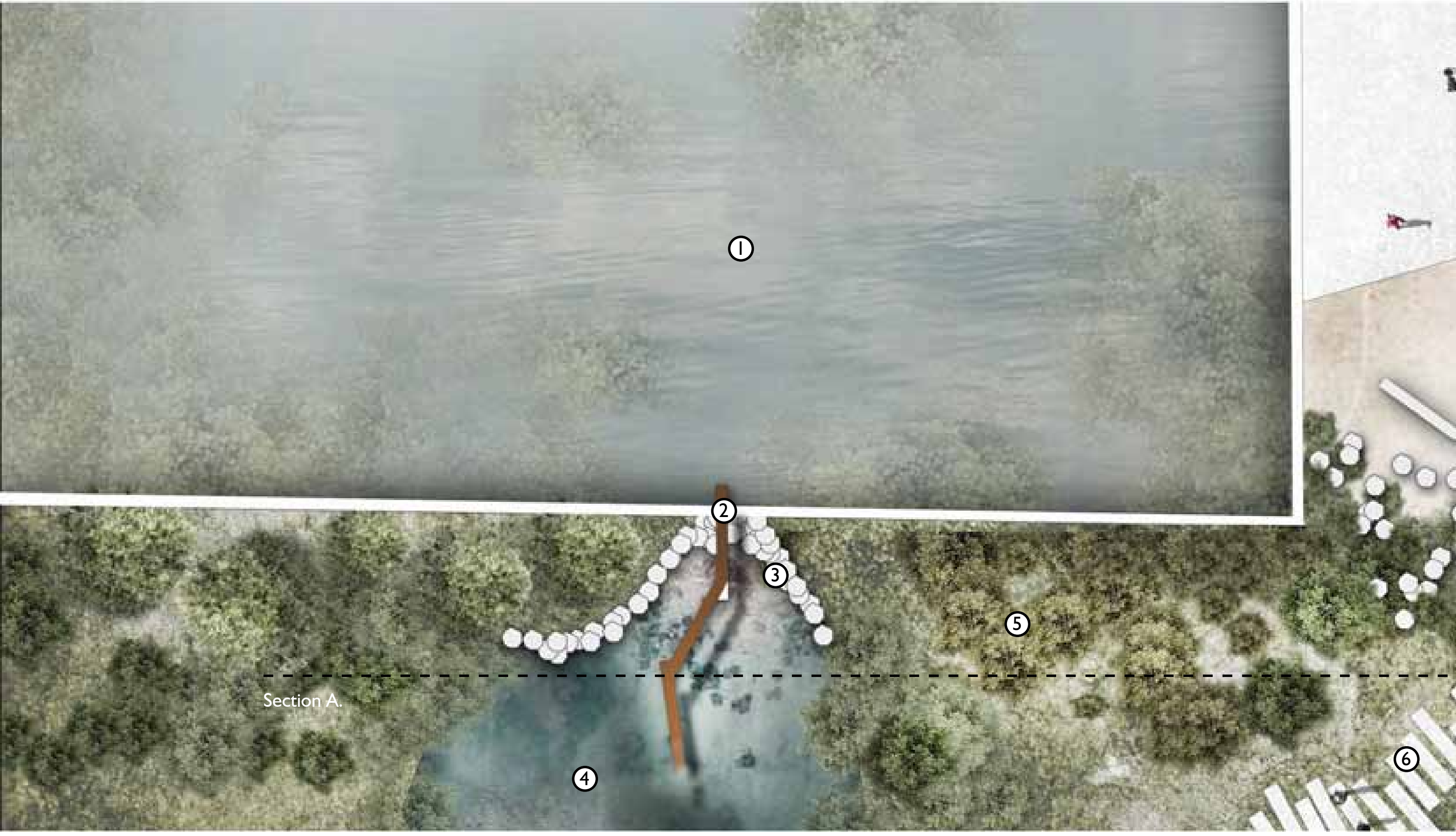
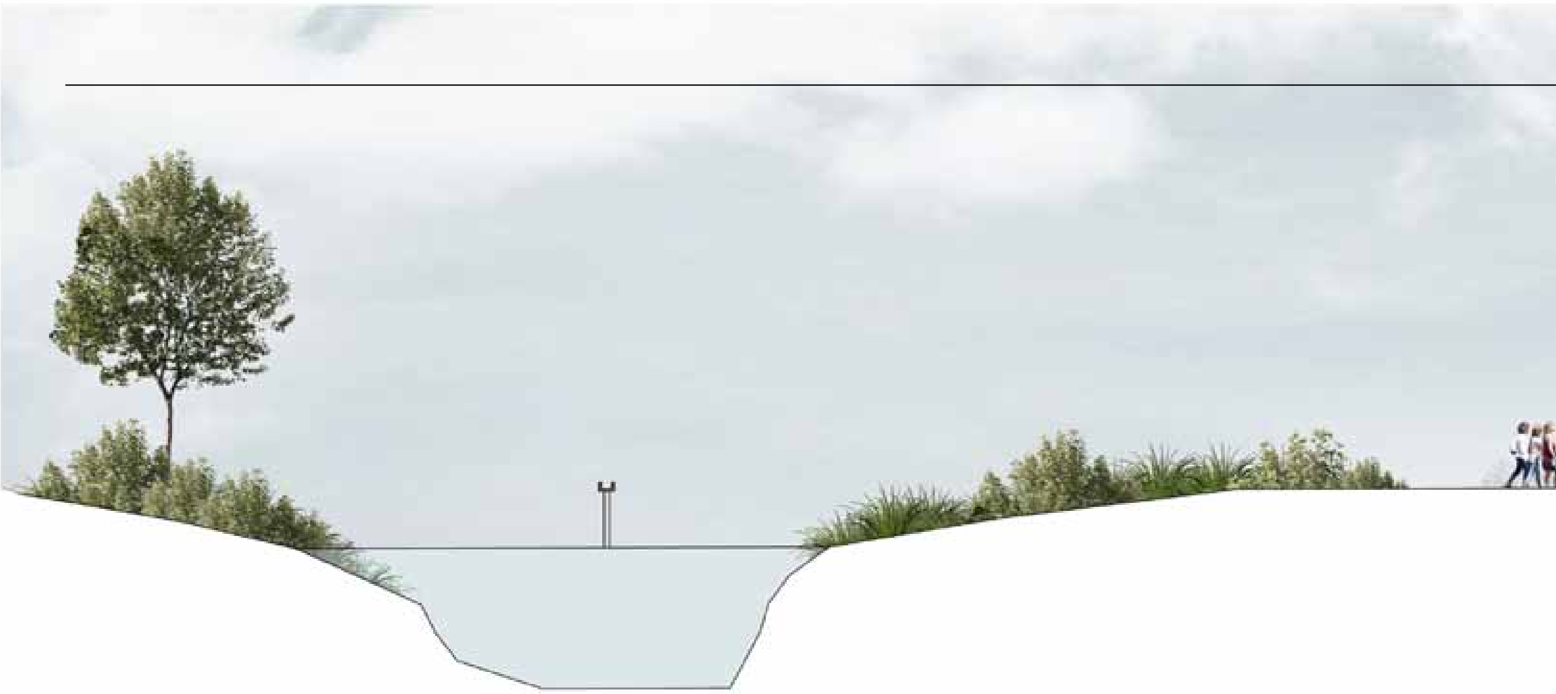



Fig. 9.45. Authors Own, Coastal Edge Before and After, 2019.



ZONE 5. FLOOD PARK.

1. Filtered Pipitea Catchment SW Wetland
2. Wetland Outlet
3. Groyne erosion control
4. Reintroduced Pipitea Stream
5. Vegetated habitat space
6. Walkway
7. Step Access into Flood Park
8. Permeable sand resting zone
9. Open thoroughfare zone
10. Boardwalk
11. Vegetated Swale
12. Vehicle Road
13. Centreport

Fig. 9.46. Authors Own, Zone 5, 2019.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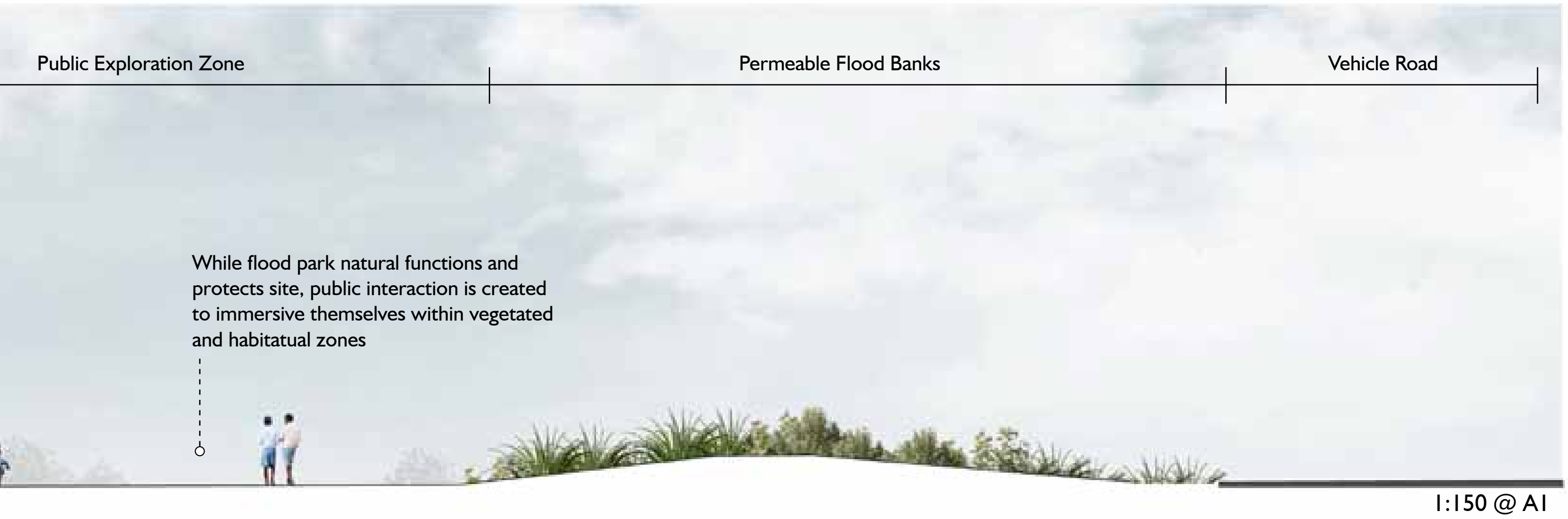
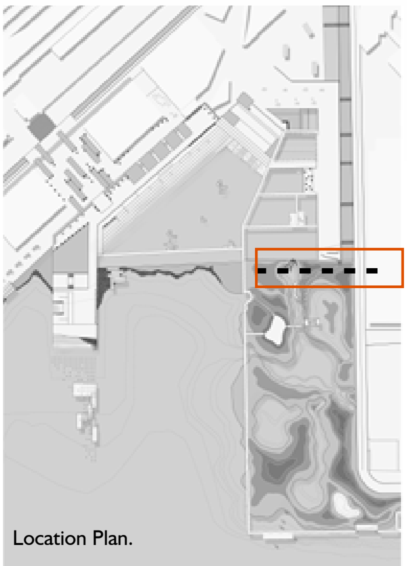
1:200 @ A1


Public Exploration Zone
Permeable Flood Banks
Vehicle Road
While flood park natural functions and
protects site, public interaction is created
to immersive themselves within vegetated
and habitatual zones
1:150 @ A1


Location Plan.

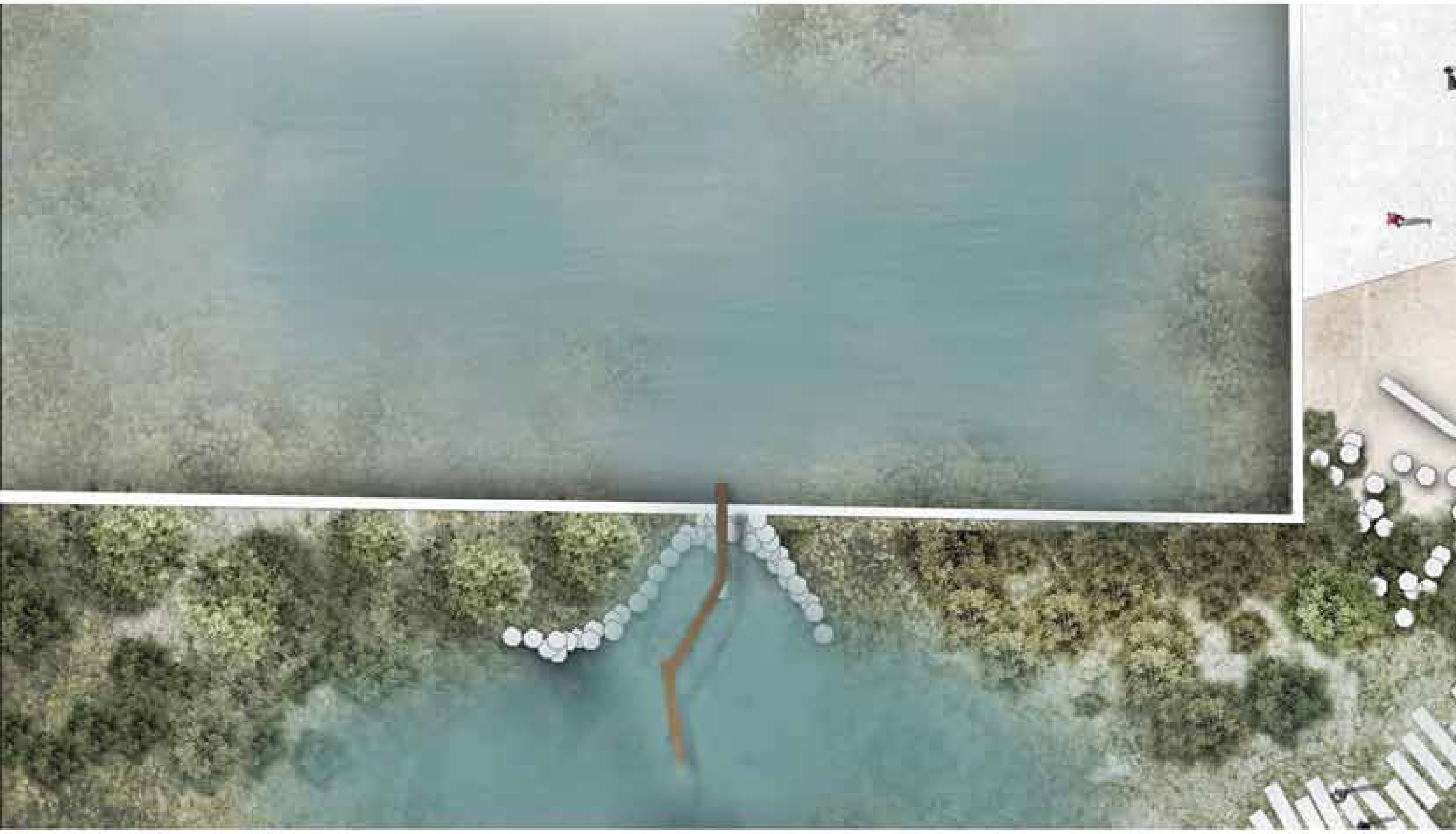
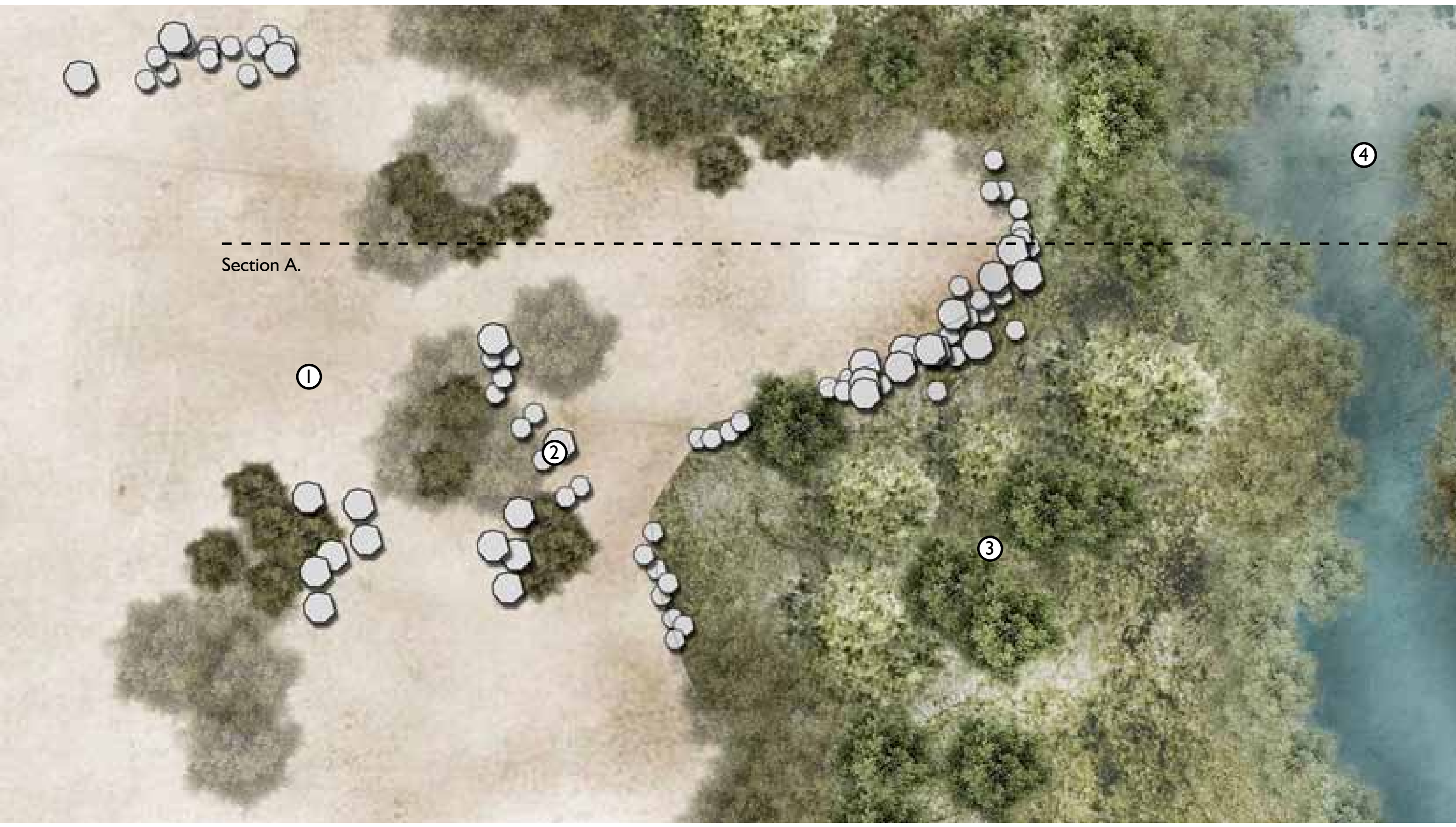




Fig. 9.47. Authors Own, Zone 5 in Flood Event, 2019.

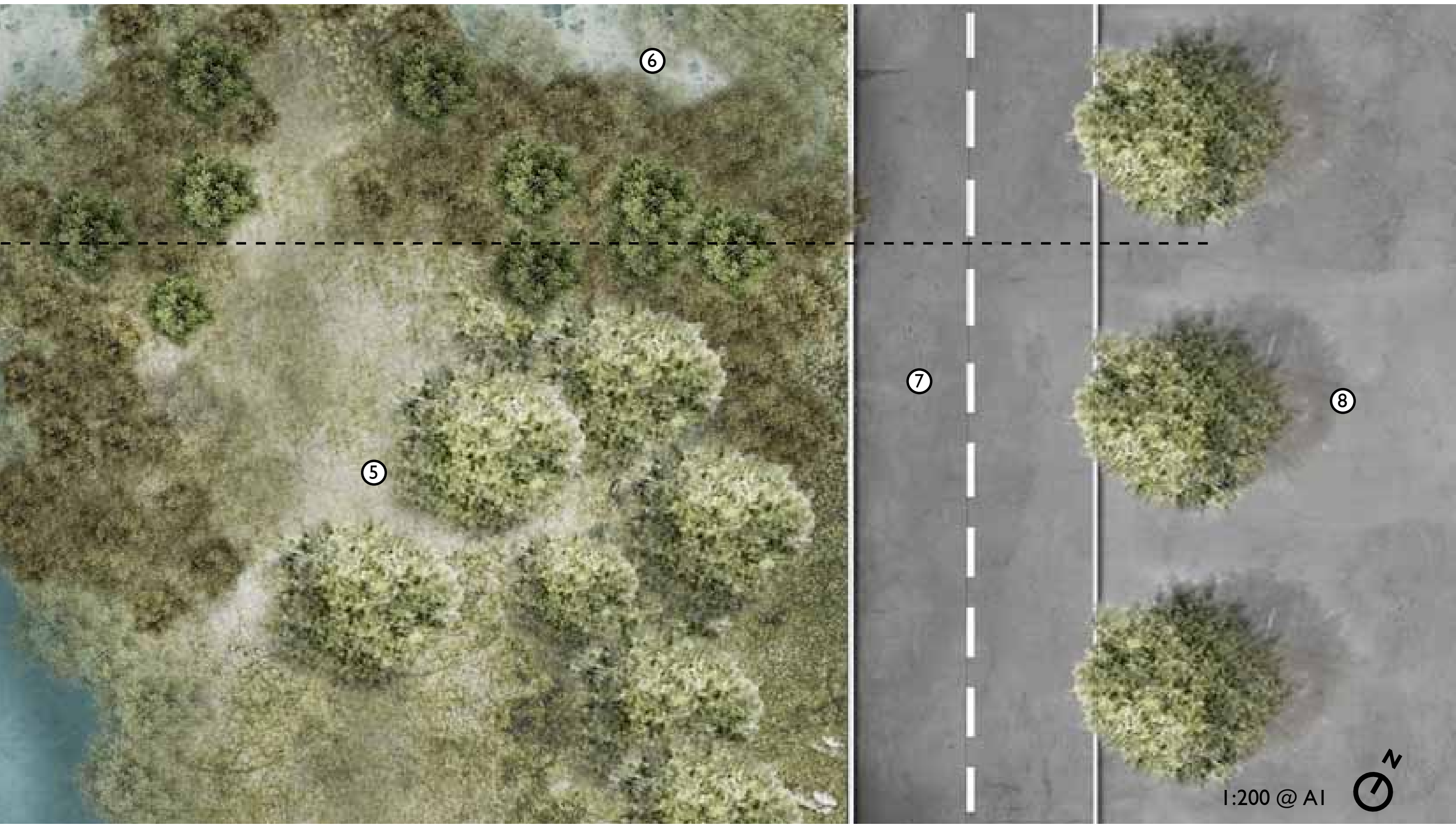



ZONE 6. FLOOD PARK.

1. Permeable Flood Bank for informal Public Use
2. Informal Boulder seating
3. Flood Bank with vegetation for stabilisation
4. Pipitea Stream
5. Flood Bank
6. Natural Wetland (still water lets plants settle and filtrate)
7. Vehicle road
8. Centreport



Fig. 9.48. Authors Own, Zone 6, 2019.



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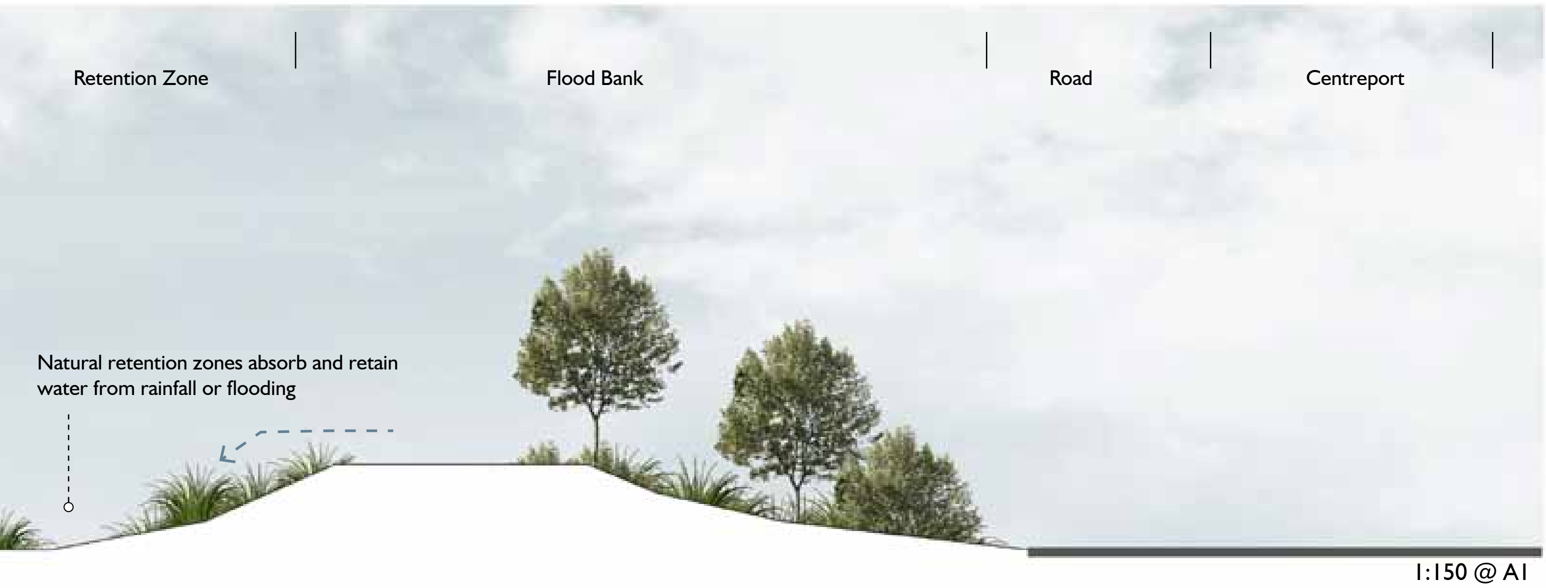


Retention Zone
Flood Bank
Road
Centreport
Natural retention zones absorb and retain water from rainfall or flooding
1:150 @ A1


Location Plan.

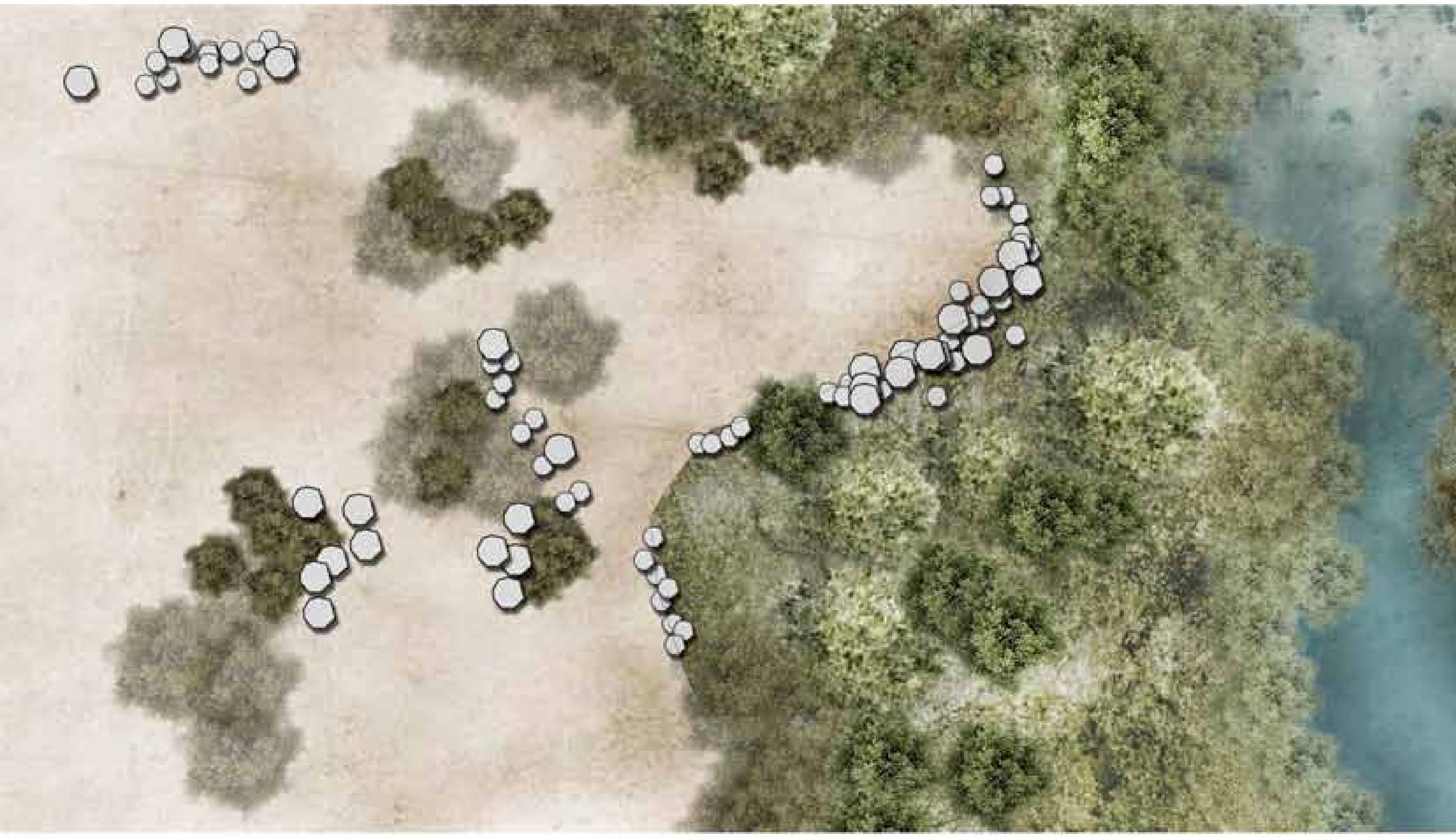
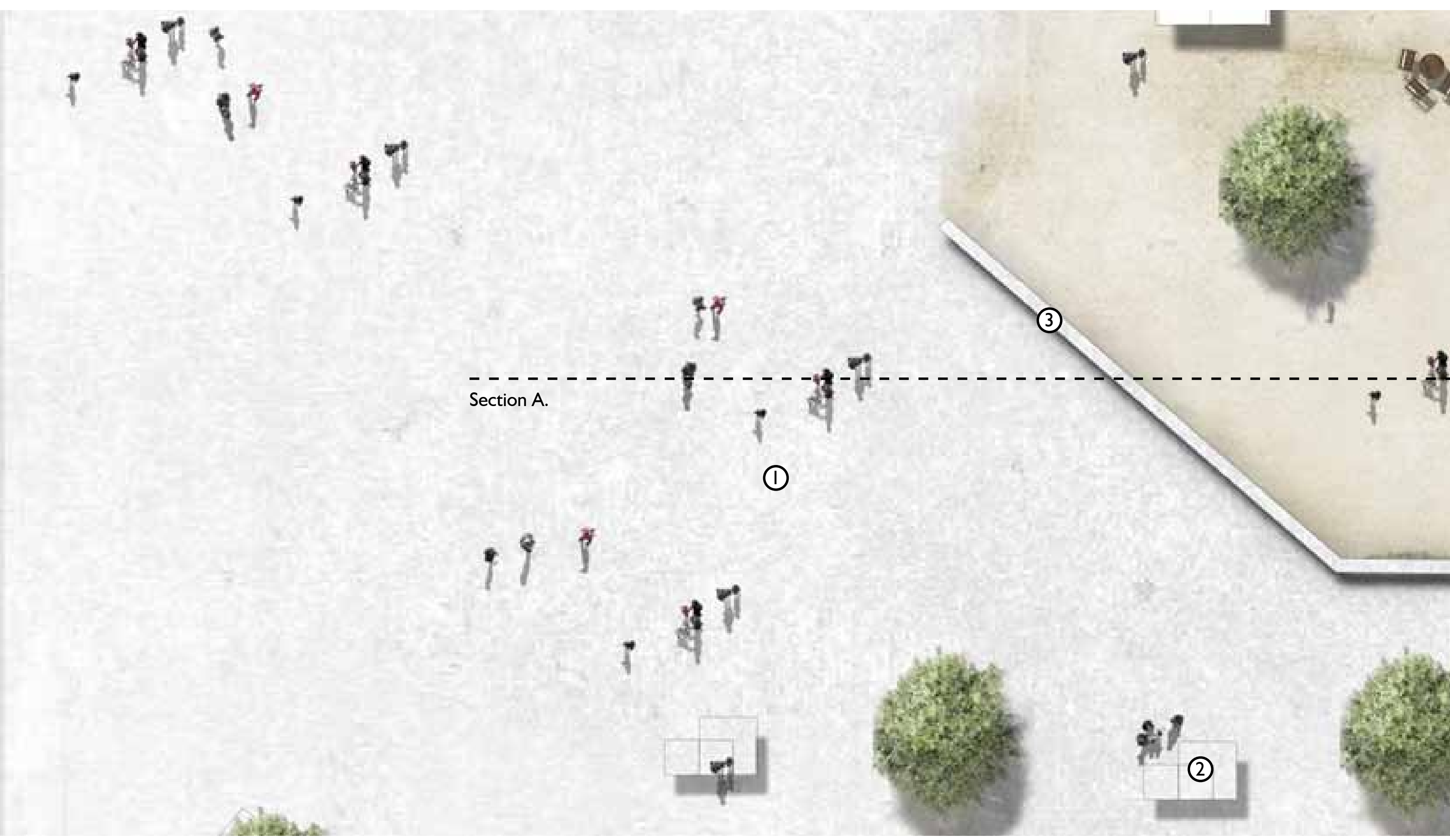
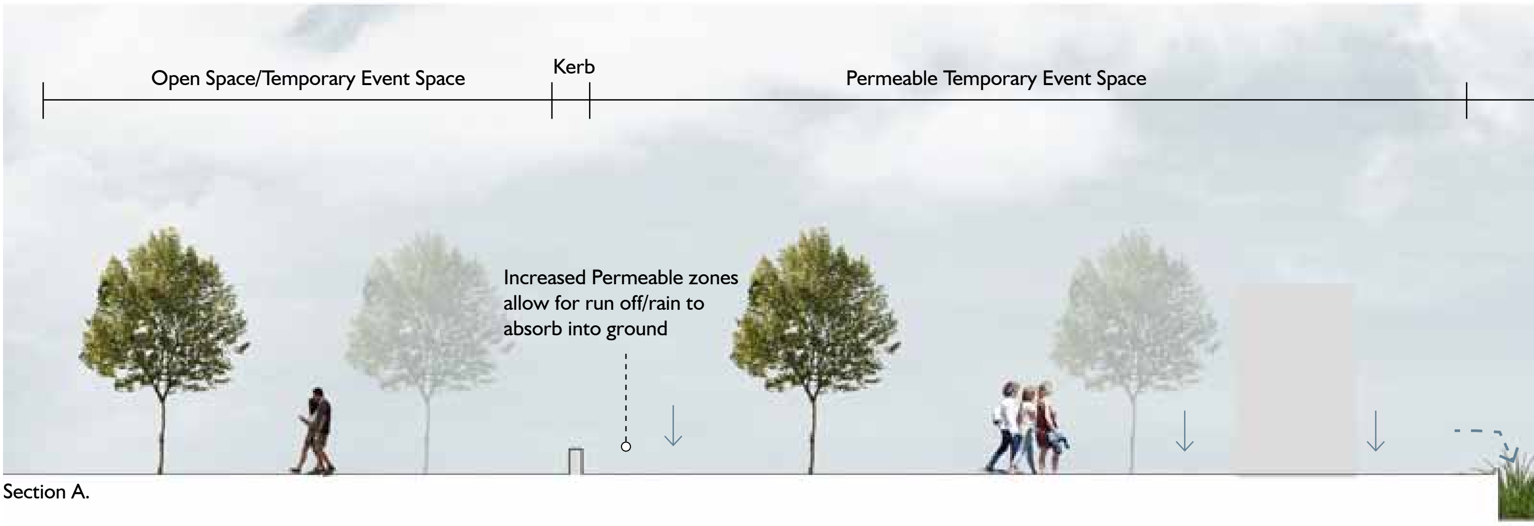




Fig. 9.49. Authors Own, Zone 6 in Flood Event, 2019.

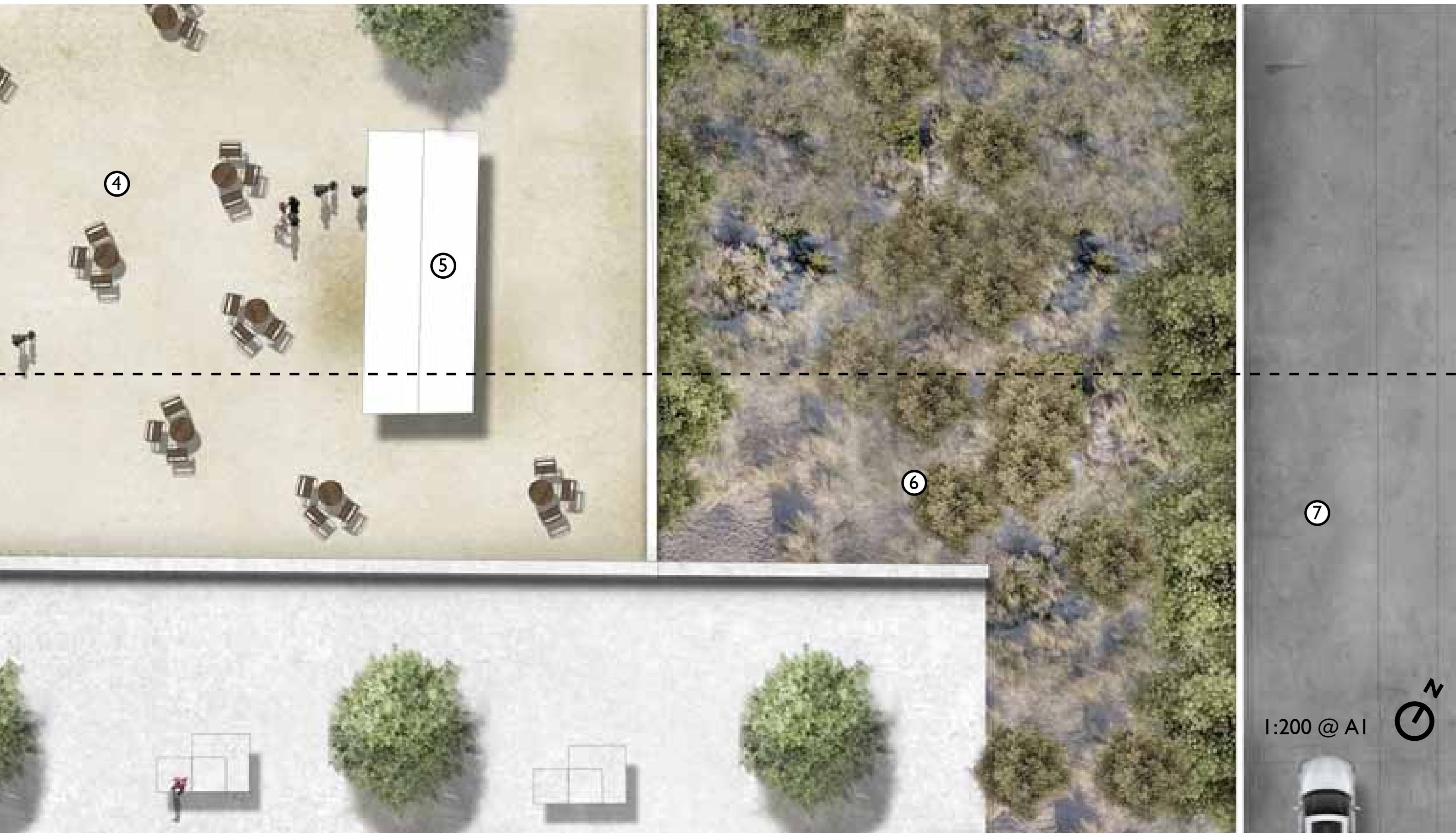



ZONE 7. OPEN SPACE/ TEMPORARY EVENT SPACE.

1. Open thoroughfare Zone / Pop up Event Space
2. Block Seating
3. Kerb/Informal Seating
4. Permeable Pop up Event Space
5. Temporary Cargo Container Cafe
6. Vegetated Swale
7. Vehicle Road

Fig. 9.50. Authors Own, Zone 7, 2019.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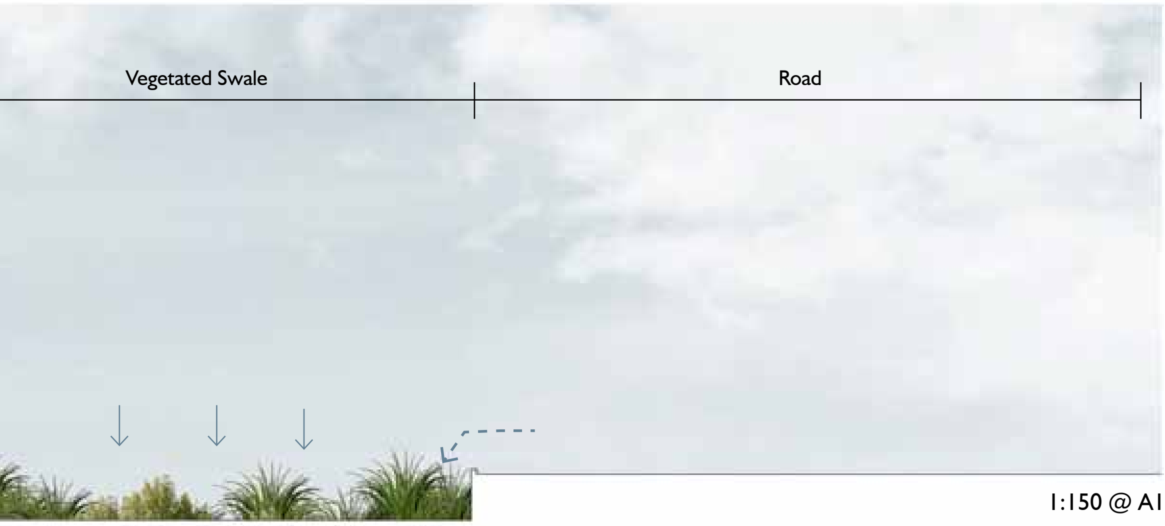
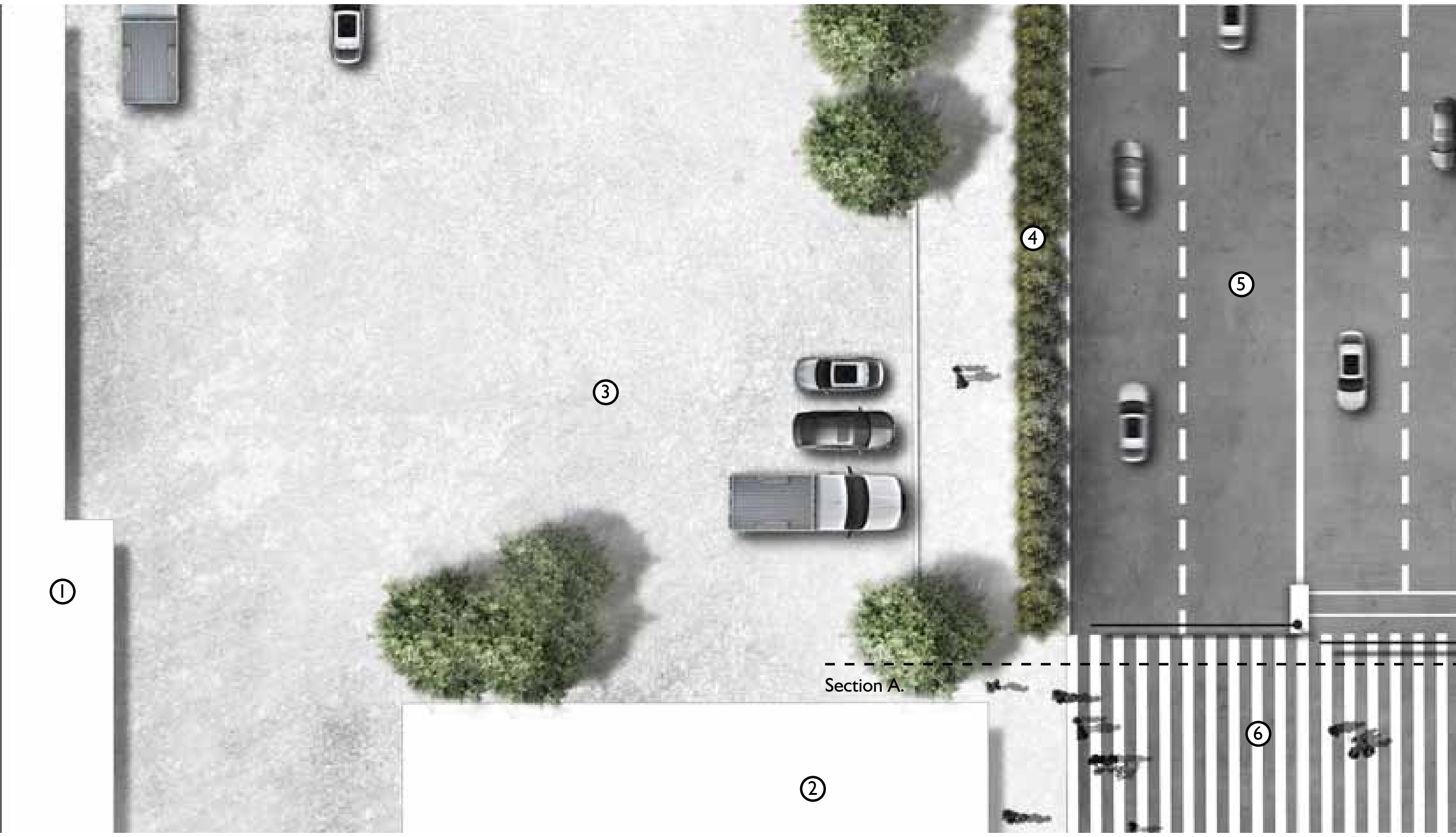
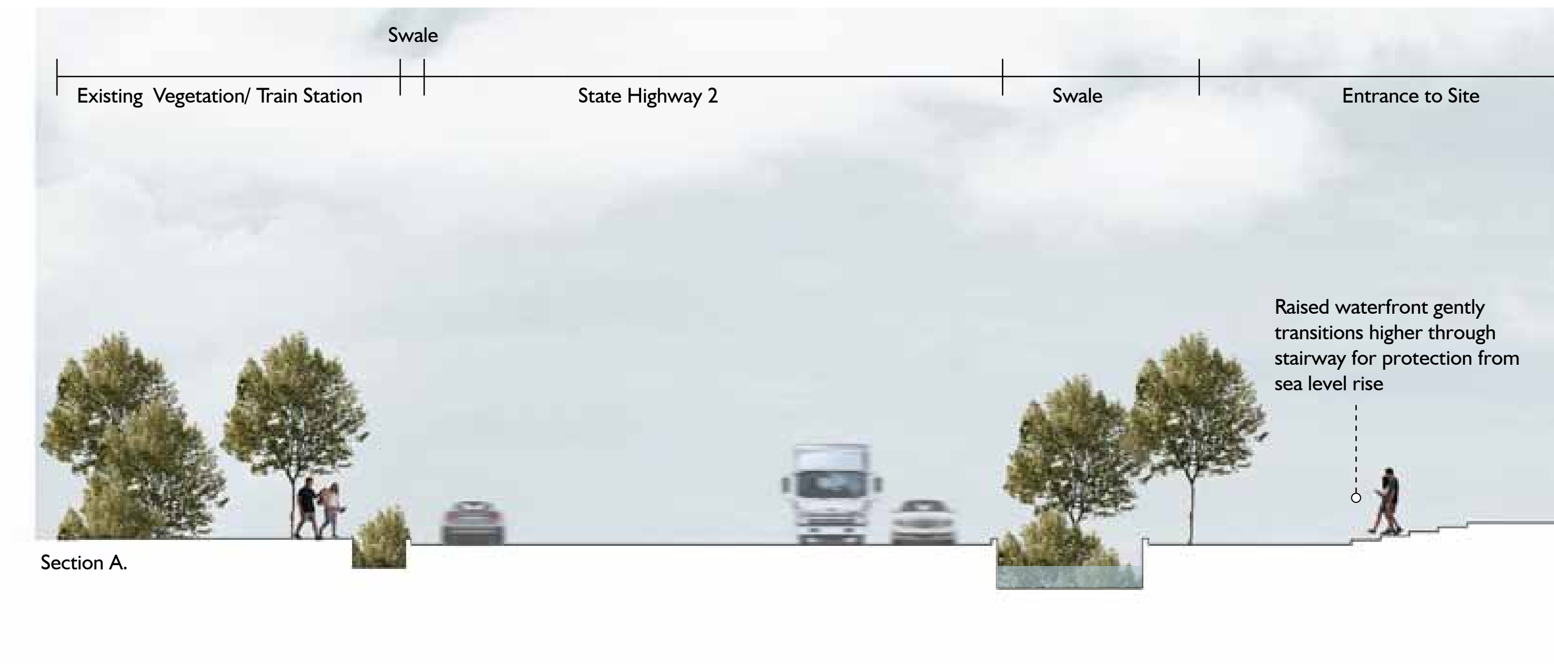
1:200 @ A1


Vegetated Swale
Road
1:150 @ A1


Location Plan.


Fig. 9.51. Authors Own, Zone 7 in Flood Event, 2019.




ZONE 8. PRIMARY SITE ENTRANCE.

1. Wellington Train Station
2. Office Space
3. Existing Carpark
4. Vegetated Swale
5. State Highway 2
6. Pedestrian Crossing to Site
7. Primary entrance staircase
8. Proposed mixed use development
9. Cafe/Outdoor Seating
10. Thoroughfare Zone
11. Movable timber block seating

Fig. 9.52. Authors Own, Zone 8, 2019.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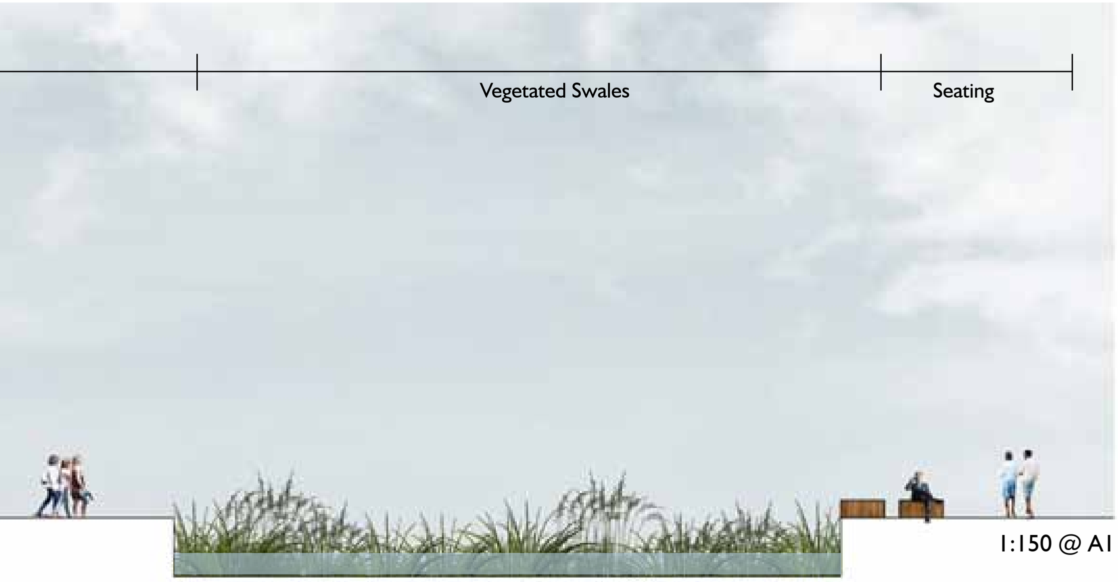
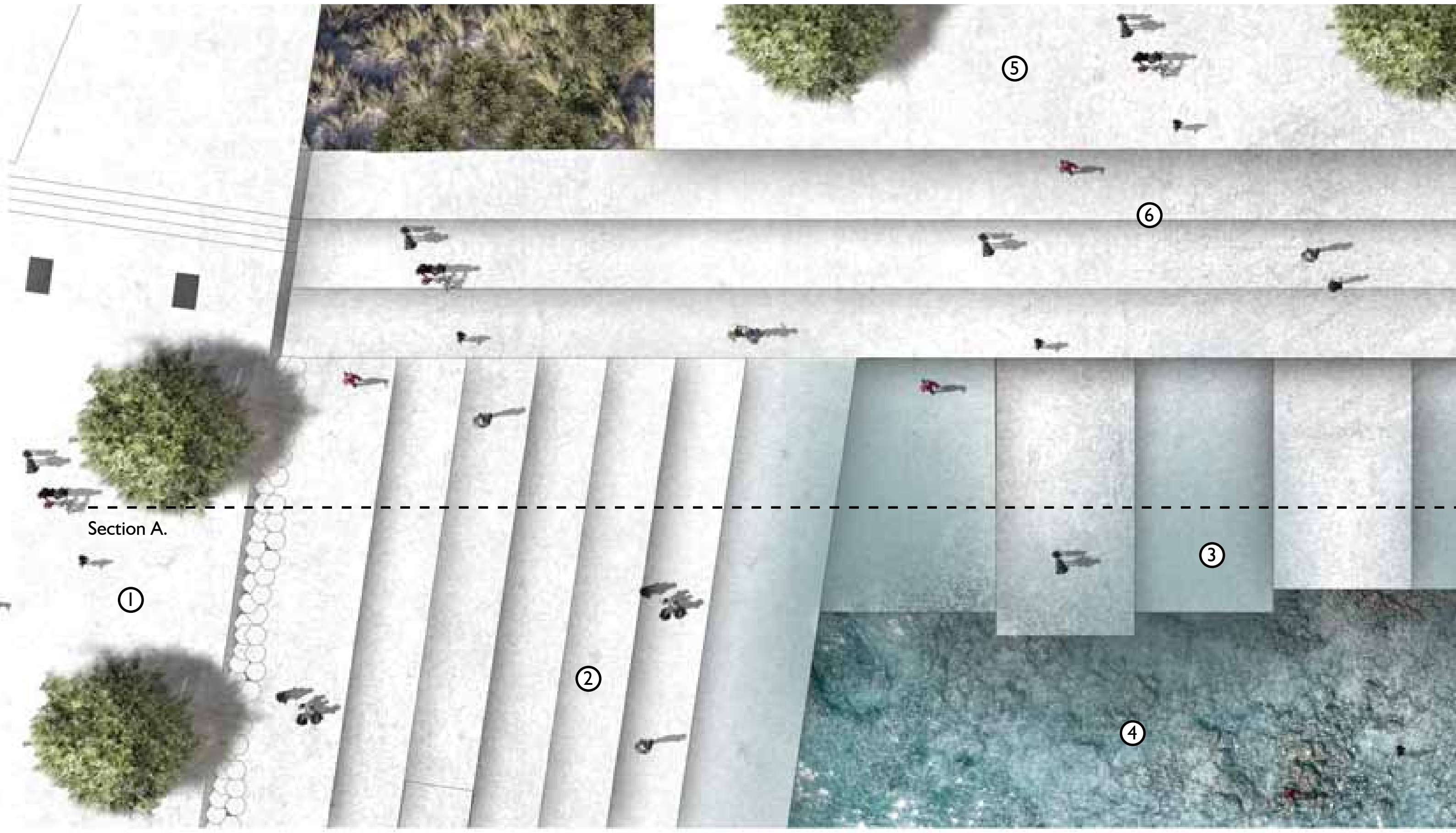
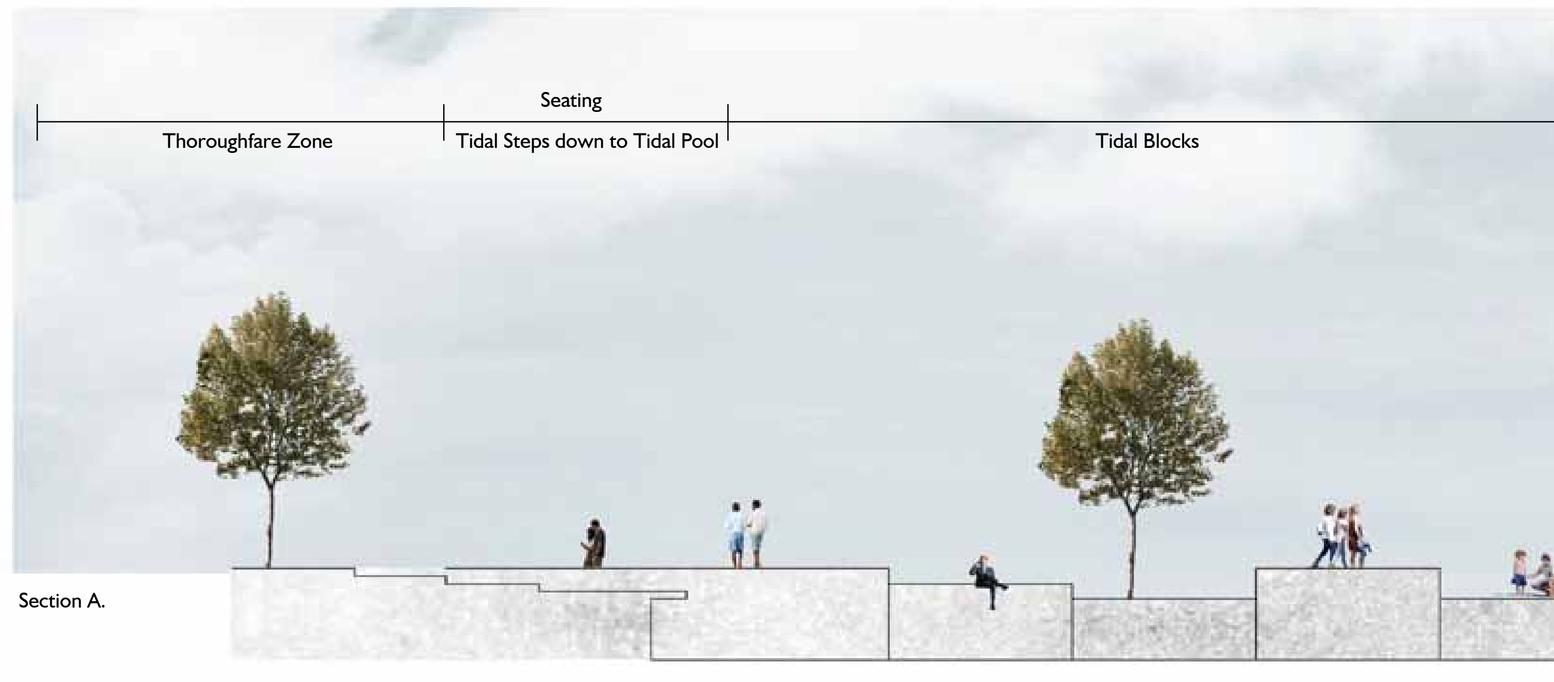

Vegetated Swales
Seating
1:150 @ A1


Location Plan.



Fig. 9.53. Authors Own, Zone 8 in Flood Event, 2019.

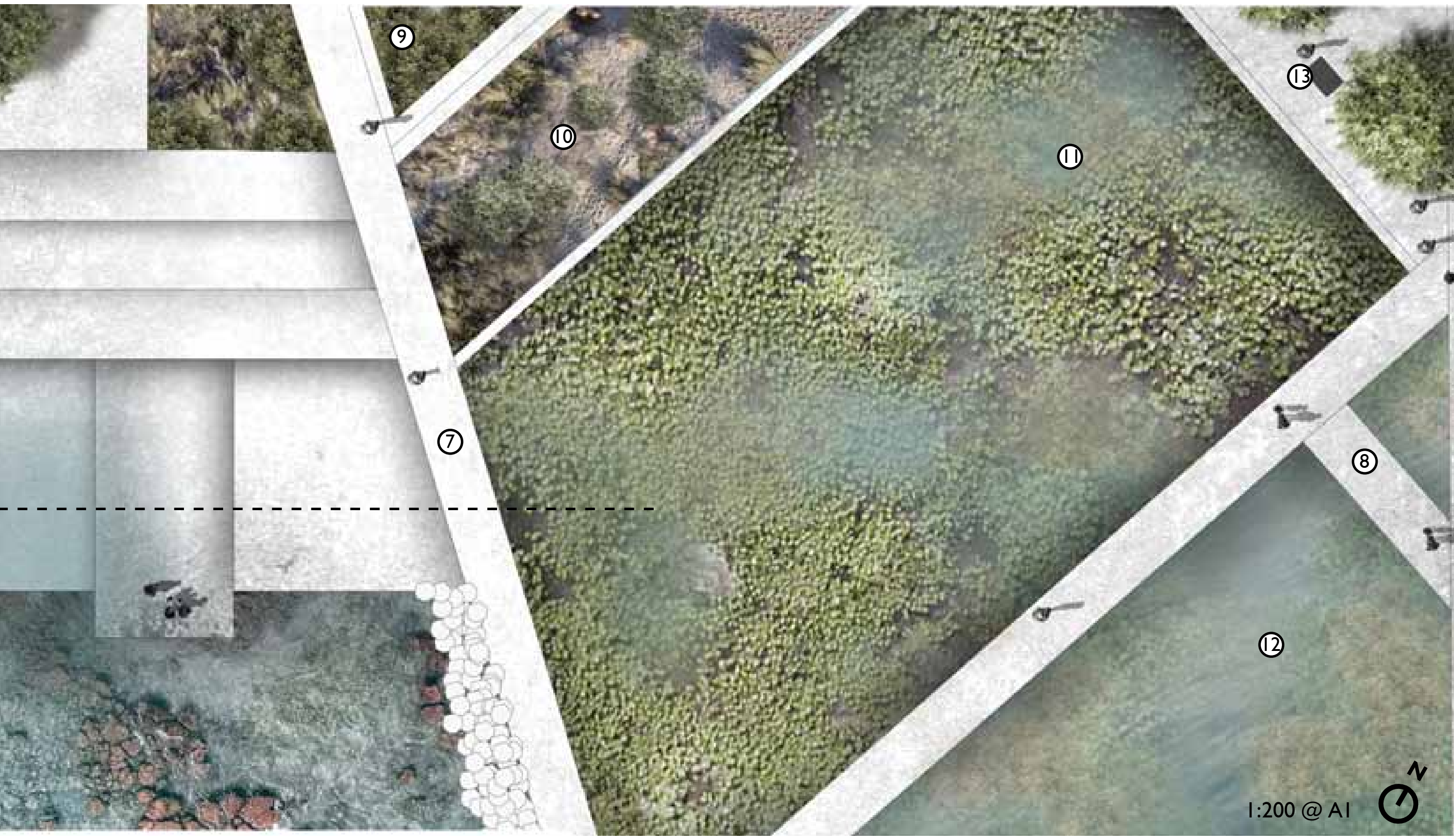


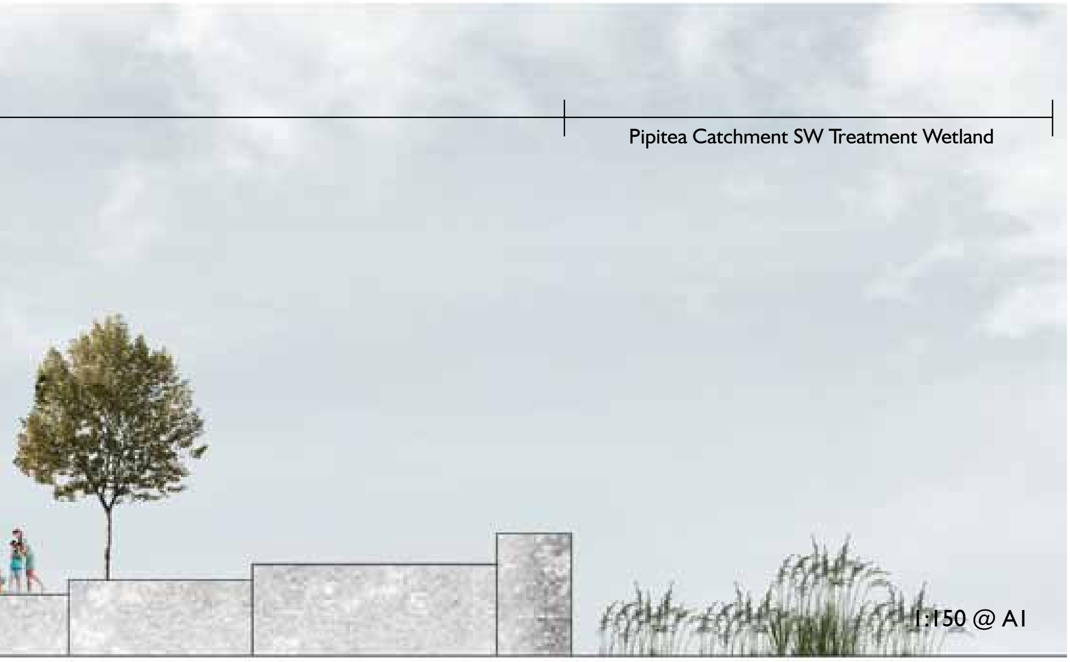




ZONE 9. TIDAL POOLS.

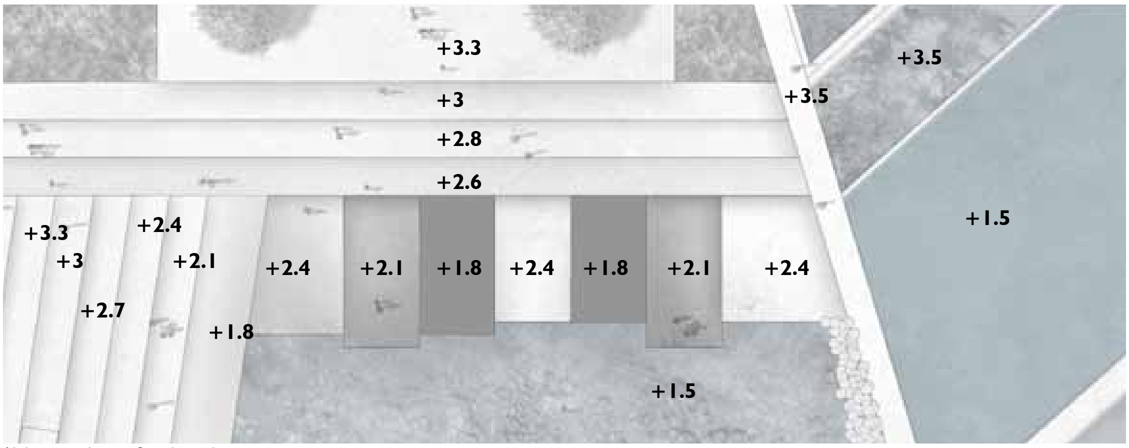
1. Open Space/ Thoroughfare Zone
2. Tidal Steps down to Tidal Pool/ Seating
3. Tidal Level Blocks
4. Tidal Pool
5. Open Space
6. Platform Steps/Seating/Resting Area
7. Seawall/Walkway
8. Boardwalk through Wetland
9. Surface Wetland
10. Subsurface Wetland
11. Deep Treatment Pond
12. Shallow Surface Pond
13. Resting Area

Fig. 9.54. Authors Own, Zone 9, 2019.



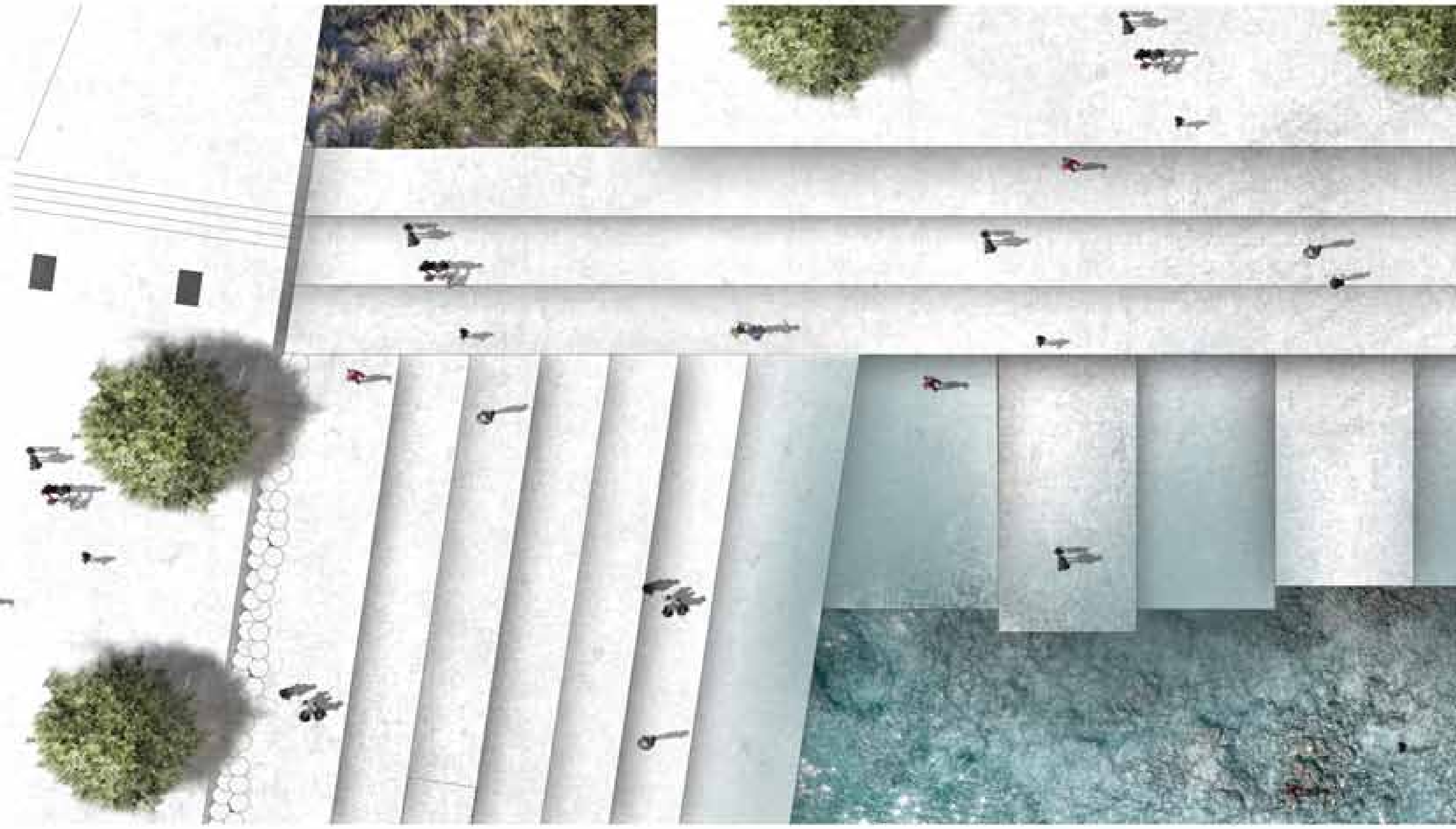








*Meters above Sea Level

1:250 @ A1





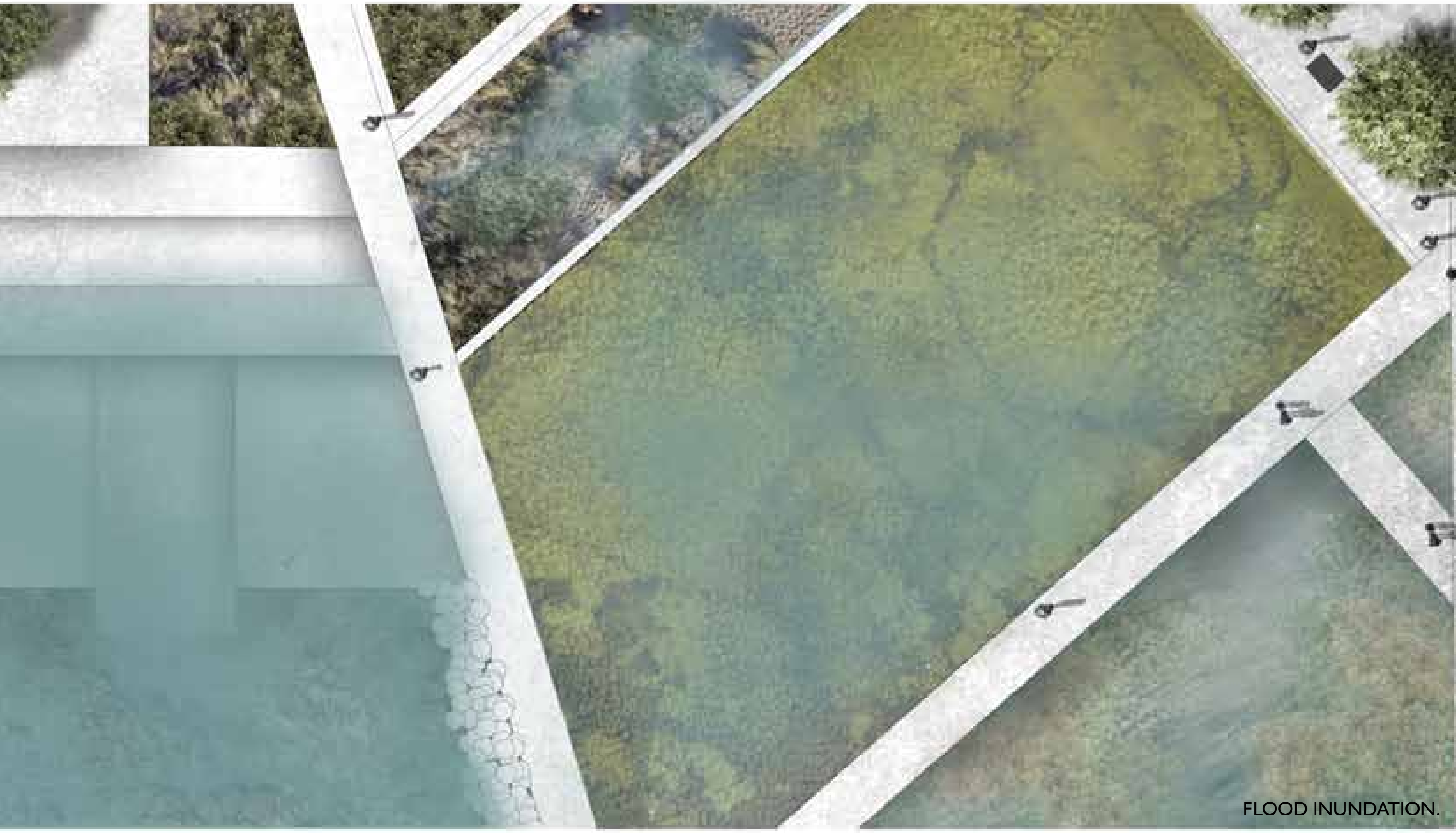
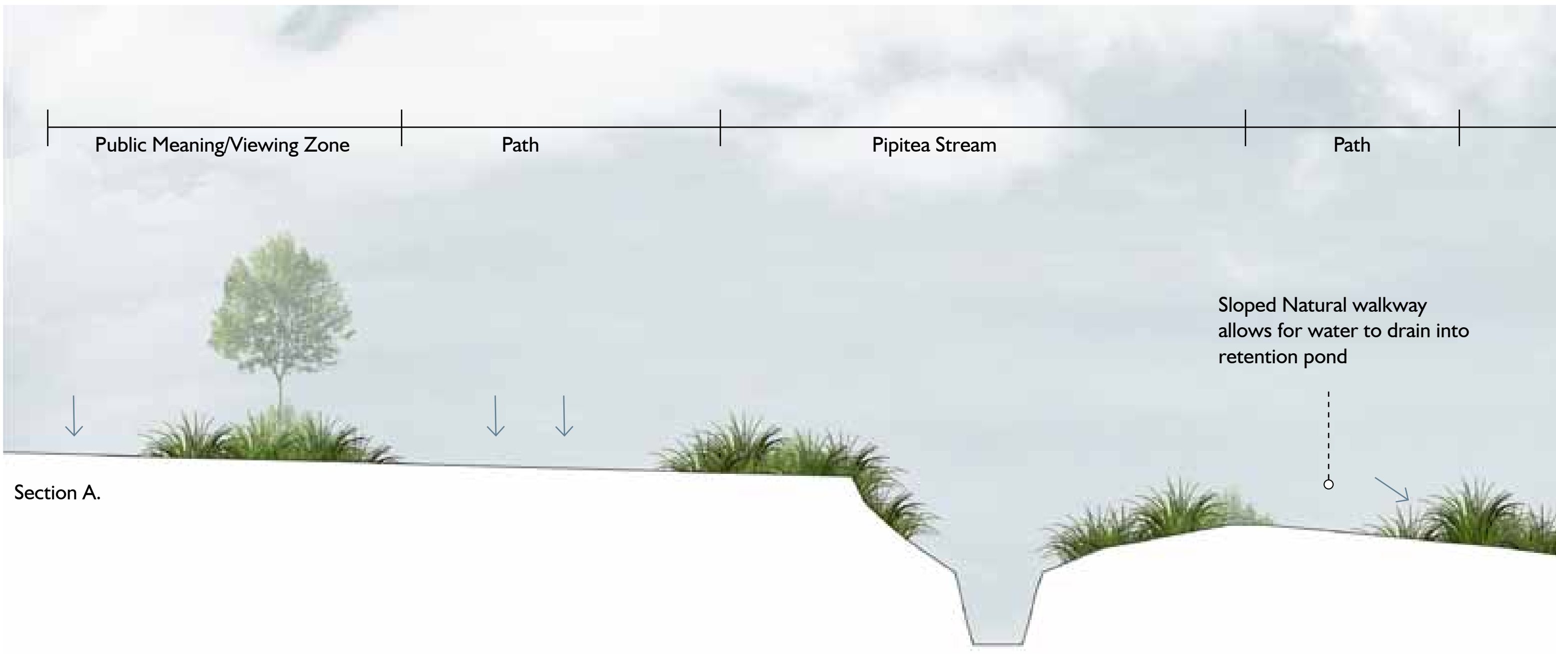


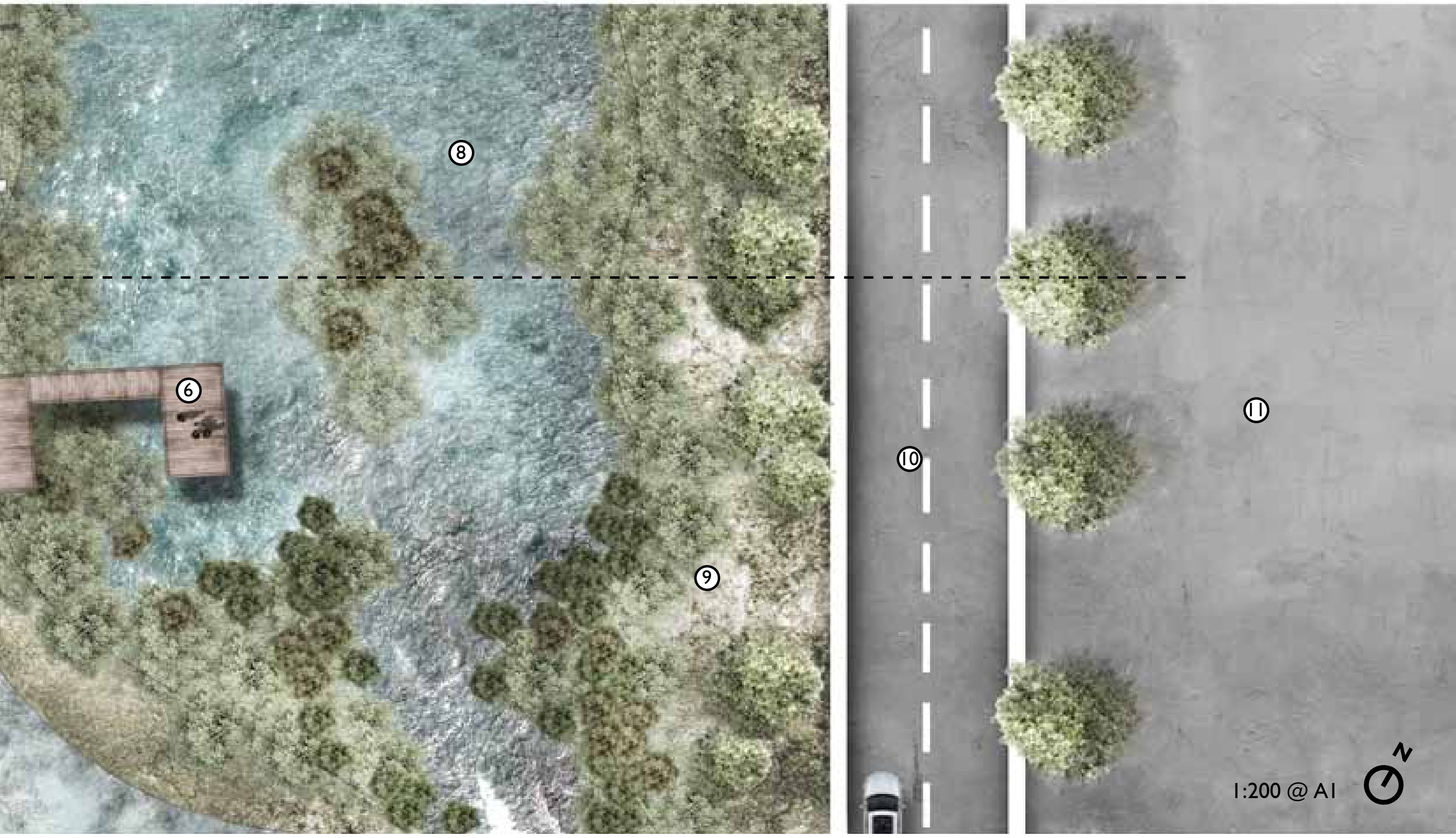

Fig. 9.55. Authors Own, Zone 9 in Flood Event, 2019.


ZONE 10. FLOOD PARK.

1. Inner Harbour
2. Boardwalk
3. Block Steps/ walkway
4. Permeable Meandering Zone
5. Nature Walkway
6. Boardwalk/Viewing/Resting Platform
7. Pipitea Stream
8. Retention Pond
9. Flood Bank
10. Road
11. Centreport

Fig. 9.56. Authors Own, Zone 10, 2019.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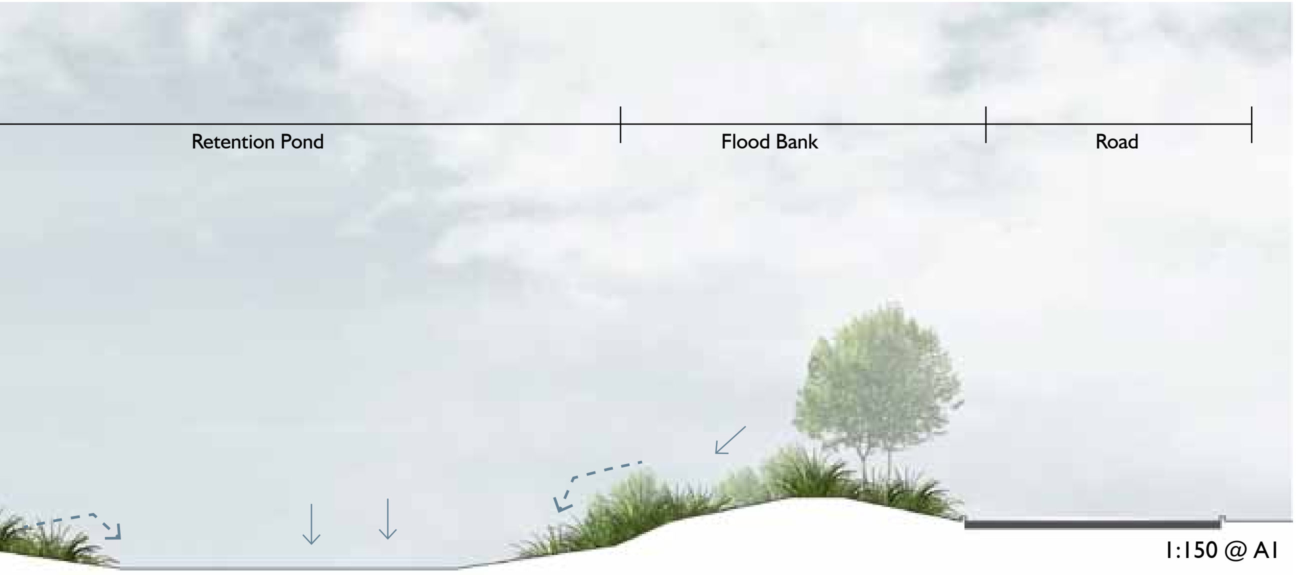
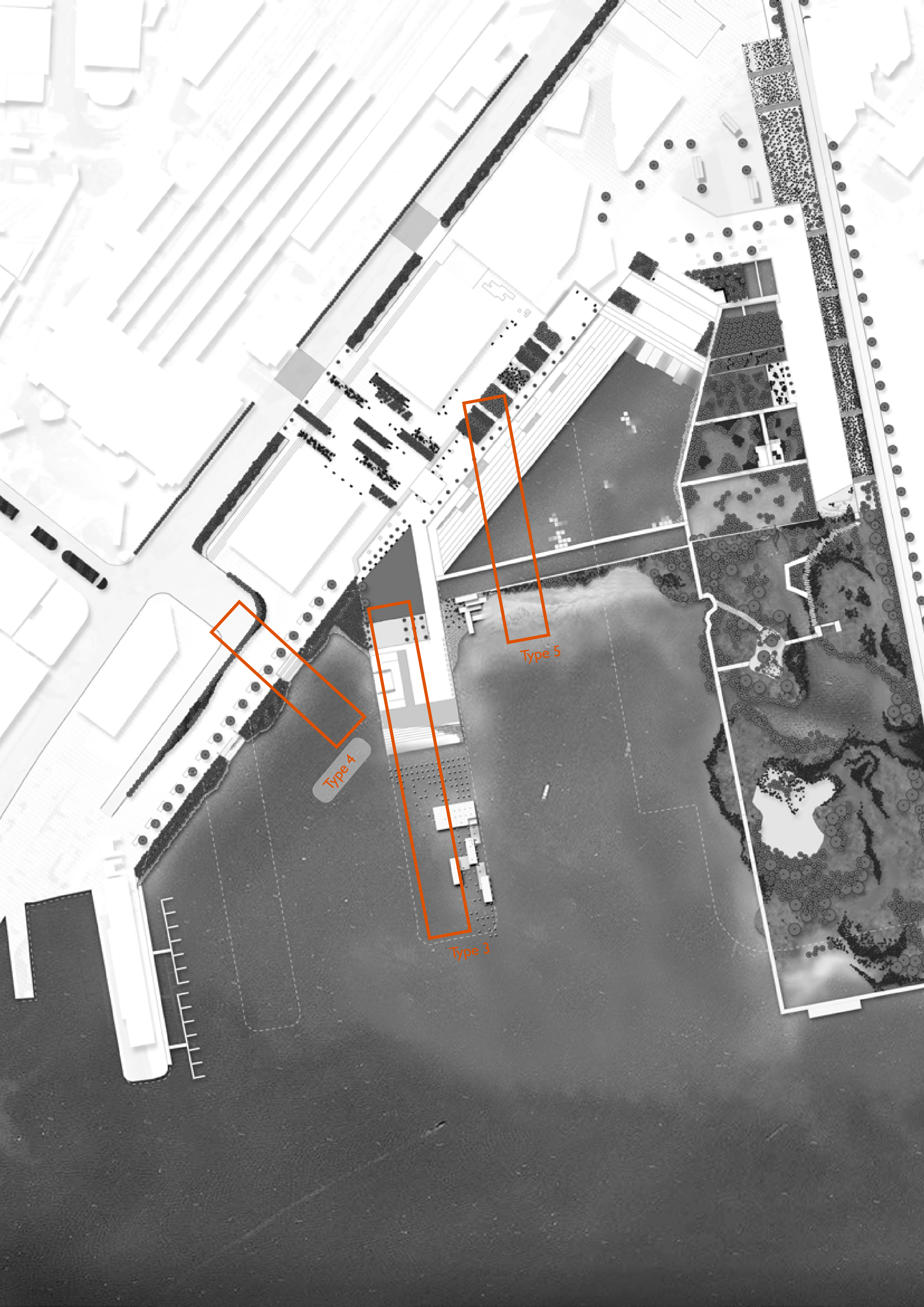
1:200 @ A1


Retention Pond
Flood Bank
Road
1:150 @ A1


Location Plan.


Fig. 9.57. Authors Own, Zone 10 in Flood Event, 2019.


Type 4
Type 5
Type 3

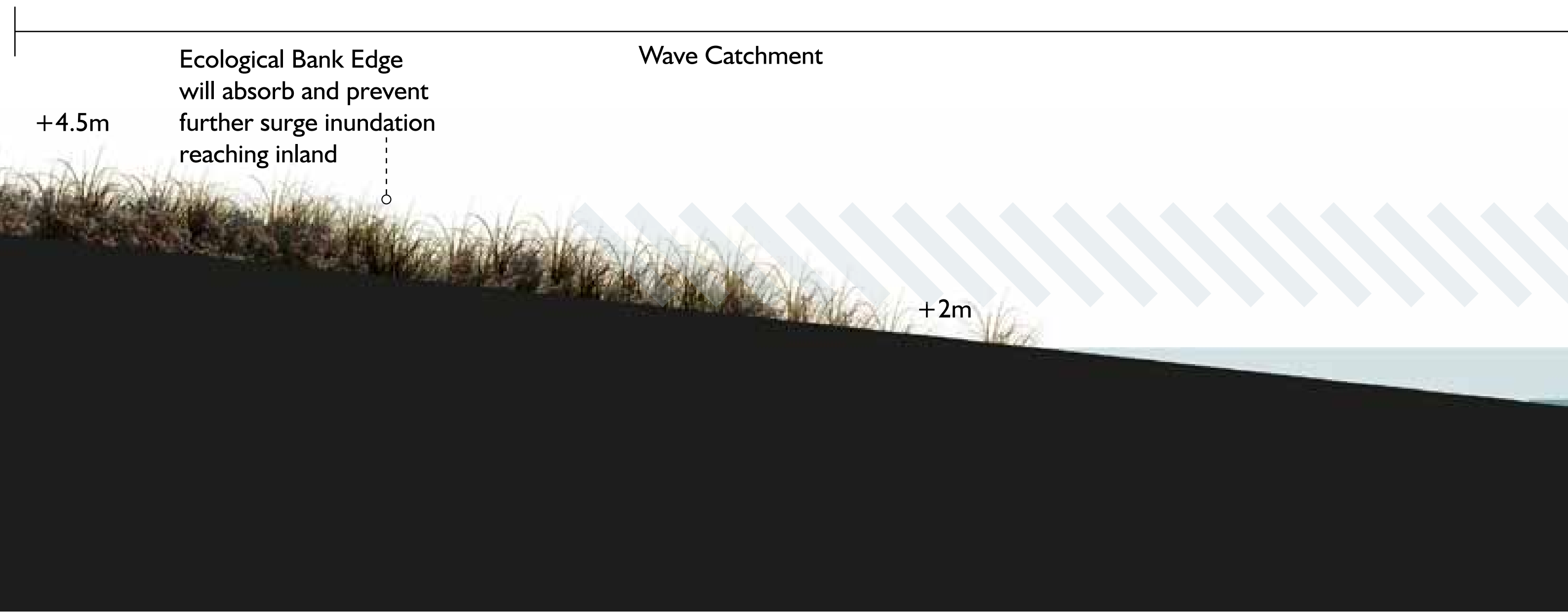

EXPLORATION OF COASTAL EDGES.

Coastal edges are the foremost point of defence. Along site, a range of edge conditions is explored.

Type 1. Wave Absorbing Catchment
Type 2. Buffer
Type 3. Urban Edge
Type 4. Ecological Edge
Type 5. Tidal Catchment Edge

1:1250 @ A1

Fig. 9.58. Authors Own, Coastal Edge Location Map, 2019.




Ecological coastal edge restoration

Sandy Plantation

Raised Coastal Sea Beach

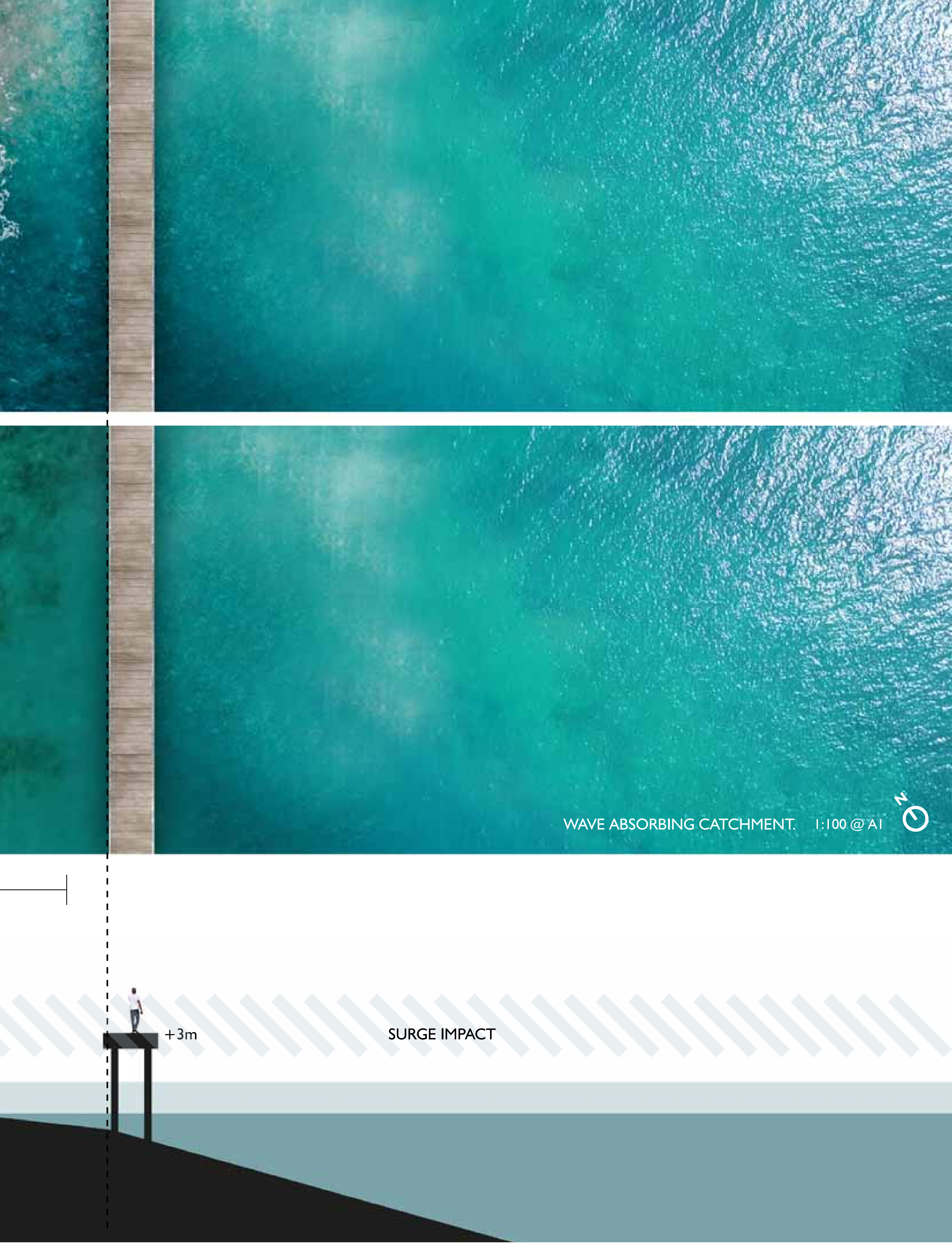
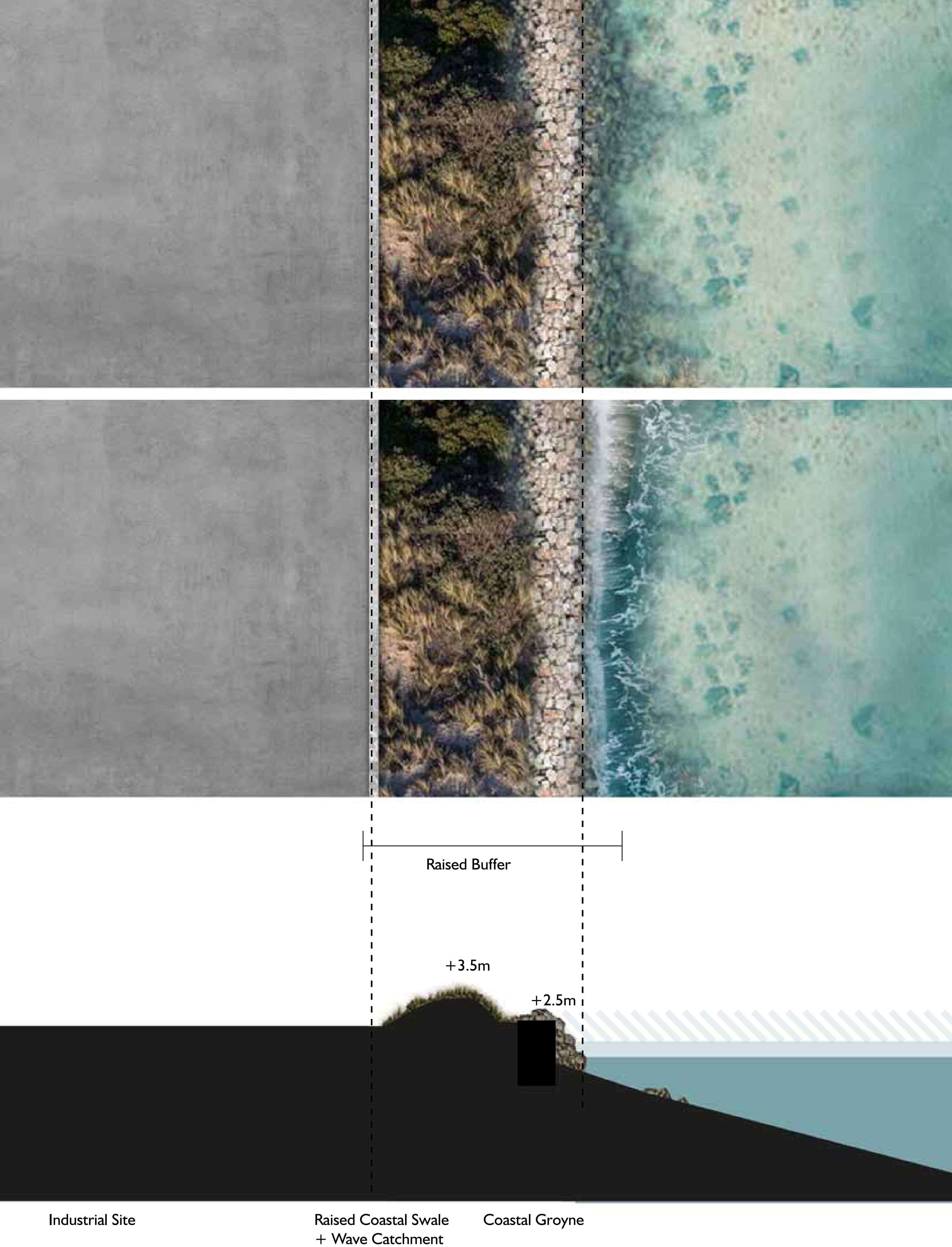



Fig. 9.59. Authors Own, Coastal Edge Type 1, 2019.


Raised Buffer
+3.5m
+2.5m
Industrial Site
Raised Coastal Swale
+ Wave Catchment
Coastal Groyne

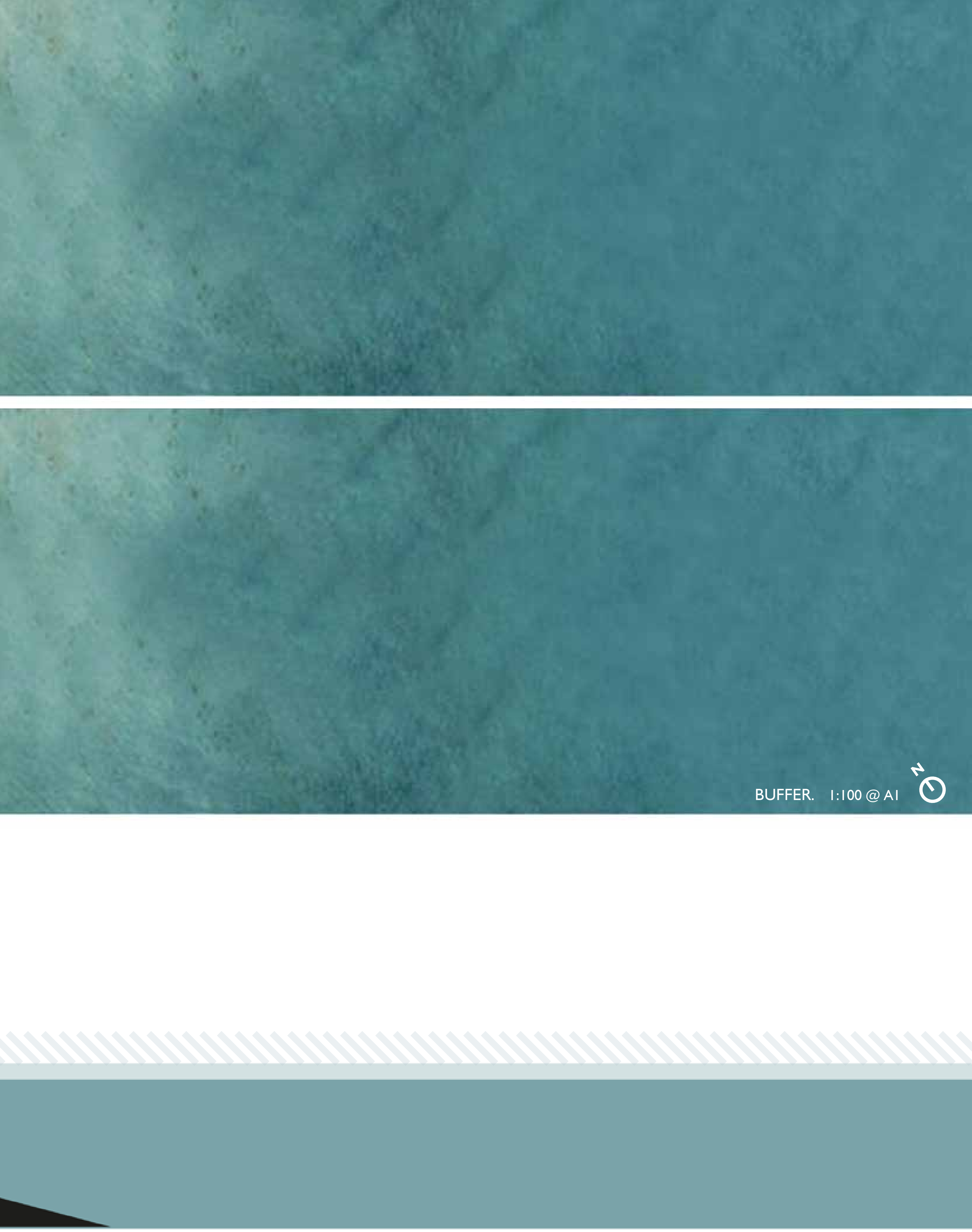
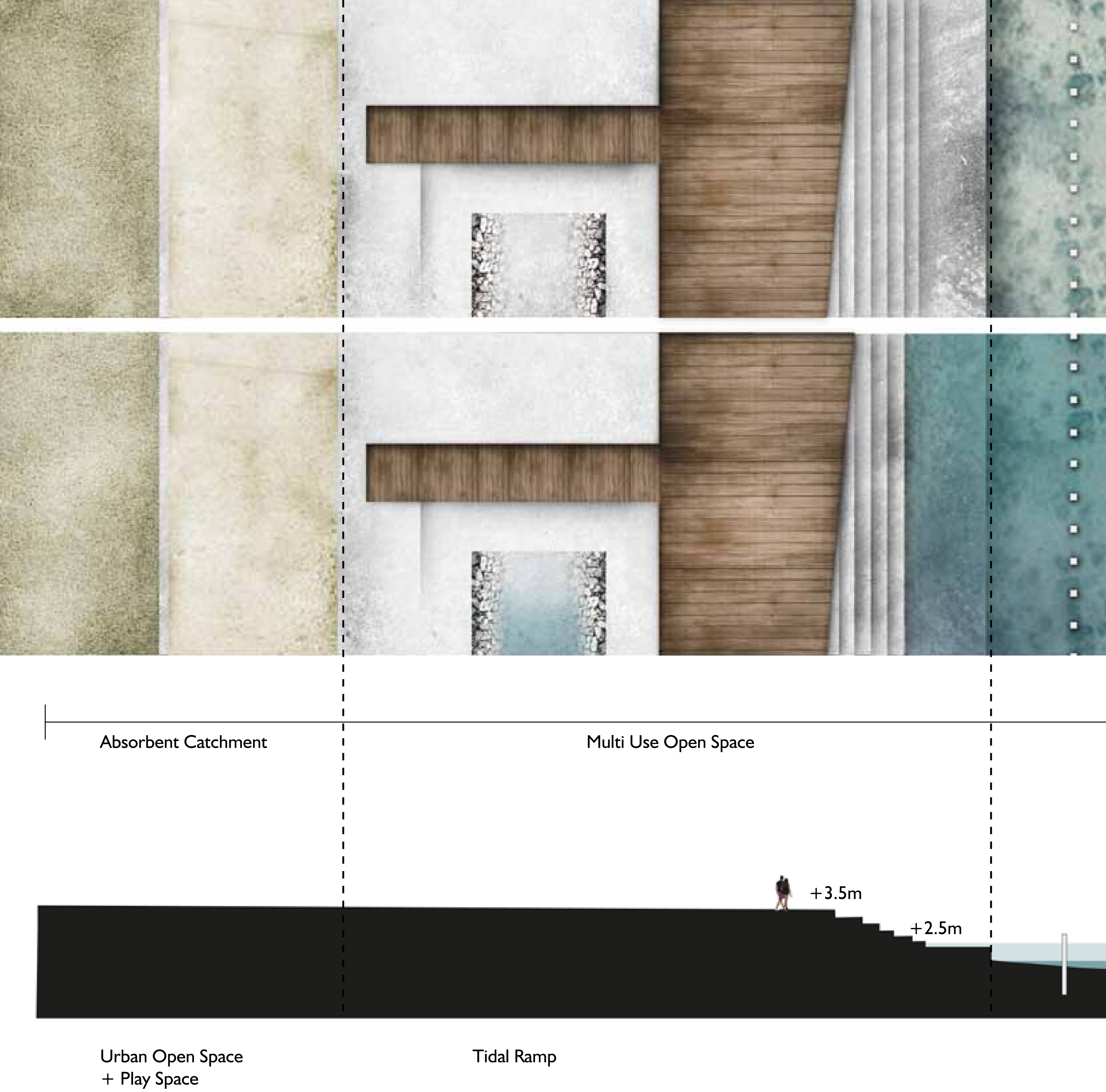



Fig. 9.60. Authors Own, Coastal
Edge Type 2, 2019.


Absorbent Catchment
Multi Use Open Space
+3.5m
+2.5m
Urban Open Space
+ Play Space
Tidal Ramp

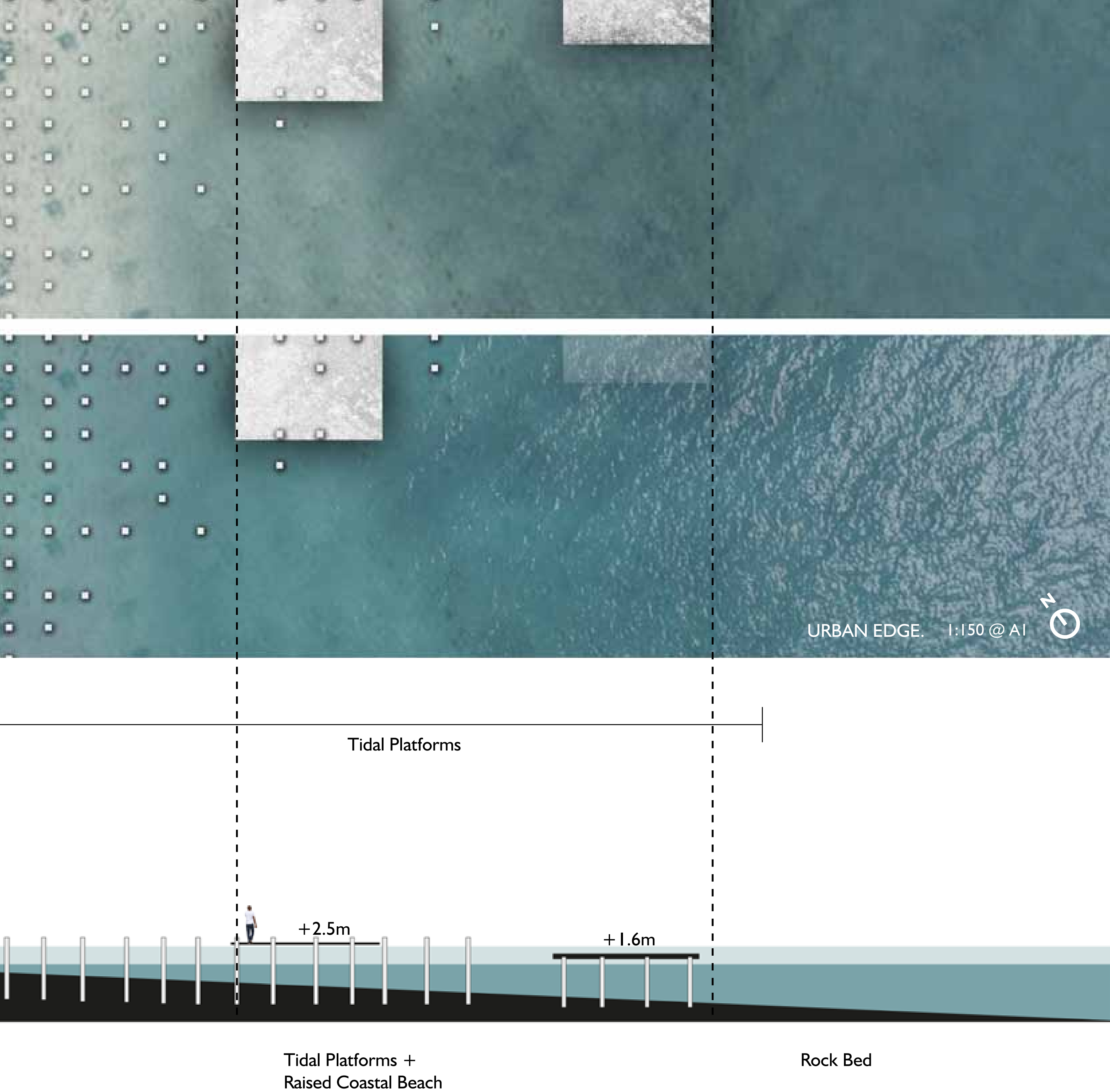
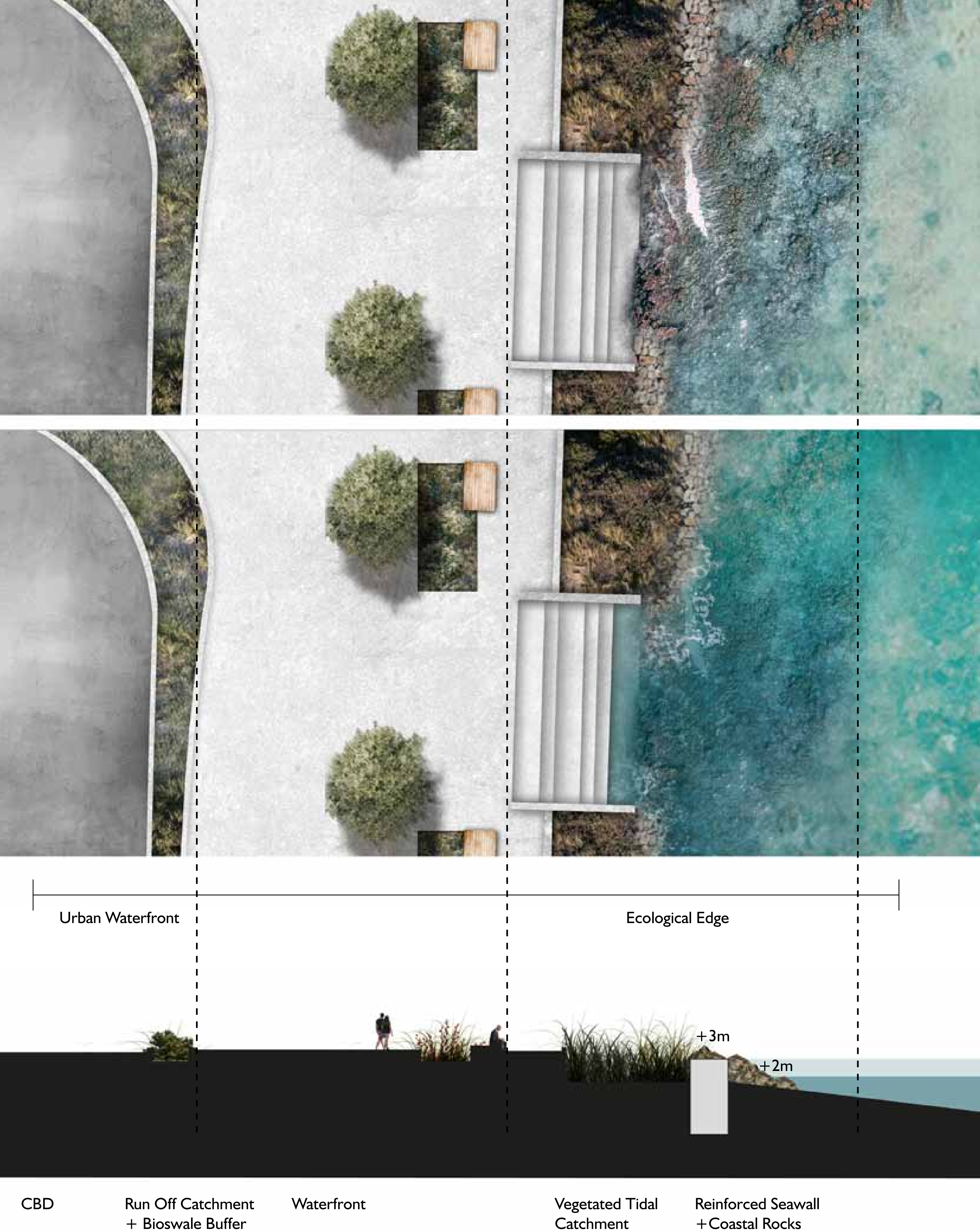
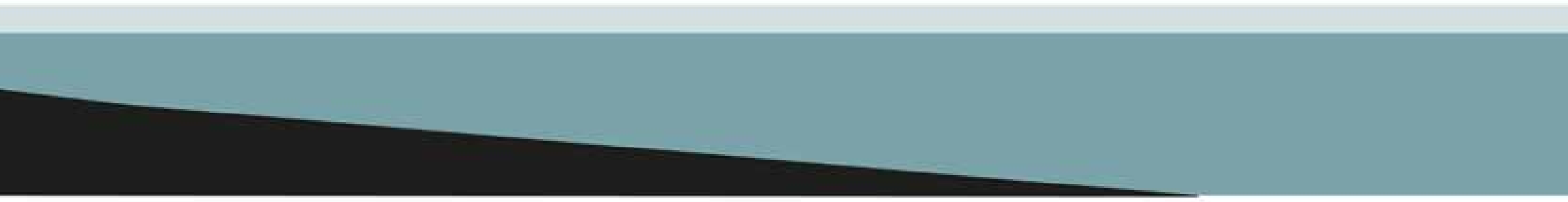


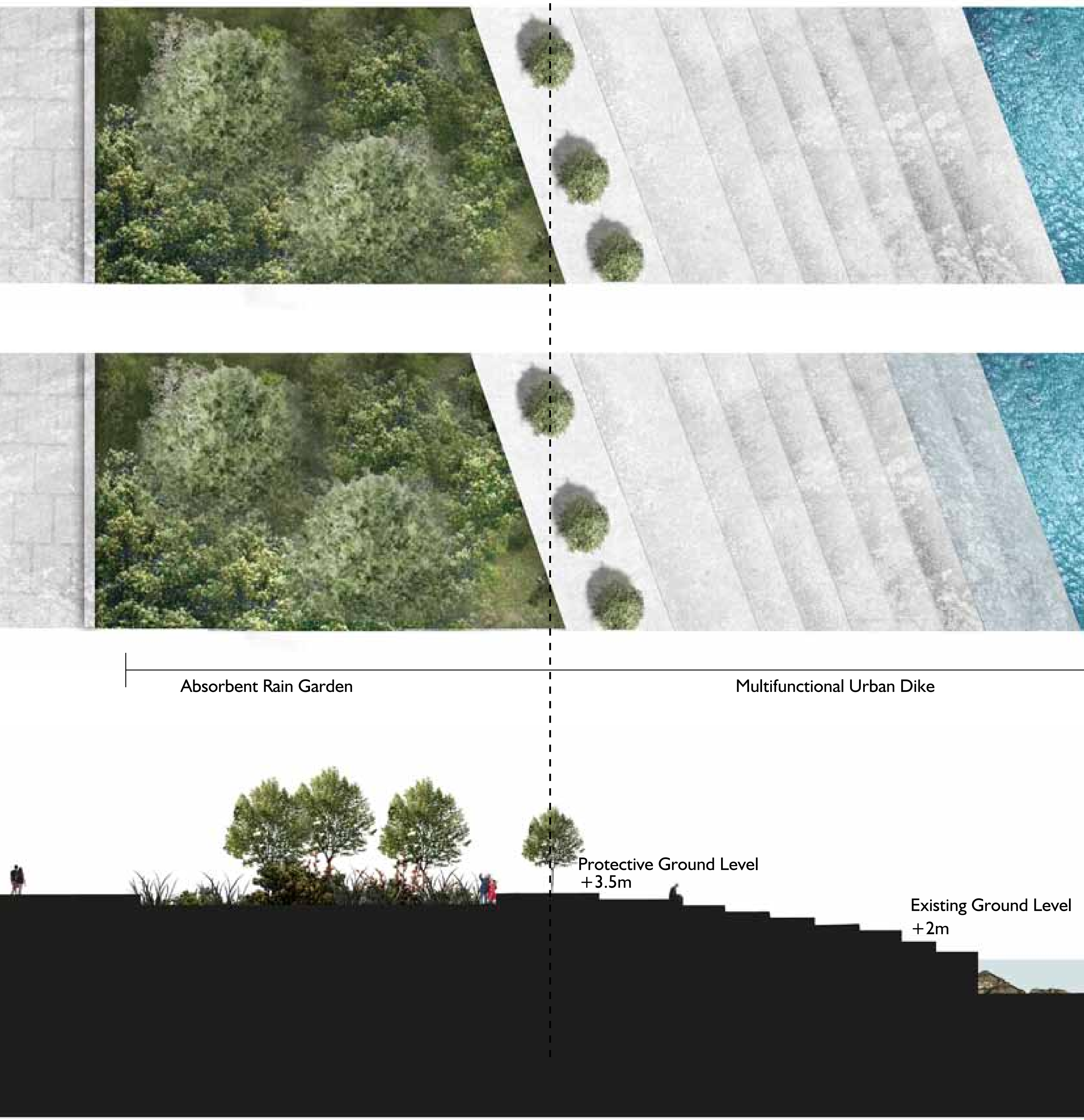

Fig. 9.61. Authors Own, Coastal Edge Type 3, 2019.


Urban Waterfront
Ecological Edge
+3m
+2m
CBD
Run Off Catchment
+ Bioswale Buffer
Waterfront
Vegetated Tidal
Catchment
Reinforced Seawall
+Coastal Rocks

Raised Coastal Beach

Fig. 9.62. Authors Own, Coastal Edge Type 4, 2019.




Run off + Rain Garden

Tidal Urban Waterfront Seating/Sea Wall

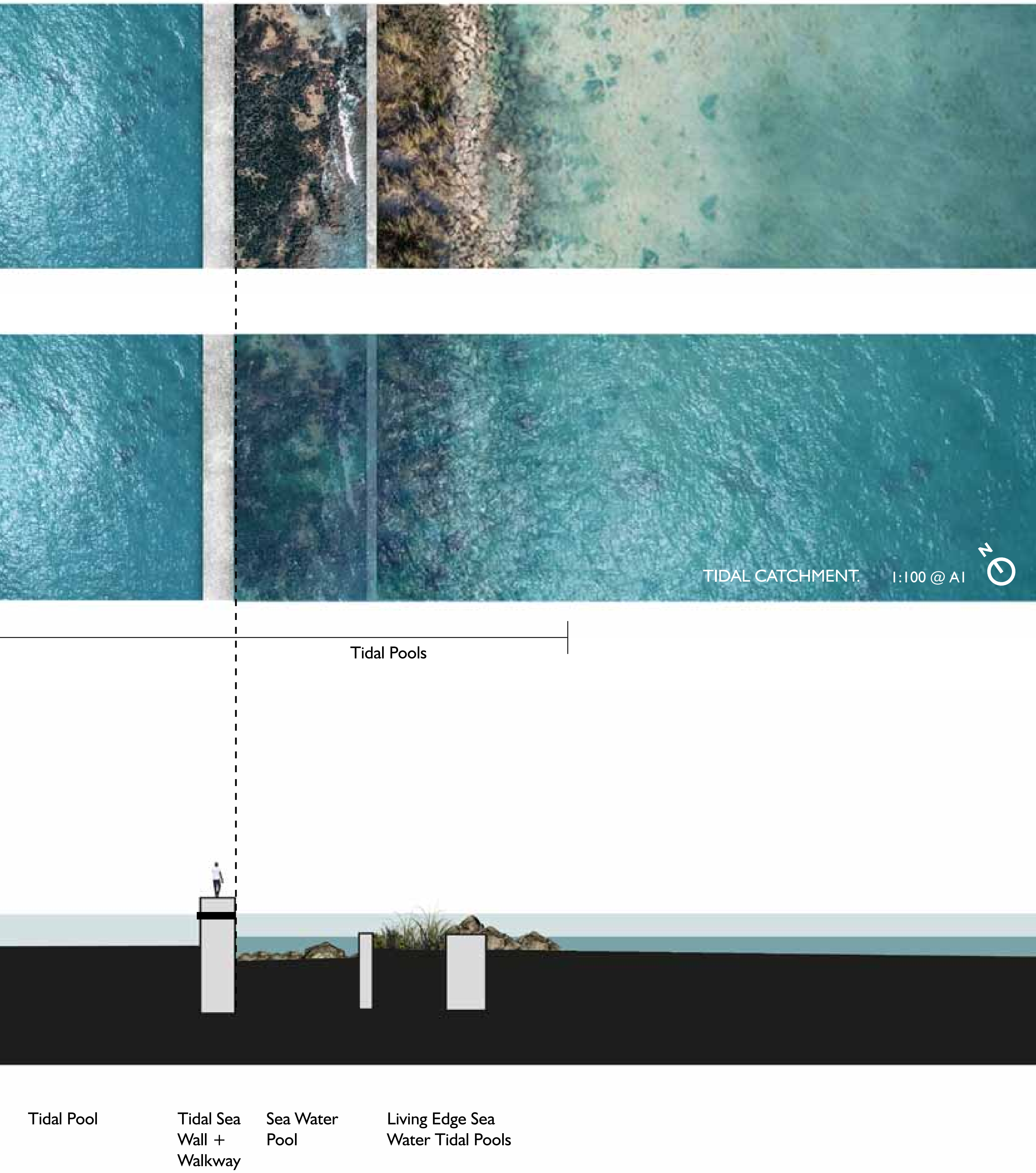



Fig. 9.63. Authors Own, Coastal Edge Type 5, 2019.

SEATING AND MATERIALITY.

## SITE MATERIALITY.

TIMBER SEATING. Timber Slats fixed into precast concrete block.

CONCRETE BLOCK. Pre cast concrete fill. Large bulk material reflects industrial site components



Fig. 9.64. Authors Own, Site Materiality and Furniture, 2019.

Event 6 - Harbour Access.

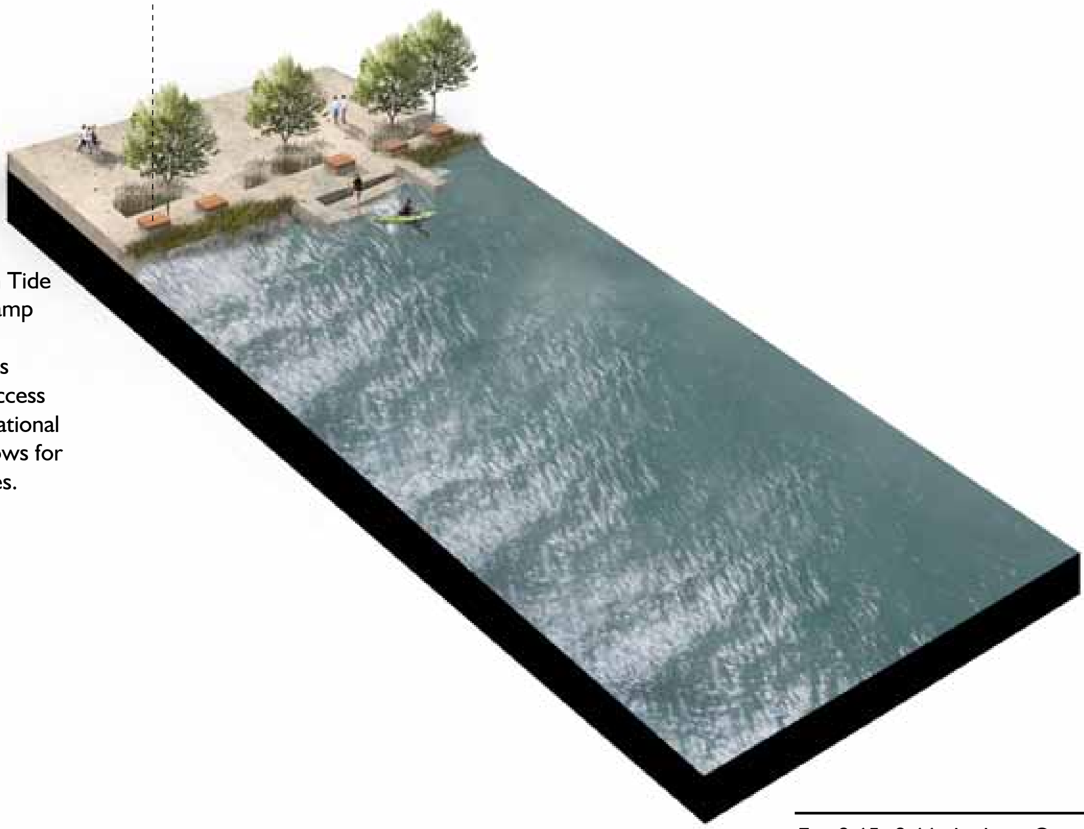
SOCIAL TIDAL INTERACTION.

**TIDAL STEPS.**
Providing increased public access and interaction with the waters

Low Tide

In low tide, concrete ramps are exposed, leading down towards the sea bed. This invites people to walk down to the area and enjoy low tidal waves

Seating allows for users to admire the waterfront and harbour surrounding, encouraging users to stop and relax between multiple places.

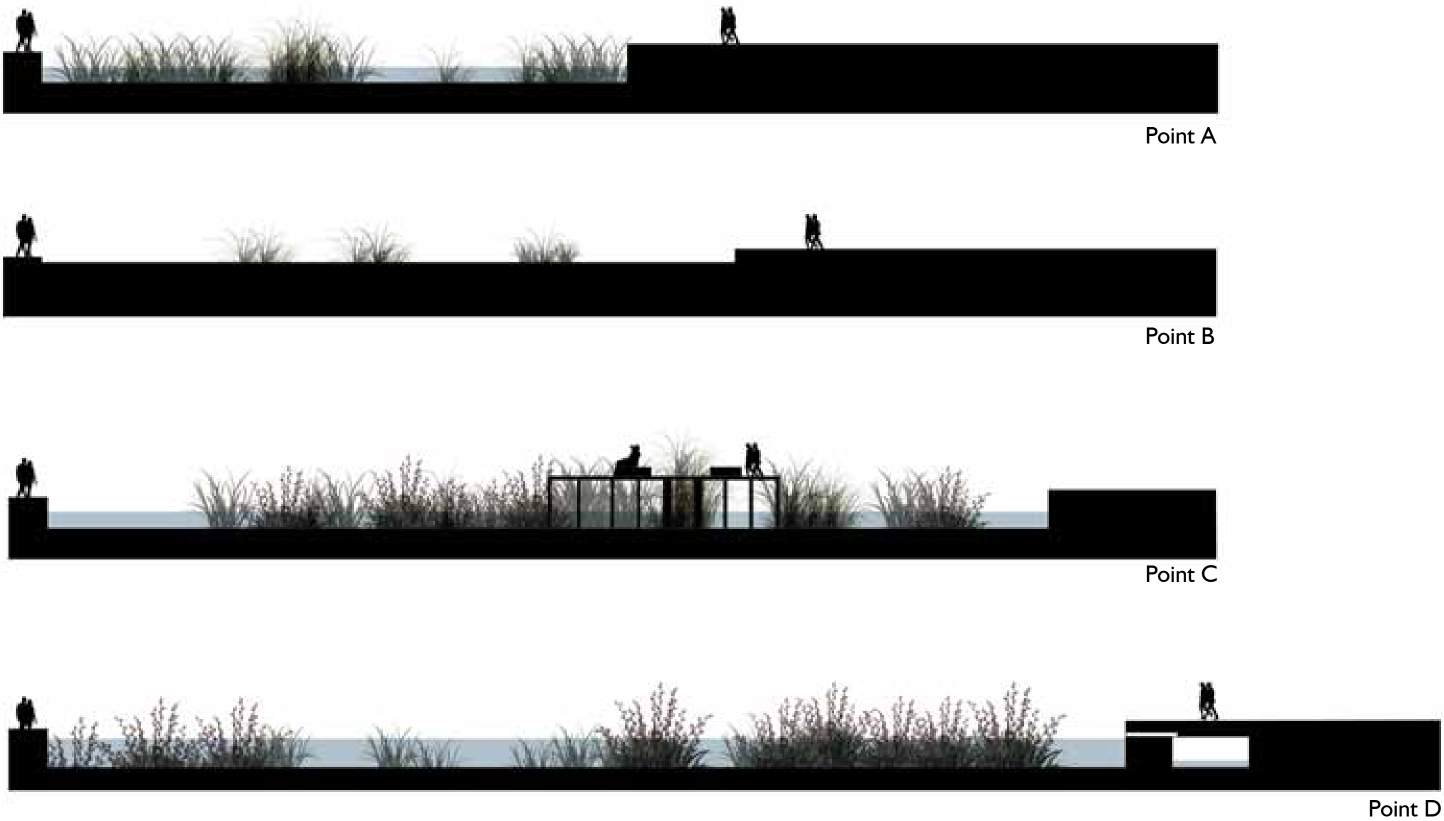


High Tide

In High tide, the ramp starts to disappear into the water. This encourages user access to water for recreational activity. Ramps allows for easy kayak launches.

Fig. 9.65 -9.66. Authors Own, Change in Tidal Access to Harbour, 2019.

Event 7 - Wetland Boardwalks.

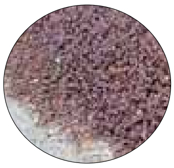

TREATMENT WETLAND SOCIAL EXPLORATION POINTS.
1:75 @ A1

Fig. 9.67 -9.68. Authors Own, Public Use of Wetland Boardwalk, 2019.

## PLANT PALETTE.

### 01 ABSORBENT GROUND COVERS

Makara
*Raoulia hookeri*



Purpurea
*Acaena inermis*

Misty Blue
*Pimelea prostrata*

### 02 FILTRATION GRASSES.

Toetoe
*Cortaderia toetoe*

Raupo
*Typha orientalis*

Kapungawha
*Schoenoplectus tabernaemontan*

Harekeke
*Phormium tenax*

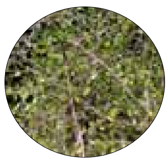
Purei
*Carex secta*

Purei
*Carex flagelifera*

### 03 SHRUB/TREE.

Shrubby Tororaro
*Muehlenbekia astonii*

Hebe
*Hebe elliptica*



Coprosma
*Coprosma crassifolia*

Akeake
*Dodonaea viscosa*

Akiraho
*Olearia paniculata*

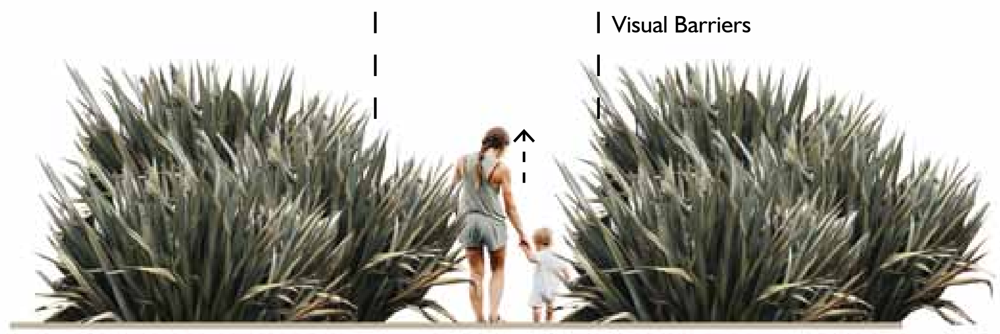
Koromiko
*Hebe salicifolia*

## PLANT SCHEDULE.

| CLASS | CODE | NAME | SCIENTIFIC NAME | HEIGHT (M) | WIDTH (M) |
|---|---|---|---|---|---|
| ABSORBENT GROUND COVERS. | Rh | Makara | Raoulia hookeri | 0.2 | 1 |
| | Ai | Purpurea | Acaena inermis | 0.1 | 1 |
| | Pp | Misty Blue | Pimelea prostrata | 0.1 | 1 |
| FILTRATION GRASSES. | Pt | Harakeke | Phormium tenax | 8 | 3 |
| | St | Kapungawha | Schoenoplectus tabernaemontan | 2 | 1 |
| | Cs | Purei | Carex secta | 2 | 2 |
| | Cf | Purei | Carex flagelifera | 2 | 2 |
| | To | Raupo | Typha orientalis | 4 | 2 |
| | Ct | Toetoe | Cortaderia toe toe | 4 | 3 |
| SHRUB/TREES. | Dv | Akeake | Dodonaea Viscosa | 7 | 2.5 |
| | Op | Akiraho | Oleria Paniculata | 4 | 2.5 |
| | Cc | Coprosma | Coprosma crassifolia | 4 | 2 |
| | He | Hebe | Hebe elliptica | 3 | 2 |
| | Hs | Koromiko | Hebe salicifolia | 4 | 2 |
| | Ma | Shrubby Tororaro | Muehlenbekia astonii | 2 | 1.5 |

**EXPERIENCE THROUGH VEGETATION.**
1:20 @ A3

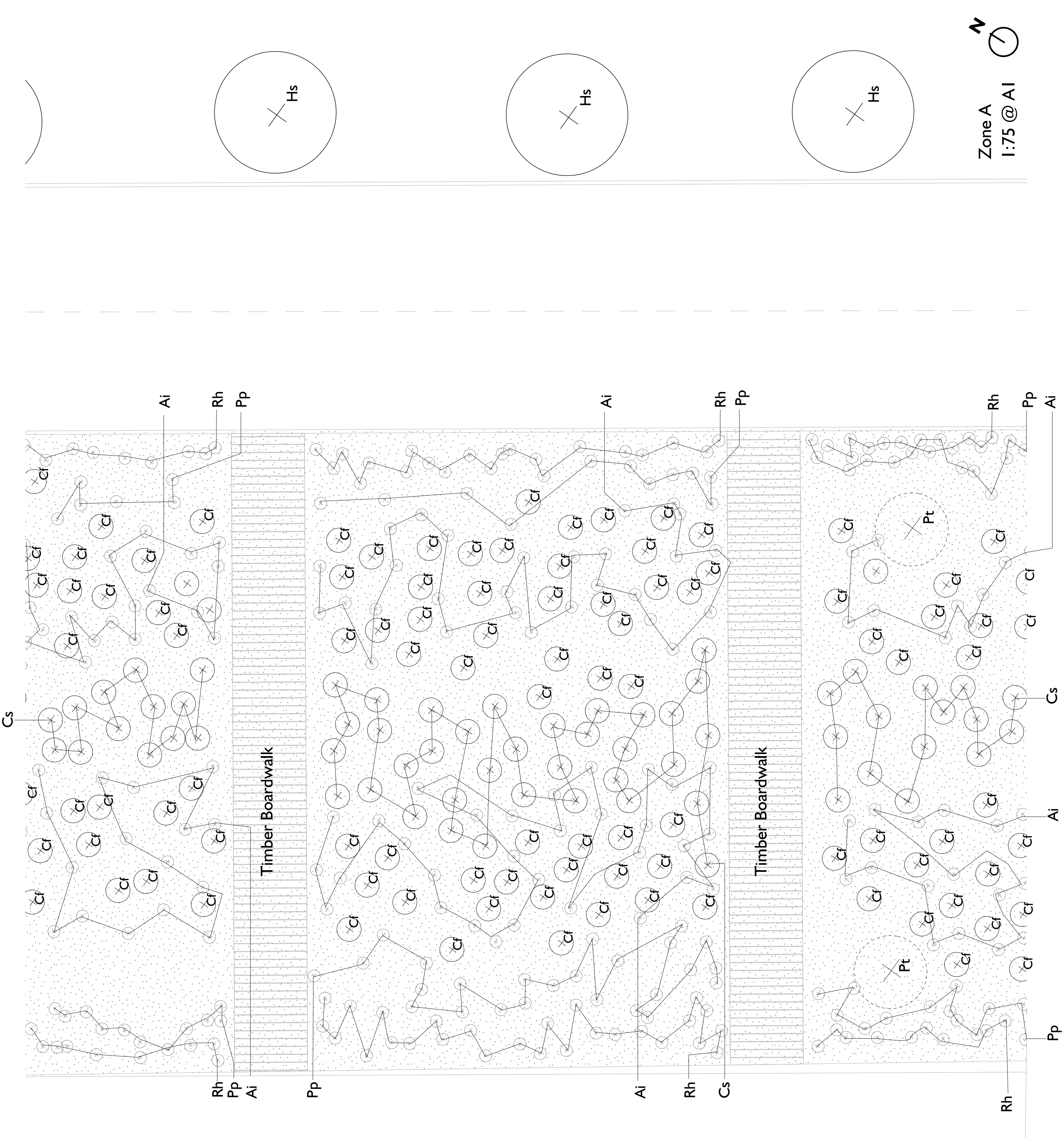
Vegetation plays a large role in the proposed design to immerse users within hidden and unique natural environments. The heights of vegetation play different roles in drawings users to a place, changing views and orientations.




High Vegetation surrounding users draws user attention forward by densely covered sides, this is helpful in directing users to different locations. This enclosed feeling gives a sense of privacy, being hidden in nature

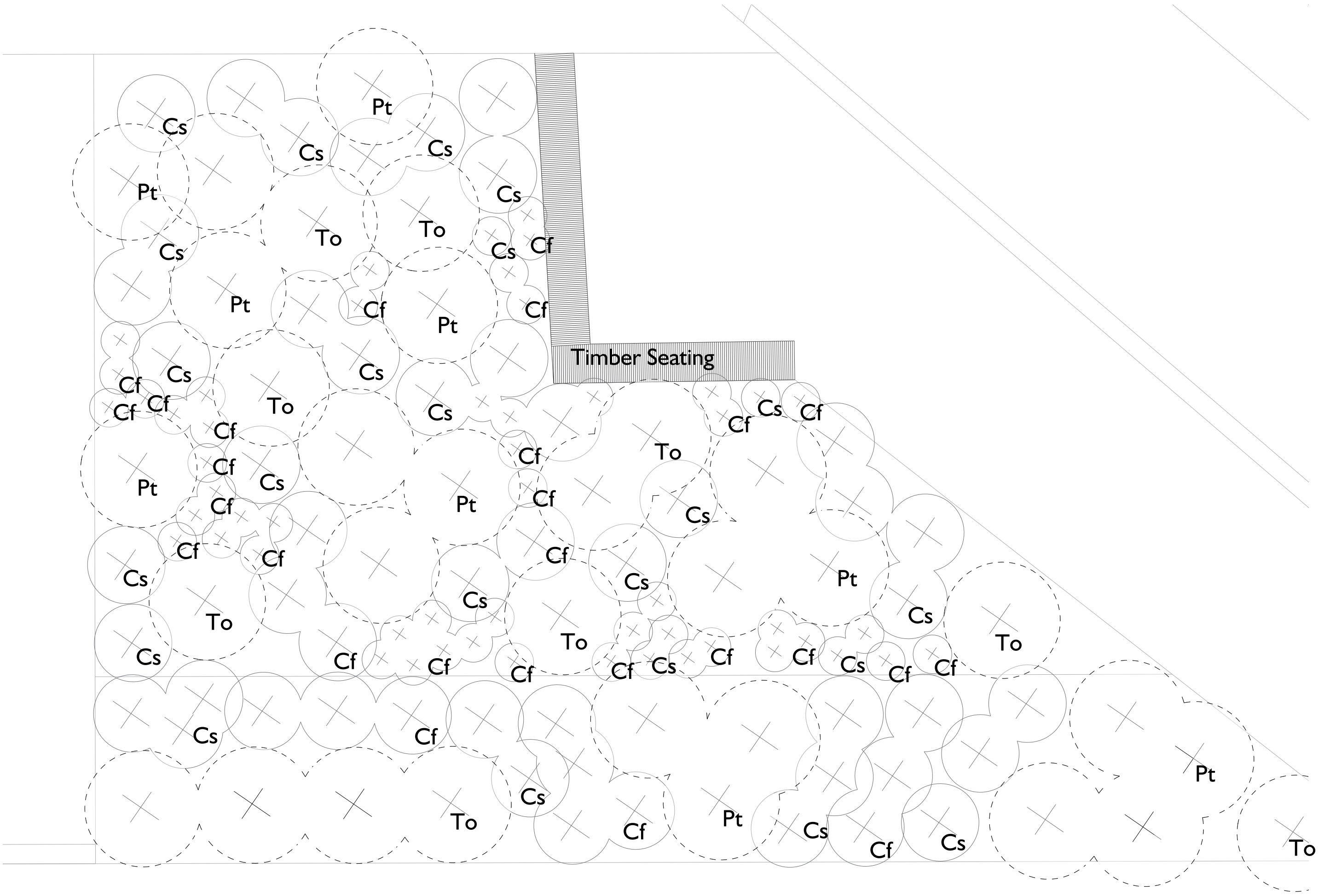
Low Vegetation allows users to look around their surroundings, finding views of different areas and habitats. Often such places are good for resting and sight seeing where people tend to spend longer periods of time.

Fig. 9.69 - 9.70. Authors Own, Plant Palette and Sectional use of Vegetation, 2019.



Zone A
1:75 @ A1
N
Hs
Ai
Rh
Pp
Cf
Cs
Pt
Timber Boardwalk


A
B
Location Plan




Zone B
1:75 @ A1

Tree

Shrub

Grass

A selection of native filtration grasses are primarily used within site as these are beneficial in absorbing and filtering water. Within swale areas, species are shown in zones A & B to help in absorbing run off and rain fall water within the site catchment.

Fig. 9.71 - 9.72. Authors Own, Planting Plans of Selected Filtration Plants, 2019.

## FINDINGS.

### Final Design Accomplishments.

Through the process of this thesis investigation, it was found most beneficial to identify and develop principles design can follow in order to achieve the most beneficial results. Looking at the five principles, these can be seen to have been achieved and are reflected within refined design.

DESIGN PRINCIPLES.

### Breathable Wharf Ecologies.

The site being prone to inundations of flooding by its foremost positioning to strong harbour conditions was ecologically deficient to mitigate any inundation. Its vulnerability was increased by its impermeability to flooding. The site was also a large contributor to degrading harbour qualities as its industrial function and urban vehicle use of State highway 2, allowed for polluted runoff to pour into the harbour. The degradation of harbour and surrounding environment being a massive contributor to arising climate temperatures needed to be minimised. For this natural and increased ecological systems needed to be restored. By implementing methods of breathable and ecological habitats, site would be able to remove and filter any pollution and absorb inundation naturally. Its self-sustaining qualities provide an opportunity for site to become an absorbing body to flood inundations and retain it, being a crucial protective barrier site needed. In design, this can be seen through the implementation of a floodable park composition, that allows public to use and enjoy site, and in events of storms it can adapt to becoming an absorbing and mitigating system. Part of Centerport was proposed to be declaimed in order for this to function. Being the most vulnerable site too, allowed it to be the perfect host for mitigation. By absorbing inundations of flood at first contact.

The site design was also composed to allow maximum tidal and recreational movement. Tidal zones are known for producing great habitual ecologies such as oysters and snails that naturally filter out water. This allowed for breathable ecologies to produce and was maximised through site design in order to achieve this, as well as providing interactive public destination to be integrated aswell.

### Social Destination Points.

This was initially discovered and tested through hybrid ecologies. There a great potential seen in integrating engineered protective of social interactive functions. Site design displays an increased appreciation and connection to natural environments. This also was opportunity for public destination points to be integrated into the functions. Maximum public opportunity is displayed through design to allow public to enjoy qualities of a waterfront, while site can still function as a protective system.

### One Large Infrastructural System.

The key components of design deal with different ways of improving and restoring ecological habitats. These are all combined through public inventions and destination points to serve as one system that filtrates water and mitigates flood inundation.

### Permeable Residential Spaces.

Urbanisation and development is global issue with population wanting to live closer to urban centres within the last decade. It is an important criteria to work with, and adapt to the arising climate conditions. Mixed use residential and commercial development is proposed to be a central connecting feature within site. Through analysis it is found public destinations are more successful and more opportunity is created when there are physical drivers for people to want to go to an area. Within waterfronts this is largely restaurants and events that make an area more dynamic and utilised. The composition allows users to go to a destination and meander within the near area. People often then relax and gather around waterfronts where there is close access to facilities. Keeping this is mind the proposal for development is centrally placed within site, to draw users to the area, as well as easy connecting to regions of site. This allows flexible use of space and residential space to be easily connected to the urban area.

### Raised Seawall.

It is often found seawalls are perceived as negative contributors to the environment. Its static structure dominates areas and reduces interaction with coastal zones. It's however also commonly used for protection against waves and flooding, being one of the most effective structures to retain this. With the implications of rising sea levels proposed, raised seawalls are the first defensive system globally recognised to implement. Through design, opportunities have been created to push boundaries of a Seawall and provide more interactive spaces while being raised and protective at the same time. In order to protect site from sea inundation, the design shows a raised waterfront promenade as prevention. This subtle rise of the waterfront is intended to visually draw people into site, where the harbour can still be seen. This proposes an alternative suggestion for utilizing static sea wall structures that still provide interactive public opportunities and protection. Tidal steps have been implemented in design which draw users to the water edge and allow for interaction. Tidal zones such as tidal steps and pools are also great for habitats to generate, serving ecological purposes as well, while structural composed to be static.

## REFLECTION.

Future designs of cities are confronted with the issues climate change will bring. It is not noticeable to some people the effects urbanisation has upon the environment, though recent events in Wellington have implied what it is yet to come, and more if it. There is opportunity to act now, and reduce the impact urban development has had on environments. On reflection, the design process has enabled a better understanding of natural structures of landscapes. It has set criteria and allowed thesis design to become a model for future design to recognise natural values and appreciate landscapes that function and adapt to change.

This thesis considered the implications climate change could pose of Wellingtons urban waterfront. Being a site exposed to inundations of flooding and its current orientation as a mix of unused and industrial site, this became a good catalyst to test grounds of improved ecological and storm defensive system. Coming to the original thesis question of how can we integrate multifunction spatial design and coastal defence along vulnerable city waterfronts was through a successful study of social and ecological relationships that could be applied to site. The research question in itself posed two key topics, looking at the first section of how can we integrate spatial design, this was answered through understanding and testing the social and ecological hybrid technologies. There is a substantial reliance on improved ecological functions within this thesis, primarily because of its self-sustaining and low environmental impact this thesis wanted to achieve. There are numerous possibilities to designing with natural systems and planting that opens diverse ranges of function and social interaction, from formal intended design to informal spatial opportunities, having a successful impact on the social interaction with the harbour.

The second part of this questing looking into how we can integrate coastal defence has also been addressed through consistently critiquing the preexisting edge conditions the waterfront faces and developing soft and hard system technologies along with this. With spatial design it was crucial to engage people with the harbours edge, in doing this, the opportunity to design harbour edge protection and social use composed. Initially it was discovered, people interacting which these edge spaces was an indirect form of inclusion. This lesson has allowed for multi-use of space through informal and formal directed spaces that people can access while function as protective edge systems.

A component that was seen work to successfully within design was the system of a river body. This, through design process was studied and tested through forms multiple times order understand how a stream functions, how it can adapt to floods and deal with the intrusion of salt water in fresh water conditions and how it can include public activity. It was found successful through site analysis to look at historic stream compositions before Wellingtons streams were culverted for urban construction. Similar ideas were reflected through multiple historic streams in how it dealt with such issues, its raised vegetated edges stabilised and prevented high flood levels from spreading, low and new forming river corridors provided still water which cleaned water through native filtration plants. It was also understood that the less exposure areas had to human contact, the more prosperous areas became in increasing fauna and flora habitats that protected inland through its natural processes. This knowledge provided a strong aspect to integrate into design. Areas more prone to flooding and retaining water where intended to function without public interaction. Some areas allowed public interaction, and site adaptability to flooding would restrict this access at times.

A major finding with this thesis was the endless possibilities ecological and social parameters could develop upon. This wouldn't have to be a major design move, small interaction points would allow for this. Users would indirectly want to discover areas, which makes design very diverse for all social groups.

For a functioning industrial port to be designed with an active social and highly ecological landscape was a challenge, many things needed to be considered, foremost safety, and for this purpose it was considered cautious to exclude major port functions with site. There is however a lot of opportunity that could be provided for to function with full usability with this space. If there was extra time and room for development, this would be considered and possibly tested out through different strategies.

# 10

# Appendices.
CHAPTER TEN.

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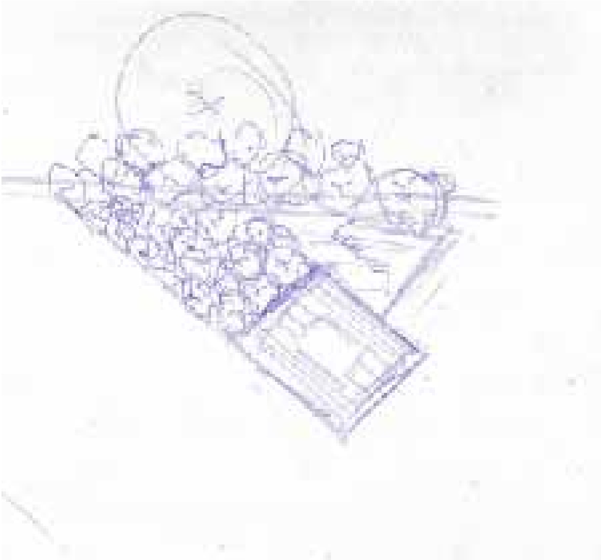

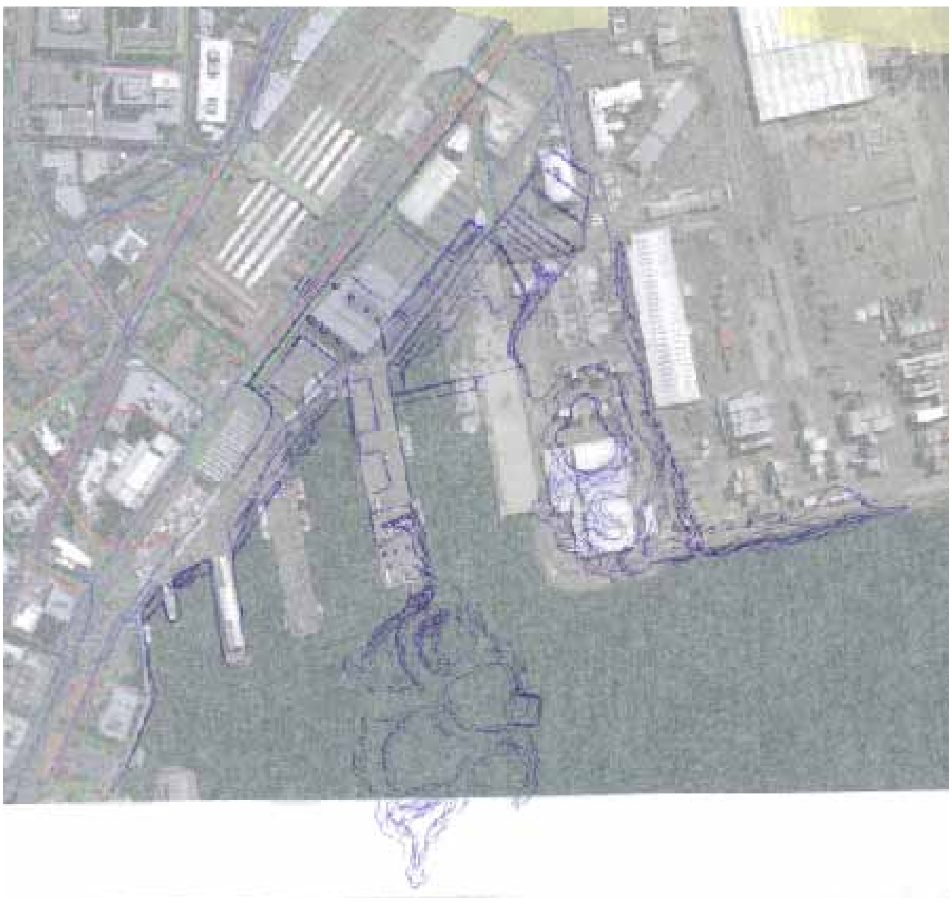

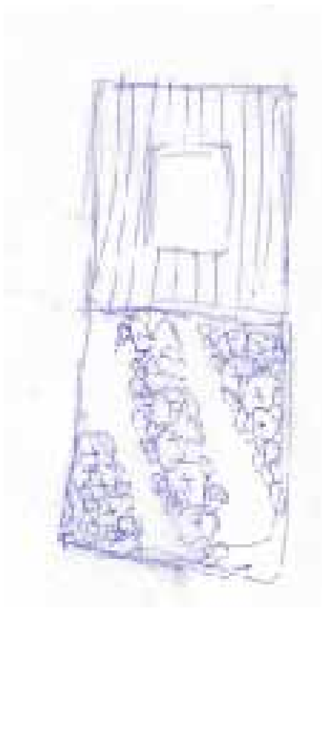

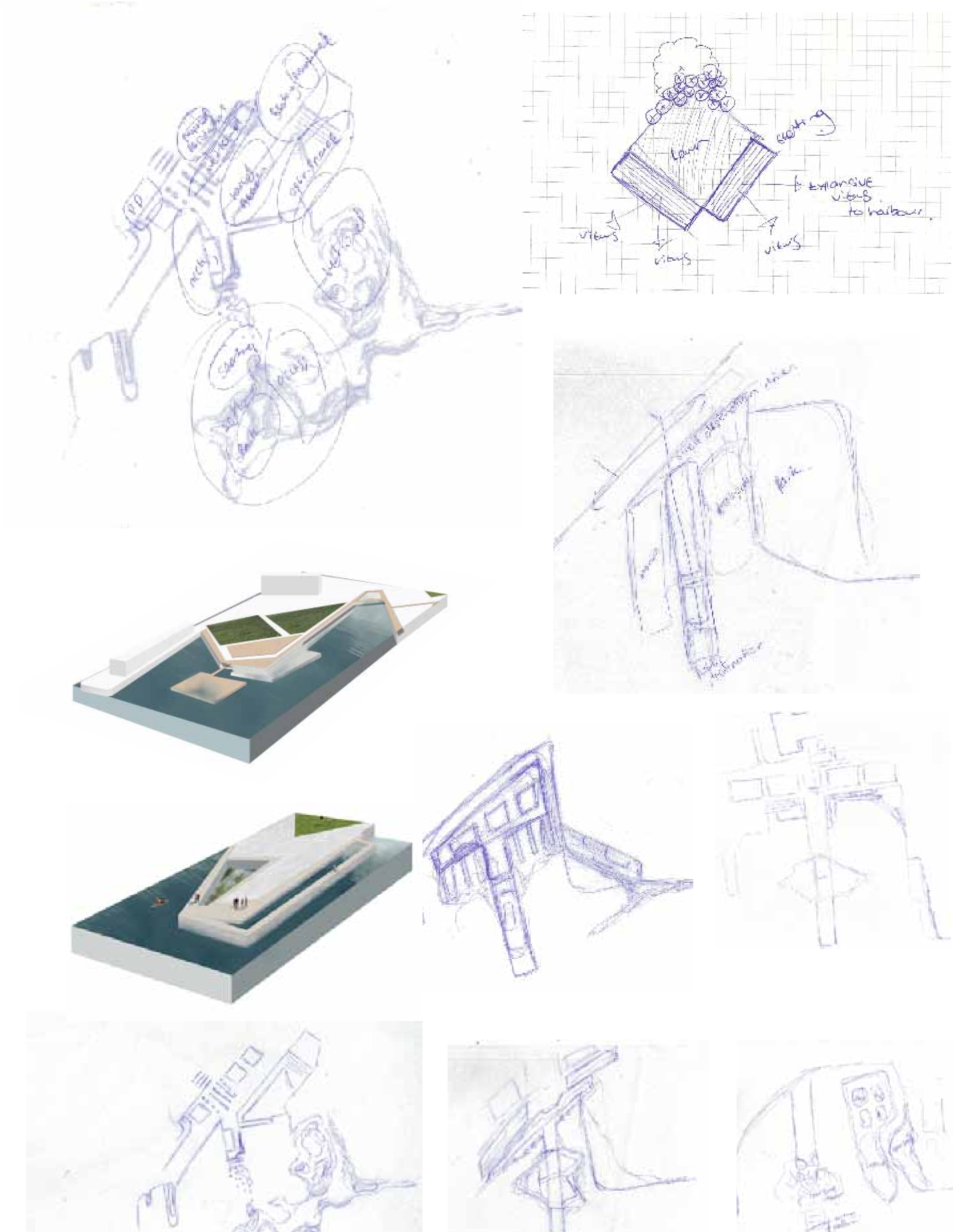


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